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CLIMATE CHANGE ADAPTATION PLAN

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CBO	Community-Based Organisation
DEA	Department of Environmental Affairs
DMP	Disaster Management Plan
ECD	Early Childhood Development
EPWP	Extended Public Works Programme
FPA	Fire Protection Agency
GHG	Greenhouse gas
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
KPA	Key Performance Area
LM	Local Municipality
M&E	Monitoring and Evaluation
MSP	Municipal Support Programme
NCCRP	National Climate Change Response Policy
NGO	Non-Governmental Organisation
RCP	Representative Concentration Pathways
SDF	Spatial Development Framework

Preface

Climate change has become a measurable reality, and along with other developing countries, South Africa is extremely vulnerable and exposed to the impacts of climate change due to its socio-economic realities and environmental context. Climate variability - including the increased frequency and intensity of extreme weather events - will disproportionately affect the poor. South Africa is already a water-stressed country and faces future drying trends and weather variability with cycles of droughts and sudden excessive rains. As such, South Africa should urgently strengthen the resilience of its society and economy to mitigate climate change impacts, and should develop and implement policies, measures, mechanisms and infrastructure which protect the most vulnerable.

In response to climate change impacts and vulnerabilities, the South African government developed the National Climate Change Response Policy (NCCRP White Paper 2011) for an effective climate change response and in the long-term, effect a transition to a climate-resilient and lower-carbon economy and society. South Africa's response to climate change has two objectives:

- Effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity; and
- Make a fair contribution to the global effort to stabilise greenhouse gas (GHG) concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

All spheres of government have a varying degree of roles in the implementation of the NCCRP. The NCCRP indicates that local government plays a crucial role in building climate resilience through planning human settlements and urban development; the provision of municipal infrastructure and services; water and energy demand management; and local disaster response, amongst others.

The NCCRP addresses the municipality's vulnerabilities in areas like water quality, water security, flooding, infrastructure, land use and spatial planning, fires, etc. The plan also addresses how departments can adjust their operations to respond to climate change impacts as well as maximising on the opportunities presented, where applicable.

Given this responsibility and the fact that climate change impacts are felt most directly at the local level, there is a great need for proactive efforts to build climate resilience and finalise the Drakenstein Climate Change Adaptation Plan. The Climate Change Adaptation Plan aims to bring about coordinated response to climate change and encourage collaboration between stakeholders within Drakenstein. It was developed with the aim of designing a document that is as practical as possible to different line departments.

INTRODUCTION

1 Introduction

Scientific evidence confirms that the climate is changing and that most of the warming trends observed during the last few decades is due to human activities (IPCC, 2001). In Southern Africa, projections suggest that climate change will bring about **increased variability in rainfall, more frequent extreme events and increased temperatures** (Hewitson & Crane, 2006).

A significant number of past disasters in the Western Cape have been associated with weather conditions. These types of disasters cost local municipalities millions of rands and further strains resources that are already limited.

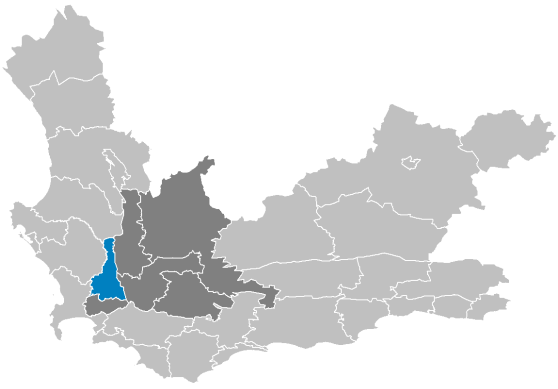
It is acknowledged that besides the City of Cape Town, local municipalities throughout the Western Cape do not have the human and financial resources to mobilise a separate portfolio for climate change. Therefore, **it is essential that climate change is mainstreamed throughout line departments** within the municipality by integrating it into all strategic objectives, policies, plans, strategies, operations, etc. Climate change causes economic and social problems that pose significant risks to everyday operations, infrastructure and service delivery, that needs to be addressed by all departments.

This approach will move planning from business-as-usual to **effective climate resilient planning** through successful project implementation.

This plan aims to create a coordinated response to climate change within Drakenstein Municipality by highlighting the work that has already been done and to offer a structure through which interventions can be further strengthened and supported. It also aims to encourage collaboration between stakeholders and attempts to outline the various roles and responsibilities that can enhance this more effective approach towards reducing Drakenstein's climate vulnerability.

- Increased variability in rainfall
- More frequent extreme events
- Increased temperatures

Map showing the location of Drakenstein Municipality within the Western Cape Province



The effective implementation of the National Climate Change Response Policy (NCCRP) is dependent on the efforts of provincial and local governments (DEA, 2010). Local governments are at the forefront of building resilience in communities to adapt to climate change impacts. In section 10.2.6 the policy recognizes the role of local government in building climate resilience and states:

> "Local government plays a crucial role in building climate resilience through **planning human settlements** and **urban development**; the provision of **municipal infrastructure** and **services**; **water** and **energy** demand management; and **local disaster response**, amongst others. Climate change considerations and constraints will be integrated into municipal development planning tools such as **Integrated Development Plans**, and municipal service delivery programmes."

The Western Cape Government committed to assisting and supporting local municipalities in the development of sustainable energy plans, climate change adaptation plans, and implementation frameworks (Western Cape Government, 2014). A **Municipal Support Programme (MSP)** was therefore initiated, of which Drakenstein Municipality expressed interest to participate in.

Twelve municipalities responded positively to both the development of Sustainable Energy Plans and Climate Adaptation Plans. Eight municipalities were selected, four per programme. Drakenstein was one of the municipalities selected for the development of a draft climate adaptation plan. This would then be developed into a more concrete plan and be adopted by Council, with elements mainstreamed into key municipal documents such as the Integrated Development Plan (IDP), the Spatial Development Framework (SDF), and the Disaster Management Plan (DMP).

Western Cape Government

The MSP is not approached as a discrete once-off engagement, but rather as an ongoing series of partnerships between national, provincial, and local government; NGO's, CBO's and special interest groups; scientists and specialists; and the private sector. It is envisaged that in this way capacity can be developed amongst all involved, knowledge co-produced and shared, and valuable experience developed around successful climate adaptation. It is hoped that this model will assist in the relatively low cost, rapid roll out of climate adaptation mainstreaming in local municipalities across the province.

aurecon

Aurecon was commissioned by the Drakenstein Municipality to **finalise the draft Climate Change Adaptation Plan** that was developed by the MSP.

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1.1 Defining Adaptation

Many people use the IPCC definition of adaptation which states that it is the:

> "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation" (IPCC TAR, 2001).

Moser and Ekstrom's (2010) definition of adaptation is also useful:

> "Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting non-climatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities."

These definitions recognize that adaptation to climate change takes place in a complex context where climate variability and change is only one of many stressors that require response. It also acknowledges that some adaptive responses help deal with current variability and others may be more transformative and sustainable; yet there is no defined separation between the two and they can, and in fact in many circumstances should, be linked.

Much research on climate change adaptation jumps right in to assume that all sectors and actors want and need to adapt to climate change. However, it is very important to understand the broader development context and urgent priorities first, to determine where climate impacts and potential responses might fit in. Climate change adaptation needs to be cross-sectoral and multi-level to bring stakeholders with different knowledge, interests and values together.

Climate change adaptation does not mean that departments have to do more but rather think differently to develop innovative ways of dealing with risks, hazards, uncertainty and complexity of vulnerabilities (Climate ADAPT, 2015).

1.2 Existing policies, strategies, plans and reports

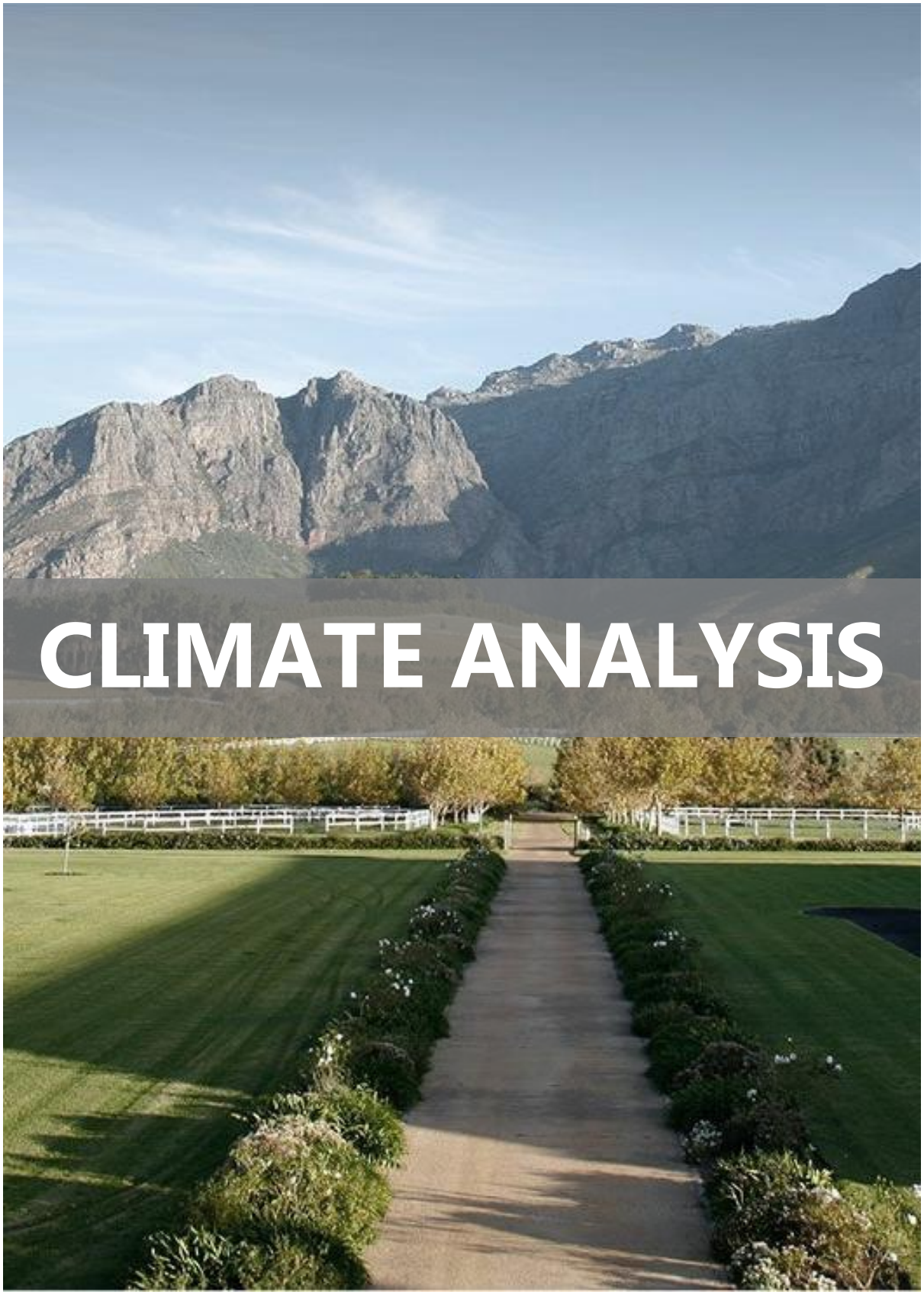
It is essential to first examine existing related strategies, plans, and reports that Drakenstein has to avoid duplication and ensure alignment with current local strategic initiatives. A list of these are presented in Table 1.

Table 1: Existing policies, strategies, plans and reports and how they address climate change

Existing policies, strategies, plans and reports	How they address climate change
Integrated Development Plan (IDP) (2017-2022)	The IDP has a strong climate change focus. Climate change falls under KPA 6: safety and environmental management. The IDP builds on the Sustainable Development Goals and indicates that urgent action needs to be taken to combat climate change. The IDP also states that a Climate Change Adaptation Plan needs to be developed and implemented. The IDP explains two partnerships that the municipality has embarked on to improve development in the context of climate change. One partnership is with the Municipality of Neumarkt in Germany to promote climate change mitigation and adaptation. The other partnership is with local schools to create environmental awareness and grow food gardens to address issues linked to climate change.
Spatial Development Framework (2017)	No mention of climate change within the document.

Environmental Management System	The document recognizes that climate change is an issue and indicates that Environmental Management Systems can address such environmental challenges.
Water Services Development Plan (2017/18)	The Plan has a strong climate change focus and recognizes that it is necessary to develop water-related climate change response strategies to ensure the careful management of water resources. The Plan proposes adaptations that should be adopted in the context of climate change. The plan also incorporates the information presented in the Draft Climate Change Adaptation Plan for the Drakenstein Municipality.
Transport Management Plan (2016)	Not available
Drakenstein Biodiversity Priorities (2006)	No mention of climate change within the document.
State of Environment Report (2015)	2015 report not available, however the 2013 report is available but does not discuss anything in relation to climate change.
Local Economic Development Strategy (2015). Only 2007 Strategy.	2015 report not available. The 2007 report does not discuss climate change issues that may have an impact on the economy of Drakenstein.
Air Quality Management Plan (2011)	Not available
Integrated Waste Management Plan (2009)	The document does not specifically focus on climate change but does discuss the implications of flooding on waste management.
Draft Environmental Management Framework for the Drakenstein Municipality (2015)	This document has a strong reference of climate change in the Drakenstein. The document lists effective climate change responding as a sustainability priority and strategic goal. The document also makes reference of Programmes for Action under which climate change are being addressed as a critical output.
Drakenstein Emergency Response Plan (2014)	The document only discusses procedures to identify, respond, mitigate and review and revise potential emergencies and accidents affecting the environment. Climate related impacts are amongst the emergencies and accidents discussed, however no specific focus on climate change has been included in the document.
Drakenstein Green Building Manual (2010)	Not available
Disaster Management Plan (2017)	

Integrated Sustainable Human Settlement Plan (2016)	No mention of climate change within the document.
River Management Plan (2007)	Although the Plan does not have a specific climate change focus it discusses floods and storm water.
Storm water Management System (2009)	No mention of climate change within the document.
Water and Sewerage Master Plans	The Sewerage Master Plan does not have a specific climate change focus but does identify flooding during heavy rains to be an operational problem in the Paarl system. The Water Master Plan does not address climate change.
Wastewater Risk Abatement Plan	No mention of climate change within the document.
Energy Master Plan	Not available
State of the Berg River Report (2016)	Climate change has been listed as a driver of changes in the river due to changes in rainfall and runoff. The river's resilience has been compromised leaving the river vulnerable to climate change causing loss to the ecosystem's health and services.
Drought and Flooding Disaster Management Plan (2017)	The document has a strong climate change focus and states that climate change will increase the flood and drought risk.
Drakenstein Heritage Survey (2010)	Not available
Arboretum Urban Design and Landscape Framework (2015)	Not available
Rural Development Strategy	The draft strategy does not mention any focus or issues relating to climate change.



CLIMATE ANALYSIS

2 Climate Analysis

Although no detailed studies were done to address future projections in the Drakenstein municipal area the University of Cape Town modelled the impact of the expected climate change for the Western Cape for the 2030 - 2045 period (Western Cape Government, 2014).

The following climate changes are projected.

Table 2: Projected climate changes

Projection	Example of Possible Impacts
Higher mean annual temperature	▪ Increased evaporation and decreased water balance; and ▪ Increase wild fire danger (frequency and intensity).
Higher maximum temperatures, more hot days and more heat waves	▪ Heat stress on humans and livestock; ▪ Increased incidence of heat-related illnesses; ▪ Increased incidence of death and serious illness, particularly in older age groups; ▪ Increased heat stress in livestock and wildlife; ▪ Decreased crop yields and rangeland productivity; ▪ Extended range and activity of some pests and disease vectors; ▪ Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. traffic lights, road surfaces, electrical, etc.); ▪ Increased electric cooling demand affecting reduced energy supply reliability; and ▪ Exacerbation of urban heat island effect.
Higher minimum temperatures, fewer cold days and frost days	▪ Decreased risk of damage to some crops and increased risk to others; ▪ Reduced heating energy demand; ▪ Increased risk to crops such as deciduous fruits that rely on cooling period in autumn; ▪ Extended range and activity of some pests and disease vectors.
General drying trend in western part of the country	▪ Decreased average runoff, stream flow; ▪ Decreased water resources and potential increases in cost of water resources; ▪ Decreased water quality; ▪ Decrease in shoulder season threatens the Western Cape fruit crops;

	▪ Increased fire danger (drying factor); and ▪ Impacts on rivers and wetland ecosystems.
Intensification of rainfall events	▪ Increased flooding; ▪ Increasing challenge to storm water systems in urban settlements; ▪ Increased soil erosion; ▪ Increased pressure of disaster relief systems; and ▪ Increased risk to human lives and health.
Increased mean sea level and associated storm surges	▪ Salt water intrusion into ground water and coastal wetlands; and ▪ Increased storm surges leading to coastal flooding, coastal erosion and damage to coastal infrastructure.

Drakenstein Climate Profile

Climate analysis requires that data be of sufficient duration and resolution to account for the cycles of natural meteorological variability as well as any climate change signal present in the existing record. While there is currently a dearth of locally sourced climate change data of sufficient length and integrity for trend analysis available for this analysis, other datasets that can be utilised are as follows:

The **historical** datasets used for this longer-term analysis are:

- CRU Reanalysis (Climate Research Unit) v3.23 at 0.5°x0.5° spatial resolution and monthly temporal resolution from the year 1901 to 2016. This data is created through the modelling of the climate over time but being forced to match station observations where available.
  - The strength of CRU reanalysis data is the long-time scale and the completeness of the data.
  - Furthermore, the reanalysis is able to provide estimated climatological occurrence in areas that do not have long term observation data.
  - The creation of this data, if not forced by sufficient long-term observation station data, will be subject to large scale synoptic estimations based on known climatology's. The output will be less aligned to the true observation on the ground.
- ARC2 satellite (NOAA NCEP CPC African Rainfall Climatology version 2) at 0.1°x0.1° spatial resolution and daily temporal resolution from the year 1983 to 2016. The data is created by assessing the cloud temperatures, infrared measures and microwave soundings. These are validated against known station data to remove bias, where possible.
  - The strength of this data is the high spatial and temporal resolution of the output data. It is also available in near

real time to provide the most up-to-date and complete data set possible.

- The weakness of this data is that is can only measure from the point that the satellite was operational and therefore doesn't provide data earlier than 1983. Long term trend analysis will require a longer time frame than this duration. Furthermore, the rainfall is an estimate and can't be validated on the ground unless there is reliable station data against which to validate.

Projected datasets that will be used for analysis are:

- CORDEX (Coordinated Regional Climate Downscaling Experiment) downscaled RCP4.5 and RCP8.5 data. Presented by Swedish Meteorological and Hydrological Institute – SMHI CORDEX CMIP5 historical and CMIP5 IPCC AR5 projected experiments at 0.5°x0.5° spatial resolution and daily temporal resolution from the year 1951 to 2005 and 2006 – 2100.

Downscaled data has several advantages over the large scale GCMs, chief among them the increased spatial and temporal resolution. Having spatial higher resolution provides greater local context between areas of interest, while daily scale temporal scales allow for analysis such as extreme events or accumulation anomalies that is not possible in monthly data. The CORDEX experiments seeks to downscale the GCMs utilised in the IPCC AR5 analysis. Understanding the computation requirements for this task, regions were allocated to different climate analysis institutes and models known to better simulate conditions in those regions. The Africa region was assigned to the Swedish Meteorological Hydrological Institute (SMHI).

RCP scenarios

The scale of the future climate impacts will vary based on the anthropogenic mitigation of factors responsible for currently experienced changes. The mitigation scenarios account for several variances of potential global economic and environmental development and are quantified as the Representative Concentration Pathways (RCP). The four RCP scenarios depicted below are estimated concentrations of CO_2, CH_4 and N_2O based on a combination of assessment models (MESSAGE (Riahi, et al., 2007), AIM (Hijioka, et al., 2008), GCAM (Wise, et al., 2009), IMAGE (van Vuuren, et al., 2007)), global carbon cycle, and atmospheric chemistry and climate models. They also integrate assumed land use changes and sector-based emissions of greenhouse gasses from present day levels. These present GHGs include the sectoral assessment of energy supply, industry, transport, and buildings with contributions of 47%, 30%, 11% and 3% respectively (IPPC, 2014).

Representative Concentration Pathways

	CO_2 (ppm)	CH_4 and N_2O (ppm)	Resulting radiative forcing ($W.m^{-2}$)	Scenario
RCP 2.6	421	54	2.6	Best case
RCP 4.5	538	92	4.5	Best case - Medium scenario
RCP 6.0	670	130	6.0	Worst case - Medium scenario
RCP 8.5	936	377	8.5	Worst case

These RCPs were used as input for the coupled model ensembles of the IPCC Assessment Report Five (IPPC, 2014) (AR^5). These RCPs show the change from pre-industrial insolation watts per m^2 resulting from the emissions. RCP 2.6 represents the mitigation scenario leading to a very low forcing level – best case – emissions stabilise from 2010 – 2020 and decrease thereafter (best case scenario with global focus on environmentally sustainable practices).

RCP 4.5 – likely best case – emissions stabilise from 2040 and decrease thereafter. RCP 6.0 – likely worst case – emission stabilise from 2080 and decrease thereafter. RCP 8.5 represents the very high GHG emission scenario – emissions don't stabilise, worst case scenario with a focus on economic advancement at the expense of environmental sustainability. These emission scenarios give light to the varying potential climatic futures based on human development goals in the present and near future.

Using climate projection data requires the acknowledgement of various uncertainties. The IPCC projections rely on forty different GCMs with different accuracies forecasting to the varying RCP scenarios. These RCPs are themselves estimates of potential future thermal forcing, as informed by adherence to emission policies and potential future technologies. The downscaling of the IPCC data required robust constraining parameters to present a more accurate local projection. In areas where observational data is limited, these constraining parameters have increased uncertainty.

Results obtained and recommendations made based on these data should be used as a guideline to adapt/mitigate to a potential future climate rather than a definitive one. This is particularly prevalent when noting the significant disparity even in the current variability of rainfall regimes. This is influenced by things like topography, wind, vegetation and even ocean currents. Beyond that, a further layer of complexity is added with looking at rainfall intensity, diurnal and seasonal onsets before accounting for short and long-term influences such as the diurnal, seasonal, inter annual cycles, the ENSO cycles as well as decadal changes. When projecting precipitation changes into a semi unknown future these uncertainties are further exacerbated.

The projection parameters are therefore presented in terms of a probability of changes highlighting the most likely range of precipitation experienced in the future. The probabilities also allow for the possibility of more extreme anomalous occurrence of events in both directions i.e. probability of more extreme rainfall days as well as less extreme rainfall days.

Understanding climate analysis

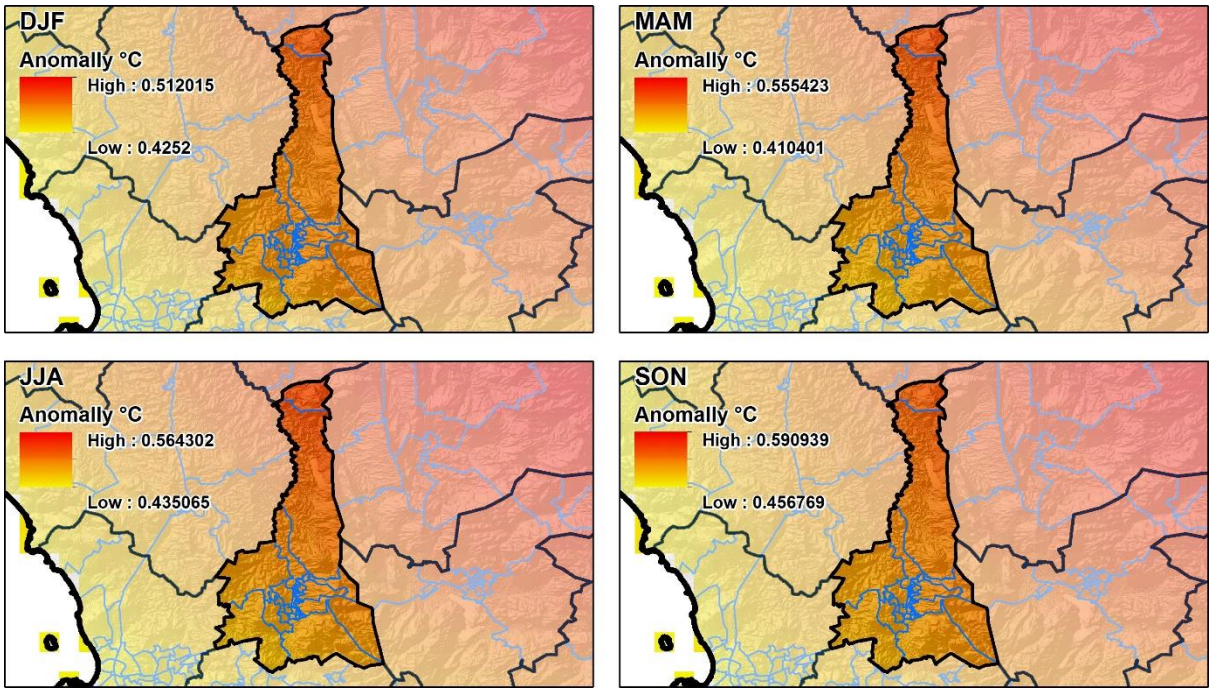
Presenting climate data is often a complex task, particularly when assessing multiple variables with different measured units and anomalies, time scales and RCP scenarios. Analysis should seek to present the data in a way that is fully indicative while remaining understandable and useful to decision makers. This is done by assessing changes in the variables of maximum temperature, precipitation and precipitation intensity individually. Each variable has particular characteristics that need to be assessed. These analysis methodologies are explained below.

Maximum temperature per season

The figure below illustrates how maximum temperatures will change from current temperatures to those in 2030. The figure is divided into four maps according to the seasons; summer in December, January and February (DJF), autumn in March, April and May (MAM), winter in June, July and August (JJA), and Spring in September, October and November (SON).

Maximum temperature is going to **rise** in all areas of the municipality, however the magnitude of warming is going to be larger in the **north** than in the south. The magnitude of warming is also going to be larger in spring, winter and autumn. As a result, **summer** is going to **begin earlier** and **end later** in the year.

Figure 1: Maximum temperature anomaly (seasonal changes), 2030



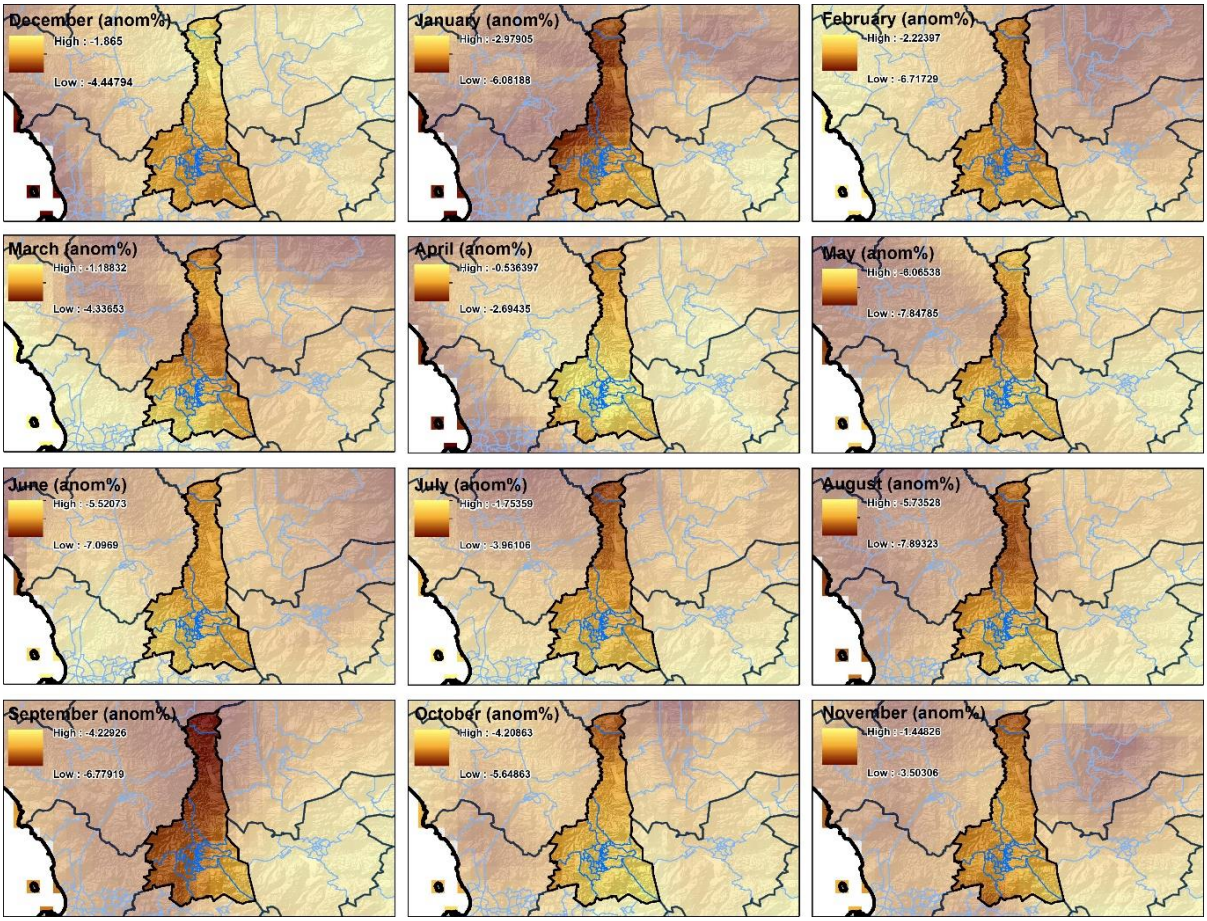
Rainfall changes per month

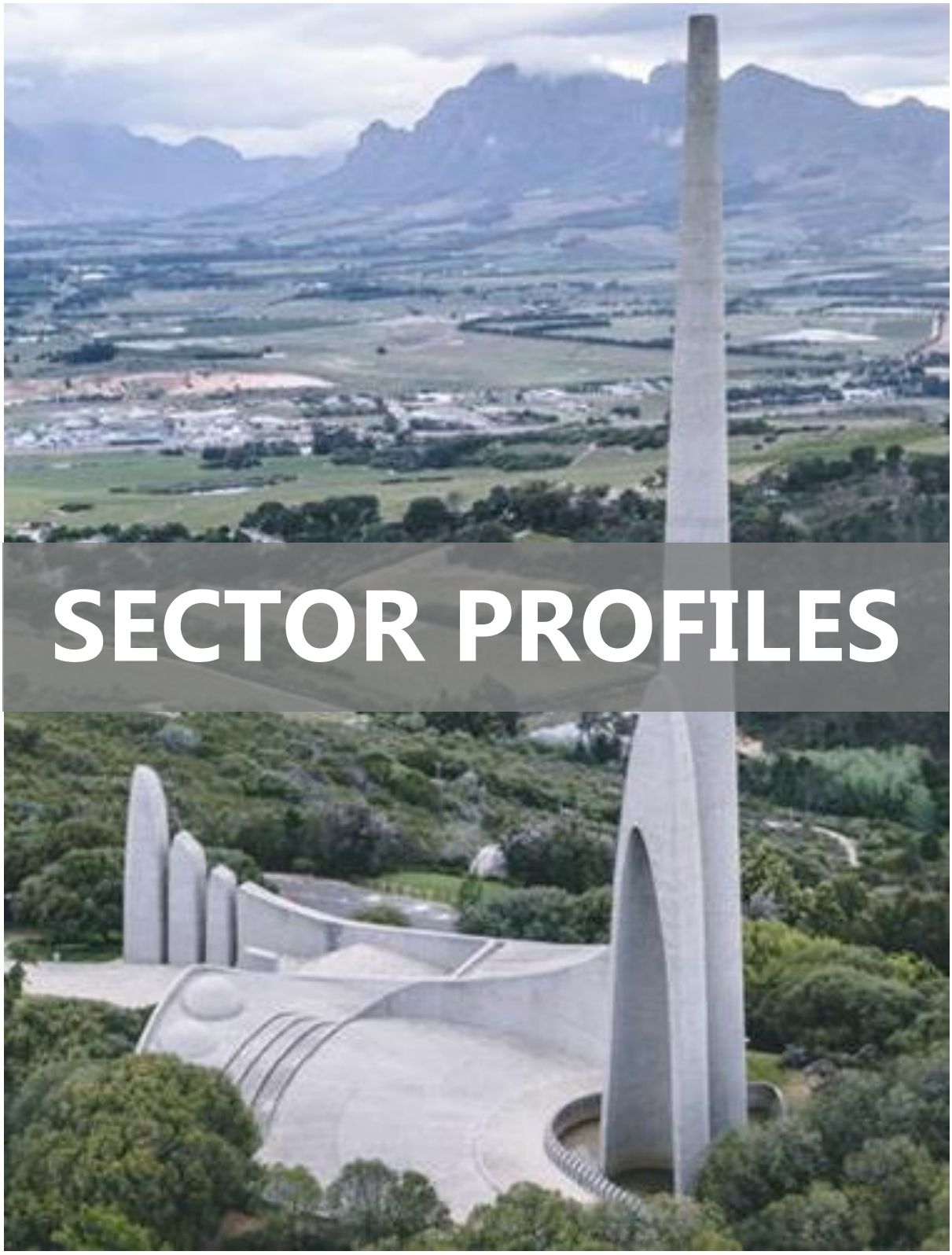
The figure on the following page displays changes in rainfall per month from current rainfall to 2030. Rainfall is more complex, variable and more challenging to model than temperature. As a result, changes in rainfall are more difficult to detect.

The Western Cape receives winter rainfall as a result of cold fronts and extratropical cyclones moving over the Western Cape. Climate change is increasing the strength of the south Atlantic high-pressure system which pushes cold fronts further south of South Africa. Consequently, causing a drying trend over the Western Cape.

There is a **drying** trend expected for all months of the year in all areas of Drakenstein. However, the magnitude of drying is expected to be larger in the **north** than in the south. **May, June** and **August** are expected to have the largest decrease in rainfall which is an indication that the length of the rainfall season is becoming **shorter**.

Figure 2: Anomalies showing changes in rainfall per month, 2030





SECTOR PROFILES

3 Sector Profiles

Climate change impacts will affect almost all sectors. Local government will have to pay attention to time horizons and the evolution of risks associated with projected climate changes, and reassess the suitability of response options and projects over time. Climate change related insecurity in one sector may also be diffused to other sectors through their complex interrelationships. A balanced approach with short, medium and long-term adaptation interventions will be critical for reducing vulnerability to climate change impacts and achieving sustainable growth and development.

To implement an effective response to climate change, primary response efforts will be focused on priority sectors to assist with the mainstreaming of climate change response. The priority sectors should be reviewed on a regular basis to assess relevance in the context of future conditions.

Priority sectors have been identified based on the climate and potential significance of impacts, sectors' economic importance, significance of adaptation measures in the sector, time horizons of impacts and urgency of intervention, and potential social and environmental significance of climate change impacts.

It is important to note that this adaptation work is based on the assumption that many of the current climate vulnerabilities will be amplified by projected climate changes.

The following section consolidates information that was collected during a desktop study as well as during stakeholder engagements. The section discusses sectors that have been identified as being affected by either current climate vulnerability or projected vulnerability within the Drakenstein municipal area. These sectors are:

- **Water Security and Efficiency**
- **Human Settlements and Infrastructure**
- **Ecological Infrastructure and Biodiversity**
- **Social and Economic Development**
- **Solid Waste Management**
- **Energy**

First order adaptation interventions aimed at mitigating climate risks have been suggested, with the understanding that the municipality will review, align, and mainstream these into the existing municipal master plans such as the IDP, SDF and Disaster Management Plan. The Western Cape Government will continue to give support throughout this process, if resources are available to assist with the following areas:

- Project identification and implementation
- Identifying and assisting with appropriate funding sources
- Facilitating expert input where possible
- Networking with other municipalities doing similar work
- Facilitating the sharing of information and resources across municipalities
- Monitoring and evaluation of climate change related projects and programmes.

3.1.1 Water Security and Efficiency

Top climate risks:

- Temperature
- Drought
- Fires
- Flash floods
- Wind

Time horizon of impacts:

Short term (2018 – 2020) and medium term (2020 - 2050)

Municipal Departments concerned:

- Water Services
- Wastewater Services
- Disaster Management

Impacts:

Water shortages (which impact agriculture and ultimately the economy); Fires melt pipelines; Increasing Demand; Pollution of water bodies; Decreased water quality; Users competing for water; Irresponsible borehole management

Response options:

Additional reservoirs and pipelines to store and transport water; Drilling of boreholes; Awareness and educational campaigns; Removal of alien vegetation that uses more than acceptable quantities of water; Water reticulation systems for new housing developments; Water wise gardening; Policing of water resources; Stronger legislation; Greywater harvesting; Use of greywater for irrigation; Apply organic mulches; Metered water use to prevent water wastage; Artificial wetlands; Water conservation

Climate change mitigation options:

Partner with Electricity Department to create hydropower; Reduce energy consumption at Wastewater Treatment Plants

3.1.1.1 Problem Statement

Water has reached the headlines in the Western Cape for the past three years as the region that has been gripped in a drought crisis through **less rainfall events in a warming climate.** During this period the region is reminded of its natural claim to water scarcity as water shortages of this nature were not experienced since the early 90's. These **water shortages** have brought a heightened sense of worth and importance of water, and made the consumer more aware that water does not find its origin from a tap. They have also posed additional stress on water resources in the municipality.

Water availability will remain a concern with storage being highlighted as an ongoing area of requiring improvement. Promoting the efficient use of water should be one of the key focus areas of any Water

Services Authority, particularly since South Africa is a water scarce country.

Another concerning factor is the dependency of Drakenstein on the City of Cape Town for its water supplies.

The highly variable climate of Drakenstein is likely to be exacerbated by the effects of climate change. Drakenstein is particularly vulnerable to droughts if they occur in numerous consecutive years. For example, 2011 was a dry year however Drakenstein received sufficient rainfall the year after and so the area was able to recover. However, in 2015 Drakenstein experienced another drought and sufficient rainfall has still not been received. Drakenstein is particularly vulnerable during prolonged droughts and is dependent on what occurs in the Theewaterskloof.

As temperatures rise, the flows of water in the hydrological cycle will be altered. Water availability, timing, quality and demand will be altered. As a result, harvests of apples and grapes are altered. However, if dams contain water throughout droughts, agricultural potential remains high.

The implementation of a **Water Demand Management Strategy** can have a significant impact in ensuring effective, affordable and sustainable water services with social, economic and environmental benefits to all. Many of the towns in South Africa are facing a growing problem of providing sufficient water to support their growing demands. In most of the cases this requires the construction of new and expensive infrastructure and in some cases, it may be necessary to develop new water resource transfer schemes. It is therefore critical to manage water demand to save costs.

Most of the supply to Paarl and Wellington is from the Western Cape Water Supply System (City of Cape Town), which also supplies Hermon with treated water. Gouda is supplied with bulk treated water by the West Coast District Municipality from the Swartland Water Treatment Works. Groundwater accounts for a very small percentage of supply.

Groundwater use is projected to increase because many boreholes have been drilled during the recent drought. However, it is expensive to drill boreholes and there are no projects in place to recharge the water table which may result in the overexploitation of groundwater. In addition, during the recent drought many people have replaced water intensive vegetation with impermeable surfaces that also prevent groundwater recharge.

The municipality is facing increased demand for water due to **urbanisation, economic development, intensification of land use practices and the provision**

Water Risk and Vulnerability:

- Inundation of storm water and sewage systems;
- Increased peak flow rates;
- Changes in groundwater levels;
- Shifting flood plains;
- Reduced dry weather flow rates;
- Increased intensity of precipitation causing intrusion into waste water networks;
- Potential for blockages and overflows;
- Changes in the mean and peak flow rates of rivers and streams;
- Unreliable/insufficient water supply;
- Increased risk of contamination;
- Salination of water sources;
- Changes/shifting of groundwater used for irrigation; and
- Increased risk of water theft

of water to meet the basic needs of a growing population. Drakenstein Municipality realised the importance of implementing a Water Demand Management Strategy to delay the development of additional water sources and to defer the upgrading of bulk infrastructure and therefore started with the active implementation of the Strategy.

Water quality in the Berg River is also a current concern, which is expected to deteriorate with the drying effects of climate change resulting in less dilution of the numerous sources of pollution affecting the river. There are burgeoning informal settlements along the river with insufficient sanitation infrastructure. In addition, formal settlements also pose a problem with inadequate maintenance of sanitation infrastructure, resulting in significant pollution going unnoticed into the river.

The direct impact of climate change is not the only reason to be concerned about water security and efficiency. The **increasing population** means more demand for agriculture, greater use of water for irrigation and more water pollution. In parallel, **rising affluence** in some municipal areas means a larger number of people living water-intensive lifestyles, including watering of gardens, cleaning cars and using washing machines and dishwashers. Rapid development also results in more industry and in many cases, these come without modern technology for water saving and pollution control. Therefore, concerns about climate change must be viewed alongside management of pollution and demand for water.

Drakenstein is currently experiencing a boom in the development of private housing complexes which is placing additional strain on water resources.

The Water Services Department makes use of climate change information displayed on maps as well as water quality information to support their decision-making.

3.1.1.2 Current Interventions

Interventions relating to climate change and water that Drakenstein is currently implementing include:

- Implementation of drought and flood plan to combat the impacts of the drought
- Drilling boreholes
- Investigating the feasibility of building new dams (Drakenstein Municipality, 2018)
- Demand management
- Bulk resources study conducted by Aurecon to plan for the next 10 to 20 years
- Water saving and awareness campaign
- Action plan to manage high water consumers (over 50kL per month)
- Clearing of alien vegetation in the Berg River by the Cape Winelands District Municipality to increase the water flowing to the Berg River Dam. This water fulfils the required ecological reserve and is also provided to farmers
- The Cape Winelands District Municipality Health Services conducts water sampling to comply with the National Environmental Management Act (NEMA)
- EPWP Programme by Cape Winelands with Environmental Management to clean streams flowing through Mbekweni into the Berg River (Pilot Project).

3.1.1.3 Response

Some of the most common solutions to water security and efficiency, and a way of insuring against possible climate change impacts, is the engineered redistribution of freshwater over space and time which requires **reservoirs to store water, and pipelines to transfer it.**

Efforts should also be made to create a new "local water culture" that promotes sustainable water management practices to meet long-term societal needs. This includes **increased water saving, reuse and recycling of greywater** and investments into **education** to combat water scarcity in the future.

A broad educational initiative can foster partnerships and collaboration among local governments, educational and research institutions, energy and industrial users and the public. Increased public education may be the single most effective enabling element of long-term drought mitigation and water resource management.

The National Climate Change Response Strategy lists the following options for adaptation of the water sector to climate change (DEA, 2010):

- Integrate climate change in the short-, medium- and long-term planning;
- Sustain water-related research and development of capacity;
- Implement water and catchment management. Water management, including investment into water saving technologies and infrastructure are essential;
- Explore different water sources; and
- Monitoring and evaluation

In order to overcome crop losses associated with water shortages the following response options can be considered:

- Focus on drought and heat tolerant crops or species with relatively low water requirement per kilogram produced and increased yield;
- Use other technologies, such as hydroponics in periods of drought to produce vegetables and fodder;
- Development of crops optimised for decreased evapotranspiration;
- On-farm water capture, storage and improved rainwater harvesting. In addition, on-farm water control and application should be improved;
- Adapting integral system approaches to improve water use efficiency by better crop, soil and irrigation management.

Mitigation of climate change

Wastewater collection and treatment as well as pumping of water includes high electricity demands (International Energy Agency, 2017). Using electricity more efficiently at wastewater treatment plants can reduce the carbon footprint of the water sector and make an attempt at mitigating climate change.

3.1.1.1 Key Actions for Mainstreaming Climate Change in Drakenstein

- Management of impermeable surfaces to reduce the risk of flash floods occurring after intense rainfall events
- Municipal floodline studies should be updated due to the shifting pattern of rainfall in order for disaster management to respond appropriately

3.1.2 Human Settlements and Infrastructure

Top climate risks:

- Floods
- Drought
- Heatwaves
- Windstorms

Time horizon of impacts:

Short (2018 – 2020) to long term (+2050)

Municipal Departments concerned:

- Human Settlements
- Spatial Planning
- Roads, Storm Water and Traffic Engineering
- Land Use Planning
- Disaster Management

Impacts:

Impacts on agricultural production; Damage natural assets; Damage heritage; Damage to infrastructure; Water shortages for certain land uses; Land users competing for water; Flooding of settlements and infrastructure built in floodline; Inaccessibility to areas when roads are flooded or damaged; Pollution of storm water systems in times of drought; Personal loss to residents; Potential injuries and loss of life

Response options:

Diversify crops; Reskill farmworkers; Resilience Conditions of Approval; Balance between environment and development; Build stakeholder buy-in; Mainstream climate change into SDF (of Drakenstein as well as Cape Winelands); Floodline awareness programmes

Climate change mitigation options:

Resilience Conditions of Approval; Public transport; Good engineering practice

3.1.2.1 Problem Statement

The primary town of Paarl is located along the banks of the Berg River and as such flooding poses a real threat to key infrastructure and human settlements

In addition to the **pollution** potential posed by informal and formal housing located along the river, there are a number of other climate related impacts associated with human settlements along the Berg River.

Many developments such as Mbekweni along the river are prone to flooding, particularly informal settlements that lack or have **inadequate drainage**, and those developments built in flood plains. However, alternative land that is suitable for housing is limited.

Clearing and maintenance of **storm water infrastructure** is currently constrained by **budget** to taking place once a year, which is not adequate under current conditions and will most certainly not suffice under changing climatic conditions. Some storm

water systems are also in need of upgrading, being of inferior quality and condition which is being done as budget permits. It must be noted that with the changes in climate taking place, flooding situations are expected to increase in frequency. In addition, the current capacity of the storm water system (e.g. pipe diameter) may become inadequate in the face of projected increased rainfall intensification. The City of Cape Town has recently increased the storm water pipe diameter by 15% to accommodate the projected increased rainfall intensity.

Drakenstein is revising the basis for storm water run-off detainment and storm water system design to better cope with emergency situations relating to higher intensity rainfall.

The observed and projected increase in rainfall intensification will increase the flood risk in these areas. In addition to increased intensity of rainfall, seasonality is also projected to shift, which may demand a change in the time of year the maintenance is scheduled.

Behaviour change campaigns may also need to be considered to target reduced litter ending up in storm water drains exacerbating the flooding problem.

Transport infrastructure is very important in emergency / disaster situations, to both access and evacuate people in need of emergency assistance. Some areas in Drakenstein get cut off by flooding, effectively becoming inaccessible.

The municipality has identified areas prone to flooding and it has also developed a list of properties that will likely be affected by flooding events. The flood lines, flood risk areas and list of affected properties require regular updating as flood lines keep shifting due to change in land use next to rivers as well as climate variability.

Risk and Vulnerability of Human Settlements and Infrastructure:

- Provision of basic services is limited in unplanned human settlements
- Dense settlements are more vulnerable to all hazards
- Rural settlements are the most vulnerable due to likely climate change impacts on agriculture
- Challenges faced by human settlements and infrastructure include migration, urbanisation, inequality, poor spatial planning, poverty, service provision, aging and deteriorating infrastructure
- Poor maintenance and replacement of infrastructure due to limited budget
- Communication systems failure and damage
- Changes in rates of deterioration due to changes in precipitation and temperature
- Inundation of roads resulting in deterioration or destruction
- Interruption of road traffic and disruption of emergency transport routes due to extreme climatic events
- Disruption of emergency routes;
- Increased intensity of precipitation causes intrusion into waste water networks
- Capacity of existing flood defenses and drainage systems may be exceeded
- Reduced precipitation impacts functioning of storm water systems
- Increased risk of fires

Flooding is also a potential risk due to the **impermeable surfaces** that accompany the development of human settlements and infrastructure which are usually built in high-density. Poorly maintained **storm water drains** may also result in flash floods after a rainfall event.

The lack of adequate **temperature control** in informal and low-income settlements remains a major driver of vulnerability to climate related hazards. These include the use of open fires or paraffin stoves for heating, particularly in winter, which pose a fire risk; as well as heat stress in summer from inadequate cooling or insulation. Mitigating this risk provides an opportunity to tackle both the energy-related and climate vulnerability related sides of climate change in single projects.

Temperature control is an important factor to consider particularly when new development (such as the development taking place south of the N1) starts to contribute to the **heat island effect.** New development also contributes to the area that is under hard impermeable surfaces. It is therefore important to achieve a balance between the environment and development.

The **Paarl Arboretum** is a green lung located next to the Berg River which could be utilised as a green open space. An Urban Design Framework was developed however it is not being implemented. Utilising **open spaces** (such as the Paarl Arboretum and areas identified as **Critical Biodiversity Areas)** and creating new open spaces and outdoor activities can also be used to market Drakenstein as an ecoadventure tourist attraction.

New development also increases the demand for **transportation** particularly when new development is on the outskirts of town. Currently many people have not been using public transportation and prefer to use private vehicles. This increases Drakenstein's **carbon emissions** and further contributes to climate change.

The District is currently developing an **Integrated Transportation Plan** for Drakenstein. However, communication and interactions with relevant Departments such as Spatial Planning during the development of the plan can be improved.

The **Environmental Management Division** is active in providing required information in this sector and is moving in the right direction in terms of showing their commitment to climate change response. However, the division could use more support in order to successfully implement options and shift the mindset of stakeholders to focus more on climate change.

3.1.2.2 Current Interventions

Interventions relating to climate change and human settlements and infrastructure that Drakenstein is currently implementing include:

- Implementation of the **drought and flood plan**
- **100-year Berg River flood scenarios**
- **Mbekweni Station Pilot Project** which includes greening of public spaces. Addresses the heat island effect. The Neighbourhood Development Partnership Grant given by the Department of National Treasury provides funding for urban greening initiatives.
- **Assistance program for infrastructure forward planning**
- The **Mountain Slope Study** is being developed as a policy to determine where development can take place on the mountain slopes and where

areas should be preserved for conservation, heritage and tourism.

- **Vlakkeland Catalytic Project** in which Drakenstein is developing 2500 houses in conjunction with the Provincial Department of Human Settlements. Approximately 30% of the value of the contract is to be spent on local labour and enterprises which gives unemployed people the opportunity to become registered on the Municipal Job Seekers Database. Water consumption will be measured weekly and reported on. The design of the houses is to be in line with climate change principles therefore solar geysers, thermal qualities and greywater harvesting services. One challenge that the project is limited by is the initial investment costs of the abovementioned design interventions making it difficult to implement and sustain them. Housing projects such as this are often linked to employment contracts. The municipality is counteracting farm worker evictions through its housing selection policy by providing approximately 20% of new opportunities to farm workers. It can also provide emergency accommodation (for example, the Schoongezicht site).

3.1.2.3 Response

The National Climate Change Response Strategy proposed the following interventions to reduce the vulnerability for rural and urban human settlements (DEA, 2010).

Urban Human Settlements

- Build climate resilient infrastructure and low-cost housing
- Water-Sensitive Urban Design
- Down-scale climate projections to improve decision-making and assessment tools for landuse planning and design of urban areas

Rural Human Settlements

- Diversify livelihoods
- Improve agricultural technologies to promote soil and water conservation
- Make use of drought resistant crops
- Conserve ecosystems to build climate change resilience

In addition to the responses identified by the National Climate Change Response Strategy, areas being highly impacted by climate change should be avoided when planning new housing projects. Energy efficient regulations should also be enforced and the use of safe energy

Mitigation of climate change

The housing sector consumes a large amount of electricity for heating, cooling, cooking and lighting which results in a large carbon footprint contributing to climate change. Households should be encouraged to decrease their electricity usage and to use energy efficient appliances.

Greenhouse gases emitted by transportation also contributes to climate change. Buy-in of public transportation or greener ways of travelling such as cycling may be improved by improving Drakenstein's image in terms of crime. Drakenstein is currently running a Violence Prevention Programme particularly in Chicago and Groenheuwel to reduce crime;

Furthermore, Drakenstein should engage in engineering best practice and make use of the Resilience Conditions of Approval.

sources should be encouraged. Early warning systems and Disaster Risk Management should also be activated in communities.

Mainstreaming **no-regret interventions** into planning of human settlements also minimises risk and vulnerability. Improving ecological infrastructure is another valuable response. Ecological infrastructure supplies human settlements with important services such as water regulation, climate regulation, soil formation and disaster risk reduction. Improving the thermal comfort of housing can reduce heat stress.

Alternative approaches to increased infrastructure loading due to climate change include approaches such as Sustainable Urban Drainage Systems (SUDS), the use of ecological infrastructure, by-laws and strategic plans stipulating the incorporation of climate considerations into the design and location of critical infrastructure and human settlements.

Responses specific to Drakenstein

The following responses to climate change are specific to Drakenstein and are options that were highlighted during the stakeholder engagements.

- Mainstreaming of the Resilience Conditions into development to improve the ability of development to withstand and recover from the impacts of climate change;
- Water retention to overcome droughts;
- Reuse of water;
- Alternatives to hard surfaces to prevent floods occuring from precipitation run-off; and
- The Cape Winelands District Municipality is currently working on the new SDF which will incorporate relevant climate change information. The SDF will be available to all the local municipalities as well as to the public. It is a requirement for all the local municipalities to follow the strategies laid out therein.

3.1.2.4 Key Actions for Mainstreaming Climate Change in Drakenstein

- Rainwater harvesting in housing projects to be rolled out in the next 5-10 years for 6000-7000 households
- Hard surface management
- Implementation of the Arboretum Urban Design Framework
- Mainstream climate change into local SDFs
- Mainstream information from the Disaster Management Plan into the SDF to reduce climate-related risks
- Develop capacity for awareness and education on climate change in order for people to understand why it is important to protect the environment and our resources. For example, educate people living along rivers on why it is important for them not to pollute rivers and how it will benefit them. Package climate change information specific to different communities
- Collaborate and form partnerships with property owners in order to determine who should take responsibility for risk reduction within private properties

3.1.3 Ecological Infrastructure and Biodiversity

Top climate risks:

- Mountain fires
- Wildfires
- Drought
- Increased average temperatures

Municipal Departments concerned:

- Parks
- Spatial Planning
- Disaster Management
- Environmental Management

Time horizon of impacts:

Short - Long

Impacts: Water shortages; Poor water quality; Biodiversity loss; Habitat loss; Indirect impact on eco-tourism; Loss of ecosystem services; Increased alien invasive species; Decreased air quality

Response options:

Green landscaping; Water Wise gardening; Indigenous landscaping; Green landscaping; Urban Edge Policies; Development Planning and Spatial Planning Policies; Berg River Corridor; Storm water management on mountain; Awareness and education; EMS for record keeping; Water recycling; Ecosystem rehabilitation and catchment management e.g. BRIP; Responsible and sustainable eco-tourism development and activities

Climate change mitigation options:

Reserve management plan; Energy efficient buildings and fleet management in nature reserves; Development framework to look at layers of assets; Integrated Fire management plan; Landscape Master Plans involve tree planting to offset carbon footprint; Planting of spekboom; Integrated alien invasive management; Zyrophytic landscapes

3.1.3.1 Problem Statement

As highlighted in the section above dealing with infrastructure, ecological or green infrastructure is increasingly being recognised and valued for the role it plays in supplying infrastructure services, such as wetlands purifying water or acting as slow release sponges, releasing good quality fresh water throughout the dry seasons. It was noted that the optimal functioning of the ecosystems that surround us ensures essential **ecosystem goods and services**, not only for humans, but for all species.

From a climate adaptation perspective, ecosystem-based adaptation focusses on reducing risk through the optimal functioning of ecological infrastructure, such as floodplains and wetlands. Replacing these services is costly and in many instances not as effective as the

naturally occurring, mostly self-regulating options.

Protecting biodiversity is also vital for ensuring that ecosystems continue to provide valuable services such as **flood control, purifying water, erosion control, clean air and carbon storage** (Job & Driver, 2006).

Alien invasive species, land use change, changes in nitrogen and carbon cycles as well as climate change is identified as the four top **drivers of biodiversity loss** (Masters & Norgrove, 2010).

Climate change facilitates **alien invasive species** by making conditions favourable for the spread of new species. Increased temperature and atmospheric carbon dioxide levels greatly increase the spread of alien invasive plant species (eThekwini Municipality, 2011). In turn alien invasive species also increase the vulnerability of ecosystems to climatic stress (Masters & Norgrove, 2010). The increased fuel load caused by the spread of alien invasive plant species increases the risk of **veldfires** occurring and increases their severity (CSIR, 2010).

The Berg River catchment is a key element of Drakenstein Municipality. Dysfunctional ecosystems on any part of the catchment have a concatenating negative effect on the rest of the river, particularly downstream. The better the state of upper catchment wetlands, small tributaries, and natural landscapes function, the better the river as a whole will function in supporting life. Rivers that are nothing more than scoured out channels lose this ability, becoming extremely dangerous during intense rainfall events, effectively channelling vast amounts of water at an alarming rate down the river, **destroying critical infrastructure, homes, businesses and agricultural land.**

It is therefore in the municipality's interests to encourage and support sound catchment management processes along the entire Berg River. Alien vegetation that has invaded many of our catchments nationally exacerbates many of these negative consequences and further compromises our river's ability to sustain the naturally occurring biodiversity.

Cleared vegetation left in the flood zone gets swept up in floods and if big enough, dams up behind bridges creating a build-up of water that is then big enough to remove the bridge or road once it breaks through. This can be resolved by removing cleared vegetation in these high flood risk areas.

Invasive alien vegetation also **compromises the availability of water** in the Berg River, and increases the fire risk in the area as a whole. Climate projections indicate a trend towards higher mean annual temperatures in the area, which will increase the fire risk as well as potentially compromising water supply.

Drakenstein Municipality can play a more significant role in **alien clearing initiatives** in the area through utilisation of the Extended Public Works Programme (EPWP), as well as increased municipal representation on initiatives such as the Department of Water and Sanitation,

Ecological Risk and Vulnerability:

- Alien invasive species
- Altered veldfire intensity
- Loss of biodiversity
- Changes in distribution of indigenous fauna and flora
- Increased risk of species extinction
- Reduced ecosystem resilience
- Stress on ecosystem services
- Shifting biomes

Department of Agriculture's LandCare Programme, Department of Environmental Affairs' Working for Water and Working for Wetlands programmes.

Localising involvement at the municipal level will increase **job opportunities** in the area, which may have a related positive affect on **reducing the challenges associated with the dependence on seasonal work in the area.** At present most of the municipality's EPWP funds are spent on infrastructure related projects, however the Western Cape Government EPWP co-ordinator could assist with the utilisation of EPWP funds to develop invasive alien vegetation clearing projects and the like.

Residential areas within Drakenstein also play an important role in biodiversity as a lot of households have trees and other vegetation on their properties that serve as **green areas**. Farms also serve as green areas and often have a diverse range of fauna on them. Connecting fragments of green areas with ecological corridors can improve biodiversity through increased dispersal of fauna and flora (Climate-ADAPT, 2015).

The frequency of **wildfires** increases in periods of drought and high temperatures. The risk is worsened by poor fire planning and the accumulation of combustible materials.

3.1.3.2 Current Interventions

Interventions relating to climate change and ecological infrastructure and biodiversity that Drakenstein is currently implementing include:

- Implementing Biodiversity and Alien Management Strategies
- **Environmental Emergency Plan** for mountain fires as well as strategies for fire prevention and fire breaks.
- **Record keeping management tool:** it must contain environmental risks (fires, alien invasive development), as well as mitigation measures.

3.1.3.3 Response

In order to respond to biodiversity loss caused by alien invasive species and to protect ecological infrastructure from the impacts of climate stressors a holistic interdisciplinary approach is necessary (Masters & Norgrove, 2010).

The National Climate Change Response White Paper discusses the following ways in which South Africa will integrate climate change into biodiversity and ecosystem services management:

- Monitor and assess impacts by strengthening management and research institutions;
- Conserve, rehabilitate and restore natural systems;
- Plan for all climate scenarios;
- Prioritise climate change research into biodiversity and ecosystem services;
- Enhance existing programmes to combat the spread of alien invasive species;

Mitigation of climate change

Ecological infrastructure provides opportunities to mitigate climate change by serving as a carbon sink that removes carbon from the atmosphere and fixes it into the soil (SANBI, 2014).

- Expand the protected area network where is increases climate resilience;
- Encourage partnerships for effective management; and
- Expand gene banks to conserve species that are critically endangered.

3.1.3.4 Key Actions for Mainstreaming Climate Change

- Sustainable agriculture
- Map hotpots of CBA and use them as facilities to create awareness and educate people on the importance of biodiversity for climate change
- Create a list of species that are threatened and invasive
- Biomass recycling
- Greening next to new housing developments
- Comprehensive Awareness Strategy
- Alien clearing
- Ecosystem rehabilitation
- Implement the Western Cape Biodiversity Spatial Plan Handbook
- Drafting and Approval of Events Management By-Law. Many people from outside the Drakenstein boundaries attend events and consequently use natural resources such as water that are going to become even more scarce with climate change. During these events large amounts of water are consumed and in many cases wasted, with other pollution incidents affecting the larger Drakenstein area and the nature reserve. These events need to be managed and guided by proper water management and waste management plans as regulated by the Events Management By-Law
- Promote the honey industry locally to ensure that there are enough pollinators for crops.

3.1.4 Social and Economic Development

Top climate risks:

- Drought
- Floods
- Heatwaves

Municipal Departments concerned:

- Planning and Development Directorate
- Economic Development and Tourism
- Rural Development
- Community Development
- Disaster Management
- Environmental Health

Time horizon of impacts:

Short term (2018 – 2020) and long term (2050+)

Impacts:

Water shortages; Crop losses (mostly due to decreased area under production); Failure of community gardens; Ripple effect on social-economic conditions such as unemployment due to farm worker evictions; Decreased exports of agricultural produce; Financial losses; Rural-urban migration; Increase in number of people accessing food from nutrition centres; Increase in number of street people; Impact sporting, cultural and other events and activities due to droughts; Increased occurrence of disease due to water shortages; Potential injuries and loss of life; Heat stress;

Response options:

Diversify crops; Reskill farmworkers; Resilience Conditions of Approval; Comprehensive Draft Rural Development Strategy; SmartAgri Plan

Climate change mitigation options:

Resilience Conditions of Approval;

3.1.4.1 Problem Statement

According to the 2011 Census, the Drakenstein area has an unemployment rate of 17.6%. With the agriculture sector providing the most **employment** opportunities in the municipal area, Drakenstein has not escaped farmworker strikes. Although the drivers of these strikes are complex and not the scope of this work, they raise issues around social and economic vulnerability in the region per se.

Climate change is likely to impact employment even further. Climate change will cause an increasing number of crop damages and failures (DEA, 2010). In addition, less farm area is put under production during drought due to limited water availability for irrigation. Shorter harvesting seasons will also negatively

impact seasonal workers as their working periods are shortened. This will in turn cause a number of farm worker evictions and loss of incomes.

There are also some instances of **farmers vacating** their farms leaving many farmworkers without incomes and reliant on the fruit trees that have been left on the farm.

Many famers have however **diversified their crops** or adapted by prioritising fruit exports with the water that was available during the drought in 2017/18 and abandoned other crops that had less profitable margins. A few farmers are currently considering diversifying their crops. For example, planting berries instead of grapes. However, this has created conflict with the **heritage** of the area as many generations have lived there and known the area as a wine valley. Berry farming also requires shade netting and so will affect the aesthetics of the area.

The current trend of farm worker evictions, partly due to reduced agricultural profit margins leading to reduced agricultural viability on some farms, goes hand in hand with **food security** and broader social vulnerability in the province as a whole. Many households are dependent on backyard farming for their subsistence and are often dependent on municipal water for irrigation. It is therefore expected that during drought the majority of these households are not able to produce food thereby negatively impacting their food security (Pienaar & Boonzaaier, 2018).

Social and Economic Development Risk and Vulnerability:

- Poor food security
- Poor health
- Poor safety
- Displacement and migration
- Unemployment
- Decreased tourism

Many of these evicted farmworkers, with skills specific to the agricultural sector, are now solely dependent on social grants, with a significant number **migrating** to the surrounding towns and cities seeking employment and shelter in the form of informal dwellings.

Other sectors of the economy (such as **transportation**) are also impacted indirectly by climate change due to less demand for transport of agricultural products as less are produced.

This places additional strain on the towns and cities regarding carrying capacity of infrastructure, service delivery and housing backlogs. With many of the projected climate changes resulting in impacts that will favour this trend towards rapid urbanisation and the potential emergence of climate related refugees, this raises the risk profile of the area and surrounding areas as a whole.

Agriculture is arguably the economic sector the most vulnerable to the impacts of climate change however **tourism** will also be affected by projected temperature increases, altered rainfall patterns and more frequent extreme events. It is already known that less tourists visited the area during the recent drought.

Drakenstein does however have an active **Environmental Management Division** that supports Departments such as Economic Development and Tourism as well as Spatial Planning with accessing information on climate change and the green economy.

A **green economy** can be defined as a path to sustainable development that improves social equity and human well-being while reducing damage to the environment (CSIR, 2014).

There is a need to provide departments with training to understand the impacts of climate change on environmental health, cleanliness and the operation of facilities such as **Early Childhood Development (ECD) centres**. For example, the water restrictions that accompanied the recent drought caused sanitation issues in ECD centres. Droughts are expected to become more frequent with climate change therefore it is pertinent to overcome the sanitation challenges experienced by ECDs.

Furthermore, droughts can bring about challenges for **the disabled and the elderly**. For example, it may be difficult for the disabled and the elderly to collect water at water distribution points when water shortages are experienced.

Drakenstein hosts numerous sporting, cultural or other events. Hazards related to climate change such as the increasing frequency of droughts and severe windstorms could negatively impact these events. As a result, local economic development and employment opportunities will be impacted negatively.

3.1.4.2 Current Interventions

Interventions relating to climate change and social and economic development that Drakenstein is currently implementing include:

- Drakenstein's Economic Development and Tourism Department is training youth to become **truck drivers**. This also gives evicted farmworkers the opportunity to reskill themselves.
- **Contractor Development Programme for Entrepreneurs** run by the Economic Development and Tourism Department
- Implementation of **food gardens at rural schools** through the Rural Development Department. The project is however limited by water shortages and budget constraints. The schools have gutters which makes rainwater harvesting a possibility but due to the lack of budget there is no funding to buy water tanks.
- During emergency situations 3m x 1m **portable vegetable gardens** are supplied to households by the Rural Development Department to supplement their food supply. The water restrictions during the recent drought did however pose a challenge to the watering of the gardens.
- Establishment of **Arts and Culture Forums** by the Community Development Department which can help the youth to develop networks.
- **Food and Nutrition Programmes** such as soup kitchens that are run through the Community Development Programme
- **Skills Development Programme** targeting matriculants who are unable to find jobs. The programme is run through the Community Development Department to enable people to obtain a job such as home-based carers, bricklaying, carpentry, beautician and hair dresser as soon as possible.

3.1.4.3 Response

The National Climate Change Response White Paper states that the appropriate use of small-scale and labor-intensive agriculture can prevent a decline in agricultural jobs and consequently prevent other socio-economic issues associated therewith.

In addition a focus on poverty alleviation and vulnerable groups as well as social support networks and communal livelihood strategies can assist in overcoming the impacts of climate change that are experienced.

Planning for a **climate resilient economy** will assist the community and businesses to protect themselves from climatic shocks that are expected to become more frequent. As a result, less expenses are accrued to recover from shocks (Environmental Protection Agency, 2016).

It is also pertinent to pursue new opportunities that arise as the climate changes (Environmental Protection Agency, 2016).

Mitigation of climate change

Until recently, economic development resulted in higher GHG emissions and carbon footprints. However, developing a green economy presents opportunities for development and climate change development (Lund University, 2016).

The green economy is predicted to grow with regards to natural resource efficiency and management, emissions mitigation, pollution control (using electric vehicles, cleaner stoves as well as capturing and storing carbon), as well as ecosystem restoration and conservation. Natural resource management and ecosystem conservation requires government investment. Thus, establishing public private partnerships provides further opportunities for the green economy to thrive.

3.1.4.4 Key Actions for Mainstreaming Climate Change in Drakenstein

Local sustainable development

Reskilling of farmworkers – in 2019 the Economic Development and Tourism Department will be conducting a Skills Development Survey in order to see how to respond to the demand for skills.

The Economic Development and Tourism Department plans on developing a project to design an accredited course on **application design coding** for youth through a partnership with Telkom or other high-tech companies. The course will introduce youth to the gaming sector and the digital economy. They would partner with the University of Western Cape to determine the readiness of citizens to embrace the digital economy and become an e-citizen.

In rural areas such as Saron, the Economic Development and Tourism Department is developing a project which is currently in the conceptual phase. The project will involve the training of youth to become subsistence farmers but also have the capacity to be digitally ready so that they can become part of the digital economy. The project involves using digital technology to assist subsistence farmers with selling their produce. The project will involve youth from the rural as well as urban landscape.

Rural Development

The Department of Rural Development is still in the process to explore and implement grey water use for schools with vegetable gardens, with the Department of Education and ASNAP.

Integrate climate change into the Rural Development Strategy

ASNET approached the Rural Development Department to produce blue berries. For this project to be successful land is needed. An approved budget was made available for the project. The two partners realize the need for more water and are currently looking for new and alternative ways of accessing water to successfully implement the project.

Implement the SmartAgri Plan and encourage its implementation amongst the farming community.

Land use diversification on farms should be encouraged in order to cater for additional income streams for farmers and farm workers. For example, guesthouses as tourist facilities could be developed.

3.1.5 Solid Waste Management

Top climate risks:

- Flooding
- Wind
- Increasing temperatures
- Drought

Municipal Departments concerned:

- Solid Waste Services
- Parks
- Human Settlements
- Disaster management

Time horizon of impacts:

Short – long term

Impacts:

Odours; Health and environmental pollution risks due to rainwater infiltrating into landfill sites;

Response options:

Recycling programme; Partnerships with industries and the private sector; Chipping of organic material; Awareness raising; Reuse of building rubble; Banning of certain materials and substances

Climate change mitigation options:

Waste to energy project

3.1.5.1 Problem Statement

The fragmented and uncoordinated way pollution and waste has been dealt with, as well as insufficient resources to implement and monitor existing legislation, contributes largely to the unacceptably high levels of pollution and waste in South Africa.

Through the promulgation and implementation of various pieces of policies, legislation, standards and guidelines as well as the implementation of co-operative governance as envisaged in the Constitution, this situation will be improved. The current fragmentation, duplication and lack of co-ordination will be eliminated.

Pollution and waste management is not the exclusive preserve of government. The private sector and civil society have crucial roles to play. The fostering of partnerships between government and the private sector is a prerequisite for sustainable and effective pollution and waste management to take place. Similarly, the spirit of partnerships and co-operative governance between organs of state is equally important due to the crosscutting nature of pollution and waste management.

There is a lack of public awareness with regards to the problem of sustainable waste management in Drakenstein Municipality. With landfill airspace becoming more and more restricted, alternative options of minimising or avoiding the need for disposal becomes necessary. Both public awareness (the dissemination of information) and public involvement (participation, comment, input or feedback) are necessary to achieve sustainable waste management practices.

The ultimate objective of the Waste Management Services is to ensure that all such services be delivered to all communities be of a high standard and that the Towns be cleaned most of the times and communities take ownership of the cleaning of their wards and build strong partnerships with the Municipality.

Currently in Drakenstein the landfill is operating at a relatively low efficency and polluting soil and groundwater as well as producing methane and carbon dioxide. The current situation is unsustainable and the landfill is estimated to be full by 2022.

Solid Waste Management Risk and Vulnerability:

- Altered decomposition rates
- Climate change may affect access to roads limiting waste collection
- Heavy rains degrade landfill site
- Stronger odours
- Dispersed waste due to wind
- Increased risk of fire

In the context of climate change solid waste management is expected to become even more challenging. Flooding poses the biggest risk to infrastructure needed for solid waste management. Increased temperatures increase the need for collection as odours become stronger in warmer temperatures. Extreme wind disperses waste from collection sites, vehicles and landfill sites.

3.1.5.2 Current Interventions

Interventions relating to climate change and solid waste management that Drakenstein is currently implementing include:

Previously unemployed people are used at the Material Recovery Facility (MRF) to sort recycling commodities in the different categories. They are thought the skills to differentiate between the diverse range of especially plastics, get to know what the recycled end product will be etc. this enables them to generate and income after their contract period, by implementing the principles of re-use, reduce and recycle. The project therefor is the Expanded Public Works Programme (EPWP), sorting of recyclable commodities at the MRF, waste awareness and education.

3.1.5.3 Response

- Reduction, re-use and recycling of waste i.e. waste diversion;
- Demand side management activities and waste recycling to reduce landfill related methane emissions
- Correct disposal of waste to decrease emissions.

Mitigation of climate change

Waste to energy.; Methane collection from landfills; As waste is a contributor to greenhouse gas emissions it is important to focus on what actions can be included in operations and to what extent it contributes, therefore the focus should be on mitigation (lowering greenhouse gas emissions).

3.1.5.4 Key Actions for Mainstreaming Climate Change in Drakenstein

- Recycling should be made easier for household by means of a multi-bin approach.
- Community awareness campaigns should be implemented to educate the communities on responsible waste management.
- The feasibility of establishing recycling centres at the main waste disposal sites must be investigated in conjunction with the distribution of recycling collection containers throughout the Drakenstein municipal area

3.1.6 Energy

Top climate risks:

- Drought
- Heatwaves
- Cold snaps
- Windstorms
- Floods

Time horizon of impacts:

Short – Long term

Municipal Departments concerned:

- Electro Technical Services
- Disaster Management
- Engineering

Impacts:

Increased temperatures increase cooling demand; change in harvest times, drought caused the harvest period to be shorter because grape harvests decreased by 50% as a result electricity usage has decreased; Drought increased need for irrigation which increased electricity usage for pumping of water; When water restrictions limit irrigation electricity usage decreases; Due to increasing temperatures transformers need cooling fans to increase their capacity and efficiency; Increased need for maintenance of electricity infrastructure; Windstorms damage electricity infrastructure; The private sector and industries will increasingly implement embedded generation, which decreases the carbon footprint of the municipality but also decreases municipal revenue from electricity sales

Response options:

Plan for increased disaster risk to infrastructure; Review materials for increased resistance to heat; Plan for increased embedded energy generation; Waste to energy; Awareness campaigns; Plan for increased wind and other extreme events

Climate change mitigation options:

Renewable energy; Embedded generation of energy; Increased energy efficiency; Waste to energy

3.1.6.1 Problem Statement

The gap between national electricity supply and demand has been experienced throughout the country over the last few years and this is not expected to change in the short-term. Electricity prices will continue to rise to fund the building of new power stations and associated infrastructure, as well as on-going maintenance of the current power generations facilities in South Africa.

By promoting energy efficiency and demand-side management, it also sets in motion a move towards greater efficiency, not only in terms of investment into

efficiency technologies, but also results in a behaviour change, which can lead to further reductions in electricity use. Energy efficiency can also play a role in promoting economic development (through creating economic opportunities around energy efficiency), social welfare and environmental sustainability.

The municipality is a major energy user in its own rights, being a single user, although it is not a significant consumer in terms of the total energy consumption for the region.

The municipality operates a vehicle fleet, manages a number of buildings and uses energy to provide services such as water and wastewater treatment, street lighting and traffic lighting. According to the Drakenstein IDP (2017-2022) 95.5% of households in the municipal area have access to electricity (for lighting), with the rest of the households being dependent on paraffin, candles and gas. Energy poverty remains a significant challenge, as low-income households can spend up to 25% of their income on meeting their energy needs.

With the decision to electrify informal settlements a sudden backlog developed. A funding application for R 8m was made for electrification projects for the 2015 / 2016 financial years but the Department of Energy only allocated R 5m. New developments are taking place at a rate faster than which the municipality can supply infrastructure with their available funds and electricity supply is no exception.

For Drakenstein to install new infrastructure to generate renewable energy to combat climate change is costly. Many households have acquired solar panels which results in the municipality selling less electricity and making less revenue.

In addition, many households do not have batteries to store the energy produced by the solar panels and therefore use municipal electricity when their solar energy is depleted. This usually occurs in the evenings when the sun is not shining and at the same time as peak electricity hours at 07:00 – 10:00 and 18:00 – 22:00. It is more expensive for the municipality to purchase electricity during the peak times and as a result, the municipality loses revenue.

A lack of revenue limits adaptation and mitigation interventions. The municipality should review the business plan of the Electro Technical Services Department to address the loss of revenue caused by a reduction in electricity usage.

Currently, there are two hydropower projects within Drakenstein. However, the recent severe drought limited the amount of energy generated by the projects.

3.1.6.2 Current Interventions

Interventions relating to climate change and energy that Drakenstein is currently implementing include:

- **Imbekweni Pilot Project**
- Installing transformers that have fans to overcome the impact of increasing temperatures and improve efficiency.
- When laying cables, they are laid 1m underground instead of 0.8m to overcome the impact of increasing temperatures and improve efficiency and capacity.
- **Solar geysers** are effective in using renewable energy as there is no electrical cost to start with they don't need any electrical connections at all.
- **Time of use domestic tariff project** which encourages changes in the times that households use electricity. For example, encourages residents

to do their washing at night instead of during the day, as afterhour tariffs are cheaper.

- **Relay project** - switch relays off during peak hours between 6-8pm. This will assist Eskom during its peak hours by using less electricity.
- Drakenstein has developed guidelines for embedded generation and special tariffs which were approved by the National Energy Regulator of South Africa.

3.1.6.3 Response

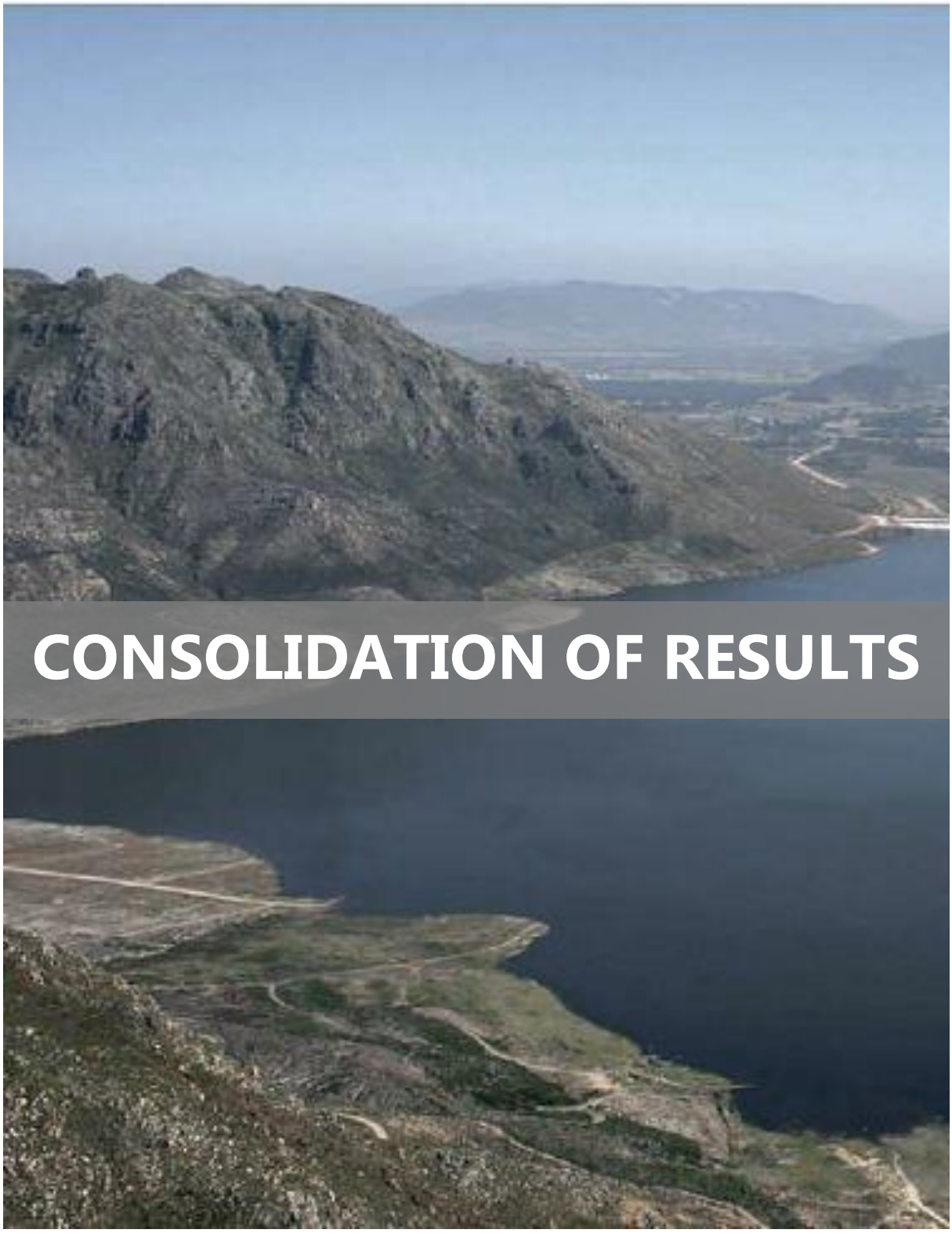
In response to the fact that Drakenstein's revenue is decreasing due to less electricity usage associated with climate change it is recommended that households change their usage to off-peak times. This allows the energy department to generate more revenue. However, shifting electricity usage to different times requires awareness campaigns. More information on tarrif charges can be found on the municipality's website at the following link: **http://www.drakenstein.gov.za/docs/Documents/Tariff%20List%202018-2019.pdf**

Mitigation of climate change

The energy sector has major potential to reduce the carbon footprint of the municipality. There are 48,195 electricity users in Drakenstein. Drakenstein uses 175 MVA per month. Reducing electricity usage and improving energy efficiency through green building construction can reduce the carbon footprint of Drakenstein thereby making an attempt to mitigate climate change.

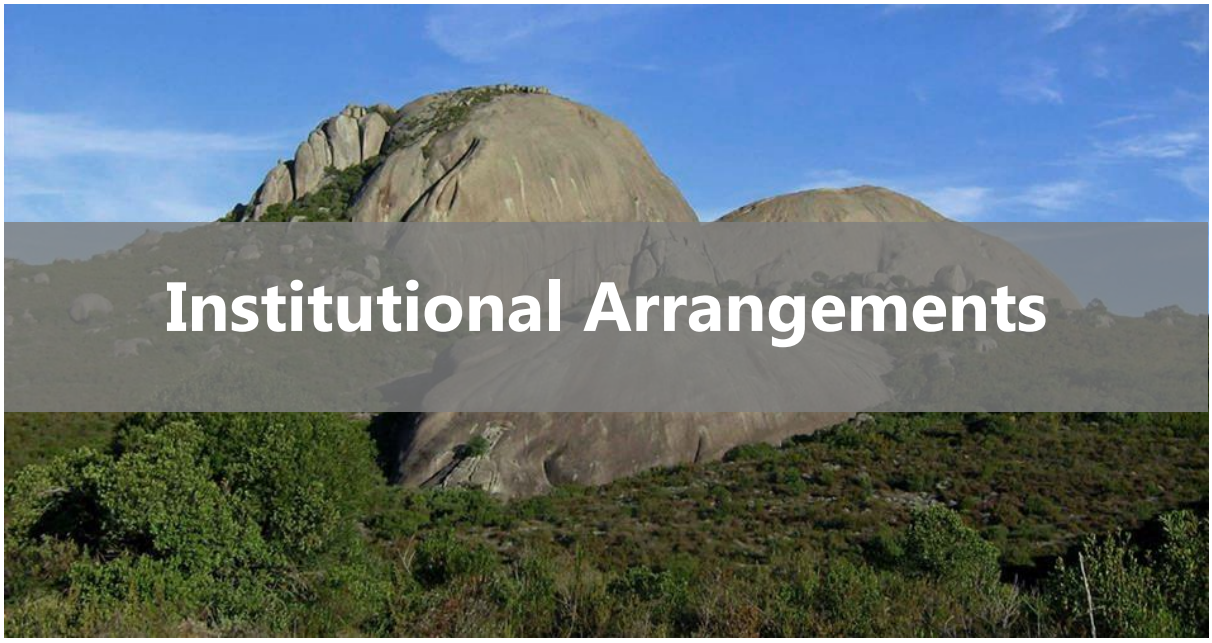
3.1.6.1 Key Actions for Mainstreaming Climate Change in Drakenstein

- Investigate advanced electricity metering infrastructure that can monitor the electricity usage of electricity users.



CONSOLIDATION OF RESULTS

4 Consolidation of Results



4.1 Roles / Responsibilities for Climate Change

Climate change will also have a significant impact on the abilities of the municipal departments to perform their mandated roles.

Climate change is relevant to a wide range of local government functions, and is another factor to take into account among the range of factors that local government already considers in all its decision-making.

A municipal climate change response has been identified in the NCCRP for inclusion into IDP planning (DEA, 2010).

Accordingly, the council will have to endorse the integration of climate change into the IDP process.

The IDP office has to mandate a suitable line department to drive climate change considerations during the drafting of the IDP.

According to national policy, the department tasked with driving climate change, will be responsible for the following:

- Appointing a 'champion' official to drive the climate change planning process;
- Gathering necessary information and liaising with other departments and institutions where necessary;
- Liaising with the IDP Office on integration of the process into IDP review timeframes;
- Participation on the IDP drafting team; and
- Establishing a steering committee from a cross sector of relevant departments to address the issues or participate in an existing committee that addresses similar issues.

Table 3: Roles and responsibilities of Municipal Departments relating to climate change

Department	Role / Responsibility
Environmental Management	Champion for issues relating to the environment. Green spaces, intact ecosystems and well-managed natural environment increases a municipality's resilience to climate change.
Planning and Development	Highlights development hot spots or no development areas where climate change impacts are likely to be most severe. Sets policy direction on climate friendly or climate resilient infrastructure and servicing (i.e. stormwater management). Identification of vulnerable areas and activities to inform mitigation and adaptations actions.
Disaster Management	Implementation of the Disaster management act and the disaster management framework. The Act has implications for the inclusion of climate change considerations in municipal disaster preparedness, and in particular the inclusion of climate change adaptation, ecosystem-based adaptation and community based adaptation measures as well as investments in future disaster management plans. Continue to develop and improve its early warning systems for weather and climate (especially severe weather events) and pest infestation events and to ensure that these warnings reach potentially effected populations timeously. Facilitate increased use of seasonal climate forecasts among key stakeholders such as those in the water and agricultural sectors. Develop mechanisms for the poor to recover after disasters.
Spatial Planning	Determine whether or not a municipality can lower its carbon emissions and maintain or enhance resilience to climate change. Resilience is a key spatial planning principle, applying the inclusion of climate change adaptation and mitigation aspects into spatial planning, and should be standard good practice to include climate change in spatial planning.

Economic Development and Tourism	Awareness with regards to the impact of climate change on the municipality's present and long term economic and social development. Incorporating climate change measures into long term development planning. Assess sensitivity of economic development plans to climate change. The need to consider climate change in all aspects of local government services to enhance resilience in a changing climate. Exploring opportunities associated with climate change.
Land Use Planning	Analyse land capability as well as suitability and feasibility for different development options
Water Services	The water sector is critical for climate change adaptation. Planning for the effects of climate change on water provision in its area, which is already of particular concern given the water stress that the region is already experiencing. Implementing the sustainability of water supply strategies such as groundwater and threats to this resource from a drying and warming climate. Reducing the vulnerability and enhancement of the resilience to water-related impacts of climate change in communities and sectors at greater risk.
Roads, Traffic and Storm water	Plan for increased storm water capacity. Implement sustainable urban design systems and water sensitive designs. Do vulnerability analysis on major roads and access roads to assess vulnerability to Climate Change impacts.
Waste Water Services	Plan for increased flooding and extreme events that may damage infrastructure.
Solid Waste Services	Plan for increased flooding and extreme events that may damage waste disposal infrastructure. Improves solid waste management, including collection, handling and infrastructure. Supports climate change mitigation through improved materials recycling or reuse and, where practical and feasible, landfill emissions are captured.

Human Settlements	In promoting bulk infrastructural development and services for the municipality as a whole, climate change considerations to be taken into account- e.g. increase in extreme climate events, flooding potential, temperature extremes, etc. Strengthening building code requirements according to increased risks of flooding, heat waves, intense storms and wind speed on building and infrastructure development projects as this will complement efforts to make Human Settlements more sustainable. Empower local communities, particularly woman who are often primary producers, in the process of designing and implementing adaptation strategies. Within the country's research and development system, prioritise technologies for climate change adaptation within rural areas, including low water-use irrigation systems, improved roll-out or rainwater harvesting strategies, and drought-resistant seed varieties.
Rural Development	Responsible for creating vibrant and equitable rural communities that are sustainable and food secure to reduce vulnerability and increase adaptive capacity to climate change. Protect and continually enhance natural resources and environmental assets to reduce climate change vulnerability in rural communities. Also responsible for educating subsistence farmers about climate change, empowering rural communities and diversifying livelihoods.
Community Development	Supporting communities and households in reducing their vulnerability as well as reducing GHG emissions. Increasing the availability of information on experiences and lessons learned in communities regarding climate change to inform adaptation policies and programmes and inform future actions.
Electro Technical Services	Setting priority areas for addressing energy efficiency and renewable energy in a changing climate. Developing and implementing energy master plans that aim to reduce the region's energy consumption in a sustainable manner to support development needs. Energy planning that should include climate change impact on infrastructure as well as the impacts of

	longer-term climate change projections e.g. the impacts of water availability. Also as part of the Environmental Management Plan, municipalities may also specify their plans for reducing their reliance on fossil fuels, increasing renewable energy usage and minimizing electricity consumption. Improves energy generation options, distribution and conservation. Identifies climate change-related risks to energy generation and distribution facilities. Supports climate change mitigation (e.g. green energy, conservation).
Environmental Affairs and Development Planning – Climate Change	Provide strategic guidance on climate change response in the Western Cape and provide ad-hoc support to municipalities on climate change matters.

Climate Resilience Objectives and Targets

4.2 Status Quo of Drakenstein's Climate Resilience

Climate change is everybody's business and Drakenstein's climate resilience can only be achieved through active participation of all relevant stakeholders. Stakeholder engagement seeks to create a broad platform for encouraging partnerships and constructive dialogue and action between stakeholders during the decision-making process, policy development and/or implementation.

It is anticipated that many climate change response projects will be executed on a partnership level and in such cases the Drakenstein Municipality should be in a position to harness private, public and academic sector networks in addressing climate change.

The provincial Department of Environmental Affairs and Development Planning as well as the Cape Winelands District Municipal Planning Services Department can assist Drakenstein in making progress against climate change. The Cape Winelands District Municipal Planning Services Department attends the meetings for the Drakenstein Reference Group for Environmental Management where they share progress and knowledge on climate change.

Consultation with various departments revealed that Drakenstein Municipality is on the right track to climate change adaptation since all of the departments were aware of the impacts of climate change and thought of them as serious concerns.

Efforts to address the impacts of climate change are ongoing particularly in terms of disaster management and emergency preparedness planning. There is also a movement to becoming green development oriented within Drakenstein. However, much more can be done in order for Drakenstein to improve its resilience to climate change. The first step would be to ensure the buy-in of all stakeholders and that their mindset is shifted to mainstream climate change adaptation in everyday activities.

Due to the increasing risk of identified hazards associated with climate change, the dependency on the municipality for assistance is increasing. The increasing

frequency of climate related hazards could potentially strain Drakenstein's ability to cope with major emergencies and prolonged local disasters.

A concern raised by some of the departments was that their knowledge on climate change is poor. It is therefore recommended that departments undergo training sessions to improve their awareness and knowledge on climate change. It is also important to create awareness of climate change and its impacts on scarce and non-renewable resources. More awareness strategies can improve Drakenstein's alignment to the macro and global adaptation vision.

In addition to creating awareness and providing information amongst municipal departments, it is important to provide the public with information on climate change as well.

Another priority would be to allocate the responsibility of driving climate change adaptation activities to a certain department.

The possibility of providing people with rebates when implementing climate change mitigation options should be considered.

Climate change adaptation should be accompanied by climate change mitigation. However, a lack of funding and budget makes it challenging to carry out. Therefore, Departments have been prioritising options that require urgent attention and are cost-effective to implement.

The sustainability of Drakenstein's capacity to manage impacts associated with climate change over the short to medium term (up to 15 years) and long term (15-20 years) should be focused on. This focus should include managing identified hazards in a clear and concise manner.

4.3 Drakenstein's Strategic Objectives and Targets

Although some efforts have been made, Drakenstein as a whole does not have clear coordinated objectives with regards to climate change response management. This can be attributed to the lack of climate change knowledge within current institutional structures and the subsequent failure to acknowledge climate change response as a top priority.

Even though the municipality's functions and powers will certainly influence or be affected by climate change, climate change is not currently considered as a core function.

The local municipality does not have an official climate change champion with clearly defined roles and responsibilities who is endorsed by the IDP office.

Subsequently, the Drakenstein local municipality will rely heavily on input from the Cape Winelands District and provincial structures, to assist them in improving their resilience. Through these partnerships, Drakenstein has the opportunity to direct climate change response and adaptation in a coordinated and priority centric manner in response to high vulnerability and coping capacity deficiency.

Drakenstein does not have **allocated funding** specifically for climate change response. It is important to note that each department is responsible for identifying and implementing its own climate change responses. It is not the sole responsibility of the climate change champion to coordinate and encourage response on a higher level.

The table below provides information on the current institutional capacity for climate change adaptation within Drakenstein.

Table 4: Current Institutional Capacity for Climate Change Adaptation

Dedicated Environmental Officer	IDP Office endorsed Climate Change Champion	Unofficial Climate Change Champion	Climate Change Response included as component of IDP	Municipal Policy addressing climate change	Climate change included as a key risk on the operational risk management system
Yes	No	No	Yes (limited)	Yes (limited)	No

Where needed, the local municipality may formally request assistance from the Cape Winelands District for climate change response management. If the Cape Winelands District is unable to provide such assistance it may in turn request the assistance of the relevant provincial or national departments.

The strategic objectives of Drakenstein are to:

- To promote proper governance and public participation;
- To ensure the financial sustainability of the municipality in order to fulfil the statutory requirements;
- To provide an effective and efficient workforce by aligning our institutional arrangements to our overall strategy in order to deliver quality services;
- To ensure efficient infrastructure and energy supply that will contribute to the improvement of quality of life for all citizens within Drakenstein as well as to improve our public relations thereby pledging that our customers are serviced with dignity and care;
- To facilitate sustainable economic empowerment for all communities within Drakenstein and enabling a viable and conducive economic environment through the development of related initiatives including job creation and skills development;
- To contribute to the health and safety of communities in Drakenstein through the pro-active identification, prevention, mitigation and management of health including environmental health, fire and disaster risks;
- To assist and facilitate with the development and empowerment of the poor and the most vulnerable. These include the elderly, youth and disabled.

The threats of unanticipated climate change impacts are real, and can jeopardize the ability of Drakenstein to meet its strategic objectives in the following ways:

- The environmental integrity of the LM can be disrupted;
- Economic growth can be stunted and job opportunities reduced;
- Social wellbeing can be threatened and replaced by increased vulnerability;
- The need for services and maintenance can rapidly increase or shift depending on climate change impacts; and
- The financial viability of the LM as a whole can be threatened.

Drakenstein therefore commits itself to effective and integrated pro-active day-to-day climate change response inclusive of monitoring, mitigation and adaptation,

thereby reducing environmental degradation and socio-economic vulnerability while building resilience against climate variability.

4.4 Key Strategic Climate Change Objectives

The table below aligns the strategic objectives of each KPA from Drakenstein's IDP to the generic climate change objectives that are necessary to effectively respond to climate change.

KPA 1: To promote proper governance and public participation

KPA 2: To ensure the financial sustainability of the Municipality in order to fulfil the statutory requirements

KPA 3: To provide an effective and efficient workforce by aligning our institutional arrangements to our overall strategy in order to deliver quality services

KPA 4: To ensure efficient infrastructure and energy supply that will contribute to the improvement of quality of life for all citizens within Drakenstein as well as to improve our public relations thereby pledging that our customers are serviced with dignity and care

KPA 5: To facilitate sustainable economic empowerment for all communities within Drakenstein and enabling a viable and conducive economic environment through the development of related initiatives including job creation and skills development

KPA 6: To contribute to the health and safety of communities in Drakenstein through the pro-active identification, prevention, mitigation and management of health including environmental health, fire and disaster risks

KPA 7: To assist and facilitate with the development and empowerment of the poor and the most vulnerable. These include the elderly, youth and disabled

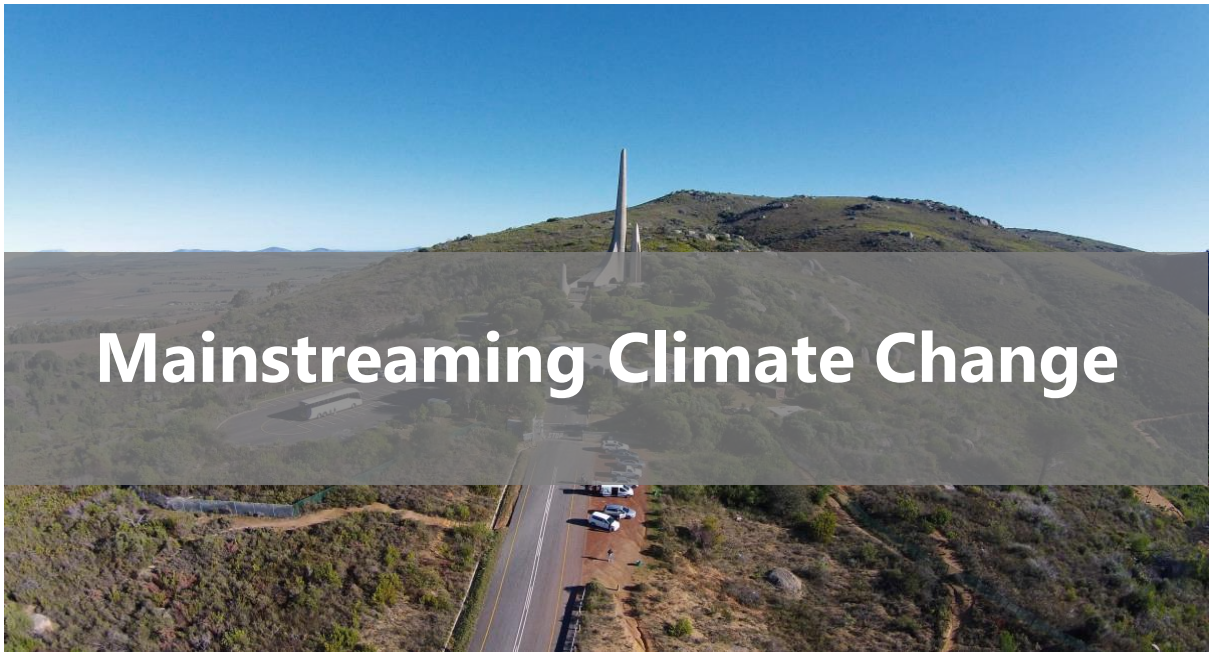
Table 5: Links between climate change objectives and KPAs

Climate change objective	KPA 1	KPA 2	KPA 3	KPA 4	KPA 5	KPA 6	KPA 7
Water security and efficiency		X	X	X			X
Climate resilient and low carbon development: ▪ **Infrastructure** ▪ **Transport** ▪ **Settlements**		X	X	X	X		
Energy efficiency and demand side management		X	X	X			X
Biodiversity and ecosystem management		X	X		X	X	
Food security (Agriculture)					X		X
Public health		X	X	X		X	
Disaster management		X	X			X	
Build response capacity through improved coordination and awareness	X	X	X	X	X	X	X

4.5 Drakenstein's Policy Commitment

The Drakenstein LM supports the idea that integrated planning at all levels of government should include the consideration of climate change aspects in relevant sectors.

The Drakenstein LM is also of the opinion that the mitigation of and adaptation to climate change will require standalone mitigation and adaptation policies and plans as well as the mainstreaming of adaptation measures into the existing activities and functions of national, provincial and local government. The mainstreaming of climate change response implies that local government adopt, expand and enhance the measures that factor climate risk into their normal day-to-day activities and planning processes.



4.6 Mainstreaming Climate Change in Drakenstein

Mainstreaming of climate change response implies that local government adopt, expand and enhance the measures that factor climate risk into their normal decision-making and planning processes. Adaptation to climate change will require standalone policies and plans as well as the mainstreaming of response measures into existing activities and functions of local government.

Subsequently the mainstreaming of climate change response into sectoral budgets will be essential. This will prove more effective in terms of facilitating effective climate change response and realising no-regrets interventions, rather than necessitating additional dedicated climate change budgets in an already resource scarce municipal context.

The mainstreaming of climate change into all municipal sectors will allow for the gradual implementation of climate change response measures within existing budgets balancing incremental costs with the economic, environmental and social values produced. High level governance related response options include:

- Address procurement to ensure it supports efficient resource use and that tender specifications, particularly for large infrastructure projects, incorporate the wide range of future climatic conditions
- Consider best institutional location of climate change issues, and incorporate climate change within agendas of all structures, from Council to management and operations; and
- Budget allocations must ensure that spending supports development of new infrastructure development and maintenance of existing infrastructure.

Given the current politics of climate change adaptation and the extent to which it is on the agenda, a useful approach may not be to focus on climate change per se but rather on improving preparedness, robustness of decision making and overall resilience. Risk management approaches along with economic analysis will help to target specific strategies to the most urgent, cheapest or highest net-benefit activities (Climate ADAPT, 2015).

Table 6: Checklist to determine level of mainstreaming climate change

Level of mainstreaming climate change	Stage	Status needed to progress to next level	Yes / no
Low	Low awareness of the importance of responding to climate change	Climate change awareness	
		Have plans for climate change adaptation	
		Assessed the threats of climate change	
		Assessed benefits of mainstreaming climate change	
		Consulted climate change literature	
		Identified instruments for mainstreaming climate change	
Medium	Improving awareness of the importance of responding to climate change. Progress is being made to integrate climate change into development processes.	Systematically integrated climate change adaptation into strategies	
		Identified responsibilities for mainstreaming climate change	
		Developed instruments for mainstreaming climate change	
		Staff have attended training on the use of instruments for mainstreaming climate change	
High	Climate change is fully integrated into development processes and is addressed in a sustainable manner in all sectors and on multiple levels.	Have measures to analyse the effectiveness of mainstreaming instruments	
		Have ways to support community based response options.	
		Continuously improving approaches for mainstreaming climate change	

4.7 Framework for Monitoring and Evaluation

Climate change response requires continuous monitoring and regular review to ensure efficacy. Successful implementation relies heavily on sustained and effective monitoring and evaluation (M&E) of its success. The monitoring and evaluation process must ensure that climate change impacts are monitored at appropriate spatial density and frequency, where feasible, of changes in spatial distribution and incidence of climate-sensitive diseases, ecosystems and the goods and services they supply, key species responses (including invasive alien species) wildfire hydrology and water resources, and agricultural and forestry production.

Based on the National Climate Change Response Monitoring and Evaluation Framework, Drakenstein will have to implement the following principles in order to monitor the success of this climate change adaptation plan and measure cost, outcome and impact:

For mitigation options:

- A GHG Inventory
- M&E System to track emission reductions;
- M&E System will assess indicators defined in the action plan, including impact on emissions, implementation and wider sustainable development benefits.

Adaptation and Impact:

Adaptation requires **proactive interventions** that minimise projected climate change impacts.

- Establish a system for gathering information and reporting progress on the implementation of adaptation actions;
- **Educate** and **build capacity** of the institutions that must implement responses.

Climate finance:

- Establish a tracking facility for climate finance mechanisms and climate responses;
- Track the use and impact of funds.

The following template can be implemented to guide the monitoring and evaluation framework.

Table 7: Template for Monitoring and Evaluation of climate change adaptation options

	INDICATOR What indicator will be used?	DESCRIPTION How will it be measured?	TARGET What are the determined target values?	DATA SOURCE Where will data for measurement be sourced from?	FREQUENCY How often will it be measured?	RESPONSIBILITY Who is responsible for reporting?	REPORTING Where will it be reported and how will it be used?
Objective							
Outcomes							
Outputs							

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6 Annexures

6.1 Annexure A: Action Plan

Strategic Objectives	Strategic Focus Area	Objective	Project / Action	Details	Institutional / Community Based Adaptation	Implementing Portfolio / Department	Supporting stakeholders	Budget Operational (OPEX) vs Capital (CAPEX)	IDP KPA Links	Key-sectoral Benefits	Cross-sectoral Benefits	Time Horizon for Implementation Short - 1 year Medium - 1-5 years Long - 2023 onwards	Priority:
Strategic objective 1: Water Security	**Improved institutional capacity for climate change response in the water sector**	**Supportive policy context for the integration of climate change response and water resource management**	A municipal policy on coordinated water resource management aligning institutional structures and policies.	Review existing water resource management structures, institutional capacity and policies for improved alignment and coordination. Develop policy guidelines for water conservation, allocation, and reuse. Develop and implement municipal guidelines for the rainwater harvesting, for communities and industry.	Institutional	Water Services; Environment	Roads and Storm Water; Housing; Property Managers;	OPEX	1; 4; 6	Water Security and Efficiency		Medium	
			Review/Compile water by-laws	Aim to support improved enforcement and demand management	Institutional	Water Services, Law enforcement	Municipal officials	OPEX	1; 4; 7	Water Security and Efficiency		Short	
			Review departmental mandates to include Climate Change Response	Integrate climate change considerations into departmental KPI's	Institutional	IDP	All departments	OPEX	1; 4; 6; 8	Water Security and Efficiency			
			Develop a database and information management systems for municipal water resources and users		Institutional	Water Services	ITC; Municipal officials; Vendors	CAPEX	1; 4; 9	Water Security and Efficiency		Medium	
			Establish partnerships with research institutes for targeted research and dissemination of results		Institutional	Water Services	Water Research; Universities; Agricultural Research Councils and related departments; Municipal Officials; SALGA	OPEX	1	Water Security and Efficiency		Short	

			Build municipal capacity through targeted training of key municipal officials and staff.	Technical background on climate change and training on the practical implications for local government.	Institutional	HR; Water Services	All departments and water and sanitation; Vendors; DWAF; SALGA	OPEX	3; 6	Water Security and Efficiency		Short/Medium	
		Implementation and enforcement of regulatory framework	Review the capacity of relevant statutory bodies to implement and enforce regulations relating to water quality and effluent discharge	Review and put forward recommendations for capacity building where relevant.	Institutional	Water Services	Water and sanitation department; DWAF	CAPEX	1; 4	Water Security and Efficiency		Short	
			Incorporate climate change considerations into planning and development of water supply infrastructure.	Refer to Guidelines for Project Managers: Making vulnerable investments climate resilienthttp://www.longfinance.net/programmes/london-accord/la-reports.html?view=report&id=390	Institutional	Water Services; Planning department	Tertiary institutions		4; 6	Water Security and Efficiency; Human Settlements and Infrastructure			
			Community Based Water Quality Monitoring	Many water quality problems are caused due to communities being unaware of the different aspects of managing and maintaining the quality of water resources. Raising their awareness of appropriate practices will help them realise the grim realities of depleting water sources and at the same time help in engaging them in monitoring and maintenance.	Community based adaptation	Municipal health services, Scientific services; Engineering; Water Services; Sanitation	DWAF	CAPEX	6	Water Security and Efficiency		Short	
			Public awareness campaigns on sanitation, water-borne diseases and climate related health risks		Community based adaptation	Health Services; Water Services; Disaster Management	DWAF	CAPEX	5; 6	Water Security and Efficiency		Short	
	Sustainable and equitable access to water.	**Improved water resource management.**	Conduct vulnerability assessments for water resources (ground and surface) and recharge areas in hotspot areas.		Institutional	Water Services; Environment	Community development; DWAF	CAPEX	4; 6	Water Security and Efficiency		Medium	

			Alien invasive management	Currently being done in Drakenstein. Explore options for privatising clearing of invasives and processing for furniture, compost, etc.	Institutional	Parks, Environmental department, Community development	Working for water and fire	OPEX	6	Water Security and Efficiency; Ecological Infrastructure and Biodiversity			
			Address water leaks and rehabilitate or decommission aging infrastructure.	Reduce water and revenue losses. Focus on improving efficiencies of water use in both private and public sectors. In the public sector, fix leaks and hunt down unaccounted-for losses. Focus on excessive water users and establish reasons for use level.	Institutional	Water Services	Finance department; Politicians; Municipal Officials	OPEX allocation per annum: R2 500 000	4	Water Security and Efficiency; Human Settlements and Infrastructure		Long	
			Public awareness campaigns on climate change projections and risks related to long term water security and behavioural changes required.		Institutional	Water Services; Environment	Tertiary institutions; Politicians; DWAF	OPEX	6	Water Security and Efficiency		Medium	
			Establish community/village based water resource management structures	Support the establishment of Community/Neighbourhood forums to allow public participation and ownership.	Community based adaptation	Water; Communities; Environment;	Community development; DWAF	CAPEX	1; 5	Water Security and Efficiency; Social and Economic Development		Short	
			School water supply programmes in rural areas	By focusing on children today and providing them with knowledge with regard to maintaining water quality and effective sanitation practices we will be securing the upcoming generation from the threats of water and sanitation related diseases. This will not only provide a hygienic environment in schools, the children will also convey the message back home.	Community based adaptation	Department of education, department of environment; Water Services	Sanitation department; Municipal Officials; DWAF	CAPEX	5; 7	Water Security and Efficiency; Social and Economic Development		Short	
			Establish micro-purification systems for areas without regular access	Rural communities relying on untreated water sources. Areas vulnerable to compromised surface and ground water quality	Community based adaptation	Community; Water Services; Sanitation	Planning department; DWAF	CAPEX	4; 5; 7	Water Security and Efficiency		Long	

			Household level grey water systems	Support uptake through subsidies, funding, community training and/or installation in all new public housing developments.	Community based adaptation	Housing; Environment; Water Services	Community development; Municipal Official	CAPEX; R 15 000 per household	4; 5; 7	Water Security and Efficiency; Human Settlements and Infrastructure		Medium	
			Household level rain water harvesting systems	Support uptake through subsidies, funding, community training and/or installation in all new public housing developments	Community based adaptation	Housing, and Environmental department	Community development	CAPEX; R 2 500 per household	4; 5; 7	Water Security and Efficiency			
Strategic Objective 2: Climate resilient and low carbon development	**Development of climate resilient, environmentally friendly and low carbon industries.**	**Establish supportive environment for the development of green and climate resilient industries.**	Conduct a baseline inventory of green industries and services.		Institutional	Environment and Spatial planning	Business and Industry, Focus groups and sectoral engagements	OPEX	5; 6	All sectors			
			Integrate the monitoring of climate resilient and green industries and services with the existing business registration system.		Institutional	Environmental department.		OPEX	5; 6	All sectors			
			Review and harmonize local policies (on trade, investment, environment, tourism, agriculture, etc.) to support resilience objectives		Institutional	IDP	Provincial Government and Environmental Planning.	OPEX; CAPEX (if outsourced)	1; 3; 5; 6	All sectors			
			Develop tourism policies integrating economic and resource conservation issues in the face of potential and observed consequences of climate change.	Ensure mutually beneficial objectives are actioned in support of holistic approaches towards sustainability and resilience.	Institutional	LED and Environmental Department	Tourism	OPEX; CAPEX (if outsourced)	1; 5; 6	Ecological Infrastructure and Biodiversity; Social and Economic Development			
			Support the development and implementation of risk transfer mechanisms for individuals and small to medium enterprises to increase capacity to cope with negative	Risk transfer measures may include: Insurance; Emergency funds; Micro-insurance.	Institutional	LED	Environmental Department and Finance	OPEX	2; 5; 6	Social and Economic Development			

			impacts of climate change.										
			Assess the effects of climate change on special designated natural areas that attract tourists such national parks and reserves.		Institutional	Parks and Environmental department.	Tourism and Spatial Planning.	OPEX	5; 6	Ecological Infrastructure and Biodiversity; Social and Economic Development			
			Ensure accurate information reaches current and potential tourists on behaviours and uses that ensure environmental quality and ecosystem resiliency at popular travel destinations.		Community based adaptation	Tourism and Environment department.	Tourism and Industry.	OPEX	5; 6	Ecological Infrastructure and Biodiversity; Social and Economic Development			
		Enforcement of regulations	Establish and enforce emissions limits particularly under the Air Quality Act		Institutional	Environment department and Health department.	Law enforcement	OPEX	1; 5	All sectors			
			Increase capacity of relevant municipal agency for environmental compliance monitoring		Institutional	environmental department, council and finance department.		OPEX	1; 3; 6	All sectors			
			Enforce compliance with environmental legislation.		Institutional	Environmental department and law enforcement.	All departments and Cape Nature.	OPEX	1; 6	All sectors			
		Capacity building in support of green climate resilient industries and services	Develop and implement a Greenhouse Gas emission inventory	Include an industry pollutants transfer registry for other pollutants apart from Greenhouse Gasses.	Institutional	Environmental department and Health Sciences		OPEX	1; 6	All sectors			
			Increase capacity of relevant municipal agency for environmental compliance monitoring		Institutional			OPEX	1; 2; 3; 6	All sectors			

			Identify training providers for government and industries		Institutional	Environmental department, HR and training	Tertiary institutions and Industry Specialists	OPEX	1; 3	All sectors			
			Engage the private sector as a partner through market and investment opportunities.		Institutional	LED, Environmental department	Tourism, Finance departments and various farmers.	OPEX	1; 5	All sectors			
			Establish partnerships with industry associations and NGO in the development and dissemination of knowledge products on green business practices.		Community based adaptation	Environmental department and LED.	Tourism	OPEX	1; 3; 5	Social and Economic Development			
		Sustainable livelihoods and job creation	Support business and job opportunities in emerging green sectors	Through policy development, incentives, subsidies, etc.	Institutional	Environmental department and LED and Council.	All departments.	OPEX	5; 7	Social and Economic Development			
			Promote education and job training programs to re-tool workforce to take advantage of green economy growth	Ensure training programmes and institutions equip trainees with contextually relevant skills.	Institutional	Environmental department, HR and LED.	3RD PARTY INSTITUTIONS	OPEX	5; 7	Social and Economic Development			
			Analyse long and short term jobs trends to identify which sectors/occupations will be positively/negatively impacted, with an emphasis on job creation opportunities		Institutional	Planning and LED.		CAPEX	5; 7	Social and Economic Development			
	Climate resilient municipality	**Climate resilient municipal infrastructure**	Integrate climate change resilience objectives into Terms of Reference for new infrastructure projects		Institutional	Supply Chain.		OPEX	4; 6	All sectors			
			Evaluate and improve capacity of storm water systems for high intensity rainfall events in key areas		Institutional	Engineering.		CAPEX	4; 6	Water Security and Efficiency; Human Settlements and Infrastructure			

			Maintenance and clearing of gutters drainage ditches and culverts		Institutional	Roads and Storm water, and Property management.		OPEX	4; 6	Human Settlements and Infrastructure			
			Develop integrated land use and transport plans to reduce average travel distance and time between work and residence, reducing GHG emissions and improving quality of life.		Institutional	SDF, engineers and planning, housing and transport department.		OPEX	4	Human Settlements and Infrastructure			
			Promote uptake of hazard insurance for home owners.	Identify hotspots and engage with relevant stakeholders. Explore partnerships with insurance companies	Community based adaptation	Disaster management and planning	Insurance company.	OPEX	6	All sectors			
		Climate responsive solid waste management	Conduct waste reduction through recycling initiatives and facilitating recycling by making recycling services easily accessible.	Explore options for privatising recycling initiatives	Institutional / Community based adaptation	Solid Waste	Communities and Industry and Politicians.	OPEX	6	Solid Waste Management			
			Promote expansion of in-store recycling programs especially for electronic waste and low value recyclables.		Community based adaptation	Solid Waste	Companies	OPEX	6	Solid Waste Management			
Strategic Objective 3: Energy Efficiency and Demand Side Management	**Energy Efficiency and Conservation**	**Develop implement a government energy management programme**	Implement energy management guidelines for all municipal facilities.		Institutional	Engineering; Environmental department; Solid Waste	All departments	OPEX	4; 6	Energy		Medium	
			Assess the financial implications of increased uptake of renewable energy solutions on municipal revenue.			Environmental departments	Finance	OPEX	2	Energy			
			Establish feasibility of alternative energy sources for public lighting.		Institutional	Environmental departments		CAPEX	4	Energy			
		Increased energy efficiency in private sector and on	Awareness Campaigns on electricity management and conservation.		Community based adaptation	Environment and engineering departments		OPEX	4; 5	Energy			

		community level											
	Green transport	**Green transport strategies and fuel conservation integrated into departmental and development plans.**			Institutional	Fleet management, department of engineering and environment department.	All departments	OPEX; CAPEX (if outsourced)	3	Social and Economic Development			
Strategic Objective 4: Biodiversity and Ecosystems Management	**Protection and rehabilitation of ecosystems and ecosystem services**	**Implementation of climate change response strategies for key ecosystems**	Conduct a comprehensive biodiversity risk and vulnerability assessment	Include as component of Strategic Environmental Analysis (SEA). Identify and demarcate vulnerable ecological management zones Create a list of threatened species.	Institutional	Environment; Planning department	Parks; Engineering; Cape Nature; SANBI; NGOs	CAPEX; R 1 000 000	6; 5	Ecological Infrastructure and Biodiversity			
			Review zoning guidelines for different ecosystems		Institutional	Environment and Planning department	Parks; Cape Nature	OPEX	6; 5	Ecological Infrastructure and Biodiversity			
			Use CBAs as educational facilities to create awareness and educate people on the importance of biodiversity for climate change		Institutional	Environment and Planning department	Education Department, Schools, Youth Groups, Conservations Organisations	R300 000 per annum. OPEX R50 000. CAPEX	6; 7; 1	Ecological Infrastructure and Biodiversity			
			Develop and implement sustainable green spaces for public spaces.		Community based adaptation	Parks; Environment; Spatial Planning	Community; Industries; Private Sector	CAPEX; OPEX	1; 4; 5; 6; 7	Ecological Infrastructure and Biodiversity			
			Drafting and Approval of Events Management By-law to protect biodiversity and ecosystems during events.			Disaster Management, Parks and environmental planning; Corporate	Law enforcement; Environmental Management Committee, Natural Resources; Reference Groups	OPEX; CAPEX (if outsourced)	1; 2; 5; 6	Ecological Infrastructure and Biodiversity			
			Implementation of the Arboretum Urban Design Framework		Institutional	Parks		R10 000 CAPEX	1; 4; 5; 6; 7	Ecological Infrastructure and Biodiversity			
			Formulate Integrated Alien Invasive Management Plan		Institutional & Community based	Environmental Management, Parks and Disaster Management.	Working for Water; Cape Winelands; DEA.	R16 000 000 OPEX	2; 1; 6; 7	Water Security and Efficiency; Ecological Infrastructure and Biodiversity		L	M

			Formulate Integrated Fire Management Plan.		Institutional & Community based	Environmental Management; Parks; Disaster Management	Winelands FPA; Landowners; Cape nature; Community, FireWise	R5 00 000 OPEX	1; 2; 6; 7	Ecological Infrastructure and Biodiversity		L	H
			Development of sustainable Eco tourism facilities in Conservation areas & POS		Institutional	Parks	Planning & building Control	R50 000 000 CAPEX	1; 2; 4; 5; 6	Ecological Infrastructure and Biodiversity		L	M
Strategic Objective 5: Food Security and Agriculture	**Enhanced resilience of agricultural production and distribution systems from climate change**	**Enhanced knowledge on the vulnerability of agriculture to the impacts of climate change**	Conduct comprehensive district level vulnerability and risk assessments for the agricultural sector.	Conduct studies on the impacts of climate change on major crops and livestock. Physical, social and economic.	Institutional	Environmental Department, Planning Department, and Agricultural Department	Agricultural Industries	CAPEX	5; 6	Social and Economic Development			
			Advocate the development and adoption of climate-resilient crop and livestock production systems and technologies in the commercial sector	Awareness Campaigns	Institutional	Agricultural Department, and Environmental Department, Local Economic Development	Green Industries	CAPEX	5; 6	Social and Economic Development			
			Establish partnerships with research institutes.	Collaborate on research to establish viable adaptation option for agriculture in Drakenstein.	Institutional	Integrated Development Plan (IDP)	Tertiary and research institutions, and Industry specialists	OPEX	1	Social and Economic Development			
			Establish a platform for collating weather data and analysis in the context of climate change and develop channels for communicating weather information to farmers across the district		Institutional	Agricultural Department	Environmental Department	CAPEX; OPEX	1; 6	Social and Economic Development			
			Public awareness campaigns on climate change projections and risks.	Make findings and recommendations of studies available to the public in easily understandable information products.	Institutional	Environmental Department	Tap into existing public forums	OPEX	1; 6	Social and Economic Development			

		Climate-sensitive agriculture policies and plans	Review and align existing plans policies on food production and distribution	Align Climate Change Strategy, Disaster Management Plans, Spatial Development Framework, Agricultural Strategies, Growth and Development Strategies, Rural Development Strategy	Institutional	department of agriculture, Planning and environmental department.	Industry	OPEX	3; 6	Social and Economic Development			
			Conduct annual climate change adaptation planning and budgeting - IDP	Consider including Climate Change Response as additional budgeting items for departments.	Institutional	IDP and Environmental Planning	Finance and other departments	OPEX	1; 2; 3; 6	Social and Economic Development			
			Rehabilitation of land owned by Drakenstein to address the concern regarding the loss of agriculturally productive land and natural resources	Rehabilitate or make available to private investors or community initiatives.	Institutional	Agriculture, Environmental Managers, Local Economic development, and Property.	Parks	CAPEX; OPEX; R 6500 p/ha	1; 5; 6	Social and Economic Development			
			Build institutional capacity by training relevant municipal staff on climate change and response.		Institutional	Environmental department	Training Institutions (HR)	R 25 000 per staff member trained	1; 3; 6	Social and Economic Development			
			Develop a subsistence farming irrigation policy to facilitate the responsible use of water for irrigation.		Institutional	department of agriculture, and environmental department.	LED, Water and Sanitation	OPEX; CAPEX (if outsourced) R 500 000	1; 6	Social and Economic Development			
			Monitor, repair and rehabilitate irrigation infrastructure to reduce water losses and improve irrigation efficiency.		Community based adaptation	Engineers	Water department and Finance	OPEX	4; 6	Social and Economic Development			
	Climate resilient agricultural communities	**Enhanced capacity for Climate Change Adaptation in farming communities and industry**	Develop education, training and extension services and establish farmer support programmes in vulnerable communities.	Organize and train farmers and farmer organizations in accessing financing and insurance	Community based adaptation	LED, Agricultural department, Environmental department.	Farming Communities	CAPEX; OPEX	5; 6; 7	Social and Economic Development			

			Establish field schools	The Farmer Field School (FFS) is a group-based learning process. During the FFS, farmers carry out experiential learning activities that helped them understand the impact of climate change. These activities involve simple experiments, regular field observations and group analysis. The knowledge gained from these activities enables participants to make their own locally specific decisions about crop management practices.	Community based adaptation	Agriculture	Farming communities, LED, Department of Finance.	CAPEX; OPEX	5; 6; 7	Social and Economic Development			
			Implementation and utilization of community gardens for agriculture and food production.		Community based adaptation	LED, and Agriculture	Community development	CAPEX; OPEX	5; 6; 7	Social and Economic Development			
		Enhanced social protection for farming communities	Identify and implement climate change risk transfer and social protection mechanisms for agriculture	Micro-financing and Insurance mechanism for commercial and subsistence farmers	Institutional	Agriculture and LED	LED.	CAPEX: R 1 000 000	6; 7	Social and Economic Development			
		Sustainable agriculture	See guidelines		Community based adaptation	Agriculture and LED			5; 6; 7	Social and Economic Development			
Strategic Objective 6: Human Security: Disaster Management and Public Health	**Integrated Climate Change Response and Disaster Management**	**Mainstreaming of Climate Change Response and Disaster Risk Reduction**	Conduct multi-stakeholder/multi-departmental Climate Change Response and Disaster Management Planning exercises			Disaster management, Environmental department, LED, Community development.	Planning and IDP.	OPEX	1; 3; 6	All sectors			
			Form partnerships with private property owners to determine who is responsible for risk reduction			Agriculture			1	Human Settlements and Infrastructure			
		Enhanced institutional capacity for disaster risk reduction and climate change response	Organise and mobilise local networks of climate change practitioners and resources that can provide assistance			Finance, IDP, and Disaster Management.		OPEX	3; 6	All sectors			

			Develop and implement clear public awareness programmes		Community based adaptation	Department Environmental		OPEX	1; 3; 6	All sectors			
	Preparedness of health and social protection services	**Improved response capacity of public health**	Assess capacity of local health facilities and personnel for emergency preparedness and response	Assess resources and capacity; Assess whether personnel understand the clinical manifestations of climate related health risks; Health care facilities should have dedicated response plans		Department of health, and Environmental department	CWDM	OPEX	6; 7	Social and Economic Development			
	Climate resilient infrastructure			Create awareness on the importance of managing impermeable surfaces	Community based adaptation	Engineering, Planning and Parks.		OPEX	4; 6	All sectors			