



GREENBOOK

adapting settlements for the future

Sedibeng District Municipality

Climate Change Adaptation Plan: Draft 1

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Abbreviations

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

WRYM	Water Resources Yield Model
WUI	Wildland-Urban Interface

Definitions

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

Risk	The potential for consequences [= impacts] where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard (DFFE, 2020, p. 11).
Hazard	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (DFFE, 2020, p. 11)..
Exposure	The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected (DFFE, 2020, p. 11).
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (DFFE, 2020, p. 11).
Sensitivity	Factors that directly affect the consequences of a hazard. Sensitivity may include physical attributes of a system (e.g. building material of houses, type of soil on agriculture fields), social, economic and cultural attributes (e.g. age structure, income structure) (DFFE, 2020, p. 11).
Coping Capacity	The ability of people, institutions, organisations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term (e.g., early warning systems in place) (DFFE, 2020, p. 11).

1. Introduction

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

The GreenBook was initially co-funded by the International Development Research Centre (IDRC) and the Council for Scientific and Industrial Research (CSIR), i.e., from 2016–2019, and in partnership with the NDMC. With more partners coming on board since 2019 to support further research and development, and the roll-out and uptake of the GreenBook. More recently, Santam, the Climate and Disaster Resilience Fund (CDRF), and the CSIR established the GreenBook Roll-out Initiative to facilitate the uptake of the GreenBook and support resilience-building within local government. The initiative aims to roll out the GreenBook to 32 DMs by 2025 by supporting each District's climate change response and adaptation planning and implementation efforts through the GreenBook. Each of the Districts targeted for support is guided along a value-chain towards the implementation of climate change response and adaptation plans in municipalities (See [Error! Reference source not found.](#) below). Thus, in fulfilment of steps four and five, each target DM is provided with a draft GreenBook Climate Risk Profile report, as well as a draft Climate Change Adaptation Plan.

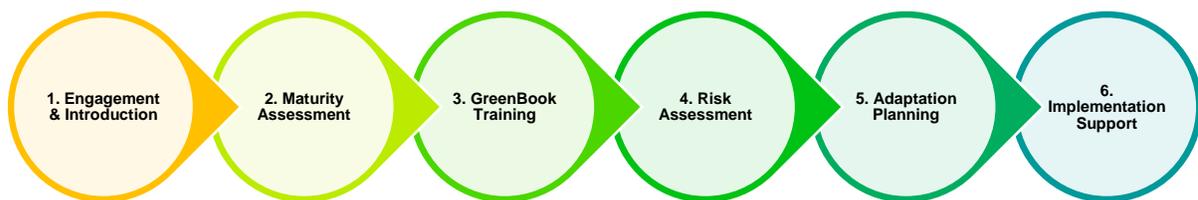


Figure 1: The value-chain towards the implementation of climate change response and adaptation in municipalities.

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

- Build and further the climate change response agenda,
- Inform strategy and planning in the district and local municipalities,
- Identify and prioritise risks and vulnerabilities,
- Identify and prioritise interventions and responses, and
- Guide and enable the mainstreaming of climate change response, particularly adaptation.

1.1. Municipal Context

Sedibeng District Municipality, a vibrant and culturally diverse region, is nestled in the southern portion of Gauteng, South Africa. Bordered by the Free State, North West, and Mpumalanga provinces, the district interfaces with Gert Sibande (Mpumalanga), Fezile Dabi (Free State), and Dr Kenneth Kaunda (Northwest) districts.

Sedibeng District is home to three Local Municipalities: Emfuleni, Lesedi, and Midvaal. It hosts several towns, including Vereeniging, Vanderbijlpark, Meyerton, and Heidelberg, and various townships such as Evaton, Sebokeng, Boipatong, Bophelong, Sharpeville, Nigel, and Devon. As of the last count, the district houses a population of approximately 1,039,908 people, which constitutes 1.80% of South Africa's total population. Notably, the district's population grew by 1.40% between 2011-2016 and increased by 1.60% between 2016-2019.

The district contributes significantly to the regional economy, with the Manufacturing Sector leading the way and accounting for 23.80% of the total Gross Value Added (GVA), equating to approximately R17.4 billion. The Community Services Sector follows closely behind at 23.70%, trailed by the Finance Sector at 20.50%. The Agriculture Sector, despite its substantial role in local livelihoods and food security, contributes the least to the regional economy.

The biophysical environment of Sedibeng is both diverse and abundant. It is marked by open grassland, wetland ecosystems, and numerous nature reserves, including the Suikerbosrand Nature Reserve, one of the largest in Gauteng. The Vaal River, a major South African water body, graces the district, serving as a vital source for domestic use, irrigation, and industry. Moreover, the Vaal Dam, located within the district, is one of the country's largest dams, providing water far beyond the district's borders. The high concentration of people and industrial development lead to several environmental challenges within the District, such as loss of biodiversity, water and air -quality, and encroachment on sensitive habitats.

However, Sedibeng faces mounting climate change challenges, such as increasing temperatures, irregular rainfall patterns, and potentially extreme weather events. These climatic shifts risk impacting the district's water resources, biodiversity, agriculture, and industry, potentially exacerbating existing socio-economic challenges.

1.1.1. Key Risks

Sedibeng District Municipality's climate risk profile underscores four fundamental areas: drought, heat, wildfires, and flooding.

Drought exposure in Sedibeng is relatively low, with no settlements in the district identified as high risk. Present data shows some minor exposure to drought tendencies in the eastern part of the district, though these are projected to decrease by 2050. This suggests that drought is not a significant climate risk for Sedibeng now or in future projections. However, an extended dry period could still impact water supply, agriculture, and local flora, highlighting the importance of water management and conservation strategies.

The wildfire risk varies across the district. Heidelberg, Vaal Marina, Sebokeng, Sharpeville, Boipatong, Vanderbijlpark, Vereeniging, Evaton, and potentially Meyerton are identified as wildfire-prone regions. Projections indicate high future wildfire risks for Vanderbijlpark, Sharpeville, Boipatong, Vereeniging, and Heidelberg, while Sebokeng, Evaton, Meyerton, and Vaal Marina have a moderate risk. Wildfires can result in loss of life, damage to infrastructure, loss of biodiversity, and soil erosion, underlining the necessity of localized wildfire response and management strategies.

Flooding also presents a significant risk to the district. The flood hazard index across the district indicates a medium to high risk, with pockets of very high risk. Under a worst-case greenhouse gas emissions scenario (RCP 8.5 low mitigation), Heidelberg and Walkerville could face increased flooding risks. Slight to significant increases in extreme rainfall days are expected in the district's eastern parts, especially Lesedi Local Municipality, signalling a potential increased future flood risk. Flooding can disrupt infrastructure, displace communities, and damage agricultural lands, highlighting the importance of flood risk management.

Heat risk, predominantly low across all settlements and very low in Vaal Marina, is projected to increase due to climate change. The urban heat island effect could render built-up urban areas particularly vulnerable to high temperatures. While the district experiences between 0 and 2 very hot days per annum currently, future projections anticipate an increase in very hot days, particularly in the western half of the district. Rising temperatures can exacerbate health issues, strain energy resources, and negatively impact agriculture, pointing to the need for heat adaptation measures in their adaptation approach.

1.1.2. Adaptation Goals and Priorities

Given the escalating climate risks and impacts in Sedibeng, a focused approach with clearly defined adaptation goals is paramount. These goals offer a broad framework to guide the region's long-term vision and action to mitigate climate change.

The proposed adaptation goals in response to the climate risks and impacts in Sedibeng are:

1. Ensure water security under a changing climate: With South Africa grappling with water scarcity, it is crucial that Sedibeng invests in comprehensive water resource management. This involves maintaining and upgrading water infrastructure, promoting water conservation practices, implementing rainwater harvesting systems, and exploring alternative water sources such as groundwater and wastewater reuse.
2. Protect natural resources and ecosystems: The conservation and restoration of natural ecosystems, like wetlands and riparian areas, is vital. These ecosystems enhance biodiversity, support water management, and act as natural buffers against climate-related hazards such as wildfires.
3. Develop effective flood management strategies: Sedibeng should establish robust flood management strategies to mitigate the risks associated with heavy rainfall events. This includes improving stormwater drainage systems, developing floodplains and retention basins, and setting up flood early warning systems to safeguard vulnerable communities and infrastructure.
4. Reduce vulnerability and exposure of human and natural systems to climate change and extreme events: Prioritizing the needs of vulnerable populations, such as low-income communities and informal settlements, is vital in ensuring that they are not disproportionately affected by climate change. This can be achieved by ensuring access to basic services, improving housing conditions, and implementing early warning systems tailored specifically to these communities.

By implementing these adaptation goals, Sedibeng can constructively respond to the pressing climate risks and impacts and build resilience for both human and natural systems in the region.

1.2. Outline of the Climate Change Adaptation Plan

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

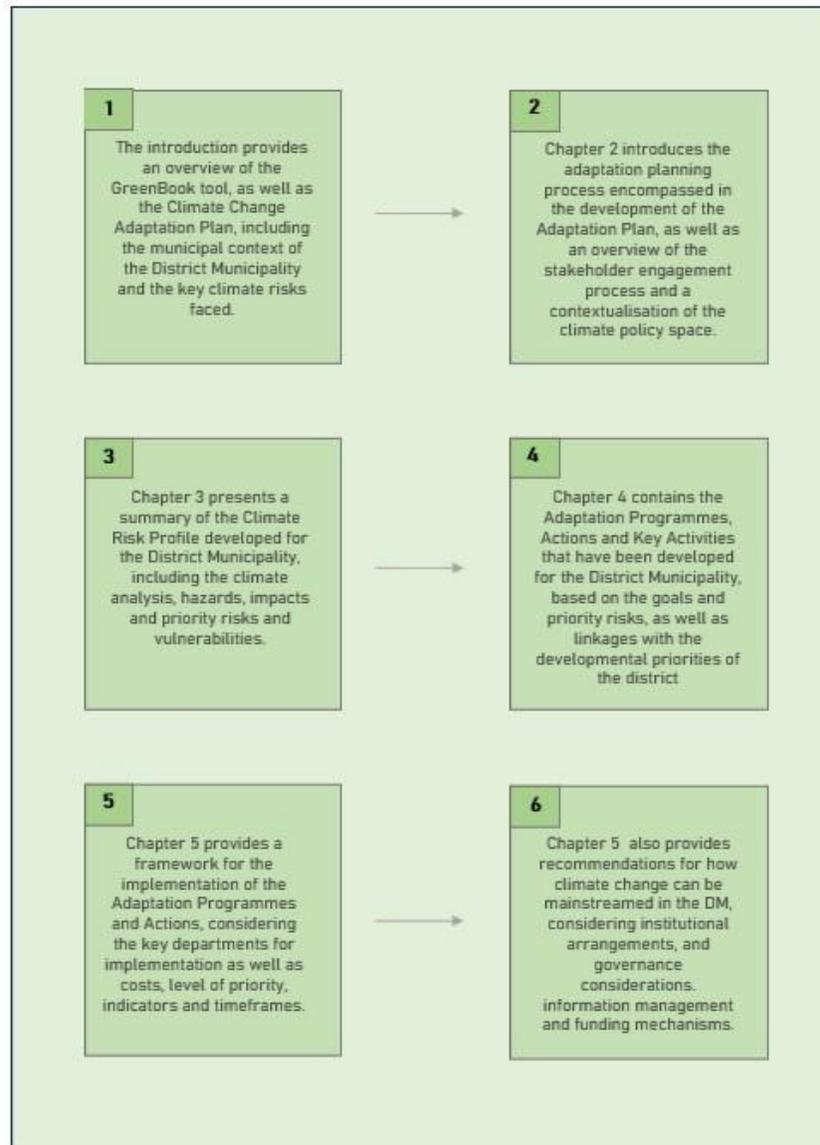


Figure 2: Outline of the climate change adaptation plan.

2. Climate Change Response

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

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

Climate change actions can either fall into one of these two broad categories, or they can encompass co-benefits of both adaptation and mitigation and fall into both categories. Adaptation and mitigation go hand-in-hand in terms of responding to the climate crisis. Mitigation encompasses the reduction of greenhouse gas emissions to curb global warming to 1.5 compared to pre-industrial levels, a target set by the Paris Agreement. Mitigating the causes of climate change is imperative as the rise in temperatures will worsen climate hazards, impacting health, livelihoods, food security, water supply, human security, and economic growth. Climate change adaptation entails altering our behaviour, systems, and ways of life to protect communities, economies, and the environment in which we live from the impacts of climate change. Climate change has resulted in changes in average temperatures, shifts in seasonality as well as increased frequency of extreme weather events. Climate change adaptation and mitigation are both equally important and time-sensitive and we need to do both. The more we reduce emissions right now, the easier it will be to adapt to the changes we can no longer avoid. Generally, the distinction is made between adaptation approaches, namely anticipatory or reactive adaptation. Anticipatory adaptation refers to acting in preparation for climate change. Reactive adaptation refers to acting when climate change effects are experienced. Future climate trends remain uncertain, highlighting the need for a flexible response and the development of adaptation strategies for the medium and long term. It also follows that adaptation will require greater consideration of local context compared to mitigation strategies.

2.1. Integrated Climate Change Response

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

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

- Facilitate the implementation of climate change response measures within existing sector plans and budgets; and
- Balancing the incremental costs with the municipal development objectives and the economic, environmental, and social benefits produced through integrated climate change response.

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

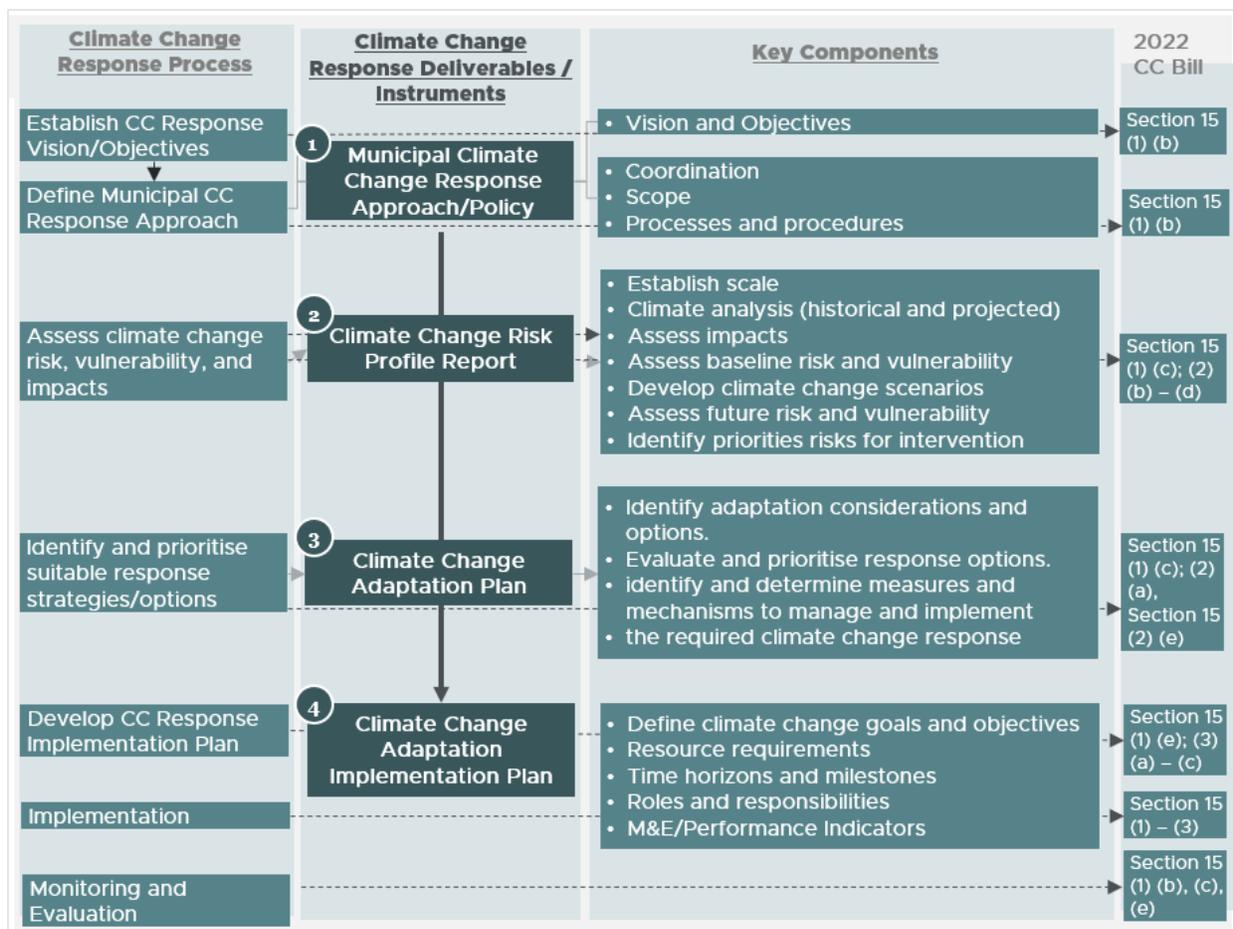


Figure 3: The municipal climate change response process (Brink and Modack, 2022).

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

2.2. Adaptation Approach

The approach framing climate change adaptation in the GreenBook and in this plan is centred around reducing climate-related risk. Climate-related risk implies the potential for adverse consequences resulting from the interaction of vulnerability, exposure, and the occurrence of a climate hazard (Figure 4). *“Relevant adverse consequences include impacts on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services, ecosystems and species)”* (Chen, et al., 2021, p. 64).

Climate change adaptation aims to reduce climate-related risks by adjusting a system to the actual or anticipated climate and seeking *“to moderate or avoid harm [and] exploit beneficial opportunities”* (IPCC, 2022a, p. 2898) that may derive from unavoidable impacts of climate change

such as extreme hazards. Through climate change adaptation, the components that make up risk can be reduced, including exposure and vulnerability. Climate change adaptation consists of measures that range from providing social protection after disasters, to retrofitting habitats or settlements with more resilient infrastructure, protecting coastlines from flooding, securing water resources to rely on during periods of drought, and improving crop production for dryland farming, among others. Although disaster risk reduction and climate change mitigation, form part of the overall climate change response agenda, the focus of this plan is on adaptation.

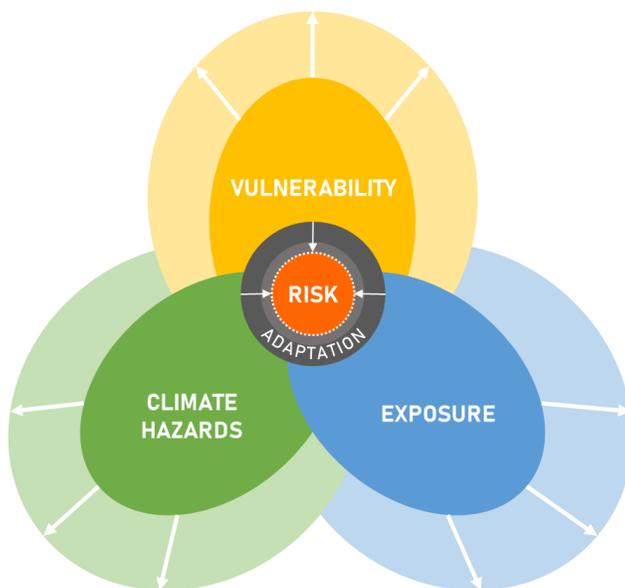


Figure 4: The interaction between the various components of risk, indicating the opportunity to reduce risk through adaptation (based on IPCC, 2014 and IPCC, 2021)

Adaptation planning uses the basis of spatial planning and climate change adaptation to shape built-up and natural areas to be resilient to the impacts of climate change and to realise co-benefits for long-term sustainable development to address root causes of vulnerability and exposure to risk. The process of climate change adaptation and planning is set out in Table 2.

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

Table 1: The Adaptation Planning Process

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

2.2.1. Stakeholder Engagement Process

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

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

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

Collectively, the stakeholder engagement process offered a platform to interact with District stakeholders, promoting a more profound comprehension of the DM's context. Feedback gleaned from these engagement procedures has been deliberated upon and woven into the draft Climate Change Adaptation Plan.

2.3. Policy Context

2.3.1. National Policy Context

South Africa's institutional policy and legislative framework make provision for climate change adaptation at all levels of government, with local governments increasingly identified as the primary drivers of climate change adaptation. For instance, there exists various national policy and legislative mechanisms that promote, necessitate, guide and/or regulate climate change adaptation at the local level. These include the Disaster Management Amendment Act of 2015, the Spatial Planning and Land Use Management Act (SPLUMA) of 2013, the Climate Change Bill (B9 of 2022), the 2011 National Climate Change Response White Paper, as well as the 2019 National Climate Change Adaptation Strategy.

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

change response needs and draft resultant climate change response assessments and implementation plans.

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

The table that follows presents a summary of both international and national policy instruments relevant to climate change mitigation and adaptation. These policy instruments range from the United Nations Framework Convention on Climate Change (UNFCCC), which governs global action against climate change, to the South African National Climate Change Adaptation Strategy (NCCAS), aimed at enhancing the country's ability to meet its obligations under the Paris Agreement on Climate Change. Other key international instruments include the International Carbon Action Partnership (ICAP), the Sustainable Development Goals (SDGs), and the Convention on Biological Diversity. On the national front, the instruments such as the Climate Change Bill, the National Development Plan (NDP), the National Climate Change Response Policy (NCCRP), the National Environmental Management Act (NEMA), and the Amended Disaster Management Act are discussed. Each of these policy instruments plays a crucial role in shaping climate change response strategies, establishing frameworks for low-carbon, climate-resilient economies, and ensuring environmental sustainability while promoting socio-economic development.

Table 2: International and National Policy Context

International	
United Nations Framework Convention on Climate Change (UNFCCC)	The UNFCCC is the primary multilateral global treaty governing actions to combat climate change through adaptation and mitigation efforts.
International Carbon Action Partnership (ICAP)	The ICAP is an international forum for governments and public authorities that have implemented or are planning to implement carbon trading systems (ETS).

United Nations Sustainable Development Goals (SDGs)	The SDGs are a universal call to action consisting of 17 goals to end poverty, protect the planet and improve the lives and prospects of everyone globally.
Sendai Framework for Disaster Risk Reduction	This framework aims to substantially reduce disaster risk and losses in lives, livelihoods and health in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years.
Nationally Determined Contribution (NDC)	The Paris Agreement requests each Country to outline and communicate their post-2020 climate actions, known as their NDCs. NDCs embody efforts by each Country to reduce national emissions and adapt to the impacts of climate change.
Convention on Biological Diversity	The Convention on Biological Diversity is an international treaty designed to promote biodiversity conservation and ensure the equitable sharing of genetic resources.
National	
Climate Change Bill (2022)	The Climate Change Bill aims to enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development and to provide for matters connected in addition to that.
South Africa Low Emission Development Strategy 2050 (2020)	The South Africa Low Emissions Development Strategy (SA LEDS) aims to succinctly build upon this foundation and articulate the path going forward in order to place the country on a low carbon trajectory, while at the same time ensuring broader socio-economic development.
National Development Plan Chapter 5: "Transition to Low-Carbon Economy"	The NDP aims to eliminate poverty and reduce inequality by 2030. According to the Plan, South Africa can realise these goals by drawing on the energies of its people, growing an inclusive economy, building capabilities, enhancing the state's capacity, and promoting leadership and partnerships throughout society. Chapter 5 of the NDP outlines ensuring environmental sustainability and an equitable transition to a low-carbon economy.
National Climate Change Adaptation Strategy (2020)	South Africa's National Climate Change Adaptation Strategy (NCCAS) supports the Country's ability to meet its obligation in terms of the Paris Agreement on Climate Change.

National Climate Change Response Policy	The NCCRP supports the national vision for a successful climate change response and long-term shift towards a lower-carbon and climate-resilient economy and society. It aims to manage efficiently climate change impacts through strategies that build and sustain South Africa's social, economic and environmental resilience, and the second is to stabilise greenhouse gas concentrations in the atmosphere.
National Environmental Management Act (NEMA)	The NEMA Act 107 of 1998 intends to provide for cooperative environmental governance by establishing principles for decision-making on matters affecting the environment. In addition, these institutions will promote cooperative governance and procedures for coordinating environmental functions by organs of state.
Just Transition Framework	This framework is a planning tool for achieving a just transition in South Africa, setting out the actions that the government and its social partners will take to achieve a just transition and the outcomes to be realised in the short, medium, and long term.
Disaster Management Act (2002)	The Disaster Management Act of 2002 provides for an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery, including climate-related disasters.
Integrated Coastal Management Act (2008)	The ICM Act sets out a new approach to managing the nation's coastal resources to promote social equity and make best economic use of coastal resources, whilst protecting the natural environment.
National Veld and Forest Fire Act (1998)	The purpose of this Act is to prevent and combat veld, forest and mountain fires throughout the Republic and to provide for a variety of institutions, methods and practices for achieving this purpose.

2.3.2. Desired Adaptation Outcomes

The development of Desired Adaptation Outcomes (DAOs) is a crucial objective that informs and directs the monitoring and evaluation of South Africa's progress towards a climate-resilient society. These DAOs are derived from sector-specific adaptation priorities, as outlined in Chapter 5 of the National Climate Change Response White Paper (NCCRWP). To establish these outcomes, consultative sessions have been held with various departments including the Department of Environmental Affairs (Biodiversity branch), Department of Water and Sanitation (DWS), Department of Health (DOH), Department of Human Settlements (DHS), and the National Disaster Management Centre. During these consultations, the proposed DAOs were widely

accepted. It is recommended that the SDM engages with the DAO figure below in the implementation and mainstreaming of the Climate Change Adaptation Plan

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

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

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

2.3.3. Local Policy Context

Situated within the larger context of South Africa's national climate change initiatives, the Sedibeng District Municipality reflects the nation's commitment to actively confront climate change and its associated challenges. In adherence to South Africa's obligations as a signatory to the Paris Agreement and a participant in the United Nations Framework Convention on Climate Change, Sedibeng has structured its local policy to align with the objectives outlined in South Africa's 2011 National Climate Change Response Policy (NCCRP) and the first National Development Plan (2012). These landmark documents, steeped in a vision for a climate-resilient, lower-carbon economy and society, mandate a crucial role for provincial and local government entities, pushing them to the forefront of climate change response implementation. As custodians of planning and development, infrastructure and services, disaster response, energy, water, and waste demand management, these local spheres are expected to echo national strategies in their local programs and policies.

In line with this expectation, Sedibeng District Municipality pioneered its Climate Change Response Plan in 2016. The plan encapsulates an exhaustive vulnerability risks assessment, focusing on sectors like agriculture, biodiversity, environment, human health, human settlement, and water, taking into account parameters like exposure, adaptive capacity, and sensitivity. This meticulous analysis underscores Sedibeng's commitment to its residents and the environment, embodying the principles of the national government's climate response plans. Moreover, the district has formulated the Sedibeng District Municipality Climate Change Mitigation Strategy and expressed a determined intention to prioritize climate change, bolster the agriculture sector, and spur job creation through township revitalization and the implementation of a green economy agenda. The evolution of these policies is a testament to Sedibeng District's unflinching commitment to climate resilience and sustainable development.

2.4. District Municipality Responsibilities

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

1. **Climate change planning:** District municipalities are responsible for developing and implementing climate change adaptation plans at the local level. These plans are required to assess the vulnerability of the district to climate change impacts and outline strategies and actions to minimize risks and enhance resilience.
2. **Infrastructure development:** District municipalities are tasked with planning and coordinating the development of infrastructure. Infrastructure should be developed to be resilient to climate hazards as well as support resilience objectives as part of an integrated climate change adaptation approach. This includes the construction of climate-resilient roads, bridges, and drainage systems that can withstand extreme weather events and reduces risk to vulnerable assets and communities.
3. **Natural resource management:** District municipalities are responsible for managing natural resources within their jurisdiction to support climate change adaptation. This involves conserving and protecting ecosystems, such as wetlands and forests, that provide a natural defence against climate impacts like flooding and erosion.
4. **Disaster risk reduction:** District municipalities have key responsibilities in disaster risk reduction, including preparedness, response, and recovery. They should play a role in establishing early warning systems, emergency response plans, and coordinate efforts with other local government entities, provincial authorities, and national disaster management agencies.
5. **Stakeholder engagement:** District municipalities facilitate stakeholder engagement processes to raise awareness about climate change adaptation and involve local communities, NGOs, businesses, and other relevant actors in decision-making

processes. They often collaborate with local organizations to implement climate change adaptation projects and programs.

6. Capacity building and training: District municipalities are responsible for building capacity and providing training to local government officials, communities, and relevant stakeholders on climate change adaptation. This helps enhance their knowledge and skills in implementing climate-resilient practices and technologies.
7. Monitoring and evaluation: District municipalities monitor the progress of climate change adaptation initiatives and evaluate their effectiveness. They collect data, measure key performance indicators, and assess the success of implemented strategies to ensure that adaptation measures are delivering the desired outcomes.

It is important to note that while district municipalities have a range of powers and functions related to climate change adaptation, collaboration with other levels of government, such as provincial and national authorities, is also crucial for effective climate action and coordination of resources and policies.

2.4.1. Power and Functions of the District Municipality

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

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

- a) Integrated development planning for the district municipality as a whole, including a framework for integrated development plans of all municipalities in the area of the district municipality.
- b) Potable water supply systems.
- c) Bulk supply of electricity, which includes for the purposes of such supply, the transmission, distribution and, where applicable, the generation of electricity.
- d) Domestic waste-water and sewage disposal systems.
- e) Solid waste disposal sites, in so far as it relates to—
 - i. the determination of a waste disposal strategy;
 - ii. the regulation of waste disposal;
 - iii. the establishment, operation and control of waste disposal sites, bulk waste transfer facilities and waste disposal facilities for more than one local municipality in the district.
- f) Municipal roads which form an integral part of a road transport system for the area of the district municipality as a whole.
- g) Regulation of passenger transport services.

- h) Municipal airports serving the area of the district municipality as a whole.
- i) Municipal health services.
- j) Fire-fighting services serving the area of the district municipality as a whole, which includes—
 - i. planning, co-ordination and regulation of fire services;
 - ii. specialised fire-fighting services such as mountain, veld and chemical fire services;
 - iii. co-ordination of the standardisation of infrastructure, vehicles, equipment and procedures;
 - iv. training of fire officers.
- k) The establishment, conduct and control of fresh produce markets and abattoirs serving the area of a major proportion of the municipalities in the district.
- l) The establishment, conduct and control of cemeteries and crematoria serving the [district as a whole] area of a major proportion of municipalities in the district.
- m) Promotion of local tourism for the area of the district municipality.
- n) Municipal public works relating to any of the above functions or any other functions assigned to the district municipality.
- o) The receipt, allocation and, if applicable, the distribution of grants made to the district municipality.
- p) The imposition and collection of taxes, levies and duties as related to the above functions or as may be assigned to the district municipality in terms of national legislation.

3. Summary of Climate Risk Profile

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

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

3.3. Overview of Baseline and Future Climate Risk.

As part of the Sedibeng Adaptation Plan, the articulation of the climate context was informed by an integrated ensemble of six Coupled Model Intercomparison Project Phase 5 (CMIP5) General Circulation Models (GCMs). These sophisticated computational tools have been instrumental in developing both baseline and future climate change scenarios, providing comprehensive projections for Representative Concentration Pathways (RCP) 4.5 and 8.5.

To ensure a more detailed and geographically precise understanding of Sedibeng's climate scenario, a process of downscaling was undertaken. This crucial step involved the application of the Conformal-Cubic Atmospheric Model (CCAM), a regional climate model that aids in refining the granularity of the climate analysis. Utilising CCAM, projections from the GCMs, initially at a 50km resolution, were downscaled to a more refined 8km resolution. This granular perspective empowers us with an in-depth understanding of the district's climate dynamics at a microscale, vital for informed, place-specific adaptation strategies.

The temporal scope of our climate analysis spans significant periods, both historical and prospective. The baseline period encapsulates historical climate data from 1961 to 1990, offering a robust foundation upon which to assess climatic trends and anomalies. Looking to the future, the analysis then projects into the forthcoming era, covering 2021 to 2050. This forward-thinking perspective allows us to incorporate anticipated climatic changes into our adaptation plan, ensuring Sedibeng's resilience in the face of climate change's unfolding challenges.

3.3.1. Climate Analysis

4.4.1.1. Average Temperatures

The thermal profile of the Sedibeng District reflects an interplay of various geographical and climatic factors, leading to the current average annual temperatures that range between 16 °C

and 20 °C. The spatial distribution of these temperatures illustrates the presence of localized thermal microclimates within the District. Higher average temperatures are particularly characteristic of the Emfuleni Local Municipality and certain parts of the Midvaal Local Municipality, both located in the western region of the District.

Looking towards the future, our climate projections anticipate a marked warming trend under a low mitigation scenario. By 2050, average annual temperatures across the District are projected to rise by 1.932 °C to 3.183 °C. This pronounced escalation in temperature constitutes a significant climatic shift, which will have consequential impacts on both the natural and human systems within Sedibeng.

4.4.1.2. Rainfall

The present hydro-climatic conditions of Sedibeng District yield an average annual rainfall of approximately 1000 mm. This average, however, conceals the variability across the district, with pockets such as Vaal Marina in Midvaal receiving notably higher annual rainfall, currently estimated at around 1600 mm. While this figure appears remarkably high for this region, it emphasizes the heterogeneity of rainfall distribution across the District.

Looking into the future, our projections under a low mitigation scenario - essentially a "business as usual" approach with respect to greenhouse gas emissions - point to changes in the district's hydrological cycle. By 2050, we anticipate an average annual rainfall change that varies between 12 mm less and 188 mm more across the District. This change, whether an increase or decrease, will undoubtedly have significant implications on water availability and associated sectors such as agriculture and water resource management.

Moreover, this projected rainfall alteration exhibits distinct spatial patterns. Increases in rainfall are projected across all three Local Municipalities, suggesting a more pluvial future for these regions. However, a slight reduction in annual rainfall is anticipated in the northern corner of Lesedi. This spatial heterogeneity underscores the need for nuanced, locally tailored adaptation strategies to effectively manage and harness the district's evolving hydro-climatic future.

3.3.2. Climate Hazards

A summary of the climate hazards is included below:

4.4.2.1. Drought

In the realm of drought dynamics, a spatial pattern emerges within the Sedibeng District Municipality, particularly when comparing the periods 1986 – 2005 (baseline) and 1995 – 2024 (initial future). The eastern sectors of the district present higher drought tendencies when

contrasted with the western territories of the municipality. This variation in drought predisposition adds an additional layer of complexity to the district's climate profile and highlights the need for differentiated drought management strategies based on geographical location within the district.

Future projections hint at an intriguing shift in these trends. As we progress further into the future, the increase in drought tendency that we currently observe in the eastern areas appears to flatten out, effectively reducing the drought tendency increase to zero. Conversely, in the western areas, the drought tendency appears to wane, implying a gradual relief from the scarcity imposed by reduced rainfall. While these projections bring some comfort, it is essential that these changes are meticulously monitored, and adaptation strategies are dynamically adjusted to align with these evolving drought dynamics.

4.4.2.2. Heat

During the baseline reference period (1961 - 1990), the Sedibeng District Municipality experienced an annual frequency of very hot days that ranged between 0 and 2 across the district. Though these figures merit further validation, they provide a preliminary understanding of the district's exposure to extreme heat conditions during this period.

As we navigate towards a future marked by a changing climate, a distinct shift in this thermal trend is discernible. Projections reveal an intensifying pattern of very hot days. The eastern half of the district is expected to witness a moderate increase of 0 to 10 additional very hot days per annum. This increase escalates to between 11 and 20 more very hot days per annum in the western half of the district, implying a more pronounced shift in thermal extremes.

Heatwave days during the baseline period ranged from 0.2 to 5 annually, exhibiting a greater likelihood of occurrence in the district's western regions. Despite the increased frequency of very hot days, the overall heat risk remains mostly low across all settlements, with the Vaal Marina displaying a notably very low risk. However, the increasing trend of very hot days is a cause for vigilance. The district must be prepared to adapt to these changes, even in areas of lower risk, and ensure that mitigation measures and emergency response plans are suitably primed for an environment that is progressively getting hotter.

4.4.2.3. Wildfire

The wildfire risk within the Sedibeng District Municipality is gauged by a comprehensive combination of elements. This includes the typical fire hazard associated with a specific fire-ecotype - encapsulating factors like the likelihood of a wildfire occurrence and its potential severity - and the socioeconomic repercussions, which pertain to the possible economic and social losses resulting from such an event.

Several settlements within the district are perched on the wildland-urban interface, which can be seen as an intersection between human settlements and undeveloped wildland. This positioning could make these areas particularly susceptible to wildfires. Such settlements encompass Heidelberg, Vaal Marina, Sebokeng, Sharpeville, Boipatong, Vanderbijlpark, Vereeniging, and Evaton, with Meyerton also identified as having potential wildfire risk.

Future projections indicate a divergent pattern of wildfire risk among these settlements. It is anticipated that Vanderbijlpark, Sharpeville, Boipatong, Vereeniging, and Heidelberg may face an escalating threat level, placing them in the high-risk category for future wildfires. Conversely, the future risk for Sebokeng, Evaton, Meyerton, and Vaal Marina is projected to fall into the moderate category. These varying wildfire risk trajectories underscore the need for nuanced, site-specific wildfire management strategies within Sedibeng's broader climate adaptation plan.

4.4.2.4. Flooding

Evaluating the flood hazard within the Sedibeng District Municipality requires the meticulous integration of multiple sources of information. This includes not only climate data but also the analysis of historical flood events and an understanding of the specific characteristics of water catchments that make them more or less susceptible to producing a flood.

The flood hazard index across the district is variable, suggesting a diverse range of flood risk across different areas. A large portion of the district falls within the medium to high flooding hazard risk categories. However, there are certain pockets in the central and northern regions of the district that present a very high flooding hazard risk.

The district is also expected to experience changes in the number of extreme rainfall days. The eastern part of the district is projected to see a slight decrease in these events. Conversely, the western region, and particularly the Lesedi Local Municipality, can anticipate a slight to significant increase in extreme rainfall days. This shift in precipitation patterns could potentially amplify the risk of flooding in these areas.

Considering the future scenario under RCP8.5, which represents high greenhouse gas emissions, certain settlements are expected to face an increased risk of flooding. These include Heidelberg and Walkerville. This analysis underscores the need for strategic flood risk management and adaptation planning to mitigate potential damage and disruption.

3.3.3. Climate Impacts

4.4.3.1. Water Resources

In the broader South African context, groundwater has established itself as a crucial asset, significantly contributing to economic development and ensuring water security for various rural and urban settlements. These communities often rely partially or entirely on groundwater supply. The availability and distribution of this natural resource are strongly dictated by climate variability and change. Yet, it's important to note that in Sedibeng District Municipality, none of the three Local Municipalities are categorized as groundwater-dependent. Despite the significant role of groundwater, no maps were available that illustrate groundwater recharge, projected changes, or risk of depletion in this report.

As the table below illustrates, the present vulnerability of the municipality's water supply is relatively low. However, looking forward, both Lesedi and Midvaal Local Municipalities could see a rise in vulnerability due to projected population increases, placing additional pressure on their water resources.

Table 3: Current water supply and vulnerability across Sedibeng District Municipality.

Local Municipality	Water Demand per Capita (l/p/d)	Water Supply per Capita (l/p/d)	Current Water Supply Vulnerability
Emfuleni	311.34	311.34	1.0
Lesedi	488.64	663.28	0.74
Midvaal	537.10	671.37	0.8

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

4.4.4.2. Sectors

Within the diverse economic structure of Sedibeng District Municipality, the Agriculture, Forestry and Fishing (AFF) sector contributes modestly to the local Gross Value Added (GVA), accounting for only 1.08% as per the most recent figures from the Cooperative Governance and Traditional Affairs Department (CoGTA, 2020). Despite this relatively minor contribution, the sector holds a critical role in supporting local livelihoods and food security.

Predominant agricultural commodities in the District Municipality encompass maize, beef cattle, chickens, and chicken eggs, each of which has unique vulnerabilities and potential benefits from future climate conditions.

The projected climate scenario for Sedibeng District Municipality is expected to evolve towards a hotter and wetter future, eliciting a myriad of consequences across the AFF sector.

The warmer, more humid conditions could potentially stimulate an increase in maize yields in the near term, adding a welcome boost to this significant sector. However, these anticipated climatic benefits must be understood in a temporal context. As we extend our gaze into the long-term future, a picture of uncertainty emerges. The projected rise in heat stress, induced by

increasing temperatures, may indeed yield negative impacts on maize production, potentially offsetting any initial gains.

Similarly, for the beef cattle sector, the forecast of a hotter and moister climate holds serious implications. These conditions are conducive to the heightened propagation of diseases and parasites, which can severely impinge upon the growth and reproductive performance of beef cattle. This scenario necessitates targeted interventions to safeguard the health and productivity of these livestock populations. Poultry farming, particularly chicken production, also stands to face significant challenges from escalating heat stress. High temperatures can inflict adverse effects on bird health and well-being, while simultaneously driving up the operational costs needed to maintain suitable temperature conditions. These potential impacts underscore the importance of building adaptive capacity within the sector to ensure its resilience against future climate shifts.

3.3.4. Priority Risks and Vulnerabilities

4.4.4.1. Municipal

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

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

Table 4: Vulnerability indicators across Sedibeng District Municipality.

LOCAL MUNICIPALITY	SEVI 1996	SEV 2011	Trend	EcVI 1996	EcVI 2011	Trend	PVI	Trend	EnVI	Trend
Emfuleni	2.77	2.82	↗	5.80	7.96	↗	4.20	n/a	5.95	n/a
Lesedi	4.46	3.13	↘	4.85	6.72	↗	4.41	n/a	4.30	n/a
Midvaal	2.95	2.21	↘	2.91	5.06	↗	5.11	n/a	3.86	n/a

The socio-economic vulnerability has decreased (improved) for two Local Municipalities between 1996 and 2011, namely Midvaal and Lesedi. Emfuleni Local Municipality's socio-economic vulnerability has decreased slightly. In 2011 Midvaal Local Municipality had the lowest socio-economic vulnerability, Lesedi Local Municipality the highest. Emfuleni Local Municipality has the highest economic vulnerability in the District and the second highest in the Province. The District experienced significant deindustrialisation because of the decline in the steel industry. The unemployment rate is therefore very high at 50.70 %, with a job shortage of 120 218. The District has therefore the highest poverty levels in the Gauteng Province. Only 42.60 % of the Sedibeng Local Municipality population is employed.

4.4.4.2. Settlement Vulnerability

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

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

Table 5: Anticipated settlement vulnerability for SDM.

Local Municipality	Anticipated Settlement Vulnerability
Emfuleni Local Municipality	<ul style="list-style-type: none"> • The major settlements in this municipality are Sebokeng, Vereeniging, Vanderbijlpark, Evaton and Sharpeville. • Settlements are projected to experience no increase, or even a decrease, in population growth, therefore no major population growth pressure is expected on local government in this Local Municipality.
Lesedi Local Municipality	<ul style="list-style-type: none"> • The major settlements in this Local Municipality are Heidelberg and Ratanda. • Heidelberg faces extreme growth pressure between 2011 and 2050. • Ratanda faces high growth pressure in the future. • Ratanda has high economic and socio-economic vulnerability and is poorly connected to the region. It has good service access.
Midvaal Local Municipality	<ul style="list-style-type: none"> • The major settlements in this Local Municipality are Meyerton and Lakeside. • Meyerton and Lakeside are faced with extreme growth pressure. Lakeside has a very high socio-economic and economic vulnerability. Both settlements have good regional connectivity.

4. Climate Change Adaptation Plan

4.1. Sedibeng's Strategic Objectives and the Linkage to Climate Change Adaptation

The Sedibeng District, renowned for its rich history and captivating landscapes, sits at a critical junction where socio-economic and environmental development imperatives collide. The district has forged a strategic plan encapsulating four pivotal objectives to navigate this intersection.

Table 6: SDM development priorities and objectives.

Strategic Objectives	Link to Climate Change
S01: To promote efficient and effective Integrated Services that address the socio-economic and environmental development imperatives of the Region	The first strategic objective underscores a commitment to promoting efficient and effective Integrated Services to address the socio-economic and environmental development imperatives of the region. The District understands that climate change is not an isolated phenomenon but interwoven with social and economic threads that comprise the community fabric. A holistic approach is necessary, acknowledging that the effects of climate change - rising temperatures, changing precipitation patterns, and increasing instances of extreme weather events - directly impact the region's socio-economic health, from livelihoods and food security to public health and infrastructure.
S02: To Implement Prudent and Cost-Effective Financial Management and Sustainability	Secondly, Sedibeng seeks to implement prudent and cost-effective financial management to ensure sustainability. It is anticipated that climate change will exert profound fiscal pressures, necessitating judicious planning and allocation of resources. Adaptation and mitigation strategies, ranging from infrastructure resilience to diversification of agricultural practices, require substantial investment. Furthermore, the District must be ready to absorb the economic shocks resulting from climate-induced disasters.
S03: To ensure Good Governance and sound management practices	Thirdly, the strategic framework emphasizes the importance of good governance and sound management practices. Good governance is critical in effectively addressing climate change, as it involves the clear articulation of policy, transparency in decision-making, effective coordination of various stakeholders, and the consistent enforcement of regulations. Sound management practices imply adaptive management in light of the uncertainties associated with climate change.
S04: To ensure effective Service Delivery	Lastly, the District is committed to ensuring effective service delivery. Climate change affects essential services like water supply, waste management, and emergency response. These services need

to be reliable and resilient to climate variability and change. Effective service delivery in the face of climate change is integral to maintaining the socio-economic well-being of the District's inhabitants.

In conclusion, the strategic objectives of the Sedibeng District demonstrate a profound understanding of the complex interplay between climate change and socio-economic development. The commitment to integrated services, financial sustainability, good governance, and effective service delivery embodies a proactive, comprehensive approach to navigating this critical intersection. The future, undoubtedly, will present challenges, but through strategic planning and robust action, Sedibeng District is poised to not just weather the storm but to thrive amidst the changing climate.

4.2. Climate Change Adaptation Vision

In Sedibeng District Municipality (SDM), attaining climate change resilience and mainstreaming implies the thorough integration of climate change response principles into all facets of municipal planning, development, and operations.

To shift towards a climate-resilient district, SDM could consider adopting several practices, including:

- **Climate-resilient infrastructure and settlements:** SDM could modify design standards and practices to incorporate future climate change impacts. This would ensure the built infrastructure within the municipality can withstand and adapt to these changes.
- **Biodiversity conservation and green spaces:** SDM is endowed with a diverse landscape, which presents significant opportunities for biodiversity conservation and the creation of green spaces. These elements are not only crucial for a resilient economy but can also present ecotourism opportunities that further economic development.
- **Water conservation and efficiency:** SDM has already been proactive in promoting strategies such as public awareness campaigns, leak detection and repairs, and water metering and billing, which are central to water conservation and efficiency.

These suggested best practices form a solid foundation, but they are not exhaustive. They could be supplemented by other strategies specifically tailored to the unique context and needs of SDM. The key to success lies in integrating these principles into all aspects of municipal decision-making and operations, and actively engaging the community in these efforts. Together, these actions can help SDM to develop the resilience necessary to navigate the challenges posed by climate change.

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

“Transitioning into a sustainable, resilient, and low-carbon municipality, Sedibeng District prioritizes the diligent safeguarding of natural resources, advances climate change mitigation and adaptation measures, and champions robust collaborations with communities and stakeholders, all oriented towards a thriving, equitable future for everyone.”

This vision is focused on creating a municipality that is sustainable and can adapt to the challenges posed by climate change. The aim is to ensure that the communities are safe, prosperous, and able to protect and preserve natural resources for future generations. The response to climate change will be driven by innovative and cost-effective solutions that promote sustainable development and economic growth. The key to achieving this vision is through collaboration with stakeholders to ensure that climate change considerations are integrated into the planning and decision-making processes. It is important that all actions are informed by the latest scientific knowledge and best practices to build a resilient and sustainable future for the municipality.

To achieve this vision, we need to develop a comprehensive list of climate actions for SDM that address climate risks, sustainability, adaptation, community safety and prosperity, natural resource preservation, innovation, collaboration, and resilience. The climate actions also offer co-benefits, promoting equity, a just -transition, and ensuring the health and resilience of people, natural resources, and the economy.

4.3. Climate Change Goals and Programmes

In response to the evolving climate-related risks, a sequenced approach was initiated to climate change adaptation planning. This process was kick-started by outcomes from the SDM Climate Change Risk profile, which has in turn informed the development of specific Adaptation Goals. These goals serve as pillars guiding a contextually relevant approach to adaptation planning within the district.

The proposed Adaptation Goals for SDM are as follows:

- *To ensure water security under a changing climate.*
- *To protect natural resources and ecosystems.*
- *To develop effective flood management strategies to mitigate the risks associated with heavy rainfall events.*
- *To reduce the vulnerability and exposure of human and natural systems to climate change and extreme events.*

From these Adaptation Goals, Strategic Adaptation Priorities were developed. These priorities facilitated the identification and categorisation of Adaptation Programmes, each meticulously designed to address the imminent climate-related risks. Each programme was then further broken down to outline the key climate actions and supportive activities necessary for

successful implementation. This systematic and sequential approach is designed to enhance the district's resilience against climate change in a comprehensive manner.

It is important to note that Sedibeng District has a number of positive attributes that help mitigate its vulnerability to climate-related hazards. The district generally displays relatively low socio-economic and physical vulnerabilities, with good access to services and regional connectivity in the major towns. Moreover, the district's settlements are not projected to experience severe impacts from climate change. Current and future drought conditions and heat extremes are not expected to significantly affect the district.

However, the greatest climate-related hazards identified in Sedibeng District are wildfires on the wildland-urban interface and surface water flooding. This risk, when combined with high population growth pressure, particularly in the Midvaal and Lesedi Local Municipalities, and economic vulnerability in the Emfuleni and Lesedi Local Municipalities, increases the district's susceptibility to adverse consequences resulting from climate change. Additionally, the environment, especially in Lesedi and Emfuleni Local Municipalities, is highly susceptible to the impacts of climate change. Towns experiencing significant population growth are set to become increasingly vulnerable and exposed to climate-related hazards. This context further underscores the relevance and urgency of SDM's systematic adaptation planning efforts aimed at building resilience against climate change impacts.

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

- Programme 1: Adopt an integrated approach to water augmentation, water use and water management.
- Programme 2: Water conservation and demand management.
- Programme 3: Enhancing Water conservation awareness and education for sustainable water management in response to climate change.
- Programme 4: Assessing alternative water sources.
- Programme 5: Groundwater management.
- Programme 6: Conserve, protect and restore natural open spaces, ecosystems with climate change adaptation benefits.
- Programme 7: Enhanced natural resource management.
- Programme 8: Integration of ecological support areas and ecosystem services into SDFs.
- Programme 9: Stormwater drainage systems improvement programme.
- Programme 10: Floodplain and retention basin development programme.
- Programme 11: Flood early warning systems implementation programme.
- Programme 12: Flood risk awareness and education programme.
- Programme 13: Infrastructure resilience programme.
- Programme 14: Flood insurance programme.
- Programme 15: Integrated fire management for climate resilience.

- Programme 16: Identify and prioritise climate change risks and develop response measures for settlements.
- Programme 17: Climate-smart waste management promotion.
- Programme 18: Community-based adaptation in communities most at risk of climate-related hazards.
- Programme 19: Climate-resilient spatial planning.

4.4. Climate Change Goal 1: Ensure water security under a changing climate.

Goal:	<ul style="list-style-type: none"> • To reinforce water security within the Sedibeng District Municipality in the face of climate variability, by instituting robust, climate-adaptive water management strategies and infrastructure.
Outcome:	<ul style="list-style-type: none"> • A Sedibeng District Municipality where water security is upheld amidst climate shifts, characterized by resilient, efficient water systems capable of providing consistent, safe water supply to all its inhabitants, thus ensuring their well-being and regional economic stability.
Linkage to SDM Development Priorities	<ul style="list-style-type: none"> • The strategic objective "<i>S01: To promote efficient and effective Integrated Services that address the socio-economic and environmental development imperatives of the Region</i>" can directly be linked to the vision "To implement measures to secure water availability for all users and uses, while reducing water demand, use, pollution and waste, in response to the impacts of climate change on the water cycle." This objective seeks to enhance socio-economic and environmental development, which can include efforts to secure water availability and promote sustainable use. • Additionally, "<i>S02: To implement prudent and cost-effective financial management and sustainability</i>" also ties in with this vision, as implementing measures to secure water availability and reduce water demand requires cost-effective and sustainable financial management. Allocating resources wisely to implement measures such as improving water infrastructure or investing in water-saving technologies would fall under this objective. • Finally, "<i>S04: To ensure effective service delivery</i>" can be tied to this vision as well, as securing water availability and reducing water demand is part of delivering effective services to the community. This would involve the development and maintenance of a robust water management system that meets the needs of the community, particularly under the conditions of changing climate.

4.4.1. Rationale/Context:

In the heart of Sedibeng District Municipality, a complex and robust water supply network operates, catering to the area's needs and maintaining its water heritage, which spans an

impressive total river length of 2,863 km, dam coverage of 4,570ha, and wetland coverage of 4,486ha. Rand Water, a major player in this network, supplies bulk water to each municipality in the district, including Lesedi, Midvaal, and Emfuleni. Despite this, the water supply is increasingly strained due to urbanization and migration, placing additional pressure on the existing water resources and infrastructure.

In Lesedi, water reservoirs are strategically placed at Ratanda/Heidelberg, Jameson Park, Devon, and Vischkuil, serving as significant sources of water for the area. Similarly, in Midvaal, the main water supply points are located in Meyerton, Ohenimuri, and Vaal Marina, with 10 operational reservoirs helping to ensure steady water availability. Over in Emfuleni, the local municipality has nine reservoirs and a small water treatment plant, providing a valuable supplement to the water supplied by Rand Water. However, the bulk water network in Emfuleni is overworked and ageing, with parts of it being 60–70 years old, representing a potential challenge for water security as demand continues to increase.

This growth in demand, coupled with significant environmental challenges such as water, waste, and air pollution, seriously threatens the sustainable development of the district. In particular, water pollution in river systems and bodies, especially the Kliprivier and Blesbokspruit, exacerbates water scarcity and quality concerns. Given these pressures and the unique drought dynamics of the district, a clear strategic priority is the assurance of water security under a changing climate. This involves implementing dynamic and proactive drought management strategies, adapting to the anticipated increase in extreme weather conditions, and developing robust water management strategies that focus on conservation, efficient use, risk mitigation, and pollution control.

Moreover, with the increasing risk of wildfires and their impact on watershed integrity and water quality, ensuring water security under these challenging conditions becomes paramount. This underscores the need for Sedibeng District to prioritize water security in its climate adaptation efforts while considering the vast water resources, environmental challenges, and socio-economic activities within its boundaries. Efforts towards securing water resources will demand vigilant monitoring, strategic planning, and robust water management practices to navigate the shifting landscapes of climatic and population pressures.

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

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

The first programme under the Sedibeng District Municipality's climate change adaptation plan is titled "*adopt an integrated approach to water augmentation, water use and water management.*" This programme is a strategic response to the district's dynamic and multifaceted

water-related challenges in the context of climate change, and it embodies a comprehensive and collaborative approach to water resource management. The rationale for this programme arises from the interrelated climate projections, environmental challenges, and socio-economic factors within Sedibeng District that shape water availability and quality.

- **Water-sensitive urban design (WSUD):** Given the escalating climate extremes, including very hot days and increased potential for flooding, implementing WSUD is crucial to enhance the district's resilience. WSUD principles promote the sustainable use and management of water in urban design and planning, treating water as an integral part of the urban ecosystem. This approach involves creating urban landscapes and infrastructures that mimic natural water cycles, managing stormwater, conserving water, and reducing runoffs. WSUD can also help alleviate water pollution issues by filtering runoffs before they reach water bodies, contributing to improved water quality.
- **Addressing human resources constraints for effective water management:** Climate change adaptation requires effective water management, which in turn necessitates a competent and robust human resources pool. Addressing any human resources constraints within the district is vital for implementing and managing the various initiatives under this programme. Training and capacity building in water management, conservation, and climate change adaptation are crucial for enhancing the district's ability to adapt to future climate-related water challenges.
- **Review bulk water master plan:** With the ageing and overworked water networks in Sedibeng, reviewing the Bulk Water Master Plan is an essential activity. This review should consider the expected increase in water demand due to urbanization and population growth, the projections of climate change, and the need to ensure water security. Such a review will help identify any necessary upgrades or replacements for ageing infrastructure and plan for potential expansions to meet growing demand.
- **Developing a water safety plan (WSP):** A WSP is a comprehensive risk assessment and risk management approach that encompasses all steps in the water supply from catchment to consumer. Considering the threats to water quality and availability in Sedibeng, including pollution and climate change impacts, a WSP will provide a systematic framework for ensuring safe drinking water. This will involve identifying potential risks, implementing control measures, and establishing monitoring systems and management procedures to ensure ongoing water safety.

In sum, the rationale behind this first programme is to develop a holistic and forward-looking approach to water management in Sedibeng District, recognizing and addressing the various challenges and vulnerabilities associated with climate change, pollution, and socio-economic factors. The ultimate goal is to secure a sustainable water future for the district, irrespective of the changing climate.

Table 7: Programme 1 - Integrated approach to water augmentation, use, and management.

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

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

4.4.3. Programme 2: Water Conservation and Demand Management

This Programme aims to reduce water consumption and wastage, while also protecting the water quality in the district. This is integral to ensuring the sustainability of water resources, especially in the context of climate change, where water scarcity and pollution are expected to intensify. The specific activities under this programme are designed to address the major pressures on Sedibeng's water resources, as detailed in the district's environmental profile.

- **Implementing monitoring mechanisms and reducing pollution:** Given the serious water pollution challenges in Sedibeng, particularly in the Kliprivier and Blesbokspruit, implementing rigorous monitoring mechanisms is essential. These mechanisms will provide regular and reliable data on water quality, allowing for timely interventions. Additionally, this activity seeks to reduce pollution at its source, whether that be industrial activities, mining effluent, agricultural runoff, or sewer blockages. This is critical, as clean water is a vital part of ensuring water security, especially under changing climatic conditions.
- **Implementing water conservation measures:** As climate change could intensify drought conditions and increase the frequency of very hot days, water conservation becomes more important than ever. 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 drought periods.
- **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 involves implementing strategic clearing of these invasive species from catchment areas, which in turn protects these vital water sources. This initiative not only improves the health and resilience of these areas but also enhances their capacity to provide clean, usable water.
- **Enforce 'green' approaches in residential areas and developments:** The green approach in residential areas and developments promotes the sustainable use of resources, which includes water. It can range from encouraging rainwater harvesting and greywater recycling to implementing green infrastructure like permeable pavements and green roofs that can help manage stormwater and reduce runoff.

The rationale for this programme arises from the urgent need to conserve water and manage demand in the face of climate change, as well as the significant internal and external pressures that threaten Sedibeng's water resources. By focusing on these activities, the programme aims to ensure that Sedibeng's water resources are managed sustainably, allowing the district to adapt effectively to the projected impacts of climate change.

Table 8: Programme 2 - Protect and conserve water through monitoring mechanisms and water conservation through water conservation and water demand management (WCWDM).

Programme 2: Protect and Conserve Water Through Monitoring Mechanisms and Water Conservation through Water Conservation and Water Demand Management (WCWDM).	
ACTIONS	KEY ACTIVITIES
Implementing monitoring mechanisms and protecting water sources by reducing pollution.	<ul style="list-style-type: none"> • Water quality monitoring: Implement a regular testing schedule to monitor the health of water sources and identify potential pollution sources. This will support the mandate of providing and maintaining efficient and sustainable water services. • Buffer zone establishment: Create and manage buffer zones around water sources, such as rivers and wetlands, to protect them from pollution. The design of these zones should prevent runoff from agricultural and urban areas from entering the water sources, supporting the district government's role in coordinating and integrating water management efforts. • Sustainable Agricultural practices promotion: Facilitate awareness campaigns, training, and capacity-building programmes to encourage farmers to use environmentally friendly fertilizers and pesticides. This contributes to the provincial government's mandate of developing and implementing plans and programmes for the sustainable use of water resources. • Effluent discharge regulation: Develop by-laws and regulations to control the discharge of industrial and domestic effluent municipal sewer systems. Regular monitoring of industries will ensure compliance, supporting the mandate of ensuring activities do not negatively impact water resources. • Responsible waste disposal advocacy: Further provide facilities for the disposal of hazardous waste and improve public awareness campaigns on the importance of responsible waste disposal. This will help reduce the risk of water source pollution and aligns with the broader mandate of protecting water resources.
Implementing water conservation measures.	<ul style="list-style-type: none"> • Increase public awareness campaigns: engagement with the public through campaigns, workshops, and educational programmes that promote water conservation practices. • Improve leak detection and repairs: Enhance efforts to identify and repair leaks in water supply systems and infrastructure to prevent water loss. • Continue water metering and billing: Persist with the installation of water meters and implement billing systems that charge consumers based on the amount of water used, as a means to encourage water conservation. Water-efficient infrastructure: The municipality can install water-efficient fixtures and appliances, such as low-flow showerheads, faucets, and toilets and in municipal buildings.

	<ul style="list-style-type: none"> • Greywater recycling: Promote the use of greywater for irrigation and other non-potable uses to reduce demand on the municipal water supply. • Water restrictions: Implement water restrictions during times of drought or water scarcity to limit water use and prevent wastage. • Reclaimed water systems: Install and operate reclaimed water systems that treat wastewater for non-potable uses like irrigation, industrial processes, or firefighting. • Rainwater harvesting: Encourage the installation of rainwater harvesting systems in households and municipal buildings to capture and store rainwater for non-potable uses like irrigation, cleaning, or flushing toilets.
<p>Alien invasive species clearing initiatives in catchment areas.</p>	<ul style="list-style-type: none"> • Stakeholder collaboration and equitable contribution: Recognising that catchment areas, especially those affected by alien vegetation encroaching into river systems, fall outside SDM boundaries and that various water users utilise it, there is an essential need to collaborate with all stakeholders. Equitable contributions from all parties to manage and enhance water security in these catchments should be determined and facilitated. • Identifying, mapping, and monitoring invasive species: A comprehensive survey of invasive species within the catchment areas, particularly focusing on alien vegetation encroaching into river systems, should be conducted in partnership with relevant stakeholders. This step involves identifying, mapping, and continuously monitoring the areas affected by invasive species. • Removal and control of invasive species: This includes the collaborative removal and control of invasive species, particularly those posing a threat to water security, using various techniques such as mechanical, chemical, and biological control methods. Such an approach should be supported by contributions from all stakeholders. • Rehabilitation of cleared areas: After the successful removal of invasive species, the cleared areas need to be rehabilitated. This can be accomplished through the restoration of indigenous vegetation and the implementation of erosion control measures, effectively enhancing water security in river systems. • Education and awareness: Alongside practical actions, education and awareness campaigns can be implemented in coordination with stakeholders. The aim of these campaigns is to increase understanding of the negative impacts of invasive species on catchment areas, especially concerning water security, and to promote responsible behavior in preventing the spread of invasive species. • Monitoring and evaluation: The effectiveness of invasive species control measures, and their impact on water security, can be monitored and evaluated in partnership with stakeholders. This

	ensures the long-term sustainability of the project and allows for assessing the contributions and impact of each stakeholder in enhancing water security.
Enforce 'Green' Approaches In Residential Areas and Developments.	<ul style="list-style-type: none"> • Developing and implementing guidelines and standards for sustainable residential and commercial development. • Enforcing compliance with building codes and regulations that promote sustainable water use practices, such as the installation of low-flow fixtures and rainwater harvesting systems. • Providing incentives for property owners to invest in green infrastructure and technologies that reduce water consumption and improve water efficiency. • Conducting public awareness campaigns to educate residents on the importance of water conservation and the benefits of green infrastructure. • Implementing water-efficient landscaping practices, such as xeriscaping, in public spaces and parks to reduce water use and promote sustainable development.

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

As the climate projections suggest more frequent periods of water stress due to increased temperature and reduced rainfall, it's of paramount importance that Sedibeng District Municipality 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. It's grounded in the belief that an informed and engaged community is crucial to achieving long-term water security in the face of climate change.

Key actions under this programme are:

- **Developing water conservation education programs:** Educational programs can be designed to increase community awareness about the importance of water conservation and sustainable water management practices. Workshops, community outreach, and public campaigns can be used to relay information about the benefits of water conservation, water-saving techniques, and the long-term impact of these actions on water availability and quality.
- **Promoting 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, low-flow showerheads and toilets, rainwater harvesting systems, and greywater recycling.
- **Encouraging businesses to implement water-saving measures:** Businesses can be encouraged to reduce their water footprint through a combination of guidance, support, and incentives. This might involve 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.

- Researching water conservation: To ensure the effectiveness of these efforts and adapt to changing circumstances, it is important to conduct regular 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.

Through these activities, the "*enhancing water conservation awareness and education for sustainable water management in response to climate change*" programme seeks to build a culture of water conservation among residents and businesses in the Sedibeng District, helping the region become more resilient to the predicted impacts of climate change.

Table 9: Programme 3 - Enhancing water conservation awareness and education for sustainable water management in response to climate change.

Programme 3: Enhancing Water Conservation Awareness and Education for Sustainable Water Management in Response to Climate Change.	
ACTIONS	POSSIBLE KEY ACTIVITIES
<p>Developing water conservation education programs. <i>(The programs can include activities such as workshops, community outreach, and public campaigns to promote the benefits of water conservation and the importance of sustainable water management).</i></p>	<ul style="list-style-type: none"> • Conducting a needs assessment: This involves identifying the target audience, understanding their knowledge level, attitudes, and behaviours related to water conservation, and identifying the gaps that need to be addressed. • Developing educational materials: This involves creating educational materials, such as brochures, pamphlets, posters, and videos that effectively communicate the importance of water conservation and offer practical tips on how to save water. The materials should be designed to appeal to the target audience and be culturally appropriate. • Conducting education and outreach activities: This involves organizing events and activities, such as workshops, seminars, public presentations, and social media campaigns, to promote water conservation and distribute educational materials to the target audience. • Partnering with community organizations: This involves collaborating with community-based organizations, such as schools, churches, and community centres, to disseminate educational materials and raise awareness of water conservation. • Evaluating the effectiveness of the program: This involves collecting data to measure the impact of the education program on knowledge, attitudes, and behaviours related to water conservation. This data can be used to refine the program and make it more effective.

<p>Promoting water conservation in households.</p>	<ul style="list-style-type: none"> • Developing and distributing educational materials: This involves developing materials such as brochures, posters, and pamphlets that provide tips and guidelines on how to conserve water at home. These materials can be distributed to households, community centres, and other public places to promote water conservation. • Providing incentives for water conservation: Providing incentives such as rebates for installing water-efficient devices and appliances can encourage households to adopt water conservation practices. This can include rebates for low-flow toilets, showerheads, and faucets. • Conducting water audits: Water audits involve identifying and fixing leaks, as well as identifying areas where water can be conserved. Households can conduct their own water audits or seek the assistance of trained professionals. • Encouraging the use of rainwater harvesting systems: Rainwater harvesting involves collecting rainwater and using it for non-potable purposes such as watering plants and flushing toilets. This can help households reduce their reliance on potable water for non-potable uses. • Implementing water-efficient landscaping: Water-efficient landscaping involves planting drought-resistant plants and using irrigation systems that deliver water directly to plants' roots. This can reduce the amount of water needed to maintain a garden or lawn. • Providing training and workshops: Providing training and workshops on water conservation can help households learn about the importance of water conservation and how to implement water conservation practices in their daily lives. • Engaging community leaders and stakeholders: Engaging community leaders and stakeholders in promoting water conservation can help to build momentum and increase participation in water conservation efforts.
<p>Encouraging businesses to implement water-saving measures. <i>(This can include providing support and guidance on water-efficient practices, offering incentives for businesses to reduce water consumption, and promoting the use of water-efficient technologies)</i></p>	<ul style="list-style-type: none"> • Conducting water audits to identify areas where water savings can be made. • Developing and distributing guidance material to help businesses implement water-saving measures. • Providing financial incentives, such as rebates or tax credits, for businesses that implement water-saving measures. • Working with industry associations to promote water conservation practices and encourage member businesses to take action. • Conducting outreach and education programs to raise awareness among businesses about the importance of water conservation and the benefits of implementing water-saving measures. • Providing training and technical assistance to help businesses implement water-saving measures effectively.

	<ul style="list-style-type: none"> • Collaborating with large water users, such as industrial facilities, to develop customized water-saving plans and targets.
<p>Conducting Research On Water Conservation. <i>(Research can include investigating the effectiveness of water conservation measures, identifying barriers to water conservation, and exploring innovative approaches to water conservation)</i></p>	<ul style="list-style-type: none"> • Collaborating with large water users, such as industrial facilities, to develop customized water-saving plans and targets. • Conducting studies on the water usage patterns of different sectors, including households, agriculture, and industry, to identify areas where water conservation measures can be implemented. • Developing and testing new technologies and practices that promote water conservation, such as efficient irrigation systems, water recycling and reuse, and rainwater harvesting. • Analyzing the economic, social, and environmental impacts of water conservation initiatives, to help decision-makers prioritize and implement effective conservation strategies. • Evaluating the effectiveness of existing water conservation programs, and identifying opportunities for improvement. • Collaborating with other stakeholders, such as government agencies, academic institutions, and non-governmental organizations, to share knowledge and best practices related to water conservation. • Conducting public outreach and education campaigns to promote awareness of the importance of water conservation, and to encourage individuals and organizations to take action to conserve water. • Monitoring and evaluating the implementation and impact of water conservation programs, to ensure that they are achieving their intended goals and objectives.

4.4.4. Programme 4: Assessing Alternative Water Sources

As climate change projections for Sedibeng District Municipality suggest increased temperature and reduced rainfall, water scarcity could become a more pressing issue. The "Assessing Alternative Water Sources" programme is designed 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.

Key actions under this programme include:

- **Water resource management planning:** This action involves a comprehensive analysis of the water resources in the district, determining the current and future demand, and assessing how this demand can be met through a mix of traditional and alternative water sources. It is about planning for the present and future, considering both the quantity and quality of the available water resources.
- **Investigating alternative water sources:** Identifying potential alternative sources of water is crucial for diversification. These can include the extraction of groundwater and the reuse of treated wastewater. Each of these sources has its own benefits and challenges and their

feasibility would need to be evaluated considering economic, environmental, and social factors.

- Investing in alternative water sources: Once feasible alternative water sources are identified, the necessary infrastructure and technology to extract, treat, and distribute these water sources would be developed. This could involve drilling new boreholes for groundwater extraction and upgrading wastewater treatment facilities to enable wastewater reuse.
- Developing and implementing a treated effluent reuse strategy: wastewater reuse can be a viable alternative water source, especially for non-potable uses such as irrigation, industrial processes, and toilet flushing. A comprehensive strategy can provide guidelines for the treatment, distribution, and usage of reclaimed water, ensuring its safe and efficient utilization.

By implementing these activities, the "Assessing Alternative Water Sources" programme aims to enhance Sedibeng District Municipality's resilience to climate change-induced water scarcity, ensuring sustainable water management in the face of changing environmental conditions.

Table 10: Programme 4 - Assessing the feasibility and sustainability of alternative water sources for climate change adaptation.

Programme 4: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Water resource management planning.	<ul style="list-style-type: none"> • Conducting a water resource assessment: A comprehensive assessment of the existing water resources should be conducted to determine the available water sources, water quality, and quantity. • Identifying water demands: Understanding the current and future water demands of the municipality, including domestic, industrial, and agricultural water use, is crucial for developing a water resource management plan. • Developing a drought management plan: Droughts can have a significant impact on water resources, so developing a drought management plan can help to prepare for and mitigate the impacts of drought. • Developing water conservation strategies: Water conservation strategies can help to reduce water demand and optimize the use of available water resources. • Engaging stakeholders: Stakeholder engagement is critical for the successful development and implementation of a water resource management plan. It is important to engage with all relevant stakeholders, including the community, industries, and agricultural sectors, to ensure that their needs are considered in the plan

<p>Investigating alternative water sources. <i>(This activity involves identifying potential alternative water sources, such as groundwater, and wastewater reuse).</i></p>	<ul style="list-style-type: none"> • Feasibility studies: Conduct feasibility studies to identify and assess the viability of various alternative water sources, such as rainwater harvesting, groundwater extraction, and stormwater capture. • Hydrological assessments: Undertaking hydrological assessments to determine the water availability and potential yield of alternative water sources, such as aquifers and rivers. • Cost-benefit analysis: Conducting cost-benefit analysis of alternative water sources to determine the economic and environmental costs and benefits of investing in them. • Water quality assessments: Conducting water quality assessments to determine the suitability of alternative water sources for various uses, such as drinking water, irrigation, and industrial processes. • Stakeholder engagement: Engaging with stakeholders, including communities, businesses, and other water users, to identify their water needs and preferences and to get their input on the development of alternative water sources. • Regulatory compliance: Ensuring that any proposed alternative water sources comply with relevant regulations and standards, such as those related to water quality, health and safety, and environmental impact. • Implementation planning: Developing implementation plans for any viable alternative water sources, including detailed designs, procurement of equipment, and construction and operational plans.
<p>Investing in alternative water sources. <i>(Once alternative water sources have been identified, the programme will invest in the infrastructure and technology needed to extract, treat, and distribute these water sources. This may include, drilling new boreholes, and upgrading wastewater treatment facilities).</i></p>	<ul style="list-style-type: none"> • Researching and evaluating potential alternative water sources: This may involve identifying and assessing the feasibility of various water sources, such as wastewater reuse, rainwater harvesting, or groundwater. • Developing infrastructure for alternative water sources: This may involve the construction of treatment plants and pipelines necessary for the collection, treatment, and distribution of alternative water sources. • Developing partnerships and collaboration: This may involve partnering with other stakeholders, such as neighbouring municipalities, government agencies, and private sector entities, to develop and implement alternative water source projects. • Identifying and securing funding: This may involve identifying and securing funding from various sources, such as grants, loans, or public-private partnerships. • Educating and raising public awareness: This may involve educating and raising public awareness about the importance of alternative water sources, how they work, and their benefits, to encourage community support and participation in the development and implementation of these projects.

Develop and implement a treated effluent reuse strategy for sustainable water management.	<ul style="list-style-type: none"> Assessing the feasibility and potential benefits of a treated effluent reuse strategy for the SDM. Identifying and prioritising potential sites for treated effluent reuse, including public spaces, industrial sites, and agriculture. Developing a comprehensive treated effluent reuse plan, including infrastructure and system requirements, stakeholder engagement, and potential risks and mitigation strategies. Conducting a cost-benefit analysis of the treated effluent reuse plan and identifying potential funding sources. Building and implementing the treated effluent reuse infrastructure, including treatment facilities and distribution systems. Conducting monitoring and evaluation activities to assess the effectiveness of the treated effluent reuse strategy and identify opportunities for improvement.
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4.4.5. Programme 5: Groundwater Management

Groundwater is a critical water resource for the SDM and is increasingly vulnerable to the impacts of climate change. Implementing a sustainable groundwater use and development strategy is essential for adapting to climate change impacts, ensuring groundwater sustainability, and securing the continued supply of safe water. Implementing a sustainable groundwater use and development strategy is an important step towards adapting to climate change impacts in the SDM. By promoting groundwater sustainability, this programme can help secure the continued supply of safe water for the community while also reducing the vulnerability of the water resource to climate change impacts.

Table 11: Programme 5 - Implementing sustainable groundwater use and development strategy.

Programme 5: Implementing Sustainable Groundwater Use and Development Strategy	
ACTIONS	POSSIBLE KEY ACTIVITIES
Conducting groundwater resource assessments to establish the availability and quality of groundwater in the SDM area.	<ul style="list-style-type: none"> Desk-based research: Conduct a review of existing literature, data, and reports to gain an understanding of the historical and current state of groundwater resources in the area, as well as any previous studies that have been conducted. Field investigations: Collect and analyse data from monitoring wells, boreholes, and other sources to determine the quantity and quality of groundwater in the area. This may involve drilling new boreholes or installing monitoring wells to collect data on groundwater levels, water quality, and other relevant parameters. Hydrogeological modelling: Develop and use computer models to simulate the behaviour of groundwater resources in the area, including the movement of water through the aquifers and the interaction between surface water and groundwater.

	<ul style="list-style-type: none"> • Stakeholder engagement: Engage with local communities, water users, and other stakeholders to understand their needs and concerns related to groundwater resources in the area. • Developing a groundwater management plan: Use the data collected and the models developed to develop a plan for the sustainable management and use of groundwater resources in the SDM area. This may include measures such as setting sustainable yield limits, establishing groundwater protection zones, and implementing monitoring programmes to track the status of the resource over time.
<p>Establishing sustainable groundwater use policies and guidelines to promote efficient and effective groundwater management.</p>	<ul style="list-style-type: none"> • Conduct a review of existing policies and guidelines related to groundwater use to identify gaps and areas for improvement. • Consider local conditions and needs, developing new policies and guidelines that promote sustainable and efficient groundwater management. • Develop a stakeholder engagement process to gather input from water users, industry representatives, and other stakeholders in developing sustainable groundwater use policies and guidelines. • Establish mechanisms for ongoing review and revision of policies and guidelines to ensure they remain relevant and effective in promoting sustainable groundwater use.
<p>Implementing groundwater monitoring programmes to monitor water levels, water quality, and potential pollution sources, enabling early detection of potential problems and timely intervention.</p>	<ul style="list-style-type: none"> • Install and maintain a network of groundwater monitoring wells and equipment to collect data on groundwater levels, water quality, and potential pollution sources. • Conduct regular field visits to measure and record groundwater levels and collect water quality samples for laboratory analysis. • Analyse data collected from monitoring programmes to detect changes in groundwater levels, identify trends in water quality, and assess the impact of potential pollution sources. • Develop and implement early warning systems to alert water users and decision-makers to potential problems, enabling timely intervention. • to promote awareness and informed decision-making, providing regular reports on groundwater conditions and trends to water users, decision-makers, and the public. • Collaborate with other agencies and stakeholders to share data and coordinate monitoring efforts to ensure comprehensive coverage of the groundwater resources.
<p>Promoting groundwater conservation and efficiency by encouraging the adoption of water-saving technologies and practices in all sectors.</p>	<ul style="list-style-type: none"> • Encourage water conservation pricing mechanisms, such as tiered water rates, incentivise water users to reduce their water use, water-efficient irrigation systems, drought-resistant crops, and low-flow fixtures. • Develop and implement water conservation standards for new and existing municipal buildings and properties. • Encourage the adoption of water reuse and recycling technologies to reduce the demand for fresh groundwater resources.

	<ul style="list-style-type: none"> Promote the use of rainwater harvesting systems in households, buildings, and public spaces to reduce demand for groundwater resources.
<p>Developing groundwater recharge and artificial recharge strategies to enhance aquifer recharge rates and improve groundwater storage capacity.</p>	<ul style="list-style-type: none"> Conduct studies to identify suitable sites for groundwater recharge, including areas with high permeability, favourable soil conditions, and sufficient rainfall. Identify potential sources of water for recharge, such as stormwater runoff, treated wastewater, and excess surface water. Develop and implement recharge infrastructure, such as recharge basins, injection wells, and spreading grounds. Monitoring and evaluating the effectiveness of recharge strategies, including assessing changes in water levels, water quality, and aquifer storage capacity. Developing outreach and education programmes to promote groundwater recharge benefits and encourage participation from stakeholders, such as farmers, local governments, and water users.
<p>Implementing land-use planning and zoning regulations to protect groundwater resources from pollution and overuse.</p>	<ul style="list-style-type: none"> Conduct a groundwater vulnerability assessment to identify areas where groundwater resources are most at risk from pollution and overuse. Develop and enforce land-use planning and zoning regulations that limit activities that may threaten groundwater quality, such as restricting the construction of hazardous waste facilities near groundwater sources. Establish setback requirements that limit the distance between certain land uses and groundwater sources. Develop best management practices for land uses that have the potential to impact groundwater quality, such as agriculture, mining, and construction. Encourage the adoption of sustainable development practices that reduce the demand for groundwater, such as green roofs, rainwater harvesting, and greywater recycling. Establish monitoring programmes to track changes in groundwater quality and quantity over time, and to detect and respond to potential threats to groundwater resources. Providing education and outreach to stakeholders, including landowners, developers, and the public, about the importance of protecting groundwater resources and the regulations and guidelines in place to do so.
<p>Develop a information management system for groundwater data to provide accurate and timely information to water users, decision-</p>	<ul style="list-style-type: none"> Conduct a comprehensive inventory of all groundwater monitoring wells in the SDM area and assessing their condition and functionality. Establish a standard methodology for groundwater data collection, analysis, and reporting to ensure consistency and accuracy of information.

makers, and the public.	<ul style="list-style-type: none"> Develop a database and web-based portal for storing and accessing groundwater data, including water levels, quality, and other relevant information. Establish protocols for sharing groundwater data among relevant stakeholders, including water users, regulators, researchers, and the public. Develop data visualisation tools and models to help decision-makers interpret and use groundwater data effectively. Establish procedures for quality control and quality assurance to ensure the accuracy and reliability of groundwater data. Provide training and technical assistance to water users, regulators, and other stakeholders on collecting, analysing, and using groundwater data effectively. Conduct regular reviews and updates of the groundwater information management system to ensure that it remains current, relevant, and effective.
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4.5. Climate Change Goal 2: Protect Natural Resources and Ecosystems.

Goal:	<ul style="list-style-type: none"> To safeguard and sustainably manage the Sedibeng District Municipality's natural resources and ecosystems under the changing climate conditions, thereby preserving biodiversity and promoting ecological balance.
Outcome:	<ul style="list-style-type: none"> A thriving District with resilient natural ecosystems and responsibly-managed natural resources, contributing to a harmonious balance between human activity and environmental sustainability and supporting an ecologically robust future for generations to come.
Linkage to SDM's Strategic Objectives	<ul style="list-style-type: none"> S01 - To promote efficient and effective Integrated Services that address the socio-economic and environmental development imperatives of the Region. The protection of natural resources and ecosystems directly ties into this objective, as these are integral to the socio-economic health and environmental sustainability of the region. The changes in climate, such as rising temperatures and extreme weather events, can negatively impact the region's ecosystems, thereby affecting the overall socio-economic structure. S02 - To implement prudent and cost-effective financial management and sustainability. The sustainable management of natural resources and ecosystems, as highlighted in Climate Change Goal 2, is an important factor in financial sustainability. By investing in protecting and sustaining our ecosystems, Sedibeng can help buffer against climate-induced financial pressures and promote the long-term economic resilience of the region. S03 - To ensure good governance and sound management practices. Effective governance and management practices are vital in managing and protecting our natural resources and ecosystems. This includes the development and enforcement of policies related

to conservation, sustainable resource use, and adaptation to climate change.

- S04 - To ensure effective service delivery. The safeguarding of natural resources and ecosystems directly affects service delivery in the district. Services such as water supply are often reliant on the health and sustainability of local ecosystems. By protecting these, Sedibeng can ensure the continued effective delivery of essential services amidst changing climate conditions.

4.5.1. Rationale/Context

The changing climate poses distinct challenges to the Sedibeng District Municipality, including escalating drought tendencies, increasing temperatures, heightened wildfire risk, and variable flood hazards. These shifts not only directly threaten human life and property but also imperil the local ecosystems and natural resources, which play a vital role in mediating the impacts of these climatic changes. The district's ecosystems, whether the grasslands and savannahs of the Suikerbosrand Nature Reserve or the aquatic habitats of the Vaal, Klip, and Suikerbosrand Rivers, host a rich diversity of life and serve key ecosystem functions such as water filtration, flood control, carbon sequestration, and provision of habitats for various species. These roles, in turn, support human livelihoods, water supply, and overall environmental health. Given the looming threats of drought, heatwaves, wildfires, and flooding, it is clear that safeguarding these natural assets is indispensable to the district's climate adaptation strategy.

Furthermore, the Sedibeng District Municipality's rich biodiversity, exemplified by the numerous species that inhabit the Suikerbosrand and Vaal Dam Nature Reserves and the multitude of life found in the district's rivers and wetlands, adds an additional layer of complexity and urgency to the call for resource and ecosystem protection. These protected areas and critical biodiversity areas function as important environmental corridors, maintaining the continuity of habitats and enabling species to adapt to changing conditions by moving across the landscape. The potential escalation of wildfires, exacerbated by climate change, could disrupt these corridors and result in a significant loss of biodiversity. This, combined with the possible impacts of increased heat, altered rainfall patterns, and fluctuating flood hazards, underlines the critical importance of ecosystem resilience in buffering the impacts of climate change.

Lastly, it is important to note that protecting natural resources and ecosystems is not just about conserving biodiversity and beautiful landscapes. It is also about maintaining the crucial services these ecosystems provide to society, including food and water provision, climate regulation, and recreational opportunities, among others. Changes in precipitation patterns and the projected increase in extreme rainfall events could, for instance, exacerbate flood risks, with potentially dire consequences for the district's water systems and the communities they support. Consequently, maintaining healthy, well-functioning ecosystems could offer an effective, natural line of defence against some of the most severe anticipated impacts of climate change. Hence,

it is imperative to position the protection of natural resources and ecosystems as a top strategic priority in Sedibeng's climate adaptation efforts.

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

In light of the evolving climate dynamics in Sedibeng District Municipality, the sixth programme "*conserve, protect and restore natural open spaces, ecosystems with climate change adaptation benefits*" emerges as an essential strategy for a resilient future. It addresses the significant risks posed by climatic variations, such as drought, heatwaves, wildfires, and flooding, on the district's natural resources, ecosystems, and open spaces, and prioritizes their conservation, protection, and restoration. This is geared towards leveraging these spaces' inherent ability to absorb greenhouse gases, buffer against severe weather, and provide vital habitats for a range of species.

The first key action under this program is the assessment of natural resources and the ensuring of conservation, protection, and restoration of natural open spaces and ecosystems. This will involve regular monitoring and scientific analysis of the condition and health of these spaces, such as the Suikerbosrand Nature Reserve and the Vaal Dam Nature Reserve, as well as the rivers and wetlands of the district. The evaluation will also identify critical biodiversity areas that require urgent protection and will map out environmental corridors that should be maintained for species adaptation and migration.

The second action focuses on harnessing the potential of open spaces to absorb and mitigate the impacts of climate change. This will involve the strategic management of these spaces to maximize their carbon sequestration potential and their ability to buffer against extreme weather events. This could include initiatives like reforestation, the creation of urban green spaces, and the restoration of wetlands and riparian zones, which not only absorb carbon but also serve to regulate water flow and minimize flood risk.

Finally, implementing programs that focus on mitigating the impact of climate change and severe weather, particularly in climate-risk zones, forms the third key action. Given the district's vulnerability to drought, heatwaves, wildfires, and flooding, these programs will need to be tailored to the unique challenges and needs of each climate risk zone. 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 management practices to reduce runoff could be key actions. In essence, the sixth programme underscores the intrinsic value of natural open spaces and ecosystems in climate change adaptation, viewing them not merely as passive victims of climatic shifts but as active contributors to climate resilience. The activities within this programme will

work synergistically to secure the district's natural wealth and ensure its continued role in mitigating and adapting to climate change.

Table 12: Programme 6 - Conserve, protect and restore natural open spaces, ecosystems and natural resources.

Programme 6: Conserve, Protect and Restore Natural Open Spaces, Ecosystems and Natural Resources.	
ACTIONS	KEY ACTIVITIES
Assessing natural resources and ensuring that natural open spaces, ecosystems, and resources are conserved, protected and restored.	<ul style="list-style-type: none"> • Conduct a comprehensive inventory of natural resources, including land, water, and biological resources, to identify areas of high conservation value and areas of concern. • Assess the current state of natural open spaces, ecosystems, and resources to determine their condition and any threats or vulnerabilities they may face due to climate change. • Develop conservation plans and management strategies for high conservation value areas, ensuring that they are integrated into municipal spatial plans and protected through legislation, policy and land use management. • Implement measures to restore degraded natural open spaces and ecosystems, such as wetlands and riparian areas, to improve their function and resilience in the face of climate change. • Establish protected areas and ensure that they are managed effectively to ensure the conservation of natural resources and ecosystems.
Harnessing the potential of open spaces to absorb and mitigate the impacts of climate change.	<ul style="list-style-type: none"> • Conducting a green infrastructure assessment to identify natural areas that can provide climate benefits such as carbon sequestration, stormwater management, and temperature regulation. • Developing a plan to integrate green infrastructure practices into new development and redevelopment projects, such as using permeable pavement, green roofs, and bioswales to manage stormwater runoff and reduce the urban heat island effect. • Planting trees and other vegetation in strategic locations provides shade, reduces air pollution, and improves overall air quality. • Establishing community gardens and urban agriculture programmes to increase access to fresh, healthy food and provide opportunities for residents to engage with natural areas and learn about sustainable practices.

	<ul style="list-style-type: none"> • Protecting and enhancing existing natural areas by preserving wetlands, riparian corridors, and other important habitats. • Creating and maintaining trails, bike paths, and other recreational infrastructure to encourage outdoor activity and promote physical and mental health.
<p>Implementing programmes focused on mitigating the impact of climate change and severe weather, particularly in climate-risk zones.</p>	<ul style="list-style-type: none"> • Conducting vulnerability assessments to identify areas and communities most at risk from the impacts of climate change and severe weather events. • Developing and implementing early warning systems and emergency response plans to enable timely evacuation and disaster relief efforts. • Promoting nature-based solutions, such as restoration of wetlands, and green infrastructure, to help mitigate the impacts of climate change and severe weather events. • Encouraging the adoption of sustainable land use practices, such as low-impact development, agroforestry, and sustainable agriculture, to help build resilience in the face of climate change. • Providing education and awareness campaigns to inform residents and businesses about the risks of climate change and the actions they can take to mitigate their impacts. • Encouraging community participation in climate adaptation and resilience planning efforts, through stakeholder engagement and collaboration with local organisations and community groups. • Establishing partnerships with other municipalities, government agencies, and non-governmental organisations to leverage resources, share best practices, and coordinate efforts in addressing the impacts of climate change and severe weather.

4.5.3 Programme 7: Enhanced Natural Resource Management

Amidst the rapidly changing climate within the Sedibeng District Municipality, the seventh programme, "enhanced natural resource management," comes into play as an integral strategy for resilient and sustainable development. It addresses the pressing need for careful stewardship of the district'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 first key activity under this programme revolves around ensuring the quality of water resources, which is vital to the district's sustainable development trajectory. Water serves as the lifeblood of ecosystems, a cornerstone of human health, and a driver of socio-economic

development. In light of projected climate changes, such as potential increases in extreme rainfall events and drought, the monitoring, protection, and improvement of water quality become paramount. This activity could involve steps such as regular water quality testing, watershed management planning, and the implementation of strategies to reduce water pollution from agricultural runoff and urban waste.

The second activity involves monitoring and preventing soil erosion, an environmental threat that not only jeopardizes the health and productivity of ecosystems but also has implications for water quality. Soil erosion can lead to the siltation of rivers and dams, which can harm aquatic life and disrupt water supply. Preventing soil erosion requires a holistic approach that incorporates regular monitoring of erosion hotspots, land-use planning that factors in erosion risk, and the implementation of soil conservation measures, such as sustainable agricultural practices.

The third key activity involves providing training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines. This is an essential step towards ensuring compliance with these regulations, as well as building capacity within the municipality and the broader community to manage natural resources sustainably and adaptively. Training sessions could cover topics such as biodiversity conservation, watershed management, soil conservation, and climate change adaptation, and could equip participants with the skills to interpret and apply regulations and guidelines effectively.

Finally, the establishment of a District Municipal Environmental Management Forum (DEMF) marks the fourth key activity of this programme. The DEMF will serve as a platform for enhanced collaboration and coordination between various sectors, organizations, and agencies involved in natural resource management. The DEMF could facilitate the sharing of knowledge and resources, the harmonization of strategies and plans, and the resolution of conflicts over resource use.

Through these interlinked activities, the seventh programme underscores the critical role of responsible natural resource management in navigating the district's climate future. It seeks to empower the district and its communities to protect and enhance their natural resources, not just as an end in itself, but as a means to secure the district's resilience and sustainability in the face of climate change.

Table 13: Programme 7 - Enhanced natural resource management and use of ecosystem services.

Programme 7: Enhanced Natural Resource Management and Use of Ecosystem Services	
ACTIONS	ACTIVITIES
Ensuring the quality of water resources is critical to the	<ul style="list-style-type: none"> Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies.

<p>sustainable development of SDM, as they play a vital role in maintaining the health of ecosystems, human health, and socio-economic development.</p>	<ul style="list-style-type: none"> • Developing and implementing pollution prevention measures to reduce the number of pollutants entering water sources, such as through agricultural and industrial runoff or sewage discharge. • Encouraging the use of environmentally-friendly practices in households, businesses, and industries to reduce the discharge of pollutants into water resources. • Developing and implementing water treatment technologies to remove pollutants from wastewater before discharge or reuse. • Creating public awareness campaigns to educate the public about the importance of protecting water resources and reducing their impact on the environment. • Participating in the development and implementation of regulations and policies to manage and regulate the use of water resources, particularly in areas where water scarcity is a concern. • Collaborating with neighbouring municipalities and stakeholders to manage shared water resources and prevent transboundary pollution.
<p>Monitoring and preventing soil erosion is crucial to ensure the long-term health and productivity of natural ecosystems, as well as to maintain the quality of water resources. <i>(Preventing soil erosion requires a multifaceted approach that involves monitoring, planning, and implementing strategies that protect natural resources).</i></p>	<ul style="list-style-type: none"> • Conducting soil erosion risk assessments on municipal land to identify areas that are most vulnerable to erosion and prioritise action. • Developing and implementing erosion control plans to minimise soil erosion, such as the use of vegetation cover. • Promoting the use of sustainable land use practices that preserve natural vegetation and minimise soil disturbance. • Monitoring soil erosion levels through regular assessments and surveys, and implementing remedial measures where necessary. • Educating the public about the importance of preventing soil erosion and promoting sustainable land use practices through outreach and education campaigns.
<p>Provide training to municipal staff and stakeholders on biodiversity and natural resource</p>	<ul style="list-style-type: none"> • Developing a training programme that covers key biodiversity and natural resource management regulations and guidelines, as well as the penalties for non-compliance. • Identifying the staff and stakeholders that require training based on their roles and responsibilities in natural resource management.

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

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

The eighth programme, *"integration of ecological support areas and ecosystem services into SDFs"* underscores the vital importance of acknowledging the intrinsic and instrumental value of natural spaces and ecosystems in the planning and development agenda of the Sedibeng District Municipality. The climate change projections we've discussed further amplify the necessity of this initiative. Here's how each of these key activities might function within the context of this programme:

- Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales: This action mandates identifying those areas within Sedibeng that are particularly significant for biodiversity and ecosystem services. For instance, the Suikerbosrand Nature Reserve and Vaal Dam Nature Reserve are two primary examples. These and other ecologically vital areas should be incorporated into the municipal spatial planning process to guarantee their preservation and sustainable use. With the impending risk of droughts, heatwaves, and flooding, the conservation of these areas could also provide valuable climate change mitigation and adaptation benefits.
- Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating inventories in the Spatial Development Framework and the open space framework: This involves conducting a comprehensive assessment of the municipality's natural assets, which should encompass not only areas of significant biodiversity but also other open spaces, ecosystems, and natural resources. These findings should then be woven into the District's Spatial Development Framework and Open Space Framework, providing a blueprint for sustainable development that respects and upholds the value of these natural resources.
- Identifying undeveloped open space with potential for green infrastructure: This action is about recognizing those undeveloped areas within the municipality that hold potential for the development of green infrastructure. Given the projected increase in heatwaves, such spaces can provide vital climate adaptation benefits, such as heat mitigation, increased stormwater management, and provision of habitats for biodiversity, contributing to the overall resilience of the municipality.
- Assessing the value of open spaces and ecosystem services: This action speaks to the need to quantify and appreciate the ecological, economic, and socio-cultural value offered by the district's open spaces and the services its ecosystems provide. Recognizing the tangible and intangible benefits these spaces offer can strengthen the case for their protection and management, particularly in light of the escalating impacts of climate change.

Table 14: Programme 8 - Integrate critical biodiversity areas and ecological support areas into the spatial framework.

Programme 8: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Framework.	
ACTIONS	KEY ACTIVITIES
<p>Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales. <i>(This involves identifying areas of high ecological value and ensuring that they are given due consideration in the municipality's spatial planning activities).</i></p>	<ul style="list-style-type: none"> • Conduct a comprehensive analysis of existing municipal spatial plans and policies to determine where critical biodiversity and ecological support areas are currently included or excluded. • Identify critical biodiversity areas and ecological support areas within the municipality, using relevant data and information sources, such as aerial imagery, ecological surveys, and other mapping tools. • Analyse and map the spatial distribution of critical biodiversity areas and ecological support areas to determine their location and extent, as well as any potential threats or vulnerabilities. • Conduct stakeholder consultations with relevant departments, experts, and community members to gather input and feedback on the inclusion of critical biodiversity and ecological support areas in municipal spatial plans. • Develop policies, guidelines, and standards for the inclusion of critical biodiversity and ecological support areas in municipal spatial plans, including considerations for zoning, land use, and development regulations. • Integrate critical biodiversity and ecological support areas into the municipal spatial plans at all relevant scales, such as the Spatial Development Framework, Open Space Framework, and other relevant plans. • Monitor the implementation and effectiveness of the policies and guidelines for the inclusion of critical biodiversity and ecological support areas in municipal spatial plans and make adjustments as needed to ensure their continued protection and conservation.
<p>Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating inventories in the Spatial Development Framework and the open space framework.</p>	<ul style="list-style-type: none"> • Conducting surveys and assessments of the natural resources and ecosystems in the municipality. • Collecting and analysing data on the location, size, and ecological value of open spaces and natural resources, such as wetlands, and water bodies. • Identifying areas of high ecological value, such as critical habitats for threatened or endangered species, and designating them as protected areas. • Mapping the location and extent of identified open spaces, ecosystems, and natural resources, using geographic information system (GIS) technology or other mapping tools. • Integrating the mapping and inventory information into the Spatial Development Framework, open space framework, and other relevant plans, to guide future development and land-use decisions.

	<ul style="list-style-type: none"> • Updating the mapping and inventory information regularly to ensure it remains accurate and up-to-date with any changes in the natural environment.
<p>Identifying undeveloped open space with potential for green infrastructure.</p>	<ul style="list-style-type: none"> • Conducting an inventory of undeveloped open spaces within the municipality. • Evaluating the potential for green infrastructure development in identified spaces. • Assessing the suitability of undeveloped open spaces for different types of green infrastructure (e.g., parks, urban forests, green roofs, bioswales). • Considering factors such as land ownership, existing land use, soil conditions, topography, and hydrology when identifying undeveloped open spaces with potential for green infrastructure. • Prioritising undeveloped open spaces based on their potential to provide multiple benefits, such as biodiversity conservation, climate change mitigation and adaptation, and public health and well-being. • Engaging with stakeholders and the public to gather input and support for identifying and prioritising undeveloped open spaces with the potential for green infrastructure.
<p>Assessing the value of open spaces and ecosystem services</p>	<ul style="list-style-type: none"> • Conducting ecological assessments to determine the ecological value of open spaces and ecosystems. • Identifying the ecosystem services these areas provide, such as carbon sequestration, water filtration, and habitat provision. • Assessing the potential impacts of development or other human activities on these ecosystem services and the overall ecological value of the areas. • Using this information to inform decisions about land use and development ensures that these areas' ecological value is protected and enhanced. • Developing policies and regulations to protect and manage these areas, such as zoning restrictions or conservation easements.

4.6. Climate Change Goal 3: To Develop Effective Flood Management Strategies to Mitigate the Risks Associated with Heavy Rainfall Events.

Goal:	<ul style="list-style-type: none"> To design and implement robust flood management strategies in Sedibeng District Municipality to alleviate the hazards related to heavy rainfall events, adapting to the evolving climate change patterns.
Outcome:	<ul style="list-style-type: none"> A resilient Sedibeng District Municipality effectively equipped to manage and mitigate the risks of flooding events, safeguarding communities and infrastructure while enhancing adaptive capacity to handle climate-induced heavy rainfall scenarios.
Linkage to SDM Strategic Objectives	<ul style="list-style-type: none"> S01: To promote efficient and effective integrated services that address the socio-economic and environmental development imperatives of the Region. The development of flood management strategies directly aligns with this objective, as climate change, including increased heavy rainfall events, directly impacts the region's socioeconomic well-being. Effective flood management can protect livelihoods, food security, public health, and infrastructure. S02: To implement prudent and cost-effective financial management and sustainability. Implementing effective flood management strategies can be a cost-effective way to mitigate the potential fiscal pressures of climate change. These strategies, ranging from infrastructure improvements to community education and early warning systems, can reduce the cost of climate-induced disasters, promoting long-term financial sustainability. S03: To ensure good governance and sound management practices. Effective flood management strategies require good governance and sound management practices. These include clear policy articulation, transparency in decision-making, effective coordination of stakeholders, and consistent enforcement of regulations. This objective underscores the importance of adaptive management in responding to the uncertainties of climate change. S04 - To ensure effective service delivery. Climate Change Goal 3's emphasis on flood management strategies is integral to ensuring effective service delivery. Services such as emergency response and waste management may be directly affected by heavy rainfall and flooding. By implementing robust flood management strategies, Sedibeng ensures that its services can remain effective and reliable in the face of changing climate conditions.

4.6.1. Rationale/Context

The Sedibeng District Municipality is faced with a dynamic and potentially escalating flood risk. As climate change progresses, fluctuations in extreme rainfall patterns pose significant threats to the region. The western region, including the Lesedi Local Municipality, is projected to see a rise in extreme rainfall days, which could increase the risk of flooding. Meanwhile, settlements

such as Heidelberg and Walkerville, under high greenhouse gas emissions scenario RCP8.5, are predicted to face an elevated risk of flooding. Evaluating these risks requires a thorough integration of diverse data sources, including climate data, historical flood events, and an understanding of the specific attributes of local water catchments.

Given the variable flood hazard index across the district, it's clear that the risk of flooding is not uniform but concentrated in certain areas, particularly in the central and northern regions. This underscores the importance of adopting location-specific flood management strategies that not only consider the anticipated future changes in climate but also the current topography, land use, and existing infrastructure. As these flood-prone areas are often home to vulnerable communities and critical infrastructure, it is imperative that flood management strategies are designed to effectively mitigate risks and ensure the safety of both people and property. Developing effective flood management strategies is therefore a critical part of Sedibeng District Municipality's climate change adaptation plan. The Climate Goal involves the following programmes:

- Programme 9 - Stormwater drainage systems improvement programme: Enhance the capacity and resilience of the stormwater drainage system to cope with increasing volumes of water during extreme rainfall events.
- Programme 10 - Floodplain and retention basin development programme: Create and manage floodplains and retention basins that can absorb and store excess water during flooding events, reducing the flood risk to surrounding areas.
- Programme 11 - Flood early warning systems implementation programme: Develop and implement a system that provides early warnings for floods. This would allow communities to evacuate in time, reducing the risk to life and property.
- Programme 12 - Flood risk awareness and education programme: Increase community awareness about flood risks and educate residents about actions they can take before, during, and after a flood event to reduce damage and ensure their safety.
- Programme 13 - Infrastructure resilience programme: Strengthen key infrastructure to withstand flooding and ensure continuity of essential services during extreme rainfall events.
- Programme 14 - Flood insurance programme: Promote flood insurance as a means of financial protection against flood damage for homeowners and businesses in high-risk areas.

By developing and implementing these programmes, Sedibeng District Municipality can significantly reduce the impacts of flooding on its communities and infrastructure, improving its resilience in the face of climate change.

4.6.2. Programme 9: Stormwater Drainage Systems Improvement Programme

Programme 8 - The stormwater drainage systems improvement programme is of paramount importance to the Sedibeng District Municipality given the projected increase in extreme rainfall events and flood risk. An efficient, robust, and resilient stormwater drainage system is crucial to managing the excess water produced during such events. It not only reduces the immediate flood risk by directing water away from populated areas and critical infrastructure but also mitigates the secondary effects of flooding such as water pollution, erosion, and sedimentation that can impact water quality and availability in the long term.

Table 15: Programme 9 - The stormwater drainage systems improvement programme.

Programme 9 - The Stormwater Drainage Systems Improvement Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Assessment and upgrade of existing infrastructure.	<ul style="list-style-type: none"> • Conduct comprehensive assessments of the current stormwater drainage systems to determine the need for upgrades or repairs. • Map the existing drainage network, evaluate its capacity, and condition, and identify bottlenecks or areas prone to blockages.
Design and construction of new infrastructure.	<ul style="list-style-type: none"> • Where necessary, initiate the design and construction of new stormwater drainage infrastructure to accommodate the projected increases in rainfall. • Incorporate future climate scenarios, urban growth trends, and land use changes into the design and planning of new stormwater infrastructure.
Green infrastructure integration.	<ul style="list-style-type: none"> • Advocate for the use of green infrastructure such as rain gardens, bioswales, and permeable pavements to supplement traditional drainage systems. • Educate stakeholders on how green infrastructure not only helps manage stormwater but also provides additional benefits such as improving water quality, creating habitat, and enhancing urban aesthetics.
Maintenance and management plan.	<ul style="list-style-type: none"> • Develop a plan for regular maintenance and management of the stormwater drainage system. This should include provisions for clearing debris and blockages and repairing damaged infrastructure. • Establish a routine inspection schedule to ensure the system is functioning optimally.
Field surveys.	<ul style="list-style-type: none"> • Conduct field surveys to gather data on existing drainage infrastructure
Use of GIS and hydraulic modelling.	<ul style="list-style-type: none"> • Utilize Geographic Information Systems (GIS) and hydraulic modelling tools to simulate stormwater flow and identify areas at risk of flooding

Engagement of professionals.	<ul style="list-style-type: none"> Engage with engineers, architects, urban planners, and landscape architects in the design of new drainage infrastructure and the integration of green infrastructure.
Public awareness campaigns.	<ul style="list-style-type: none"> Run public awareness campaigns to educate the community about the importance of keeping stormwater drains clear of waste and debris.
Training for maintenance crews.	<ul style="list-style-type: none"> Provide regular training for maintenance crews to ensure they are equipped with the necessary skills and knowledge to effectively maintain and manage the stormwater drainage system.

4.6.3. Programme 10: Floodplain and Retention Basin Development Programme

The Floodplain and Retention Basin Development Programme is critically important for the Sedibeng District, especially in light of projected increases in extreme rainfall events. This programme focuses on creating and managing floodplains and retention basins, which act as natural or engineered catchment areas capable of absorbing and storing excess water during flooding events. By doing so, they significantly reduce the flood risk to surrounding areas, protecting both human lives and infrastructure.

This form of green infrastructure can also provide additional environmental and societal benefits, such as supporting biodiversity by creating new habitats for various species, improving water quality through natural filtration processes, and providing recreational areas for communities. Consequently, these strategies not only contribute to climate resilience but also promote ecological sustainability and social well-being.

Table 16: Programme 10: Floodplain and retention basin development programme.

Programme 10: Floodplain and Retention Basin Development Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Floodplain and retention basin identification and design.	<ul style="list-style-type: none"> Conduct a thorough assessment of the district to identify suitable areas for the creation or enhancement of floodplains and retention basins. This would take into account factors such as topography, soil type, and existing waterways. Design floodplains and retention basins in a manner that maximizes their water storage capacity enhances local biodiversity, and, where possible, provides recreational opportunities for local communities.
Construction and restoration of floodplains and retention basins.	<ul style="list-style-type: none"> Carry out construction or restoration work to create new or enhance existing floodplains and retention basins. This would involve activities such as earthworks, planting of appropriate vegetation, and the creation of water control structures.

Regular maintenance and management.	<ul style="list-style-type: none"> Develop a maintenance and management plan to ensure the ongoing functionality of floodplains and retention basins. This could include activities such as periodic removal of sediment, control of invasive species, and repair of any damaged water control structures.
Community engagement and education.	<ul style="list-style-type: none"> Engage local communities and stakeholders in the planning and management of floodplains and retention basins. This could include public consultation during the design phase, community involvement in planting activities, and educational programmes to raise awareness of the benefits of these natural flood mitigation measures.
Monitoring and evaluation.	<ul style="list-style-type: none"> Implement a monitoring and evaluation programme to assess the effectiveness of floodplains and retention basins in reducing flood risks and delivering additional benefits. This could involve the collection and analysis of data on water levels, biodiversity, and usage of the area by local communities.

4.6.4. Programme 11: Flood Early Warning Systems Implementation Programme

The Flood Early Warning Systems Implementation Programme is crucial to enhancing Sedibeng District's resilience to climate change, particularly concerning the increasing risk of extreme rainfall events and subsequent flooding. By developing and implementing an early warning system for floods, the district can ensure that communities are adequately forewarned, allowing for timely evacuation and safeguarding of possessions. This reduces the risk to human lives and minimizes property damage.

Early warning systems can also serve to strengthen community preparedness and response capacity, enhancing overall disaster resilience. Furthermore, they can guide local government decision-making related to emergency response and recovery operations. Therefore, the implementation of a comprehensive flood early warning system is a critical climate adaptation measure for Sedibeng District.

Table 17: Programme 11 - Flood early warning systems implementation programme.

Programme 11: Flood Early Warning Systems Implementation Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Development of early warning systems.	<ul style="list-style-type: none"> Undertake a detailed study to identify flood-prone areas, taking into account current and future climate scenarios as well as geographical and hydrological factors.

		<ul style="list-style-type: none"> • Design and develop the early warning system, incorporating technologies such as real-time monitoring stations, rainfall radar, hydrological models, and communication systems.
Installation monitoring equipment.	of	<ul style="list-style-type: none"> • Install monitoring equipment such as rain gauges and water level sensors in key locations throughout the district. This equipment should be linked to a centralized system for real-time data collection and analysis.
Establish communication channels.		<ul style="list-style-type: none"> • Establish efficient and reliable communication channels to disseminate early warning information to communities, emergency services, and relevant government departments. This could involve the use of SMS alerts, social media, local radio stations, and community alarm systems.
Community engagement and education.	and	<ul style="list-style-type: none"> • Conduct community awareness and education programmes to ensure that residents understand the early warning system, know how to interpret warnings, and are familiar with evacuation procedures.
Regular maintenance and system upgrades.		<ul style="list-style-type: none"> • Implement a regular maintenance schedule for the monitoring equipment to ensure its continuous and accurate operation. Periodically review and upgrade the early warning system to incorporate advances in technology and reflect changes in climate risk.
Monitoring and evaluation.	and	<ul style="list-style-type: none"> • Continually monitor and evaluate the effectiveness of the early warning system in reducing flood risk. This could involve the collection and analysis of data on response times, evacuation rates, and flood damage incidents.

4.6.5. Programme 12: Flood Risk Awareness and Education Programme

The *flood risk awareness and education programme* is a significant component of the district's climate change adaptation plan. It aims to ensure that the community is informed about flood risks, as well as the actions they can undertake before, during, and after a flood to minimize damage and ensure their safety. Moreover, increasing awareness of the problems caused by refuse in stormwater systems, responsible use of refuse transfer stations, and general environmental health problems caused by indiscriminate dumping of waste material is integral to mitigating flood risks and maintaining a healthier environment. Indiscriminate waste disposal can block drainage systems, exacerbating flood risks and contaminating water sources. Hence, responsible waste management and disposal is a necessary measure to mitigate flood risks and safeguard water quality.

Table 18: Programme 12: Flood risk awareness and education programme.

Programme 12: Flood Risk Awareness and Education Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Development of an integrated public education programme.	<ul style="list-style-type: none"> Design and launch a comprehensive education programme focusing on flood risk awareness, emergency preparedness, and responsible waste management.
Anti-littering campaign.	<ul style="list-style-type: none"> Initiate an anti-littering campaign to educate the public on the problems caused by refuse in stormwater systems. This should emphasize the detrimental impact of blocked drains on flood risk.
Responsible waste management education.	<ul style="list-style-type: none"> Conduct educational sessions on the correct use of refuse transfer stations, including segregation and disposal of household waste.
Awareness on environmental health problems.	<ul style="list-style-type: none"> Organize workshops or community events to highlight environmental health problems caused by indiscriminate dumping of waste material. Stress the importance of maintaining a clean environment for overall public health and safety.
Community training on flood preparedness and response.	<ul style="list-style-type: none"> Offer training sessions for community members on flood preparedness, including what to do during and after a flood event, and evacuation procedures.
Regular monitoring and evaluation.	<ul style="list-style-type: none"> Periodically evaluate the effectiveness of the awareness and education programme and adjust strategies based on feedback and evolving needs. This could involve conducting surveys to measure community knowledge and preparedness levels and identifying areas for improvement.

4.6.6. Programme 13: Infrastructure Resilience Programme

The Infrastructure Resilience Programme is vital for the Sedibeng District, particularly in the face of climate change projections that indicate an increase in extreme rainfall events. Flooding can have devastating impacts on the community, not just in terms of immediate physical damage, but also by disrupting essential services such as electricity, water supply, and transportation. By strengthening key infrastructure to withstand these events, Sedibeng can ensure the continuity of these services, mitigate potential damage, and increase the resilience of the community to weather-related hazards.

Table 19: Programme 13 - Infrastructure resilience programme.

Programme 13: Infrastructure Resilience Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Vulnerability assessment of existing infrastructure.	<ul style="list-style-type: none"> Carry out a thorough vulnerability assessment of existing infrastructure to identify areas most at risk during flood events and extreme rainfall. This will involve examining the structural integrity of buildings, bridges, roads, and other infrastructure, as well as their proximity to flood-prone areas.
Infrastructure upgrade and retrofitting.	<ul style="list-style-type: none"> Based on the vulnerability assessment, upgrade or retrofit the infrastructure identified as high-risk. This could involve improving the design of buildings to make them more flood-resistant, reinforcing roads and bridges, and enhancing drainage systems to manage stormwater effectively.
Integration of climate resilience in future infrastructure development.	<ul style="list-style-type: none"> Integrate climate resilience into the planning, design, and construction of all new infrastructure projects. This means ensuring that any new infrastructure is designed to withstand predicted future climate conditions, including increased flooding.
Emergency power and communication systems.	<ul style="list-style-type: none"> Install emergency power and communication systems to ensure the continuity of essential services during extreme events. This could include backup generators at key facilities and robust communication systems to keep the public informed during a disaster.
Regular inspection and maintenance.	<ul style="list-style-type: none"> Conduct regular inspections and maintenance to ensure the structural integrity of key infrastructure, and to identify and fix potential issues before they lead to more serious problems.
Infrastructure resilience training for engineers and planners.	<ul style="list-style-type: none"> Provide training for engineers and urban planners on the latest techniques and technologies for building resilient infrastructure. This can help to ensure that the district's infrastructure is able to withstand future climate challenges.

4.6.7. Programme 14: Flood Insurance Programme

The Flood Insurance Programme represents an important risk management tool for homeowners and businesses in Sedibeng District, especially those located in high-risk flood areas. Given the increasing incidence of extreme rainfall and subsequent flooding due to climate

change, financial protection against flood damage becomes crucial. Flood insurance helps spread the financial risk of flood damage over a larger group of people, making recovery more feasible for individuals and businesses. This programme can play a vital role in improving the district's resilience to flood events and ensuring a quicker return to normalcy after a flood.

Table 20: Programme 14 – Flood insurance programme,

Programme 14: Flood Insurance Programme,	
ACTIONS	POSSIBLE KEY ACTIVITIES
Awareness and education campaign.	<ul style="list-style-type: none"> Run an education campaign to increase awareness about the risks of flooding and the benefits of flood insurance. This could involve community meetings, distribution of informational materials, and social media campaigns.
Collaboration with insurance providers.	<ul style="list-style-type: none"> Establish partnerships with insurance providers to offer affordable and comprehensive flood insurance policies. This could involve negotiating group rates or incentives for homeowners and businesses in the district.
Risk mapping and assessment.	<ul style="list-style-type: none"> Conduct risk mapping and assessments to identify the areas most at risk of flooding. This information can be used by insurance companies to determine premiums and by homeowners and businesses to understand their level of risk.
Assistance with insurance enrolment.	<ul style="list-style-type: none"> Provide assistance with insurance enrollment, particularly for those in high-risk areas. This could involve setting up assistance centres or providing online resources to help residents understand their coverage options and complete the enrollment process.
Review and adapt insurance policies.	<ul style="list-style-type: none"> Regularly review and adapt insurance policies to reflect changes in flood risk due to climate change and other factors. This ensures that insurance coverage remains relevant and provides sufficient protection for policyholders.

4.7. Climate Change Goal 4: To Reduce The Vulnerability and Exposure of Human and Natural Systems to Climate Change and Extreme Events.

Goal:	To cultivate resilience in the District's human and natural systems against climate change and extreme weather events, by initiating comprehensive risk mitigation and adaptation strategies.
Outcome:	A fortified District, with human and natural systems, exhibiting heightened resilience and decreased vulnerability to climate-induced changes and extreme events, ensuring the safety and sustainability of communities and ecosystems.

Linkage to SDM
Strategic
Objectives

- S01 - To promote efficient and effective Integrated Services that address the socio-economic and environmental development imperatives of the Region. Reducing vulnerability and exposure to climate change aligns directly with this objective, as such actions can protect the region's socio-economic health, from livelihoods and food security to public health and infrastructure.
- S02 - To implement prudent and cost-effective financial management and sustainability. Initiating comprehensive risk mitigation and adaptation strategies can contribute to cost-effective management and long-term sustainability. By proactively investing in these strategies, the District can lessen the potential fiscal pressures that may arise from climate-induced disasters.
- S03 - To ensure good governance and sound management practices. Cultivating resilience requires the practice of good governance, including clear policy articulation, transparency in decision-making, effective coordination of stakeholders, and consistent enforcement of regulations. This also aligns with the need for sound management practices that are adaptive to the uncertainties of climate change.
- S04 - To ensure effective Service Delivery. Climate Change Goal 4 directly relates to this objective, as climate change affects essential services like water supply, waste management, and emergency response. These services need to be resilient to climate variability and change, and risk mitigation and adaptation strategies can ensure these services remain effective, thereby maintaining the socio-economic well-being of the District's inhabitants.

4.7.1. Context

The climate change projections for Sedibeng District Municipality illustrate a dramatic shift in regional climate dynamics, marked by increased instances of extreme heat, drought tendencies, wildfires, and heightened flood risks. Such transformations are liable to put substantial pressure on both human and natural systems, potentially jeopardizing socio-economic stability and ecosystem health. Therefore, the strategic priority, "To Reduce The Vulnerability and Exposure of Human and Natural Systems to Climate Change and Extreme Events," is essential to protect life, livelihoods, and biodiversity in the district.

The trend towards rising temperatures, with a projected increase of up to 20 more very hot days per annum, indicates a heightened risk of heatwaves and associated public health issues such as heat stress and exacerbated chronic illnesses. The incidence of wildfires also appears set to increase in various settlements. These events not only pose direct physical risks but also lead to significant economic damages and affect air quality, aggravating respiratory conditions. Hence, protecting communities from these challenges becomes crucial, requiring robust disaster management strategies and public health interventions.

Moreover, the shifts in precipitation patterns, with variable flood and drought tendencies across the district, could strain water resources and agricultural systems. The projected decrease in rainfall in the eastern parts of the district and increased drought tendencies could exacerbate water scarcity, while the anticipated rise in extreme rainfall days in the western regions could heighten flood risks, leading to potential damage to infrastructure, loss of property, and disruption of livelihoods. Natural ecosystems too, face the threat of disruption, altering habitats, and affecting biodiversity. Given these circumstances, reducing vulnerability and exposure to these extreme events is fundamental to securing water resources, ensuring food security, and maintaining ecosystem health, making it a top strategic priority in the climate adaptation report.

- Programme 15 - Integrated fire management for climate resilience: This programme focuses on reducing wildfire risks and impacts through comprehensive management strategies, directly contributing to reducing human and natural systems' vulnerability and exposure to climate-induced fire events.
- Programme 16 - Identify and prioritise climate change risks and develop response measures for settlements: By identifying key climate risks and creating specific response plans, this programme aims to enhance the resilience of settlements and reduce exposure to extreme climate events, in line with the strategic priority of reducing vulnerability and exposure.
- Programme 17 - Climate-smart waste management promotion: This programme not only promotes climate-smart waste practices to lower greenhouse gas emissions and prevent contamination, but it also combats issues of illegal dumping and pollution. By advocating for responsible waste disposal and pollution management, it aims to reduce the vulnerability of natural systems to environmental degradation and human exposure to health hazards associated with unsanitary conditions and polluted environments. This approach significantly contributes to reducing the vulnerability and exposure of both human and natural systems to climate change impacts and other environmental threats.
- Programme 18: Community-based adaptation in communities most at risk of climate-related hazards: This programme centres on empowering vulnerable communities to adapt to climate changes, thus directly aligning with the strategic priority of reducing human vulnerability and exposure to extreme climatic events.
- Programme 19: Climate-resilient spatial planning: By integrating climate change considerations into spatial planning, this programme aims to shape a built environment that can withstand and recover from climate disturbances, thereby reducing the vulnerability and exposure of both human and natural systems to climate change impacts.

4.7.2. Programme 15: Integrated Fire Management for Climate Resilience

The "*integrated fire management for climate resilience*" programme is crucial for Sedibeng District Municipality, considering both its current state and future projections of wildfire risk. With several settlements located at the wildland-urban interface, such as Heidelberg, Vaal Marina, and Vanderbijlpark, the district is particularly vulnerable to wildfires. Moreover, future

predictions suggest an escalating threat level for some areas, accentuated by anticipated increased temperatures due to climate change.

This programme aims to systematically reduce the risk and impact of wildfires through a range of targeted activities. First, a "comprehensive evaluation of fire hazards" would involve assessing fire ecotypes, the likelihood of wildfire occurrence, potential severity, and socioeconomic repercussions. This helps to identify high-risk areas and informs strategic planning.

Next, the "strategic fire deterrence roadmap" will outline preventive measures and actions to mitigate wildfire risk. This could include maintaining firebreaks, managing flammable vegetation, and implementing safe land-use practices. "Community Engagement and Fire Safety Education" will involve creating awareness about fire risks, preventive measures, and actions to take during a wildfire.

To monitor wildfires, an "advanced fire detection and monitoring infrastructure" will be established, which could involve remote sensing technologies and early warning systems. In case of a fire outbreak, an "Emergency Preparedness and Response Strategy" will ensure swift and efficient containment and rescue operations.

After a wildfire, the "post-fire restoration and ecosystem rehabilitation" action will involve efforts to restore the ecosystem and rehabilitate affected areas. Simultaneously, "Policy and By-Law Development" will involve creating regulations that support wildfire management and climate resilience.

"innovation and research in fire management techniques" will encourage studies into more effective wildfire management strategies. Collaborations will be sought in "Inter-Organizational Collaboration and Strategic Partnerships" to share knowledge, resources, and support. Finally, the "Empowering Fire Management Capacities and Efficient Resource Allocation" activity will focus on enhancing the skills and abilities of wildfire management personnel and ensuring resources are used efficiently.

In essence, this programme seeks to enhance Sedibeng District's resilience against wildfires in a comprehensive and integrated manner, considering the projected impacts of climate change.

Table 21: Programme 15 - Integrated fire management for climate resilience.

Programme 15: Integrated Fire Management for Climate Resilience.	
ACTIONS	POSSIBLE KEY ACTIVITIES
A comprehensive evaluation of fire hazards.	<ul style="list-style-type: none"> Hazard identification: Identify areas prone to wildfires due to factors such as vegetation type, topography, climate, and historical fire patterns.

	<ul style="list-style-type: none"> • Vulnerability assessment: Analyze the vulnerability of human settlements, critical infrastructure, and ecosystems in the identified high-risk areas. • Climate change impact analysis: Assess how climate change could affect fire risk in the future, considering factors such as increasing temperatures, changing rainfall patterns, and frequency of extreme weather events. • Resource evaluation: Evaluate the current capacity and resources (human, technical, and financial) available to manage fire risks and respond to fire incidents. • Infrastructure assessment: Assess the condition of existing fire management infrastructure, such as fire breaks, firefighting equipment, and emergency access routes. • Fire behavior modeling: Use fire behavior models to predict how fires could spread under different conditions in the identified high-risk areas. • Risk mapping: Develop risk maps using GIS tools to visualize areas of high fire risk, the potential spread of fires, and vulnerable ecosystems or infrastructure. • Review and update: Regularly review and update the fire risk assessment to account for changes in land use, climate, and other relevant factors.
Strategic fire prevention roadmap.	<ul style="list-style-type: none"> • Firebreak creation: Identify and create strategic firebreaks to halt the progress of wildfires. This may involve clearing vegetation or using controlled burns to remove fuel sources. • Controlled burns: Conduct controlled or prescribed burns to reduce excess vegetation that could fuel wildfires. This needs to be done under strict supervision and under specific weather conditions. • Public education campaigns: Develop and deliver education programs to raise community awareness about fire risks and prevention measures. This can include information on safe practices for outdoor burning, campfires, and disposal of cigarettes. • Legislation and policy: Advocate for and implement local regulations that reduce fire risk, such as restrictions on burning during high-risk periods and regulations around building materials and designs in fire-prone areas. • Vegetation management: Implement a program for managing vegetation, including the removal of dead or dying trees, pruning overgrown areas, and planting fire-resistant species in high-risk areas. • Infrastructure planning: Plan infrastructure considering fire prevention, such as the design and location of roads, utilities, and buildings to minimize fire risks. • Emergency access routes: Ensure clear and accessible emergency routes for firefighters and residents in the event of a

	<p>fire. This includes regularly inspecting and maintaining these routes.</p> <ul style="list-style-type: none"> • Community fire plans: Help communities in high-risk areas develop comprehensive fire plans, including evacuation routes, emergency contact numbers, and plans for livestock and pets. • Fire detection systems: Install and maintain early fire detection systems to identify and respond to fires as quickly as possible. • Collaboration and cooperation: Cooperate with regional, national, and international fire management agencies, sharing knowledge, resources, and best practices in fire prevention.
<p>Community engagement and fire safety education.</p>	<ul style="list-style-type: none"> • Community workshops and seminars: Conduct educational workshops and seminars about climate change, fire risks, and fire prevention. Explain the connections between climate change and increased fire risks, and what actions individuals can take to mitigate these risks. • Development of educational materials: Develop and distribute educational materials such as brochures, posters, and online resources that provide information on fire prevention, response measures, and the importance of environmental management. • Fire safety training: Organize practical fire safety training sessions, including demonstrations on how to use firefighting equipment, evacuation drills, and basic firefighting skills. • School programs: Implement education programs in schools to raise awareness among younger generations about climate change and fire prevention. • Community fire plans: Assist communities in developing comprehensive fire management plans, including evacuation routes and emergency procedures. Ensure each member of the community understands the plan and their role in it. • Public meetings: Hold regular public meetings to discuss fire risks, prevention strategies, and any updates or changes to the fire management plan. • Social media campaigns: Utilize social media platforms to disseminate information, provide updates on fire incidents, and engage the community in dialogues about fire management. • Collaborative community projects: Organize community projects such as tree planting, vegetation management, and firebreak maintenance. This not only helps reduce fire risks but also fosters community involvement in environmental conservation. • Emergency services open days: Organize open days at local fire stations to educate the community about their work, demonstrate equipment, and provide information on volunteering opportunities. • Partnerships with local organizations: Collaborate with local NGOs, community groups, and businesses to spread the message of fire prevention and climate change mitigation.

<p>Advanced detection monitoring infrastructure.</p> <p>fire and</p>	<ul style="list-style-type: none"> • Satellite monitoring: Utilize satellite imagery to monitor fire incidents across the district. Satellites can provide real-time data on the location, size, and spread of fires. • Ground-based sensors: Deploy ground-based sensors in high-risk areas that can detect smoke or heat and send an immediate alert when a fire starts. • Drone surveillance: Use drones equipped with thermal cameras for real-time surveillance of high-risk areas, especially during high-risk periods. Drones can provide detailed images of fires, helping to assess their severity and direction of spread. • Fire towers: Construct or make use of existing fire towers where personnel can visually monitor large areas for signs of smoke, especially in remote or inaccessible regions. • Community reporting systems: Establish a clear and efficient system for community members to report suspected fires. This could be a dedicated phone line or a mobile app. • Weather monitoring: Regularly monitor weather conditions, as certain conditions such as high temperatures, low humidity, and strong winds can increase fire risk. • Fire risk mapping: Use GIS and remote sensing data to create dynamic fire risk maps that can help in prioritizing monitoring efforts. • Data integration and analysis: Integrate data from different monitoring sources and use advanced analytics to identify patterns, predict fire behaviour, and improve response strategies. • Regular System maintenance and upgrades: Regularly maintain and upgrade monitoring equipment to ensure it is functioning correctly and taking advantage of the latest technology. • Collaboration with national and regional agencies: Collaborate with national and regional agencies for data sharing and to improve the effectiveness of fire monitoring efforts.
<p>Emergency preparedness and response strategy.</p>	<ul style="list-style-type: none"> • Emergency response plan development: Develop comprehensive emergency response plans outlining procedures for fire detection, suppression, evacuation, communication, and post-fire recovery. • Evacuation plans: Create evacuation plans for at-risk communities, including clear escape routes, assembly points, and emergency shelters. • Firefighting equipment and infrastructure: Ensure the availability of adequate firefighting equipment and infrastructure, such as fire trucks, water supplies, and protective clothing. Regularly check and maintain these resources to ensure they are always ready to use. • Training and drills: Conduct regular training exercises and drills for emergency services and the community to ensure everyone

	<p>understands their roles and responsibilities during a fire incident.</p> <ul style="list-style-type: none"> • Emergency communication systems: Establish reliable communication systems to quickly alert emergency services, community members, and neighbouring regions about a fire incident. • Collaboration and coordination: Coordinate with local, regional, and national fire services, law enforcement, healthcare providers, and other relevant stakeholders to ensure a cohesive response during an emergency. • Public education: Educate the public about what to do in case of a fire, including when and how to evacuate, the importance of adhering to alerts and directives, and basic fire safety measures. • Resource mobilization: Ensure mechanisms are in place for quick mobilization of resources such as personnel, equipment, and financial assistance during a fire emergency. • Post-fire assessment and recovery: Develop and implement strategies for rapid post-fire assessment and recovery, including immediate steps to prevent further damage (like soil erosion) and long-term plans for rehabilitation and restoration. • Regular plan review and update: Regularly review and update the emergency preparedness and response plan based on lessons learned from previous fire incidents, changes in the community or environment, and advancements in technology.
<p>Post-fire restoration and ecosystem rehabilitation.</p>	<ul style="list-style-type: none"> • Damage assessment: Conduct post-fire assessments to determine the extent of the damage to ecosystems, infrastructure, and communities. This will guide the restoration efforts. • Erosion control: Implement immediate erosion control measures to prevent soil loss and water pollution, especially in areas where vegetation has been destroyed by fire. • Revegetation: Undertake revegetation efforts, which may include planting native trees and plants or facilitating natural regeneration processes. • Soil restoration: Implement measures to restore soil health, such as adding organic matter or compost, which can help to promote plant growth and restore soil fertility. • Wildlife management: Implement measures to protect and support wildlife after a fire, including providing temporary food and water sources, creating safe habitats, and monitoring injured animals. • Infrastructure repair and rebuilding: Repair or rebuild damaged infrastructure, considering fire-resistant materials and designs to reduce future fire risks.

	<ul style="list-style-type: none"> • Monitoring: Regularly monitor the progress of rehabilitation and restoration activities to assess their effectiveness and make necessary adjustments. • Community support: Provide support to affected communities, which may include psychological support, temporary housing, financial assistance, and help with rebuilding efforts. • Research and learning: Conduct research to understand the impact of the fire and the effectiveness of restoration efforts, and use the findings to improve future rehabilitation strategies. • Adaptive management: Apply an adaptive management approach to restoration, which involves learning from ongoing activities and adjusting management strategies accordingly.
<p>Policy and by-law development.</p>	<ul style="list-style-type: none"> • Policy and by-law development: Develop local policies and by-laws related to fire management and environmental conservation, such as regulations on controlled burns, vegetation management, and building codes in fire-prone areas. • Policy review and revision: Regularly review and revise existing policies and by-laws to ensure they are up-to-date, effective, and aligned with current fire management practices and climate change realities. • Legislation advocacy: Advocate for state and national legislation that supports fire management, climate resilience, and environmental conservation efforts. This might involve lobbying, partnership with other municipalities, and collaboration with NGOs and civil society organizations. • Compliance monitoring: Set up systems to monitor compliance with local by-laws and policies related to fire management and environmental conservation. • Enforcement measures: Establish and implement measures to enforce local by-laws, such as fines for non-compliance, and ensure these measures are well-publicized and understood by the community. • Public consultation: Engage in public consultation when developing or revising policies and by-laws to ensure they reflect community needs and perspectives, and to encourage community buy-in and compliance. • Interdepartmental coordination: Coordinate with other local government departments to ensure policies and by-laws are integrated across different sectors and align with broader municipal strategies and plans. • Training and education: Conduct training and education programs for local government staff, stakeholders, and the community about new and existing policies and by-laws, why they are important, and what is required for compliance. • Policy research: Conduct and use research to inform policy development, including best practices from other municipalities

	<p>and regions, and evidence on the effectiveness of different fire management strategies.</p> <ul style="list-style-type: none"> • Partnerships: Build partnerships with other levels of government, research institutions, NGOs, and the private sector to support policy development and legislation efforts.
<p>Innovation and research in fire management techniques.</p>	<ul style="list-style-type: none"> • Collaborative research initiatives: Establish collaborations with local universities, research institutions, and NGOs to conduct R&D projects related to fire management and climate change adaptation. • Consultant appointments: Hire consultants with expertise in fire management, climate change, and related fields to conduct research, analysis, and provide recommendations. • Grant applications: Apply for research grants from national, provincial, or international funding sources. These funds can be used to conduct R&D projects or hire consultants. • Data gathering and analysis: Conduct surveys, interviews, and community meetings to gather local knowledge and experiences related to fire management. Analyze this data to inform strategies and policies. • Technology adoption: Explore and adopt existing technologies for fire detection, monitoring, and management, taking into account local conditions and resources. • Research dissemination and utilization: Ensure that research findings are communicated to all relevant stakeholders, including local communities, and are used to inform policies, programs, and practices. • Training and capacity building: Organize training sessions and workshops to increase the capacity of local staff in using and interpreting research findings. • Policy impact research: Commission or conduct studies to assess the impact of current policies and programs, and use the findings to improve them. • Community-based research: Engage local communities in research activities, such as citizen science projects, to leverage local knowledge and increase community buy-in. • Monitoring and evaluation: Monitor and evaluate the effectiveness of R&D activities and use the findings to improve future R&D efforts.
<p>Inter-organizational collaboration and strategic partnerships.</p>	<ul style="list-style-type: none"> • Inter-municipal collaboration: Collaborate with other district municipalities to share knowledge, best practices, and resources related to fire management and climate adaptation. This can involve formal agreements or more informal networks. • Partnerships with higher levels of government: Work closely with provincial and national government agencies responsible for the environment, fire management, and disaster response. This can help to align strategies, access resources, and advocate for supportive policies.

	<ul style="list-style-type: none"> • Partnerships with universities and research institutions: Establish partnerships with academic and research institutions to access technical expertise, conduct joint research projects, and provide training opportunities. • Community engagement: Work closely with local communities, involve them in decision-making processes, and tap into local knowledge and resources. This can increase community buy-in and resilience. • Private sector engagement: Engage with the private sector, including businesses and industry groups, to leverage their resources, skills, and influence. This can involve partnerships for specific projects or initiatives, sponsorship agreements, or corporate social responsibility programs. • Collaboration with non-governmental organizations (NGOs): Partner with local, national, or international NGOs that focus on the environment, climate change, or disaster response. NGOs can provide various types of support, from technical expertise and funding to advocacy and community mobilization. • International collaboration: Engage with international networks, organizations, and initiatives focused on climate adaptation and fire management to share experiences, learn from others, and access international resources and funding. • Joint funding Applications: Collaborate with partners to apply for funding from national, provincial, or international sources. Joint applications can be more competitive and enable larger and more impactful projects. • Collaborative training and capacity building: Work with partners to organize training programs and capacity-building activities for municipal staff, community members, and other stakeholders. • Joint monitoring and evaluation: Collaborate with partners to monitor and evaluate the impact of partnership activities, learn from experiences, and improve future collaboration.
<p>Empowering Fire Management Capacities and Efficient Resource Allocation.</p>	<ul style="list-style-type: none"> • Training programs: Organize training programs for municipal staff, community members, and other stakeholders to enhance their knowledge and skills related to fire management, climate change adaptation, environmental conservation, policy development, and other relevant topics. • Recruitment and staffing: Hire and retain qualified personnel with the necessary skills for effective fire management and climate change adaptation. This may also involve providing ongoing professional development opportunities. • Volunteer programs: Develop and manage volunteer programs to supplement municipal efforts. Training local volunteers in fire management and climate adaptation techniques can not only boost capacity but also increase community resilience.

- Resource assessment: Conduct regular assessments of resource needs (financial, human, technical, etc.) and develop strategies to fill any gaps.
- Resource mobilization: Seek funding and other resources from national, provincial, and international sources. This may involve grant writing, advocacy, and establishing partnerships.
- Equipment acquisition and maintenance: Secure and maintain necessary equipment for fire management and climate adaptation, such as fire trucks, firefighting gear, monitoring equipment, etc.
- Information management systems: Develop and manage systems for information and data management to support decision-making and coordination.
- Community capacity building: Implement programs to build capacity at the community level, such as training in fire preparedness, risk reduction, and climate adaptation.
- Stakeholder engagement: Build capacity among various stakeholders, including local businesses, schools, community organizations, and others, to effectively contribute to fire management and climate adaptation efforts.
- Evaluation and improvement: Regularly evaluate capacity building and resource mobilization activities to ensure they are effective and make improvements as needed.

4.7.2 Programme 16: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.

The programme, "*identify and prioritise climate change risks and develop response measures for settlements*," plays a significant role in addressing climate change challenges faced by the Sedibeng District Municipality, given the region's susceptibility to numerous natural, technological, and environmental hazards, including severe storms, floods, tornadoes, informal settlement fires, and veld fires.

Key actions under this programme include conducting a vulnerability assessment to identify the populations and locations most at risk of climate change impacts. This understanding is vital in a region constantly threatened by diverse hazards, as it helps in establishing priority areas for interventions and formulating effective, targeted climate adaptation strategies.

Another essential component is the development and implementation of an early warning system. Given the exposure of the Sedibeng District to severe hydrometeorological events, having a robust early warning system is crucial to prepare communities for impending hazards and facilitate timely response to minimize the impact.

To ensure sustainable climate resilience, the programme emphasizes the importance of establishing partnerships with local stakeholders, such as community groups and NGOs. These partnerships foster local capacity-building, making communities more adept at handling climate change-related challenges, a critical need in a region frequently exposed to various environmental threats.

Lastly, the programme integrates climate change considerations into land use planning and zoning regulations. Given the area's vulnerability to environmental hazards, it's essential to adopt planning practices that consider potential climate impacts. These practices ensure the long-term resilience of human settlements, thereby reducing their vulnerability to the escalating effects of climate change.

Table 22: Programme 16 - Identify and prioritise climate change risks and develop response measures for settlements.

Programme 16: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.	
ACTIONS	KEY ACTIVITIES
Conducting a vulnerability assessment to identify the populations and locations most at risk of climate change impacts.	<ul style="list-style-type: none"> Analysing climate data to determine the frequency and severity of extreme weather events. Assessing the vulnerability of infrastructure to flooding and wildfire. Mapping areas with high concentrations of vulnerable populations.
Developing and implementing an early warning system to help communities prepare for and respond to climate change risks.	<ul style="list-style-type: none"> Installing weather monitoring systems to provide real-time data on extreme weather events. Developing protocols for disseminating warnings to the public. Establishing community response plans for different types of extreme weather events.
Establishing partnerships with local stakeholders, such as community groups and NGOs, to build local capacity for climate change adaptation and resilience.	<ul style="list-style-type: none"> Building partnerships with community groups to identify local needs and priorities for adaptation and resilience measures. Providing capacity-building training to community members on disaster preparedness and response. Collaborating with local NGOs to implement small-scale adaptation measures, such as rainwater harvesting and urban agriculture.
Developing and implementing land use planning and	<ul style="list-style-type: none"> Analysing maps of projected climate change impacts to identify areas at risk.

zoning regulations that take into account the potential impacts of climate change.

- Developing land use and zoning regulations to ensure that settlements are built in safe and sustainable locations.
- Providing technical assistance and support to developers to ensure that new projects are designed to withstand climate change impacts.

4.7.3 Programme 17: Climate-Smart Waste Management Promotion

The "climate-smart waste management promotion" programme within the Sedibeng District Municipality is pivotal in mitigating climate change impacts and managing the region's waste-related risks more effectively. At present, the region grapples with issues related to insufficient waste collection, largely due to inadequate waste infrastructure, like compactor trucks. Illegal dumping further compounds the problem, stressing the need for effective waste management strategies.

The Integrated Waste Management Plan, approved in November 2014, aims to align with the National Waste Management Strategy's goals. These include promoting waste minimization, reuse, recycling, and recovery, ensuring effective and efficient waste services, and growing the waste sector's contribution to the green economy, among others. However, these goals have been hampered by a lack of sufficient funding and adequately trained staff, necessitating an innovative approach to waste management.

Under this programme, several key actions are set to be taken:

- "Waste minimization and recycling innovation" is a critical step towards managing waste sustainably. The district will promote innovative ways of minimizing waste production and maximizing waste recycling, in line with the National Waste Management Strategy's goals. This could involve new technologies or methodologies to reduce waste or turn it into usable products, ultimately minimizing the environmental footprint of the region's waste.
- "Staff training and capacity building" is crucial given the current constraints of inadequately trained personnel. This action will equip municipal staff with the necessary skills and knowledge to manage waste efficiently and effectively, helping to overcome staffing shortfalls that have previously hindered progress.
- "Improved waste collection and transportation" aims to address the current issues related to insufficient waste collection. This will involve optimizing waste collection schedules, upgrading waste collection vehicles, and improving waste transportation processes, all to make waste collection more efficient and comprehensive.
- "Public awareness and illegal dumping reduction" will focus on educating the public about the importance of proper waste disposal and the environmental and health impacts of illegal dumping. This action is meant to promote responsible waste disposal practices among residents and help reduce the incidence of illegal dumping, thus safeguarding the health of the community and the local environment.

Table 23: Programme 17 - Climate-smart waste management promotion.

Programme 17: Climate-Smart Waste Management Promotion.	
ACTIONS	KEY ACTIVITIES
Waste minimization and recycling innovation.	<ul style="list-style-type: none"> • Conduct a feasibility study to identify innovative waste processing technologies that could be implemented within the municipality. • Develop recycling programs that incentivize households and businesses to recycle more, such as offering discounts or rebates based on the amount of waste recycled. • Establish dedicated recycling centres across the municipality to facilitate easier access for residents and businesses. • Monitor and evaluate the impact of these innovations on waste reduction and recycling rates, adjusting the program as necessary for maximum effectiveness.
Staff training and capacity building.	<ul style="list-style-type: none"> • Identify key areas of knowledge and skills required for effective waste management, such as waste collection, separation, and processing procedures. • Develop and implement a comprehensive training program for waste management staff, covering these key areas. • Provide ongoing support and resources for staff to continue learning and improving their skills. • Regularly review and update the training program to ensure it remains relevant and effective.
Improved waste collection and transportation.	<ul style="list-style-type: none"> • Carry out an assessment of the existing waste collection and transportation infrastructure to identify areas for improvement. • Develop a plan for upgrading this infrastructure, such as purchasing new, more efficient compactor trucks. • Implement the plan, monitor its effectiveness, and make necessary adjustments over time. • Conduct routine maintenance on the infrastructure to ensure it remains in good condition and operates efficiently.
Public awareness and illegal dumping reduction	<ul style="list-style-type: none"> • Develop a public awareness campaign to educate residents about the importance of responsible waste disposal and the dangers of illegal dumping. • Organize community clean-up events in areas affected by illegal dumping to foster a sense of community pride and responsibility. • Work with law enforcement to increase patrols in areas known for illegal dumping and impose penalties for those caught in the act. • Monitor and evaluate the impact of these activities on rates of illegal dumping, adjusting the strategy as necessary to achieve maximum effectiveness.

Each of these actions, accompanied by their subsequent activities, aim to create a robust and comprehensive approach to promote climate-smart waste management within the Sedibeng District Municipality.

4.7.3. Programme 18: Community-Based Adaptation in Communities Most at Risk of Climate-Related Hazards

The "community-based adaptation in communities most at risk of climate-related hazards" programme is crucial in building resilience and mitigating the impacts of climate change in Sedibeng District Municipality. It's built around the understanding that local communities, often the first to feel the impacts of climate change, need tailored, place-based adaptation measures. The programme emphasizes empowering local communities and leveraging their knowledge in creating and implementing climate adaptation strategies.

Key actions under this programme include:

- Conducting granular risk and vulnerability assessments in communities to identify drivers of risk and develop appropriate adaptation measures: This activity involves a detailed examination of specific climate risks that local communities face. By identifying these risks at a granular level, the municipality can develop adaptation measures that are specific, targeted, and effective.
- Developing and implementing community-based adaptation measures to reduce risks and build resilience: This involves local departments like the Department of Forestry, Fisheries, and the Environment (DFFE) that play a crucial role in promoting climate-smart agricultural practices, enhancing food security, and building community resilience. The goal is to reduce climate-related risks and strengthen the capacity of the communities to withstand and bounce back from adverse climate impacts.
- Providing training and education to build community capacity and promote sustainability: Through training and education, the programme aims to equip community members with the knowledge and skills needed to adapt to climate change. This can help to promote sustainable practices at the local level, fostering a more resilient community.
- Comprehensive Community Engagement and Public Awareness Initiative on Climate Change: This initiative is designed to raise awareness about climate change and involve the community in addressing it. By engaging local organisations, schools, and community groups, the programme ensures that the awareness campaign is inclusive, accessible, and relevant to all members of the community.

By focusing on community-level adaptation, the programme plays a crucial role in reducing the vulnerability of both human and natural systems to climate change and extreme events within the Sedibeng District Municipality.

Table 24: Programme 18 - Community-based adaptation in communities most at risk of climate-related hazards.

Programme 18: Community-Based Adaptation in Communities Most at Risk Of Climate-related Hazards.	
ACTIONS	KEY ACTIVITIES
Conducting granular risk and vulnerability assessments in communities to identify drivers of risk and develop appropriate adaptation measures.	<ul style="list-style-type: none"> Identifying populations most at risk in the community, such as the elderly, children, and those with chronic illnesses, and developing strategies to protect them. Assessing and mapping the distribution of the drivers of risk and vulnerability across communities related to exposure and sensitivity to climate hazards.
Developing and implementing community-based adaptation measures to reduce risks and build resilience falls under the purview of relevant departments, including the Department of Forestry, Fisheries, and the Environment (DFFE) at the national level. These departments play a crucial role in promoting climate-smart agricultural practices, enhancing food security, and building community resilience.	<ul style="list-style-type: none"> Support the DFFE and Province and Agriculture extension services to promote the use of climate-smart agricultural practices, such as rainwater harvesting, crop diversification, and soil conservation techniques, to improve food security and build community resilience. Partnering with stakeholders (such as the Provincial and National Department of Human Settlement) to build water security through the installation of rainwater harvesting systems, greywater recycling systems, and other water management strategies. Supporting national and provincial initiatives to encourage the establishment of community gardens and promote sustainable agricultural practices that enhance community resilience and increase food security.
Providing training and education to build community capacity and promote sustainability.	<ul style="list-style-type: none"> Providing training and education to community members on climate change impacts and adaptation strategies. Building local capacity to design, implement, and monitor adaptation measures. Promoting sustainable land-use practices and sustainable resource management to reduce pressure on natural resources and build community resilience.
Comprehensive Community Engagement and Public Awareness Initiative on Climate	<ul style="list-style-type: none"> Organising community events to enhance climate change awareness and its impacts. Designing and distributing educational materials on climate change, both physically (like pamphlets and brochures) and

Change. This initiative aims to raise awareness, educate, and involve the community in addressing climate change. By engaging local organisations, schools, and community groups, the programme will ensure that the campaign is inclusive, accessible, and relevant to all members of the community.

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

4.7.4. Programme 19: Climate-Resilient Spatial Planning

The "Climate-Resilient Spatial Planning" programme is fundamental in the Sedibeng District 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 and rural spaces are better prepared for the future.

Key actions under this programme include:

- Ensure that spatial planning frameworks consider a long-term view of climate hazards and incorporate natural infrastructure: This action aims to integrate an understanding of future

climate hazards into spatial planning and recognises the crucial role of natural infrastructure in climate adaptation, such as using wetlands for flood regulation.

- Develop local-level climate-resilient planning mechanisms - 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 Sedibeng's communities.
- Ensure collaborative strategic planning that incorporates all relevant departments: Recognising that climate change will affect all sectors of the municipality, this action promotes cross-departmental collaboration to ensure cohesive and comprehensive planning.
- Create mechanisms to strengthen public participation in planning and decision-making processes: Public involvement ensures plans reflect local needs and knowledge, improving the effectiveness and acceptance of climate-resilient plans.
- Resilient urban and township design and development to minimise the risk and impact of climate change on urban areas: This involves designing urban and township areas with climate resilience in mind, such as planning urban green spaces to mitigate heatwaves and floods.
- Identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets: By identifying these risk zones, the municipality can prioritise where resilience needs to be built most urgently, and where infrastructure upgrades or changes may be necessary.

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

Table 25: Programme 19 - Climate-smart spatial planning for climate-resilient growth and development.

Programme 19: Climate-Smart Spatial Planning For Climate-Resilient Growth and Development.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Ensure that spatial planning frameworks consider a long-term view of climate hazards and incorporate natural infrastructure.	<ul style="list-style-type: none"> • Conduct a review of current spatial planning frameworks, • Identify climate hazards and vulnerable areas in the municipality, • Develop guidelines for climate-resilient spatial planning, • Identify natural infrastructure assets that can be incorporated into spatial planning frameworks.
Develop local-level climate-resilient planning mechanisms - precinct plans.	<ul style="list-style-type: none"> • Conduct vulnerability assessments to identify areas at risk of climate hazards. • Develop climate-resilient precinct plans that incorporate the needs and concerns of the community. • Ensure that the precinct plans are adaptable to the impacts of climate change.

<p>Ensure collaborative strategic planning that incorporates all relevant departments (in both strategic planning and project implementation).</p>	<ul style="list-style-type: none"> • Identify relevant departments and stakeholders. • Establish a coordination mechanism for collaborative strategic planning. • Develop guidelines for collaboration and coordination in strategic planning and project implementation. • Conduct regular reviews and assessments of the collaboration mechanism to ensure its effectiveness.
<p>Create mechanisms to strengthen public participation in planning and decision-making processes.</p>	<ul style="list-style-type: none"> • Ensure that the public has access to information about spatial planning frameworks and other climate change response initiatives. • Ensure that public feedback is incorporated into the decision-making process.
<p>Resilient urban and township design and development to minimise the risk and impact of climate change on urban areas.</p>	<ul style="list-style-type: none"> • Promoting innovative urban and township planning and design, which takes advantage of opportunities provided by the natural infrastructure and economic growth-management strategies. • Identifying ecological corridors or climate change corridors within the District Spatial Development Framework (DSDF) is also an important aspect of innovative urban and township design and development. • Conducting comprehensive research on climate change and its potential impacts on urban areas, including projections of temperature increases, extreme weather events, and sea level rise. • Developing guidelines in collaboration with reliant government departments, for innovative urban and township design that take into account climate change risks, including those related to flooding, extreme heat, and drought. • Establishing partnerships and networks with key stakeholders in urban planning and design, including government agencies, non-governmental organisations and academic institutions, to promote knowledge sharing and collaboration. • Encouraging the use of green infrastructure in urban design, such as green roofs, permeable pavements, and rain gardens, to help manage stormwater and reduce the urban heat island effect.
<p>To identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets, SDM could undertake various activities.</p>	<ul style="list-style-type: none"> • Conducting vulnerability assessments for critical infrastructure and assets. • Analysing historical climate data to identify areas that have been particularly vulnerable in the past. • Developing climate models to assess future risks and understand the potential impacts of climate change. • Mapping vulnerable infrastructure and assets to understand where they are located in relation to climate risk zones and hotspots.

- Identifying risks and prioritising action based on the level of vulnerability and potential impact of climate change on infrastructure and assets.
- Developing and implementing strategies to manage risks and protect infrastructure and assets from climate change impacts.

5. Implementation Framework

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

Effective Water Management			implement WRM KPI's Year 3-5: Recruit water resource manager and establish partnerships.		resources manager position and			
Review Bulk Water Master Plan	Drought	Water and Sanitation	Year 0-2: Status quo assessment, Develop Plan, Assign budget. Year 3-5: Implement	Medium	Status Quo Assessment and Plan Development	Execution of the Bulk Water Master Plan		High
Developing a Water Safety Plan (WSP)	Drought	Water and Sanitation	Year 0 - 2: Develop Emergency Response Plan Year 3-5: Implementation and Review. Improved Blue Drop Scores. Year 6-10: Review of plan and continuous improvement.	Medium	Development and Implementation of a Water Safety Plan	Implementation, Monitoring and Evaluation	Execution of the Bulk Water Master Plan	
Adaptation Programme 2: Protect and Conserve Water Through Monitoring Mechanisms and Water Conservation through Water Conservation and Water Demand Management (WCWDM).								
Implementing monitoring mechanisms and protecting water sources by	Drought	Water and Sanitation	Year 0 - 2: Develop monitoring schedule, establish a buffer zone and	Medium	Implement a regular water quality monitoring schedule, create and manage	Implement	Implement	High

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

			Year 6-10: Self-sustaining operations in key areas.					
Enforce 'Green' Approaches in Residential Areas and Developments.	Drought	Water and Sanitation	Year 0-2: Guidelines developed for residential and commercial development Year 3-5: Establish technical and funding partnerships in order to establish incentive programme.	Low	Developing and implement guidelines and standards for sustainable residential and commercial development	Incentive programme. Enforcement	Enforcement.	
Adaptation Programme 3: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation.								
Water Resource Management Planning	Drought	Water and Sanitation	Year 0-2: Status quo assessment of water resources. Integrated drought management plan developed.	Medium	Conduct a water resource assessment, develop a drought management plan and develop and implement water conservation strategies.	Implement	Implement	Medium
Investigating alternative water resources	Drought	Water and Sanitation	Year 0-2: Completion of feasibility studies	Medium	Conduct a feasibility study to identify alternate water sources, and			High

			Year 3-5: Pilot project implemented.		undertake hydrological assessments to determine water availability and potential yield of alternative water sources.			
Investing in alternative water resources	Drought	Water and Sanitation	Year 3 – 5: Pilot Projects Year 6 – 10: Scaling	High		Implement	Implement	
Develop and Implement a Treated Effluent Reuse Strategy For Sustainable Water Management.	Drought	Water and Sanitation	Year 0-2: Develop Strategy and Resource. Year 3 – 5: Implement	Medium	Developing a comprehensive treated effluent reuse plan, including infrastructure and system requirements, stakeholder engagement, and potential risks and mitigation strategies.	Implement	Implement	
Adaptation Programme 4: Implementing Sustainable Groundwater Use and Development Strategy								
Conducting Groundwater Resource Assessments to Establish the Availability and Quality of Groundwater in the SDM Area.	Drought	Water and Sanitation	Year 0-2: Completion of groundwater management plan.	Medium	Develop a groundwater management plan	Implement	Implement	Medium

Establishing Sustainable Groundwater Use Policies and Guidelines to Promote Efficient and Effective Groundwater Management.	Drought	Water and Sanitation	Year 0 – 2: Updated policy and guidelines. Year 3 – 5: Source Additional funding and partnerships for enforcement.	Medium	Conduct a review of existing policies and guidelines related to groundwater use to identify gaps and areas for improvement.	Implement	Implement	Medium
Implementing Groundwater Monitoring Programmes to Monitor Water Levels, Water Quality, and Potential Pollution Sources, Enabling Early Detection of Potential Problems and Timely Intervention.	Drought	Water and Sanitation	Year 0 – 2: Establish partnerships with irrigation boards and large water users.	Medium	Establish Partnerships	Install and maintain a network of groundwater monitoring wells and equipment to collect data on groundwater levels, water quality, and potential pollution sources.		High
Promoting Groundwater Conservation and Efficiency by Encouraging the Adoption of Water-Saving Technologies and Practices in all Sectors.	Drought	Water and Sanitation	Year 0-2: Awareness campaigns. Year 3 -5: Launch technical partnership with speres of government or private sector	Medium	Develop and implement water conservation standards for new and existing municipal buildings and properties and	Establish technical support structure.	Maintain	

			to promote water efficient technologies.		encourage the adoption of water reuse/recycling technologies.			
Developing Groundwater Recharge and Artificial Recharge Strategies to Enhance Aquifer Recharge Rates and Improve Groundwater Storage Capacity.	Drought	Water and Sanitation	Year 0-2: Feasibility and recharge sites established. Year 3-5: Recharge infrastructure established	Medium	Conduct studies to identify suitable sites for groundwater recharge, including areas with high permeability, favourable soil conditions, and sufficient rainfall.	Implement	Maintain	Medium
Implementing Land-Use Planning and Zoning Regulations to Protect Groundwater Resources from Pollution and Overuse.	Drought	Water and Sanitation/ Planning and Economic Development	Year 0-2: Define setback lines Year 3-5: Monitoring and evaluation programme implemented	Medium	Conduct a groundwater vulnerability assessment and develop and enforce land-use planning and zoning regulations.	Implement and monitor.	Implement and monitor	
Develop a Information Management System for Groundwater Data to Provide Accurate and Timely Information to	Drought	Water and Sanitation	Year 0-2: Partner with DWS to establish system.	Low	Develop and update a database and web-based portal for storing and accessing groundwater data, including			

Water Users, Decision-Makers, and The Public.					water levels, quality, and other relevant information.			
Climate Change Goal 2: Protect natural resources and ecosystems								
Programme 5: Conserve, Protect and Restore Natural Open Spaces, Ecosystems and Natural Resources.								
Assessing natural resources and ensuring that natural open spaces, ecosystems, and resources are conserved, protected and restored.	Flooding/Drought / Wildfires	Environmental Health	Year 0-2: Identify high ecological value areas Year 3 - 5: Integrate into SDF on review.	Medium	Develop conservation plans and management strategies for high conservation value areas	Integrate into SDF	Review.	Medium
Harnessing the potential of open spaces to absorb and mitigate the impacts of climate change.	Flooding	Environmental Health	Year 0-2: Ecosystem service supply and demand assessment including status quo.	Medium	Compile natural resources inventory and ecosystem services assessment.	Implement maintenance and restoration project.	Establish new protected areas.	High
Implementing programmes focused on mitigating the impact of climate change and severe weather, particularly in climate-risk zones.	Flooding	Environmental Health	Year 0-2: Develop Ecosystem Based Adaptation Plan. Year 3-5: Resource Plan and Implement	Medium	EBA Plan	Implement	Implement	High
Adaptation Programme 6: Enhanced Natural Resource Management								

Ensuring the quality of water resources is critical to the sustainable development of SDM, as they play a vital role in maintaining the health of ecosystems, human health, and socio-economic development.	Health	Water and Sanitation	Year 0-2: Water quality monitoring sites identified and monitored.	Low	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies.	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies.	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies.	High
Monitoring and preventing soil erosion is crucial to ensure the long-term health and productivity of natural ecosystems, as well as to maintain the quality of water resources.	Flooding	Environmental Health	Year 0-2: Erosion Risk Assessment Year 3-5: Develop and implement erosion control plans for high-risk areas.	Medium	Conduct a soil erosion risk assessment on municipal land.	Implement control plans for high priority areas.	Review and maintain.	High
Provide training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines.	Flooding/ Drought/ Fire/ Heat Stress	Environmental Health	Year 0-2: Number of officials trained. Year 3-5: Number of officials trained. Monitoring and evaluation. Year 6-10: Number of	Low	Implement training programme.	Monitor	Monitor	Medium

			officials trained. Monitoring and evaluation.						
Establish a Municipal Environmental Management Forum (MEMF) to enhance collaboration and coordination between Sectoral Departments, Conversation Organisation and agencies related to natural resource management.	Flooding/ Drought/ Heat Stress	Fire/ Heat Stress	Environmental Health	Year 0-2: Establish forum with terms of reference	Low	Conduct regular meetings. Track progress and performance.	Conduct regular meetings. Track progress and performance. Review Terms of Reference.	Conduct regular meetings. Track progress and performance. Review Terms of Reference.	Medium
Adaptation Programme 7: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Development Framework									
Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales.	Flooding/ Heat Drought	Fire/ Stress/ Drought	Disaster Management	Year 0-2: Integrate critical biodiversity and ecological support areas into municipal spatial plans Year 3-5: Implement Year	Low	Integrate critical biodiversity and ecological support areas into the municipal spatial plans.	Implement municipal spatial plans.	Implement municipal spatial plans.	High
Identifying and mapping natural open spaces, ecosystems, and natural	Drought/ Flooding/ Heat Stress		Environmental Health	Year 0-2: Integrate and map the inventory	Low	Integrating the mapping and inventory information into the Spatial	Integrate and implement the mapped inventory	Monitor.	High

resources, and integrating inventories in the Spatial Development Framework and the open space framework.			information into the SDF Year 3-5: Implement		Development Framework, open space framework.	information from the SDF.		
Identifying undeveloped open space with potential for green infrastructure.	Flooding	Environmental Health	Year 0-2: Assess the suitability for undeveloped open spaces. Year 3-5: Implement	Low	Assess the suitability of undeveloped open spaces for different types of green infrastructure.	Implement green infrastructure.	Implement green infrastructure.	High
Assessing the value of open spaces and ecosystem services	Health	Water and Sanitation	Year 0-2: Develop policies and regulations to assess the value of open spaces. Year 3-5: Implement	Low	Develop policies and regulations to protect and manage these areas.	Implement	Implement	High
Climate Change Goal 3: Reduce the vulnerability and exposure of human and natural systems to climate change and extreme events								
Programme 8: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.								
Conducting a vulnerability assessment to identify the populations and locations most at risk of climate change impacts.	Sea level rise and coastal flooding	Environmental Management	Year 0-2: Assess the vulnerability of infrastructure to climate change. Year 3-5: Implement	Medium	Assess the vulnerability of infrastructure to sea-level rise and coastal flooding.	Develop and implement climate-resilient infrastructure.	Implement and maintain.	Medium
Developing and implementing an early warning	All	Disaster Management	Year 0-2: Install weather	Medium	Install weather monitoring systems to	Enforce early warning system	Enforce early warning system	High

system to help communities prepare for and respond to climate change risks.			monitoring systems. Year 3-5: Enforce early warning system.		provide real-time data on extreme weather events and develop warning protocols.			
Establishing partnerships with local stakeholders, such as community groups and NGOs, to build local capacity for climate change adaptation and resilience.	Flooding/ Drought	Disaster Management	Year 0-2: Building partnerships. Year 3-5: Implement	Low	Building partnerships with community groups.	Collaborate with local NGOs to implement small-scale adaptation measures.	Implement.	
Developing and implementing land use planning and zoning regulations that take into account the potential impacts of climate change, including sea-level rise, coastal erosion, and flooding.	Sea level rise and flooding	Planning and Local Economic Development	Year 0-2: Develop land use and zoning regulations Year 3-5: Implement	Medium	Developing land use and zoning regulations to ensure that settlements are built in safe and sustainable locations.	Implement land use and zoning regulations	Implement	
Programme 9: Community-Based Adaptation in Communities Most at risk of climate-related hazards								
Conducting granular risk and vulnerability	All	Environmental Health	Year 0-2: Develop	Low	Develop adaptation measures for	Implement	Implement	

assessments in communities to identify drivers of risk and develop appropriate adaptation measures.			adaptation measures. Year 3-5: Implement		populations most at risk.			
Developing and implementing community-based adaptation measures to reduce risks and build resilience falls under the purview of relevant departments.	Flooding/ Drought	Environmental Health	Year 0-2: Develop adaptation measures. Year 3-5: Support and Implement	Low	Support the DFFE and Province and Agriculture extension services to promote the use of climate-smart agricultural practices.	Support and implement sustainable agricultural practices.	Implement and monitor.	
Providing training and education to build community capacity and promote sustainability.	All	Environmental Health	Year 0-2: Provision of training Year 3-5: Design, implementation and monitoring of adaptation measures.	Low	Providing training and education to community members on climate change impacts and adaptation strategies.	Design, implement and monitor adaptation measures.	Implement and monitor adaptation measures.	
Comprehensive Community Engagement and Public Awareness Initiative on Climate Change.	All	Environmental Health	Year 0-2: Climate change awareness raising. Year 3-5: Implement training and	Low	Raise climate change awareness for communities.	Implement training and education programmes for community members.	Continue awareness raising, developing partnerships and capacity building.	

			education programmes					
Adaptation Programme 10: Climate Resilient Spatial Planning for Climate Resilient Growth and Development								
Ensure that spatial planning frameworks consider a long-term view of climate hazards and incorporate natural infrastructure.	All	Planning and Local Economic Development	Year 0-2: Develop guidelines for climate-resilient spatial planning. Year 3-5: Implement guidelines	Low	Develop guidelines for climate-resilient spatial planning.	Implement guidelines	Implement and monitor	
Develop local-level climate-resilient planning mechanisms - Precinct Plans.	All	Planning and Local Economic Development	Year 0-2: Develop climate resilient precinct plans Year 3-5: Implement	Low	Develop climate-resilient precinct plans that incorporate the needs and concerns of the community.	Implement precinct plans	Implement and monitor	
Ensure collaborative strategic planning that incorporates all relevant departments (in both strategic planning and project implementation).	All	Planning and Local Economic Development	Year 0-2: Develop guidelines for collaboration in strategic planning and project implementation. Year 3-5: Implementation of guidelines.	Low	Develop guidelines for collaboration and coordination in strategic planning and project implementation.	Implement guidelines	Implement and monitor guidelines	
Create mechanisms to strengthen public participation in planning and	All	Planning and Local Economic Development	Year 0-2: Ensure that public feedback is incorporated into the decision-	Low	Ensure that public feedback is incorporated into the decision-making process.	Ensure that public feedback is incorporated into the decision-making process.	Ensure that public feedback is incorporated into the decision-	

decision-making processes.			making process. Year 3-5: Ensure that public feedback is incorporated into the decision-making process.				making process.	
Innovative urban and township design and development is an essential component of climate change response, as it helps to minimise the risk and impact of climate change on urban areas.	All	Planning and Local Economic Development	Year 0-2: Develop guidelines. Year 3-5: Implement guidelines.	Medium	Developing guidelines in collaboration with reliant government departments, for innovative urban and township design that take into account climate change risks.	Implement guidelines.	Implement guidelines.	
To identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets, SBM could undertake various activities.	All	Planning and Local Economic Development		Medium	Develop strategies to manage risks and protect infrastructure and assets from climate change impacts.	Implement strategies.	Implement and monitor strategies.	

5.1. Enabling Mechanisms for Implementation

5.1.1. Institutional Arrangements

In the context of Sedibeng District Municipality, the formulation of a Climate Change Response Strategy signifies a monumental stride towards mitigating the impacts of climate change. Nonetheless, the cogency of this strategy hinges on the harmonious optimisation of institutional arrangements within the municipality.

A crucial first step the municipality should consider is an exhaustive evaluation of the Climate Change Response Strategy, with the objective to pinpoint distinct climate mitigation actions that warrant implementation. Drawing from this review, the municipality can delegate roles and responsibilities to the respective departments, capitalizing on the specific proficiencies, resources, and capacities each holds, thereby facilitating the competent execution of the actions.

The municipality might consider assigning the stewardship of each climate action to a department equipped with the requisite expertise, resources, and capacity. Concurrently, it is essential to identify the departments that could offer support in the actualization of these climate actions. In determining the supporting roles, it's vital to consider each department's synergistic strengths, resources, and capacity. Consulting the departmental heads can ensure consensus on the proposed lead and supporting roles, while also identifying any potential obstacles and gleaning insights on effective implementation strategies. These departmental roles and responsibilities should be clearly documented in the Climate Change Response Strategy, providing a transparent roadmap for stakeholders and facilitating collective effort towards the strategic goals. Ensuring regular updates on progress and addressing emerging issues in a timely manner further promotes the strategy's efficacy.

Additionally, aligning the Climate Change Response Strategy with the specific plans and policies of each department is essential to integrate climate mitigation efforts across all municipal operations. For instance, the Integrated Development Plan, Spatial Development Framework, and Local Economic Development Strategy of the Department of Economic Development and Strategic Services can incorporate specific targets and actions pertaining to climate change.

To summarize, optimizing institutional arrangements for tackling climate change in Sedibeng District Municipality necessitates clear delineation of responsibilities across departments and alignment of the Climate Change Response Strategy with each department's individual plans and policies. This coordination facilitates the integration of climate change mitigation goals across all facets of

municipal operations, and ensures consistent tracking and reporting of progress. By promoting collaboration and leveraging each department's unique strengths, resources, and capacities, the municipality can constructively confront and mitigate the impacts of climate change within the region.

5.1.2. Governance Considerations

In the context of Sedibeng District Municipality, it is advocated that each department within the municipality be assigned explicit responsibilities pertaining to climate change. These responsibilities should be conjoined with key performance indicators (KPIs) that monitor and evaluate progress towards defined climate objectives. This can be accomplished by harmonizing existing plans and strategies with climate change targets, subsequently tracing the advancement towards these targets using dedicated KPIs.

The Department of Economic Development and Strategic Services could align their critical plans—such as the Integrated Development Plan (IDP), Spatial Development Framework, and Local Economic Development Strategy—with climate change objectives. This alignment can act as a potent catalyst in steering the region towards a climate-resilient future.

Further, the department can establish and monitor KPIs tailored to these climate change goals. These KPIs could encompass a spectrum of parameters, from quantifying the number of local enterprises adopting sustainable practices to tracking the amount of renewable energy harvested within the municipality.

The municipality should stand ready to confront and manage natural calamities—like floods and wildfires—that are projected to intensify in frequency and severity due to climate change. By integrating climate change objectives with existing plans and strategies, and tracking progress through KPIs, municipalities can assure that climate change responses are woven into all facets of municipal operations.

This comprehensive integration will serve as a robust assurance of the municipality's progression towards a sustainable future. It will also affirm the municipality's preparedness to navigate the challenges and impacts associated with climate change, thereby safeguarding its communities and natural assets.

5.1.3. Information Management

Cultivating a culture that prioritizes risk avoidance is a cornerstone for the effective implementation of the climate change response plan within the Sedibeng District Municipality. This necessitates empowering all stakeholders—encompassing officials, policymakers, and residents—through integrated education, comprehensive training, and robust public awareness campaigns, all underpinned by scientific research. This strategic approach will foster a deeper comprehension of the implications of climate change and the necessary responses, and promote a collective sense of accountability and stewardship among all stakeholders.

To realize this objective, Sedibeng District Municipality could undertake the following measures:

- Primarily, the municipality can design and execute an encompassing educational and training programme centred on climate change and its impacts on the municipality. By targeting officials, policymakers, and residents, this will ensure a universally shared understanding of climate change and highlight the urgency of responsive action.
- Secondly, the Municipality can leverage scientific research and data to guide the creation of educational and training content, ensuring that stakeholders are informed with the most accurate and current information. This can also help pinpoint key areas of risk and zones demanding immediate action.
- Thirdly, Sedibeng District Municipality can orchestrate public awareness initiatives centred around climate change and its effects. These initiatives could be disseminated through diverse mediums, including social media, community workshops, and public gatherings. Such campaigns aim to elevate public understanding of climate change, emphasize the necessity for action, and provide pragmatic guidance on individual measures to mitigate impact.
- Fourthly, the municipality can foster active participation in climate change mitigation and adaptation efforts by residents, civil society organisations, and the private sector. This could entail providing platforms for engagement and collaboration, developing partnerships with pertinent stakeholders to conceive and implement shared initiatives, and offering resources and support to individuals and organisations that are proactively responding to climate change.

Finally, Sedibeng District Municipality can foster partnerships with academic institutions and research organizations to ensure sustained access to the latest research and expertise in the field of climate change. This will ensure that the municipality is abreast with the most recent developments in the field and can harness the latest knowledge and tools to inform its decision-making and strategies.

By promoting a culture of risk avoidance and capacitating all stakeholders, Sedibeng District Municipality can establish a conducive environment for the successful implementation of the climate change response plan, ultimately contributing to the construction of a

more resilient and sustainable municipality. This will necessitate sustained commitment and effort, as well as persistent engagement with stakeholders to ensure their needs and viewpoints are reflected in climate change policies and initiatives.

5.1.4. Funding Mechanisms

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

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

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

Municipalities can also seek funding from international entities such as the Global Environment Facility (GEF) and the Green Climate Fund (GCF). These institutions extend financing to climate change response programmes in developing nations. However, satisfying the stringent eligibility criteria to access these funds can be demanding for municipalities.

Public-Private Partnerships (PPPs) offer an additional route to financing climate change response initiatives. These partnerships represent collaborative efforts between public and private sectors to fund and execute infrastructure projects. PPPs can furnish municipalities with alternative funding sources and the advantage of private sector expertise in project management and implementation. Nevertheless, municipalities must ensure equitable terms within the partnership and a shared commitment towards the project's objectives.

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

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

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

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

5.2. Recommendations for mainstreaming

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

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

Here are some specific mainstreaming recommendations:

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

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

At the heart of these strategies is the DDM, which can act as the backbone of these efforts. Adopting a "*One District, One Plan, One Budget*" approach, SDM can ensure all development initiatives within the district are climate-friendly. The DDM's objectives of breaking down silos, maximising impact, narrowing the distance between people and government, and ensuring sustainable development align seamlessly with the goal of mainstreaming climate adaptation. In conclusion, mainstreaming climate adaptation in SDM calls for a comprehensive, integrated approach that leverages existing structures and processes, builds capacity, and involves all stakeholders. By taking these steps, SDM can ensure a more sustainable and resilient future for its residents and the environment.

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