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department of
economic, small business development,
tourism and environmental affairs
FREE STATE PROVINCE

FREE STATE PROVINCE CLIMATE CHANGE ADAPTATION STRATEGY AND IMPLEMENTATION PLAN 2024–2029

Free State Province Climate Change Adaptation Strategy and Implementation Plan 2024-2029

October 2024

This report is prepared as part of the Technical Review of Climate Change Adaptation Response Strategies in Support of the Implementation of the National Climate Change Adaptation Strategy programme.

Report submitted to

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List of Acronyms and Abbreviations

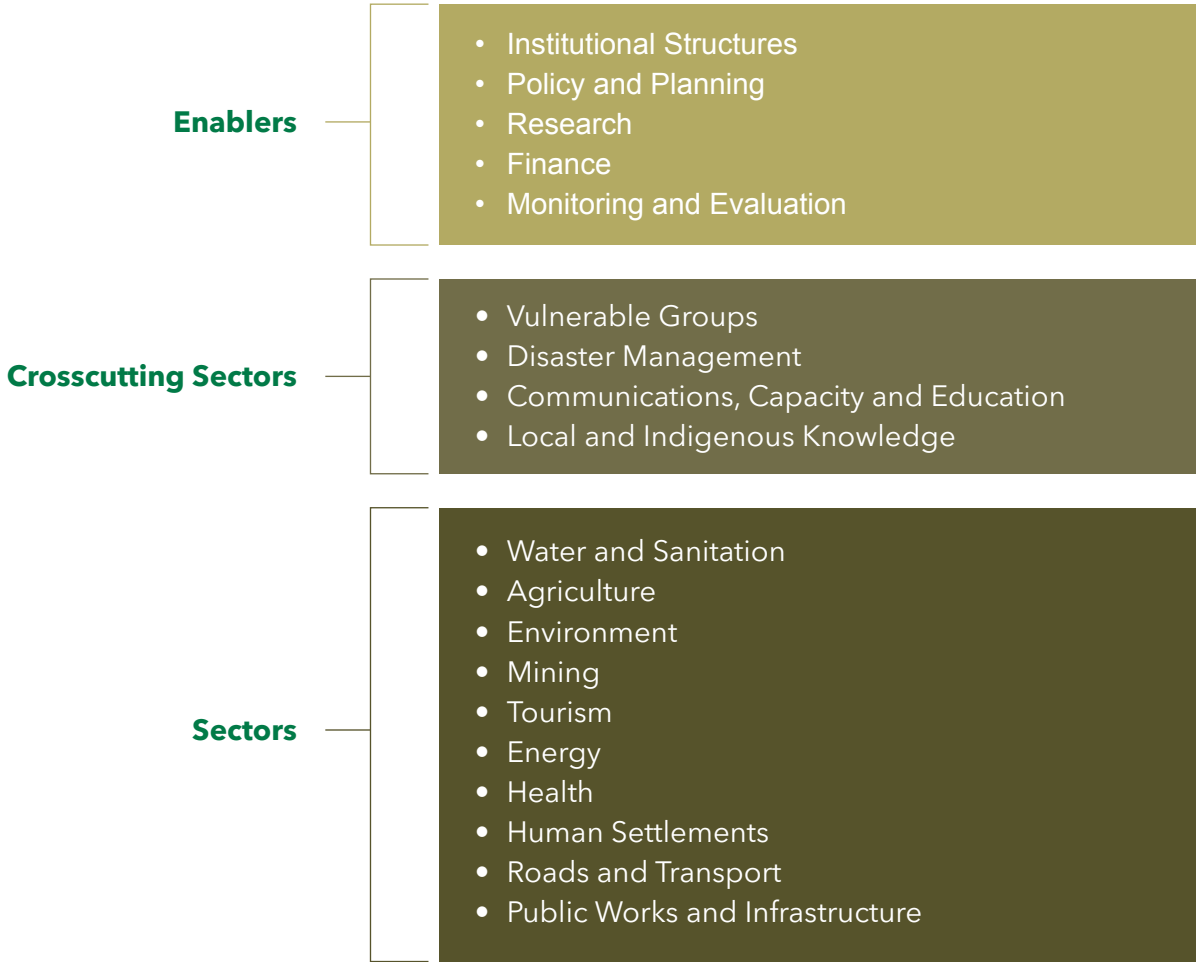
ARC	Agricultural Research Council
CSIR	Council for Scientific and Industrial Research
CSO	civil society organisation (including non-governmental organisations, community-based organisations, non-profit organisations, etc.)
DALRRD	Department of Agriculture, Land Reform and Rural Development (National)
DBE	Department of Basic Education (National)
DCOG	Department of Cooperative Governance (National)
DFFE	Department of Forestry, Fisheries and the Environment (National)
DHET	Department of Higher Education and Training
DHS	Department of Human Settlements
DMRE	Department of Mineral Resources and Energy (National)
DOH	Department of Health (National)
DOJ&CD	Department of Justice and Constitutional Development (National)
DSI	Department of Science and Innovation
DT	Department of Tourism (National)
DWS	Department of Water and Sanitation (National)
EPC	energy performance certificate
EPWP	Expanded Public Works Programme
FSDARD	Free State Department of Agriculture and Rural Development
FSDCOGTA	Free State Department of Cooperative Governance and Traditional Affairs
FSDCSRT	Free State Department of Community Safety, Roads and Transport
FSDESTEA	Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs
FSDoE	Free State Department of Education
FSDHS	Free State Department of Human Settlements
FSDOH	Free State Department of Health
FSDPRT	Free State Department of Police, Roads and Transport

FSDPWI	Free State Department of Public Works and Infrastructure
FSDSD	Free State Department of Social Development
FSGLA	Free State Gambling, Liquor and Tourism Authority
FSOTP	Free State Office of the Premier
FSPDMC	Free State Provincial Disaster Management Centre
FSPT	Free State Provincial Treasury
FSUFPA	Free State Umbrella Fire Protection Association
FSDARD	Free State Department of Agriculture and Rural Development
GCIS	Government Communication and Information System
GDP	Gross Domestic Product
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LITS	National Livestock Identification and Traceability System
MDMC	Municipal Disaster Management Centre
RCP	Representative Concentration Pathway
SAIAE	South African Institute of Agricultural Engineers
SALGA	South African Local Government Association
SANBI	South African National Biodiversity Institute
SAWS	South African Weather Service
UFS	University of the Free State

Executive Summary

Free State Province is located at the geographical centre of South Africa, and the city of Bloemfontein is the provincial capital. The province had an estimated population of approximately 2.92 million people in 2022, which represents 4.8% of South Africa's population, making the province the second smallest province in the country in terms of population size. Free State Province had an estimated 863,203 households and an estimated household growth rate of 1.03% in 2020, which was significantly higher than the national estimated household growth rate of 0.41% that same year. Free State Province is experiencing several critical challenges, including high youth unemployment, as well as growing levels of poverty and inequality. It is estimated that a quarter of South Africa's arable land is in Free State Province. The total provincial GDP for Free State Province in 2019 was just over ZAR 252 billion, making it the second smallest province in terms of provincial gross domestic product.

Figure ES1. Structure of the revised *Free State Climate Change Adaptation Strategy and Implementation Plan*



This *Free State Province Climate Change Adaptation Strategy and Implementation Plan 2024–2029* details the occurring and projected changes to climatic conditions in the province and the anticipated effects of these changes. The implementation plan details a series of response actions to increase climate change adaptation in Free State Province. These actions are divided into three broad areas: Enablers, Crosscutting Sectors, and other specific Sectors. Enablers are the necessary policies, institutional frameworks, organisational capabilities, financial resources, data, and knowledge that need to be established to implement climate change adaptation response actions in the province. Crosscutting sectors have a bearing on all the other sectors. The sectors are groups of activities with similar characteristics that are vulnerable to climate change and may also emit greenhouse gases.

1.0 Introduction

According to the Intergovernmental Panel on Climate Change's (IPCC's) recent report, the *Summary for Policymakers from Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC, 2023):

- Human activities, mainly through emissions of greenhouse gases, have unequivocally caused global warming.
- Human-caused climate change has led to widespread adverse impacts—and related losses and damages—to nature and people.
- Vulnerable communities, who have historically contributed the least to current climate change, are disproportionately affected by the adverse impacts of climate change.
- Current global financial flows for adaptation are insufficient for—and constrain the implementation of—adaptation options, especially in developing countries.

For Africa, Central and South America, and Asia, losses and damages will continue to increase, including projected adverse impacts, unless rapid, deep, and sustained mitigation and accelerated adaptation actions are implemented (IPCC, 2023). Furthermore, climate and weather extremes are increasingly driving displacement in Africa, Asia, and North America (IPCC, 2023).

This Climate Change Adaptation Response Strategy and Implementation Plan for Free State Province gives an overview of the climate change adaptation responses of Free State Province in response to the global challenge of climate change. It details the occurring and projected changes to the climatic conditions in the province and the anticipated effects of these changes. The implementation plan also details a series of response actions to increase climate change adaptation in Free State Province. These actions are divided into three broad areas: Enablers, Crosscutting Sectors, and other specific Sectors. Enablers are areas related to response actions that support the implementation of the other response actions in the implementation plan. Crosscutting Sectors influence multiple other sectors. The remaining Sectors are groups of activities with similar characteristics that are vulnerable to climate change and may also emit greenhouse gases (GHGs).

1.1 Overview of Free State Province

Free State Province is located at the geographical centre of South Africa, and the city of Bloemfontein is the provincial capital. The province had an estimated population of approximately 2.92 million people in 2022, which represents 4.8% of South Africa's population, making it the second smallest province in the country in terms of population size (Statistics South Africa, 2022). The province's population is distributed between the Mangaung Metropolitan Municipality (31%) and four district municipalities: Thabo Mofutsanyana (26%), Lejweleputswa (22%), Fezile Dabi (1%), and Xhariep (5%) (Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs [FSDESTEA], 2021a). According to the *Community Survey 2016*, the sex ratio in Free State Province was 95 males for every 100 females (Statistics South Africa, 2018).

Free State Province had an estimated 863,203 households and an estimated household growth rate of 1.03% in 2020, which was significantly higher than the national estimated household growth rate of 0.41% in 2020 (FSDESTEA, 2021a). A breakdown of the population and household information for Free State Province in 2020 at the district municipality level is shown in Table 1 (FSDESTEA, 2021b).

Table 1. Demographics in Free State Province in 2020

District municipality	Population	Number of households	Household growth rate (%)	Average income per household (R)	Income growth rate (%)
Fezile Dabi	501,612	148,269	0.6	140,680	1.40
Thabo Mofutsanyana	825,943	220,640	0.8	100,842	0.86
Lejweleputswa	660,806	187,670	0.2	169,595	1.11
Mangaung	830,354	267,486	1.4	141,771	1.03
Xhariep	93,256	39,138	0.6	99,614	0.49
Free State Province	2,926,733	863,203	-	-	-

Source: FSDESTEA, 2021b.

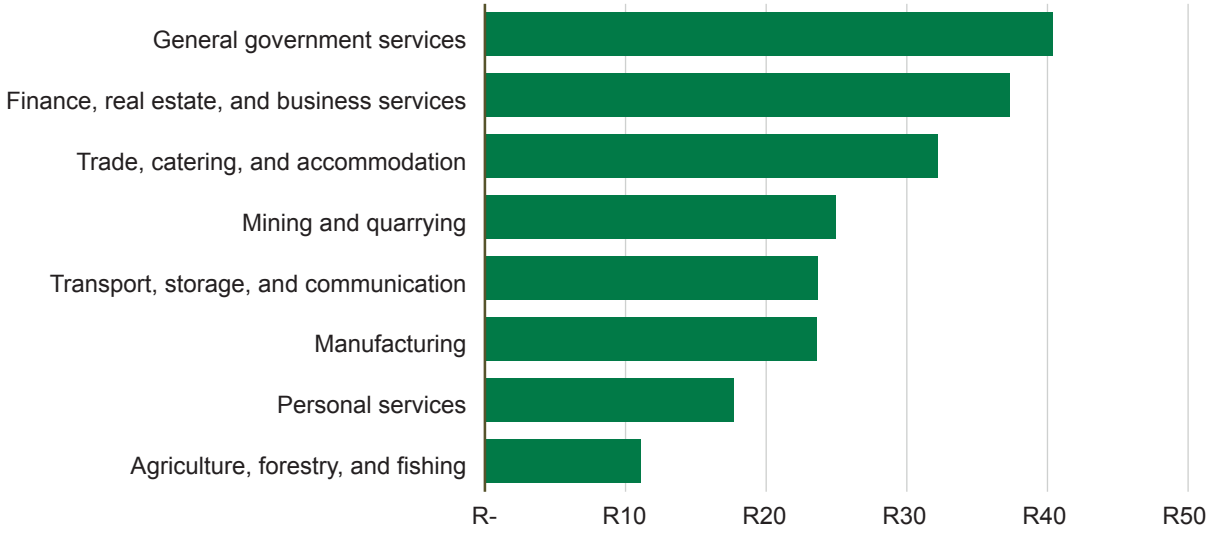
In 2016, 83.6% of households in Free State Province were classified as living in formal dwellings, while 14% of households lived in informal dwellings, and 1.6% of households lived in traditional dwellings (Statistics South Africa, 2018). In the province, there were 161 categorised informal settlements in 2022 (Free State Department of Human Settlements [FSDHS], 2022b).

Free State Province is experiencing several critical challenges, including high youth unemployment and growing levels of poverty and inequality (FSDHS, 2022a). These challenges are exacerbated by economic exclusion, and as women are more likely to experience economic exclusion than men, women are also more likely than men to experience unemployment, poverty, and inequality (FSDHS, 2022a). Poverty levels were notably higher in rural areas according to self-perceived wealth and income evaluation indicators (Statistics South Africa, 2017).

It is estimated that a quarter of South Africa's arable land is in Free State Province (Macaskill, 2023). In terms of land use by the agriculture sector, Statistics South Africa estimated that in 2018, the total land use by commercial agriculture in Free State Province was about 7.6 million hectares of land (Statistics South Africa, 2020). In 2017, Free State Province had an estimated 7,951 commercial farming units (Department of Agriculture, Land Reform and Rural Development [DALRRD], 2021).

The total provincial GDP in Free State Province in 2019 was just over ZAR 252 billion, making it the second smallest in terms of provincial gross domestic product (Statistics South Africa, 2021). In terms of contribution to the provincial GDP in Free State Province in 2019, the industries and sectors with the biggest contributions are summarised in Figure 1 (Statistics South Africa, 2021).

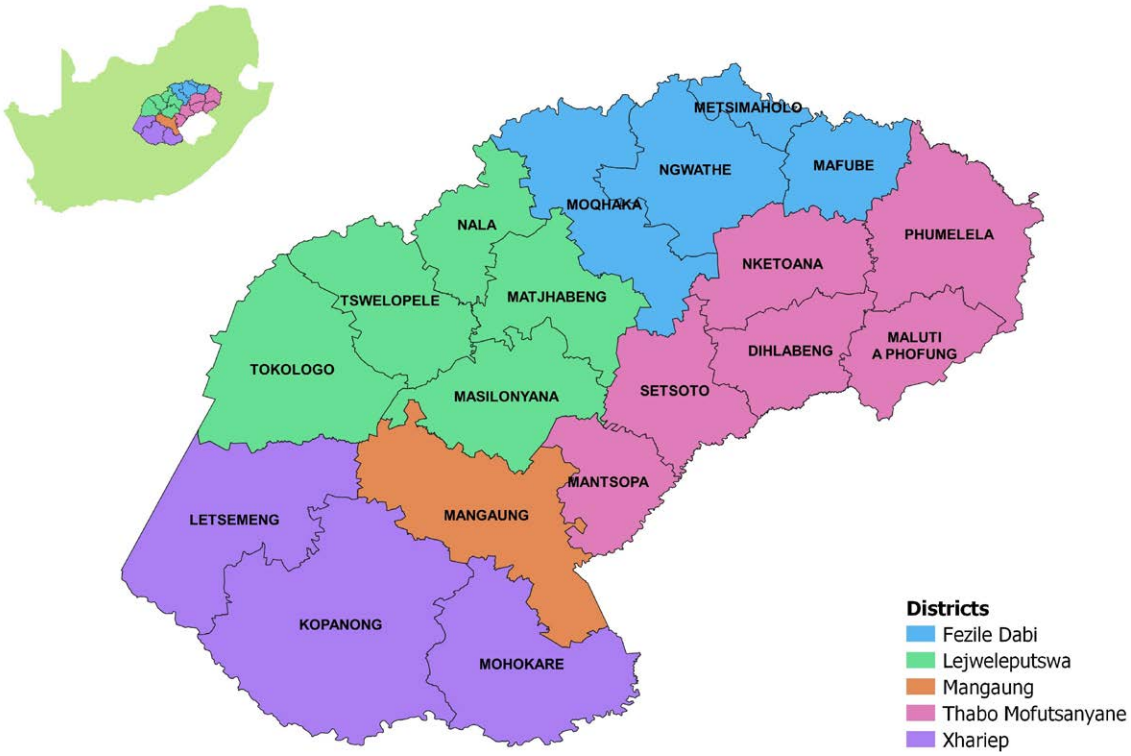
Figure 1. Summary of Free State Province's GDP in 2019



Source: Statistics South Africa, 2021.

For the municipal sphere of government, Free State Province is divided into four district municipalities and one metropolitan municipality (Mangaung Metropolitan Municipality) (Figure 2). The four district municipalities are further divided into 18 local municipalities (Figure 2).

Figure 2. Map of Free State Province and the municipalities within it



Source: Urban Earth, 2023 (reprinted with permission).

1.2 A Brief History of Climate Change Planning Within Free State Province

Free State Province has been actively planning for climate change for several years. The province published its most recent provincial climate change adaptation strategy in 2017 (FSDESTEA, 2018). This report draws on the province's 2017 climate change adaptation strategy, as well as more recent information.

1.3 Projected Changes in Free State Province's Climate and Associated Impacts

The key climatic change variables identified for Free State Province are

- increasing temperatures,
- increasing rainfall variability,
- increasing periods of drought, and
- increasing frequency and severity of extreme weather events.

For the purpose of this report, projected changes in these climate variables are summarised for the timescale 2021–2050 based on modelling conducted by the Council for Scientific and Industrial Research (CSIR) and published in the *Green Book: Adapting South African Settlements to Climate Change* (CSIR, 2019a). The modelling used the low-mitigation Representative Concentration Pathways 8.5 (RCP8.5) scenario for the 2021–2050 period and a baseline period of 1961–1990 (CSIR, 2019a).[1]

The climate variables used to project changes in climatic conditions are listed in Table 2.

Table 2. Summary of projected changes in climate variables in the mid-term (2020 to 2050)

Climate variable	Baseline (1970 to 2015)	Change under the RCP8.5 scenario (2020 to 2050)
Average annual temperature	29.5°C	+ 2.3°C
Very hot days	88 days	+ 54.15 days
Heat-wave events	13.9 events	+ 17.5 events
High fire danger days	145 days	+ 74.1 days
Average annual rainfall	527 millimetres	+ 35 millimetres
Extreme rainfall events (lightning and thunderstorms)	22.8 events	+ 0.23 events
Dry-spell days	93.5 days	+ 18.6 days

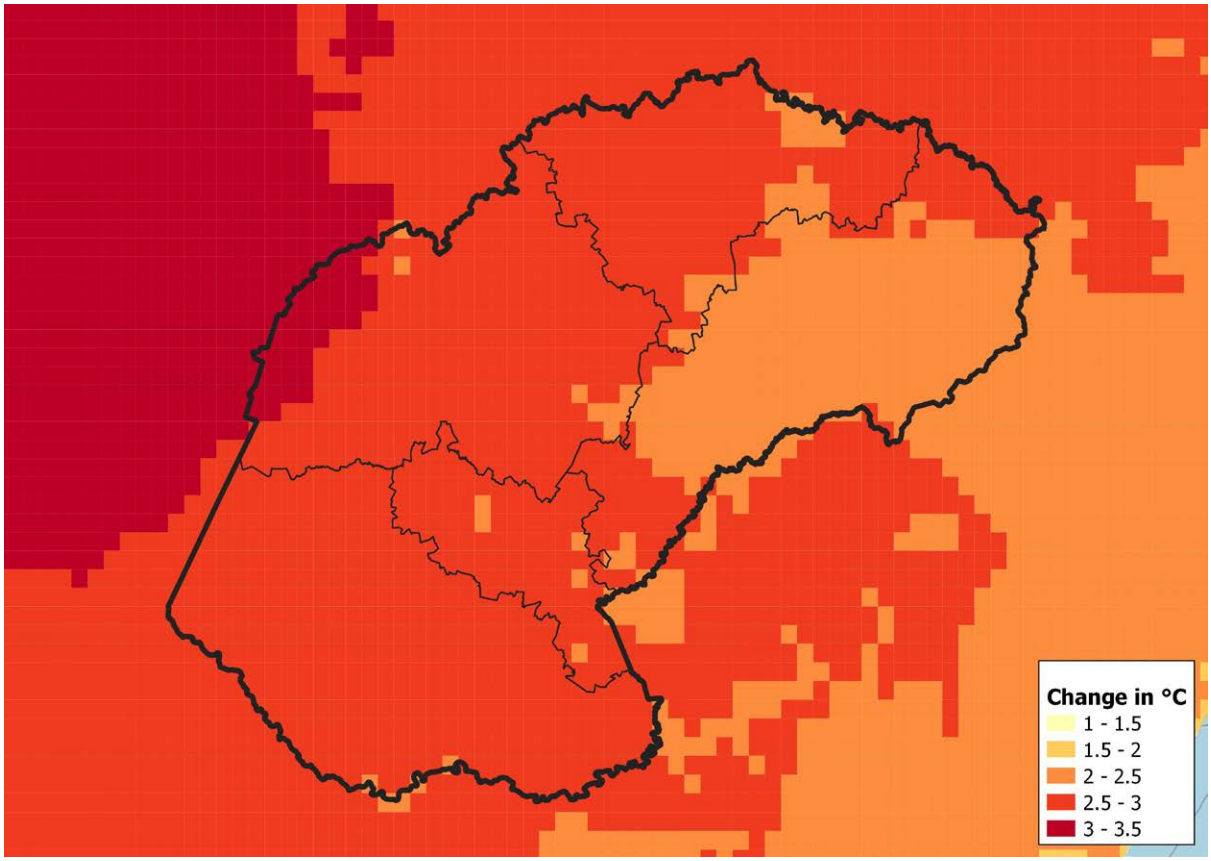
Source: FSDESTEA, 2018.

[1] It should be noted that the IPCC has developed four RCPs. These pathways project the effects of climate change based on different levels of global GHG emissions and atmospheric concentrations of GHGs (IPCC, 2014; Van Vuuren et al., 2011). To understand the extent to which climate change may affect Free State Province, the highest GHG emissions scenario (RCP8.5) is used throughout this section.

1.3.1 Increasing Temperatures

Based on Figure 3, Free State Province is projected to be affected by higher average annual temperatures. Under the RCP8.5 scenario, the projected increases in average annual temperature for the province, compared to the baseline period, are shown in Figure 3 for the 2021 to 2050 period (CSIR, 2019b). These projected increases in average annual temperatures range from increases of 2°C to 2.5°C in the east of the province, up to increases of 3°C to 3.5°C in the west of the province (CSIR, 2019b).

Figure 3. Projected change in average annual temperatures in Free State Province for the period 2021 to 2050 compared to the baseline period

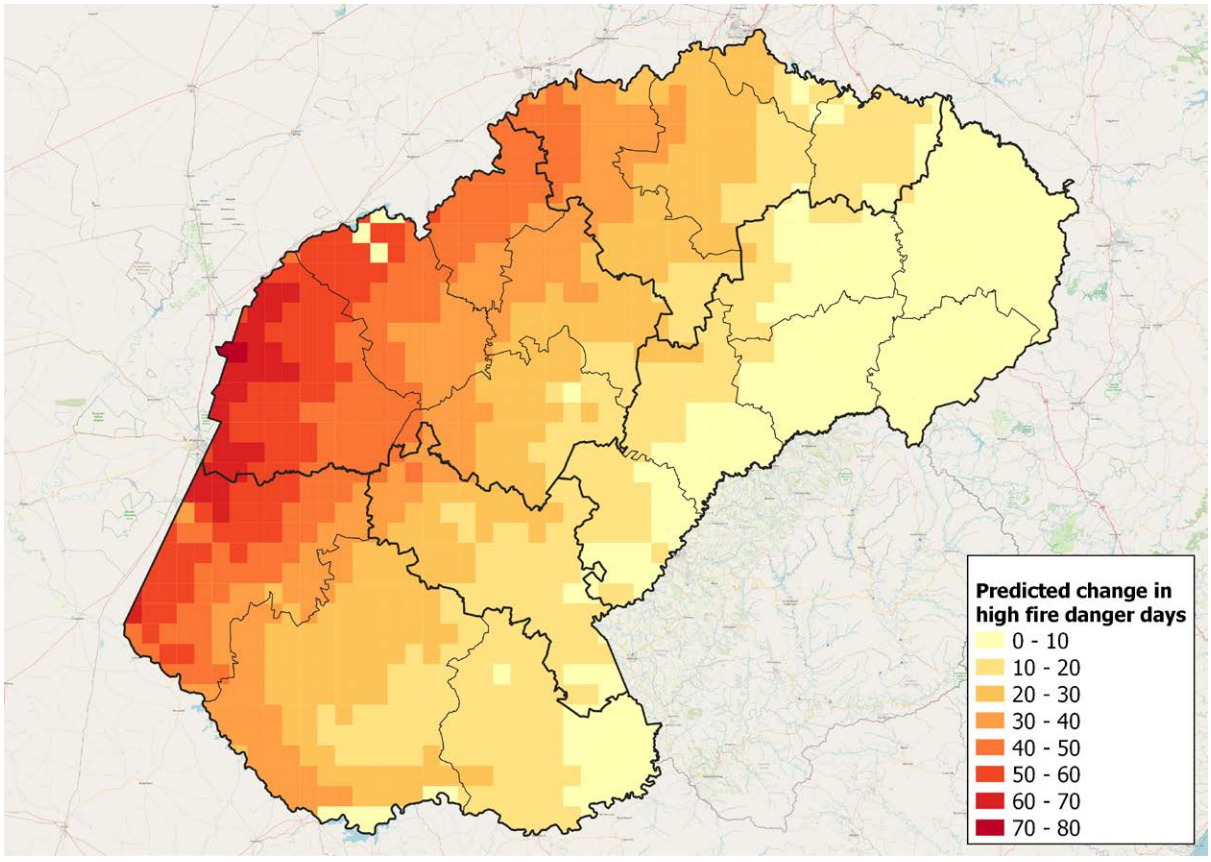


Source: CSIR, 2019b.

Changes in average annual temperature are also likely to increase the number of heat-wave events and very hot days in the province. Heat-wave events are defined as when "the maximum temperature exceeds the average temperature of the warmest month of the year by 5°C for at least 3 days" (FSDESTEA, 2018, p. 9), while very hot days are defined as "a day when the maximum temperature exceeds 35°C" (FSDESTEA, 2018, p. 9). Both the number of heat-wave events and very hot days are predicted to increase significantly compared to the province's baseline numbers (Table 2) due to climate change (FSDESTEA, 2018).

The number of high fire danger days is also projected to increase substantially (Figure 4) compared to the baseline figures for Free State Province (FSDESTEA, 2018). These projected increases in the number of high fire danger days are expected to exacerbate the risk of wildfires in the province (FSDESTEA, 2018). In addition, the frequency and severity of wildfires in the province are likely to be worsened by concurrent increases in bush encroachment and the spread and densification of invasive alien plant species, which are anticipated as a result of the impacts of climate change on the province's biodiversity and ecosystems (FSDESTEA, 2018). The increase in biomass as a result of invasions by alien plants (such as eucalyptus [gums], pines, wattles, and tall grass species like Arundo donax) enhances the risk of wildfires, especially when these plants grow close to infrastructure (Van Wilgen et al., 2020).

Figure 4. Projected change in the number of high fire danger days in Free State Province for the period 2021 to 2050 compared to the baseline period

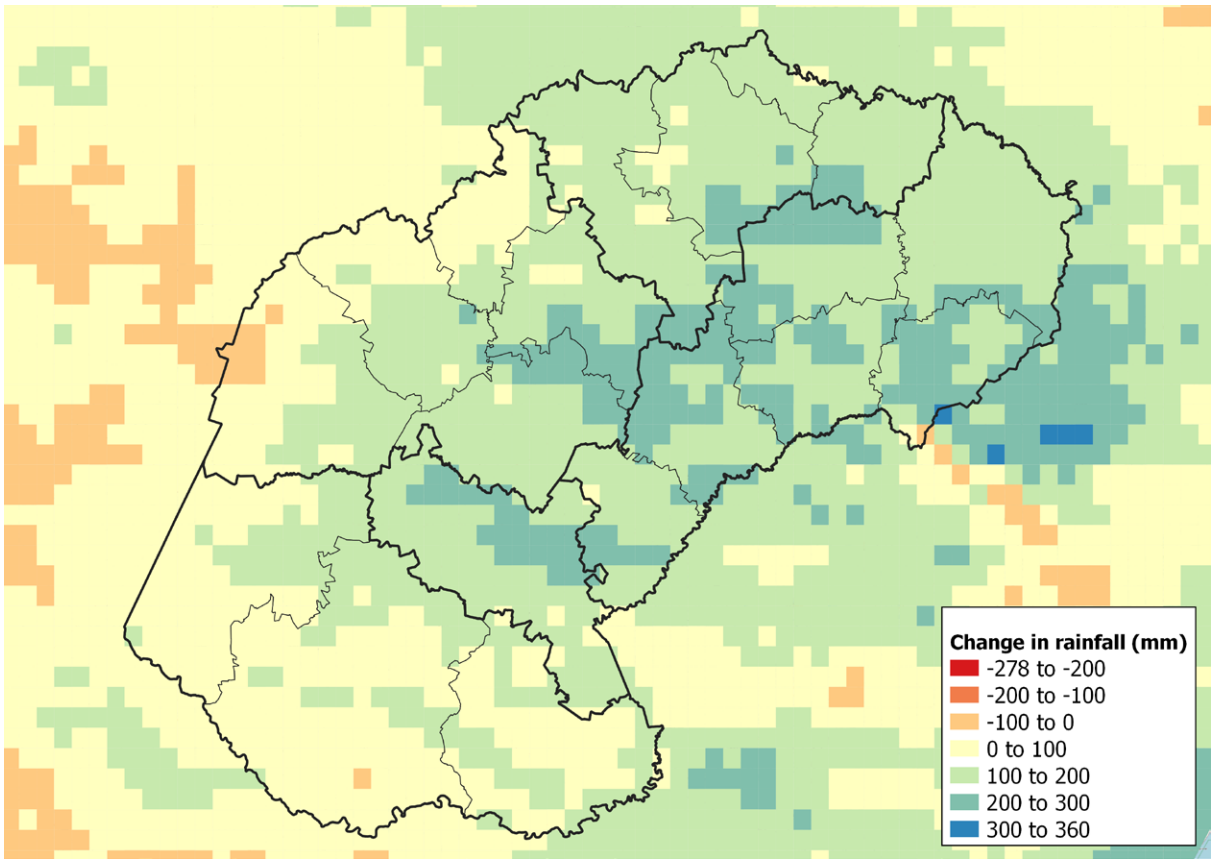


Source: CSIR, 2019b.

1.3.2 Increasing Rainfall Variability

The average annual rainfall for South Africa is 464 millimetres (mm) (CSIR, 2019b), and there is some uncertainty regarding the projected changes in average annual rainfall in South Africa, depending on how much average annual temperatures rise (Department of Environmental Affairs, 2013). In Free State Province, the average annual rainfall was 527 mm during the baseline period (FSDESTEA, 2018). The projected changes in average annual rainfall in Free State Province over the period 2021 to 2050 under the RCP8.5 scenario relative to the baseline period are shown in Figure 5 (CSIR, 2019b). Like much of South Africa, there is some uncertainty regarding projected changes in average annual rainfall in the province (CSIR, 2019b), but most of the province is projected to experience an increase in average annual rainfall (Figure 5).

Figure 5. Projected change in average annual rainfall in Free State Province for the period 2021–2050 compared to the baseline period



Source: CSIR, 2019.

1.3.3 Increasing Periods of Drought

Average annual temperatures in Free State Province are projected to increase by between 2°C and 3.5°C (Figure 3) by 2050 under the RCP8.5 scenario, compared to the baseline period (CSIR, 2019b). These predicted increases in average annual temperatures, as well as projected increases in rainfall variability in the province, will increase evaporation and evapotranspiration rates (FSDESTEA, 2018). Increased evaporation rates and rainfall variability are likely to increase the potential for drought in the province and reduce water levels in dams and rivers, which in turn will negatively affect water security and irrigation in the province (FSDESTEA, 2021c). Free State Province may experience increased frequency and severity of drought (CSIR, 2019b).

The province is also projected to experience an increase in the number of dry spells per year (FSDESTEA, 2018, 2021c). Dry spells are defined as a "period of five consecutive days without rainfall (or a longer dry period) occurring over an area of 50 x 50 km^2" (FSDESTEA, 2018, p. 17, 2021c). This projected increase in dry spells is also anticipated to contribute to increases in the frequency and severity of periods of drought in the province (CSIR, 2019b).

Increases in the frequency and severity of droughts will likely negatively affect water security, human health, agricultural production and food security, and biodiversity and ecosystem health in Free State (Botai et al., 2016). Increased rainfall variability will also likely increase risks related to water supply, water quality, and water pollution in the province (FSDESTEA, 2018, 2021c). Projected increases in average annual temperatures, the number of very hot days, and rainfall variability are projected to increase evaporation rates, the frequency and severity of droughts, and the duration and effect of dry spells, all of which will likely increase the risk, frequency, and severity of wildfires in the province (CSIR, 2019b).

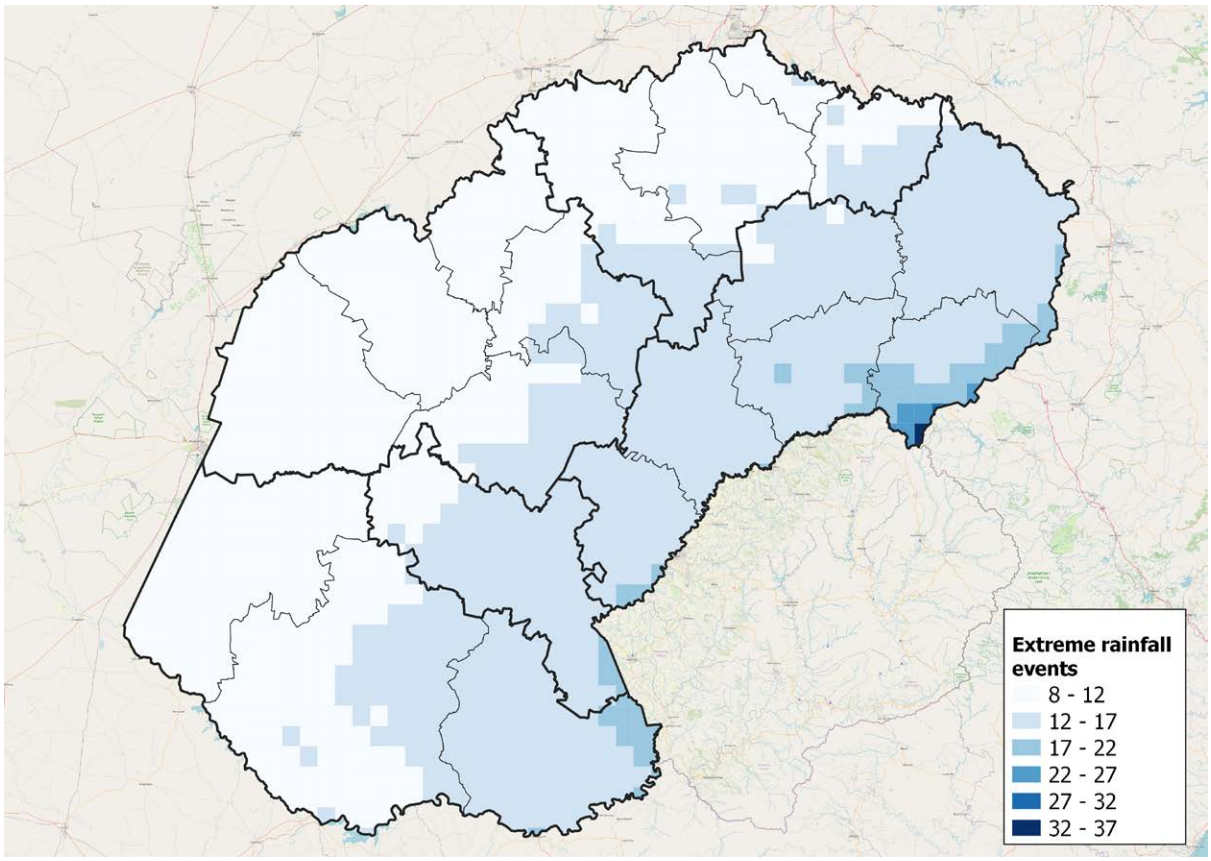
1.3.4 Increasing Frequency and Events

Free State Province's average annual rainfall, rainfall intensity, and rainfall variability are all projected to change (CSIR, 2019b). Because of these hydrological factors and projected increases in average annual temperatures, extreme weather events are likely to become more frequent and severe in the province. An extreme rainfall event is defined as more than 20 mm of rain occurring within 24 hours over an 8 km x 8 km grid point (CSIR, 2019b). Extreme rainfall events are also used as a proxy for thunderstorms that produce lightning (CSIR, 2019b). In Free State Province, thunderstorms frequently bring about dust storms (FSDESTEA, 2018, 2021c). Dust storms are anticipated to occur more frequently due to the anticipated rise in the frequency of thunderstorms (FSDESTEA, 2018).

The average annual number of extreme rainfall events has been calculated for Southern Africa using an 8 km x 8 km grid for the baseline period (1961–1990) (CSIR, 2019b). The map of Free State Province (Figure 6) shows the average annual number of extreme rainfall events for the baseline period (CSIR, 2019b). In addition, Figure 7 shows the projected change in the average annual number of extreme rainfall events over the period 2021 to 2050 under the RCP8.5 scenario relative to the baseline period (CSIR, 2019b).

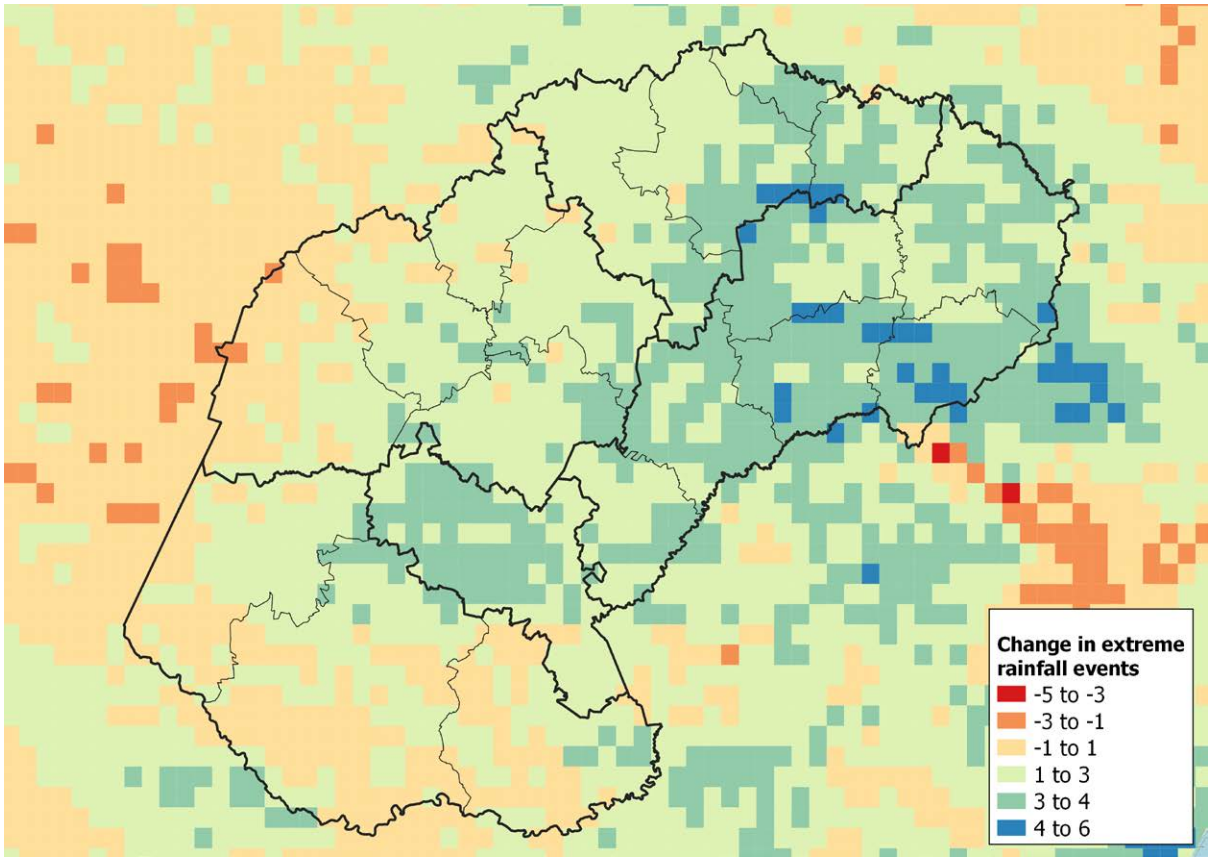
It is apparent from Figure 7 that the projected change in the average annual number of extreme rainfall events in Free State Province is highly variable, with much of the province experiencing an increase in the average annual number of extreme rainfall events, while in some parts of the province, there could be a slight decrease (CSIR, 2019b). This suggests that some parts of Free State Province will probably experience storm and flood events more often, while other parts could experience such events less often. In addition, Figure 7 indicates increased rainfall variability in the province and possibly increased uncertainty regarding the projected future average annual rainfall in the province.

Figure 6. Average annual number of extreme rainfall events in Free State Province during the baseline period



Source: CSIR, 2019.

Figure 7. Projected changes in the number of extreme rainfall events in Free State Province for the period 2021 to 2050



Source: CSIR, 2019.

2.0 Strategy Overview

2.1 Purpose of the Revised Climate Change Adaptation Strategy

The purpose of this revised and updated *Free State Province Climate Change Adaptation Strategy and Implementation Plan 2024–2029* is to provide a series of response actions to increase climate change adaptation in the province. This document includes a brief overview of the projected (and occurring) climate changes in the province, the expected effects of these changes, and a climate change adaptation implementation plan. The implementation plan details a series of response actions to increase climate change adaptation in Free State Province. These actions are divided into three broad areas: Enablers, Crosscutting Sectors, and other specific Sectors.

According to the *National Climate Change Adaptation Strategy* (for South Africa), climate change adaptation is defined as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (Department of Forestry, Fisheries and the Environment [DFFE], 2020, p. 6).

During the consultation meetings that led to the development of the strategy, in addition to adaptation responses, several mitigation actions were also identified. These mitigation actions have been listed in Appendix A. Possible Climate Change Mitigation Response Actions for inclusion in a future mitigation strategy for the province. It should be noted that some response actions in the implementation plan, while focusing on climate change adaptation, also have climate change mitigation co-benefits.

2.2 Structure of the Strategy

The strategy and implementation plan is divided into three areas: Enablers, Crosscutting Sectors, and other specific Sectors (Figure 8). Enablers are the necessary policies, institutional frameworks, organisational capabilities, financial resources, data, and knowledge that need to be established to implement climate change adaptation response actions in the province. Crosscutting Sectors have a bearing on all the other sectors. Sectors are groups of activities with similar characteristics that are vulnerable to climate change and may also emit greenhouse gases.

For the response actions in this strategy and implementation plan, the following time frame options are used (Table 3).

It should be noted that the guideline budget options presented in Table 4 are estimates, as the actual cost of implementing each response action depends on the scale of the activities undertaken.

The structure of the sectors in this strategy and implementation plan is shown in Figure 8. It should be noted that although the climate change adaptation response actions in the strategy are thematically separated by the various sectors, the implementation of response actions in some of the sectors is interlinked with the implementation of other response actions in other sectors.

Table 3. Time frame options used in the revised Free State Climate Change Adaptation Strategy

Name	Period
Short term	Within 1 to 3 years
Medium term	Within 4 to 10 years
Long Term	In more than 10 years
Ongoing	Continuous

Source: Authors.

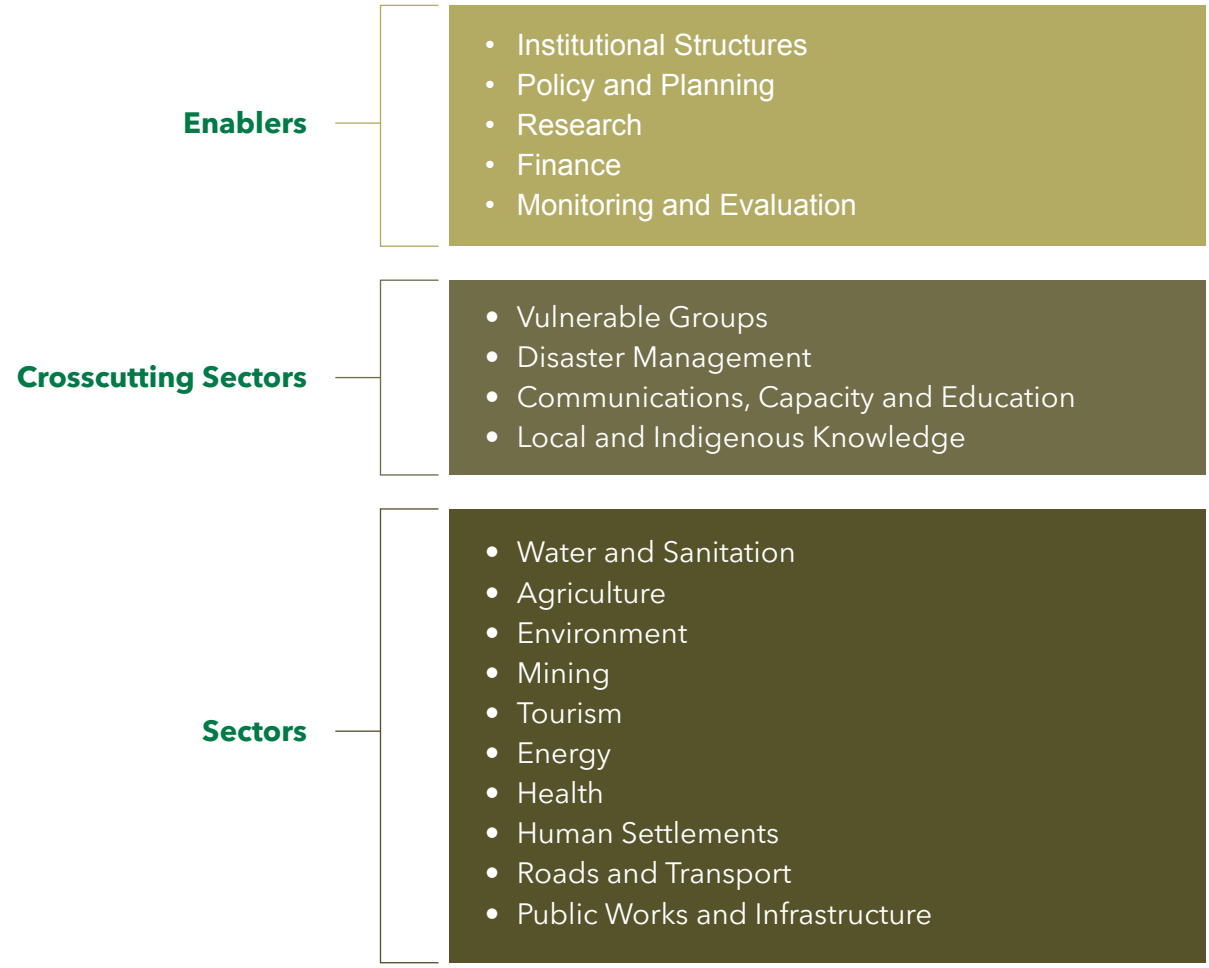
In addition, the following guideline budget options per response action are used (Table 4).

Table 4. Guideline budget options used in the revised Free State Climate Change Adaptation Strategy

Budget option	Description
< ZAR 1 million	Less than 1 million rand
ZAR 1 million–5 million	Between 1 million and 5 million rand
> ZAR 5 million	More than 5 million rand
ZAR 0–to be implemented by [specific department/ organisation] staff	The response action is to be implemented by the staff of the specific government department or organisation that is leading its implementation. Therefore, no additional budget is required.

Source: Authors.

Figure 8. Structure of the revised *Free State Province Climate Change Adaptation Strategy and Implementation Plan 2024–2029*



Source: Authors.

3.0 Climate Change Responses: Enablers

Institutional frameworks, organisational capabilities, financial resources, and the necessary knowledge and data are needed for the successful implementation of climate change policies. This section's goal is to provide an overview of the numerous elements that are necessary to support the implementation of the other response actions in the implementation plan and to suggest enabling response actions to improve those factors.

3.1 Institutional Structures

3.1.1 Climate Change Reporting Structures in Free State Province

The key structures in Free State Province for reporting on climate change issues:

- The Office of the Premier is the lead climate change department in the province, supported by FSDESTEA.
- The established Free State Climate Change Forum will report to the Premier's Coordinating Forum in line with the terms of the proposed Climate Change Bill.
- The district municipality's District Intergovernmental Forum, which, in terms of the proposed Climate Change Bill, also serves as a Municipal Forum on Climate Change.
- Lejweleputswa District Municipality's Municipal Disaster Management Advisory Forum, which has a Working Group for Climate Change.

FSDESTEA

FSDESTEA has a Climate Change Sub-Directorate that is located within FSDESTEA's Environmental Policy, Planning and Coordination Directorate. However, it should be noted that although the Climate Change Sub-Directorate has been established, it only has two filled posts. The appointment process for another official to the sub-directorate is currently underway. The sub-directorate also has three vacant posts that are unfilled owing to funding challenges. The structure of the Sub-Directorate is being reviewed, and a possible outcome of the review is a reduction in the number of officials employed to coordinate climate change response activities in the province.

Premier's Coordinating Forum

The Premier's Coordinating Forum is an intergovernmental structure that aims to promote and facilitate coordination between the Free State Provincial Government and the district and local municipalities in Free State Province. The forum's primary responsibilities involve policy coordination and development planning for the provincial government and municipalities in the province (Intergovernmental Relations Framework Bill, 2004). According to the Climate Change Bill[2] (B9–2022), the Premier's Coordinating Forum also serves as a Provincial Forum on Climate Change (Climate Change Bill, 2022).

[2] The Climate Change Bill will become the Climate Change Act once it has been promulgated.

Additionally, the Free State Provincial Government is in the process of establishing a new Free State Climate Change Forum that would advise the Premier's Coordinating Forum on climate change matters as allowed for in the Climate Change Bill, 2022

Free State Climate Change Forum

The Free State Office of the Premier (FSOTP) and the FSDESTEA have developed a terms of reference document for a new Free State Climate Change Forum. This forum will act as a technical advisory structure to the Premier's Coordinating Forum as is allowed for in the Climate Change Bill, 2022. Membership of the Free State Climate Change Technical Forum will be composed of the following categories of organisations: government departments and public entities, business and industry associations, labour organisations, civil society and non-governmental organisations, and academic and research institutions. The forum will be chaired by the FSOTP, while the secretariat services will be provided by FSDESTEA. The objectives of the Free State Climate Change Technical Forum are to

- promote peer-to-peer exchange of information between departments, municipalities, the private sector, and academic and research institutions;
- facilitate collaborative efforts in conducting research on climate change-related matters;
- build capacity and support for a regional approach to climate action in consideration of crosscutting impacts of climate change at the municipal level;
- provide guidance on sector and municipal institutional arrangements and clarify roles between spheres of government;
- identify areas of collaboration and partnerships between institutions to build resilience, reduce risks and impacts of climate change, and develop climate change strategies and action plans;
- facilitate training sessions on climate change-related matters in the province;
- identify opportunities to access green and climate funds nationally and internationally; and
- promote collective reporting on climate change response efforts and share best practices among all stakeholders.

District Intergovernmental Forums (Municipal Forums on Climate Change)

Each of the four district municipalities in Free State Province has a District Intergovernmental Forum. Each District Intergovernmental Forum is responsible for facilitating the coordination between the district municipality and the local municipalities within its geographic area. The primary responsibilities of these forums are to enable the planning, development, and implementation of municipal-level strategies and policies relating to municipal objectives. According to the Climate Change Bill (B9–2022), each District Intergovernmental Forum also serves as a Municipal Forum on Climate Change (Climate Change Bill, 2022).

Lejweleputswa District Municipality's Disaster Management Advisory Forum

The Lejweleputswa District Municipality has a Disaster Management Advisory Forum that includes a Working Group for Climate Change. This working group is actively involved in climate change-related activities in the district municipal area.

3.1.2 Goals and Response Actions

To improve institutional structures for climate change in Free State Province, the following goal is presented with related implementable response actions.

Table 5. Goal: The Free State Provincial Government has the institutional structures in place to coordinate climate change responses in the province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Fill vacant posts in the Climate Change Sub-Directorate of the FSDESTEA	FSDESTEA		Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	Personnel budget	There are no vacant posts in the Climate Change Sub-Directorate of FSDESTEA.
2	Incorporate climate change responses, as required by the Climate Change Bill, into the standing agenda of the Premier's Coordinating Forum	FSOTP	FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by FSOTP staff	N/A	Minutes of Premier's Coordinating Forum meetings reflecting Climate Change as an agenda item.
3	Ensure that regular meetings of the Free State Climate Change Forum occur	FSDESTEA	FSOTP	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	Meeting minutes from the Free State Climate Change Technical Forum are available.
4	Incorporate Climate Change responses, as required by the Climate Change Bill, into the standing agenda of the four District Intergovernmental Forums	District municipalities	FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by the staff of the district municipalities	N/A	Minutes of all four District Intergovernmental Forum meetings reflecting "climate change" as an agenda item.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Identify other municipal forums that should include climate change as a standing item	FSDESTEA	SALGA, FSDCOGTA	Short term (1–3 years)	ZAR 0 – To be implemented by SALGA staff	N/A	Climate change is included as a standing item on the agenda of at least one forum per municipality.
6	Designate climate change coordinators in all district and local municipalities in Free State Province	District and local municipalities	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 0 – To be implemented by the staff of the district and local municipalities	N/A	Climate change Coordinators are in place in district and local municipalities in Free State Province.
7	Designate climate change coordinators in all provincial sector departments in the Free State Provincial Government	Provincial sector departments	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 0 – To be implemented by the staff of the provincial sector departments	N/A	Climate change coordinators are in place in all provincial sector departments in Free State Province.
8	Establish a mailing list of all climate change stakeholders	FSDESTEA	District and local municipalities	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A contact list of all climate change focal points exists and is updated regularly.

Source: Authors.

3.2 Policy and Planning

Free State Province has been actively planning for climate change for several years. The province published its most recent provincial climate change adaptation strategy in 2017 (FSDESTEA, 2018). This report represents an update to the province's 2017 climate change adaptation strategy. Other relevant policy and planning documents are outlined below:

- The *Free State Growth and Development Strategy* is a guide to coordinating the allocation of national, provincial, and local resources and private sector investment to achieve sustainable development outcomes in the province.
- *Opportunities and Challenges for a Just Transition in the Free State Province and Gert Sibande and Nkangala Districts in Mpumalanga Province* outlines the challenges and opportunities for a Just Transition, which is a first step toward planning and implementation at the district and provincial levels.
- The *Free State Green Economy Strategy* focuses on addressing key challenges facing the province, such as a high unemployment rate, poverty, low economic growth, and degradation of the natural environment.
- The *Draft Air Quality Management Plan–Free State Province* assists the province in setting and achieving air quality management goals in a structured, coordinated, and measured manner.

3.2.1 Goals and Response Actions

To improve policy and planning for climate change in Free State Province, the following goal is presented with related implementable response actions.

Table 6. Goal: Free State has policies and plans in place to enable a provincial climate change response

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Review and update the Free State Climate Change Adaptation Strategy every 5 years	FSDESTEA	DFFE (national), the private sector, the non-government sector	Medium term (4–10 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	An updated version of the Free State Climate Change Adaptation Strategy is approved and shared publicly in 2028.
2	Incorporate the Climate Change Adapatation Strategy and Implementation Plan into the Provincial Growth and Development Strategy for Free State Province	FSOTP	FSDESTEA, built environment practitioners (engineers, town planners, environmental associations, etc.)	Short term (1–3 years)	ZAR 0 – To be implemented by FSOTP staff	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into the updated Free State Growth and Development Strategy.
3	Incorporate the Climate Change Adapatation Strategy and Implementation Plan into the Provincial Spatial Development Framework	Free State Department of Cooperative Governance and Traditional Affairs (FSDCOGTA)	FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by FSDCOGTA and FSDESTEA staff	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into the updated Provincial Spatial Development Framework.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Incorporate the Climate Change Adapatation Strategy and Implementation Plan into the Provincial Disaster Management Plan	FSDCOGTA	FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by FSDCOGTA and FSDESTEA staff	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into the updated Provincial Disaster Management Plan.
5	Provide support to develop or review a District Climate Change Adapatation Plan for each district municipality in Free State Province, as stipulated in the Climate Change Bill	FSDESTEA	South African Local Government Association (SALGA), FSDCOGTA,	Short term (1–3 years)	ZAR 1 million–ZAZAR 5 million	FSDESTEA	Each district municipality has an up-to-date District Climate Change Adapatation Plan that has been adopted by its council and implemented.
6	Incorporate this Climate Change Adaptation Strategy and Implementation Plan into the District Development Models for Free State Province	FSDCOGTA	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 0 – To be implemented by FSDCOGTA staff	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into the District Development Models.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
7	Incorporate this Climate Change Adaptation Strategy and Implementation Plan into each district municipality's integrated development plan	District municipalities	FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by the staff of the district and local municipalities	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into each district municipality's integrated development plan.
8	Incorporate this Climate Change Adaptation Strategy and Implementation Plan into each local municipality's integrated development plan	Local municipalities	FSDESTEA, district municipalities	Short term (1–3 years)	ZAR 0 – To be implemented by the staff of the local municipalities	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into each local municipality's integrated development plan.
9	Incorporate this Climate Change Adaptation Strategy and Implementation Plan into the Human Settlements Plans for Free State Province	FSDHS	FSDESTEA, DFFE (national), University of the Free State's (UFS's) Department of Urban and Regional Planning	Short term (1–3 years)	ZAR 0 – To be implemented by FSDHS staff	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into the Human Settlements Plans.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
10	Incorporate this Climate Change Adaptation Strategy and Implementation Plan into the Agricultural Master Plan for Free State Province	FSDARD	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 0 – To be implemented by Free State Department of Agriculture and Rural Development (FSDARD) staff	N/A	The Climate Change Adaptation Strategy and Implementation Plan has been meaningfully incorporated into the Agricultural Master Plan.

Source: Authors.

3.3 Research and Development

To facilitate the implementation of climate change adaptation responses in Free State Province, it is necessary to undertake climate change adaptation research and development that result in the generation of relevant and applicable knowledge and data. A coordinated approach to research and development will allow these to be undertaken and for the research and development to be communicated. Effectively and regularly communicating research and development can build awareness, improve understanding of climate change adaptation in various stakeholder groups in Free State Province, and assist in identifying the most effective adaptation actions for the province.

3.3.1 Goals and Response Actions

To improve research and development related to climate change adaptation in Free State Province, the following goal is presented with related implementable response actions.

Table 7. Goal: Relevant and useful climate change adaptation research and development are undertaken on an ongoing basis in Free State Province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Identify all operative research platforms and committees in Free State Province that include climate change research	FSDESTEA	Academic and research institutions, DFFE (national), Department of Science and Innovation (DSI) (national), SALGA, Provincial Research Advisory Council	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A report is available on all operative climate change adaptation research platforms and committees in Free State Province.
2	Identify an existing platform or committee that can coordinate climate change research undertaken in Free State Province	FSDESTEA	Academic and research institutions, provincial sector departments, DFFE (national), DSI (national), Provincial Research Advisory Council	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	An existing platform or committee is identified that can coordinate climate change research in Free State Province.
3	The identified platform or committee reports to and participates in the meetings of the Proposed Province Climate Change Technical Forum	Identified lead research entity	FSDESTEA, academic and research institutions	Ongoing	ZAR 0 – To be implemented by the lead research entity	N/A	The identified platform or committee actively participates in the meetings of the Province Climate Change Technical Forum.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Define a research agenda for research related to climate change adaptation in Free State Province	Identified lead research entity	Provincial sector departments, academic and research institutions, DFFE (national), DSI (national), SALGA, Provincial Research Advisory Council	Short term (1–3 years)	ZAR 0 – To be implemented by the identified lead research entity	N/A	The research agenda is reflected in a written document.
5	Establish a process for sharing research outputs related to all climate change adaptation research in Free State Province with all relevant entities	FSDESTEA	Provincial sector departments, district and local municipalities, academic and research institutions, DFFE (national), DSI (national), Provincial Research Advisory Council, non-governmental organisations	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A climate change adaptation research sharing process is operative.
6	Conduct research on academic and research institution outputs that are focused on climate change adaptation and that have practical and implementable applications in Free State Province	Academic and research institutions	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	Academic and research institutions	A report on research outputs with practical and implementable applications is available.

Source: Authors.

3.4 Finance

Financial resources for climate change responses are limited in Free State Province. An operating budget is in place for FSDESTEA's Climate Change Sub-Directorate; however, there is no additional budget to implement climate change response actions. In addition, FSDESTEA's Climate Change Sub-Directorate has vacant posts owing to a lack of funding to appoint officials.

3.4.1 Goals and Response Actions

To improve financing for climate change in Free State Province, the following goal is presented with related implementable response actions.

Table 8. Goal: Secure funds to enable climate change responses in Free State Province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Apply for and secure funding for vacant posts in the Climate Change Sub-Directorate of the FSDESTEA	FSDESTEA	Free State Provincial Treasury (FSPT)	Short term (1–3 years)	Annual salaries for the vacant posts	FSPT	A dedicated budget is secured for vacant posts in the Climate Change Sub-Directorate.
2	Identify a budget for the implementation of key responses in the strategy	FSOTP	FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A dedicated budget for the Climate Change Sub-Directorate is secured.
3	Develop a plan to leverage private sector and donor funding for actions in the strategy that require funding	FSDESTEA	DFFE (national)	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A plan for leverage funding is complete.
4	Mainstream climate change budgeting into all provincial sector departments in the Free State Provincial Government, as well as into all district and local municipalities in Free State Province	FSOTP	FSDESTEA, FSDCOGTA, provincial sector departments, SALGA, district and local municipalities	Short term (1–3 years)	ZAR 0 – To be implemented by FSOTP staff	N/A	Climate change adaptation responses are included as line items in each provincial sector department's budget and in the budgets of all district and local municipalities.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Establish a technical team to source financing for the implementation of climate change response actions in Free State Province	FSOTP	FSDESTEA, DFFE (national), the private sector, civil society organisations (CSOs)	Short term (1–3 years)	> ZAR 5 million	FSOTP	A technical team is established for sourcing financing for the implementation of climate change adaptation actions in Free State Province.
6	Apply for and secure funding for a provincial climate change information system for Free State Province	FSDESTEA	DFFE (national)	Short term (1–3 years)	ZAR 1 million	International funders	A provincial climate change information system is operational.
7	Capacitate and support municipalities package bankable project proposals and source climate and green funding nationally and internationally	DFFE	FSDESTEA, municipalities, SALGA	Short term (1–3 years)	ZAR 1 million	International funders	Municipalities are packaging and accessing donor funding to implement climate change response programmes/projects.

Source: Authors.

3.5 Monitoring and Evaluation

Addressing the multifaceted challenges posed by climate change adaptation demands a flexible and iterative approach. This approach will enable the province to continuously refine its execution, discover novel solutions for confronting anticipated climate impacts, and make data-driven adjustments. A vital element of this adaptive framework is the diligent monitoring and evaluation of the strategy's implementation. This section aims to specify the actions necessary for a robust monitoring and evaluation process of this climate change adaptation strategy.

3.5.1 Goals and Response Actions

To improve the monitoring and evaluation of climate change adaptation response actions in Free State Province, the following goal is presented with related implementable response actions.

Table 9. Goal: The implementation of the Free State Climate Change Adaptation Strategy and Implementation Plan is monitored and evaluated on an ongoing basis

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Monitor the implementation of the strategy's actions against the identified indicators of success	FSDESTEA	FSDCOGTA, CSOs, the private sector	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	An action tracking sheet is completed for each quarter.
2	Prepare and present a presentation to the Premier's Coordinating Forum on the progress in implementing the Free State Climate Change Adaptation Response Strategy and Implementation Plan every 6 months	FSDESTEA	FSDCOGTA, CSOs, the private sector	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A presentation and an agenda item are included on the forum agenda twice every year.
3	Draft an annual Monitoring and Evaluation Report on progress in implementing the Free State Climate Change Adaptation Response Strategy and Implementation Plan	FSDESTEA	FSDCOGTA, CSOs, the private sector	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A monitoring and evaluation report is completed annually.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Populate initiatives and programmes on the National Climate Change Response Database	FSDESTEA	Provincial sector departments, district and local municipalities, CSOs, the private sector	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	The National Climate Change Response Database includes up-to-date information on Free State.
5	Develop and periodically update a provincial climate change information system for Free State Province	FSDESTEA	DFFE (national), spatial planning and land-use management services, CSOs, the private sector	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	FSDESTEA	The Free State Provincial Climate Change Information System is functional and up-to-date.

Source: Authors.

4.0 Climate Change Responses – Crosscutting Sectors

The three Crosscutting Sectors are vulnerable groups; disaster management; and communications, capacity, and education.

4.1 Vulnerable Groups

In the realm of climate change adaptation, it is crucial to give special attention to those most vulnerable to its impacts. Vulnerable groups such as women, disabled individuals, the elderly, and young children often bear a disproportionate burden of climate-related challenges. These populations are frequently marginalised in terms of resources, social standing, and decision-making power, thereby exacerbating their susceptibility to environmental stressors.

4.1.1 Goals and Response Actions

To improve the inclusion of vulnerable groups in climate change adaptation responses in Free State Province, the following goal is presented with related implementable response actions.

Table 10. Goal: Vulnerable groups and their resilience are meaningfully considered in climate change adaptation responses implemented in Free State Province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Facilitate representation of vulnerable groups within Free State Province's climate change planning and decision-making structures, such as the Free State Climate Change Forum and the four District Intergovernmental Forums	FSDESTEA	FSOTP, Free State Department of Social Development (FSDSD), CSOs	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	Representatives of vulnerable groups are involved in Free State Province's climate change adaptation planning and decision-making processes.
2	Develop an approach for the collection and analysis of disaggregated data for vulnerable groups (women, disabled individuals, the elderly, and young children) in relation to the implementation of climate change adaptation response actions	FSDESTEA	FSDSD, CSOs	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A methodology is available for the collection and analysis of disaggregated data for vulnerable groups in relation to the implementation of climate change adaptation response actions.
3	Conduct comprehensive vulnerability and needs assessments specific to each vulnerable group to understand their unique challenges and adaptive capacities	FSDESTEA	DFFE (national), FSDSD, CSOs	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	Comprehensive vulnerability and needs assessments specific to each vulnerable group are conducted.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Establish robust monitoring and evaluation systems that include indicators specifically designed to assess the well-being and adaptive capacity of vulnerable groups in Free State Province	FSDESTEA	DFFE (national)	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	Free State Province's climate change adaptation monitoring and evaluation systems include indicators specifically designed to assess the well-being and adaptive capacity of vulnerable groups.

Source: Authors.

4.2 Disaster Management

For Free State Province, the projected (and occurring) effects of climate change, such as increases in rainfall variability and temperatures, are predicted to result in increases in the frequency and severity of extreme weather events. Increases in the frequency and severity of extreme weather events will result in more disasters occurring in Free State Province, impacting all the specific sectors discussed in the next section of the document. In the face of more intense extreme weather events occurring more often, proactive disaster management (including disaster risk reduction) will be vital for reducing the negative effects of these disasters. Proactive disaster management (and disaster risk reduction) can save lives (human and animal) and reduce the number of houses, vital infrastructure, businesses, farms, etc., that are damaged and/or destroyed by disasters. Well-designed and adequately financed disaster management that is proactively implemented will reduce recovery times and associated costs.

4.2.1 Goals and Response Actions

To improve disaster management in Free State Province, in response to the projected (and occurring) effects of climate change, the following goal is presented with related implementable response actions.

Table 11. Goal: The Free State Provincial Government responds effectively to extreme weather events

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Conduct a feasibility study into addressing the key gaps in existing disaster management services in Free State Province	FSDCOGTA	FSPDMC, FSDESTEA, DFFE (national), Department of Cooperative Governance (DCOG) (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDCOGTA	A draft feasibility study is developed to address gaps in disaster management services in Free State Province.
2	Investigate the capacity of disaster management personnel in all municipalities in Free State Province	Free State Provincial Disaster Management Centre (FSPDMC)	FSDCOGTA SALGA	Short term (1–3 years)	< ZAR 1 million	FSPDMC	A report is available on the capacity of disaster management personnel in all municipalities in Free State Province.
3	Revive the Municipal Disaster Management Centre in each district municipal area	FSPDMC	FSDCOGTA SALGA	Short term (1–3 years)	> ZAR 5 million	FSPDMC	A Municipal Disaster Management Centre is functionally operational in each district municipal area.
4	Identify the key actions that can be undertaken in Free State Province to reduce vulnerability to climate-linked disasters	FSPDMC	DFFE (national), FSDCOGTA, FSUFPA SALGA	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSPDMC	A list of clear actions is available that can be taken to reduce future vulnerability to disasters.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Integrate climate change adaptation into all provincial and (district) municipal disaster management plans in Free State Province in a meaningful way	FSPDMC	District municipalities, FSUFPA, FSDCOGTA SALGA	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSPDMC	Updated disaster management plans are available that have meaningfully integrated climate change adaptation response actions.
6	Conduct a feasibility study into the creation and operation of a provincial early warning system that can reach women, men, the disabled, the elderly, and young children	FSDCOGTA, UFS's Disaster Management Training and Education Centre for Africa	FSPDMC, National Disaster Management Centre, South African Weather Service (SAWS), FSDESTEA, DFFE (national), DCOG (national), the Working on Fire Programme, the private sector, CSOs SALGA	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDCOGTA	A draft feasibility study is developed on creating and operating a provincial early warning system.
7	Conduct research into the gaps in existing disaster management services in Free State Province and whether the different needs of women, men, the disabled, the elderly, and young children are addressed	FSDCOGTA	FSPDMC, FSDESTEA, DFFE (national), DCOG (national), CSOs, academic and research institutions, UFS's Disaster Management Training and Education Centre for Africa	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDCOGTA	A research report is developed on the status of disaster management services in Free State Province.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
8	Establish an implementation plan linked to the Wildfire Management Framework of Free State Province that includes input from the provincial sector departments	Free State Umbrella Fire Protection Association (FSUFPA)	DFFE (national), FSPDMC, provincial sector departments	Short term (1–3 years)	ZAR 0 – To be implemented by FSUFPA staff	N/A	An implementation plan is established that is linked to the Wildfire Management Framework of Free State Province.
9	Implement the implementation plan linked to the Wildfire Management Framework of Free State Province	FSUFPA	DFFE (national), FSPDMC, provincial sector departments	Medium term (4–10 years)	> ZAR 5 million	FSUFPA	The implementation plan linked to the Wildfire Management Framework of Free State Province is implemented, including robust monitoring and evaluation actions.
10	Investigate the development of techniques for creating firebreaks using new mechanised systems developed by the Agricultural Research Council and the South African Institute of Agricultural Engineering	FSUFPA	ARC, SAIAE, FSPDMC, UFS's Department of Engineering Sciences, the private sector	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSUFPA	A report is developed on new techniques for firebreak creation.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
11	Review the state of municipal fire departments in Free State Province and identify actions to improve the functionality of these departments	FSUFPA	District and local municipalities, FSDCOGTA, FSPDMC, SALGA	Short term (1–3 years)	ZAR 0 – To be implemented by the FSUFPA staff	N/A	A list of actions is available to improve the functionality of these municipal fire departments in Free State Province.
12	Evaluate the viability of insurance schemes for rapid disaster relief and response mechanisms in Free State Province	FSPDMC	FSDCOGTA	Short term (1–3 years)	< ZAR 1 million	FSPDMC	A report is available on the viability of the use of insurance schemes.

Source: Authors.

4.3 Communications, Capacity, and Education

To ensure that the projected and occurring effects of climate change are known and understood, it is important to improve communications, capacity, and education around the effects of climate change and the available climate change adaptation options that can be implemented. Improved communications, capacity, and education efforts will inform people that climate change affects every sector in a number of ways (e.g., every sector relies on having access to water of suitable quality and quantity to function). Improved communications, capacity, and education efforts will also help people understand why particular climate change adaptation solutions are being implemented.

4.3.1 Goals and Response Actions

To improve communications, capacity, and education around the projected and occurring effects of climate change and implementable climate change adaptation options in Free State Province, the following goals are presented with related implementable response actions.

Table 12. Goal: Improved awareness of–and communications around–the projected and occurring effects of climate change and implementable climate change adaptation options

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Develop and implement an awareness programme aimed at all economic sectors in Free State Province that focuses on the projected and occurring effects of climate change on all sectors, the implications of climate change for all sectors, the climate change response options that can be implemented, how to practically prepare for the risks associated with climate change, and possible emergency response actions that individuals can take	FSDESTEA	DFFE (national), provincial sector departments, FSPDMC, SALGA, district and local municipalities, Mangaung Metropolitan Municipality	Ongoing	ZAR 1 million – ZAR 5 million	FSDESTEA	A climate change awareness programme is implemented that is aimed at all economic sectors in Free State Province.
2	Implement a communication programme to raise awareness in communities on the importance of biodiversity and healthy ecosystems, their conservation, and their role in adaptation	FSDESTEA	DFFE (national), FSPDMC, Government Communication and Information System (GCIS) (national), district and local municipalities, councillors	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A biodiversity and ecosystems communication programme for communities is implemented.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
3	Implement a communication programme to raise the awareness of traditional healers on biodiversity and conservation and the projected and occurring effects of climate change	FSDESTEA	FSDCOGTA, GCIS (national), DFFE (national), district and local municipalities, CSOs	Medium term (4–10 years)	< ZAR 1 million	FSDESTEA	A communication programme is implemented to raise the awareness of traditional healers on biodiversity and conservation and the projected and occurring effects of climate change.
4	Implement an awareness programme on water losses, water conservation and demand-side management, and what Blue and Green Drop Scores are and how they relate to water and wastewater quality	Department of Water and Sanitation (DWS) (national), Vaal Central Water	Water services authorities (local municipalities), CSOs, schools, Department of Basic Education (DBE) (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	Bloem Water	An awareness programme is implemented on water losses, water conservation, and what Blue and Green Drop scores are.
5	Implement an awareness programme for employers and employees in all economic sectors about the dangers of heat stress and the adaptation measures that can be undertaken in response	Free State Department of Health (FSDOH)	FSDESTEA, district municipalities	Ongoing	ZAR 0 – To be implemented by FSDOH staff	N/A	An awareness programme is implemented on the dangers of heat stress and the adaptation measures that can be undertaken in response.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
6	Implement a programme to raise awareness in communities about sustainable waste management, which includes reducing, reusing, recycling, and repurposing waste, and the protection of stormwater management infrastructure in the face of the projected and occurring effects of climate change	FSDESTEA	District and local municipalities, schools, CSOs, the private sector	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A programme to raise awareness in communities about sustainable waste management is implemented.
7	Implement an awareness-raising programme for communities in Free State Province on keeping stormwater drainage systems clean and unblocked	SALGA	District and local municipalities, FSPDMC, Free State Department of Community Safety, Roads and Transport (FSDCSRT)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	SALGA	The awareness-raising programme on keeping stormwater drainage systems clean and unblocked is implemented.

Source: Authors.

Table 13. Goal: Improved education around the projected and occurring effects of climate change and implementable climate change adaptation options

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Create a plan for a series of educational lessons that can be incorporated into the school curriculum for high school learners on the projected and occurring effects of climate change, the implications of climate change, climate change adaptation options that can be implemented, how to practically prepare for the risks associated with climate change, and possible emergency response actions that individuals can take	FSDESTEA, DBE (national)	DFFE (national), FSPDMC, SALGA, academic and research institutions	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	Climate change lesson plans are created and implemented in all high schools in Free State Province.
2	Create a plan for a series of educational lessons that can be incorporated into the school curriculum for primary school learners on what climate change is, the projected and occurring effects of climate change, climate change adaptation options that can be implemented, how to practically prepare for the risks associated with climate change, and possible emergency response actions that individuals can take	FSDESTEA, DBE (national)	DFFE (national), FSPDMC, SALGA, academic and research institutions	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	Climate change lesson plans are created and implemented in all primary schools in Free State Province.
3	Implement programmes at school and tertiary levels to educate learners on climate change-related matters	FSDESTEA	DOE, institutions of higher learning	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA Private sector	The participation of learners in implemented programmes

Source: Authors.

Table 14. Goal: Improved capacity building around the projected and occurring effects of climate change and implementable climate change adaptation options

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Roll out targeted training on vulnerable groups and climate change to key climate change structures in the province, including the Premier's Coordinating Forum, the proposed Free State Climate Change Technical Forum, and the four District Intergovernmental Forums to ensure that decision-makers and stakeholders understand how the resilience of vulnerable groups is affected by climate change and climate change adaptation	FSDESTEA	DFFE (national), CSOs	Ongoing	ZAR 0 – To be implemented by FSDESTEA staff	N/A	Vulnerable groups and climate change training presentations are reflected on the minutes of each of the key climate change forums in the province.
2	Implement a programme to capacitate women and members of other vulnerable groups in Free State Province to better be able to respond to the projected and occurring effects of climate change	FSDESTEA	FSOTP	Ongoing	ZAR 0 – To be implemented by FSOTP staff	N/A	A programme is implemented to capacitate women to better respond to the projected and occurring effects of climate change.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
3	Enhance capacity at the municipal level in Free State Province to ensure the implementation of climate change interventions and initiatives	SALGA	District and local municipalities, DFFE (national), academic and research institutions	Ongoing	ZAR 1 million–ZAR 5 million	SALGA	A programme is implemented to enhance the capacity of municipal officials.
4	Enhance the capacity of Water Services Authorities (Local Municipalities) to enforce legislation relating to water conservation and demand-side management and compliance with Water Use Licence Authorisation conditions and restrictions	DWS (national)	FSDESTEA, the private sector, water services authorities (local municipalities)	Short term (1–3 years)	ZAR 0 – To be implemented by DWS staff	N/A	A capacity-enhancing programme is implemented.
5	Train provincial and municipal waste management staff on the implications of climate change on waste infrastructure	FSDESTEA	District and local municipalities, CSOs, academic and research institutions	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	FSDESTEA	Attendance registers of training events
6	Create a training programme on the use of waste materials for the insulation of dwellings and the related climate change benefits of better insulation on human health	UFS's Department of Engineering Sciences	FSDHS	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	UFS's Department of Engineering Sciences	A training programme exists.

Source: Authors.

4.4 Local and Indigenous Knowledge

Communities and Indigenous Peoples have been adapting to climate change-related risks and hazards by creating livelihood practices that are tailored to their unique circumstances and that enhance the resilience of their homes and communities. Since Indigenous Knowledge is embedded in local traditions and values, it is perceived as a useful resource that enables local people to respond to the projected and occurring effects of climate change.

In local communities, especially in rural areas, Indigenous Knowledge has become increasingly valuable in the fight against climate change, and it serves as an important part of community life and social capital in Free State Province. Local and Indigenous Knowledge can play an important role in addressing the social context into which external and scientific information relating to climate change adaptation is applied. Local and Indigenous Knowledge should remain a consideration when developing and updating Free State Province's Climate Change Adaptation Strategies, as adaptation is also a socio-economic issue, and there is an urgent need to customise response actions to location-specific vulnerabilities.

4.4.1. Goals and Actions

To improve the inclusion of local and Indigenous Knowledge in climate change adaptation response actions in Free State Province, the following goal and implementable response actions are presented.

Table 15. Goal: Promote the use and inclusion of local and Indigenous Knowledge in the implementation of Free State Province's climate change adaptation response actions

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Establish a programme to promote the co-production of climate change knowledge between local and Indigenous Knowledge holders and academic and research institutions	FSDESTEA, FSDCOGTA, Free State Department of Education (FSDOE), Department of Sport, Arts and Culture (national)	Traditional leaders, traditional health practitioners, academic and research institutions	Ongoing	< ZAR 1 million	FSDESTEA and FSDCOGTA	Meeting minutes are available from local and Indigenous Knowledge-sharing events.
2	Host an event with local and Indigenous Knowledge holders to review and enhance the provincial climate change adaptation and mitigation strategies and implementation plans, and to improve climate change adaptation response approaches in Free State Province	FSDESTEA, FSDCOGTA	Traditional leaders, traditional health practitioners, academic and research institutions	Short term (1–3 years)	< ZAR 1 million	FSDESTEA and FSDCOGTA	Minutes from a local and Indigenous Knowledge holders review event are available. Updated provincial climate change adaptation and mitigation strategies and implementation plans for Free State Province that incorporate local and Indigenous Knowledge are available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
3	Develop a funded research programme to incorporate local and Indigenous Knowledge on climate change into primary, secondary, and tertiary curricula to ensure that Indigenous Knowledge is captured and shared	Academic and research institutions	FSDOE, DBE (national), Department of Higher Education and Training (DHET) (national), FSDESTEA, FSDCOGTA, traditional leaders, traditional health practitioners	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	Academic and research institutions	A designed and funded research programme is operational.
4	Establish a self-sustaining Just Energy Transition–Climate Change knowledge hub for Free State Province that supports related training, research, and enterprise development	FSDESTEA, academic and research institutions	FSDOE, DBE (national), DHET (national), FSDCOGTA, traditional leaders, traditional health practitioners	Short term (1–3 years)	> ZAR 5 million	The private sector	A self-sustaining Just Energy Transition–Climate Change knowledge hub is operational in Free State Province.

Source: Authors.

5.0 Climate Change Responses by Sector

5.1 Water and Sanitation

The Free State Province, central to South Africa's water and sanitation sector, is notably water stressed. It boasts key water sources, and its borders include the Orange and Vaal Rivers. While groundwater is essential for many communities and livestock farming, it is being overused. The province's water quality has been rated poor, with numerous wastewater treatment works categorised as being in a critical or a poor state. The province's water resource planning is complicated by uncertain rainfall projections. The water and sanitation sector's sensitivity to climate change is heightened by increasing water demands, overuse of resources, ageing infrastructure, inadequate maintenance, and deteriorating treatment works. This is intensified due to the province's broad reliance on high-quality fresh water.

Climate change is projected to

- increase water demands due to rising temperatures and heat waves,
- heighten water insecurity because of elevated evaporation rates in reservoirs and rivers, and
- negatively affect water quality and ecosystem health as wetlands dry out, reducing essential services like water purification.

The province's water resources are either fully allocated or over-exploited. Challenges like water demand, failing treatment works, ageing infrastructure, and pollution further weaken the sector's adaptive capacity. However, initiatives like the Vaal-Orange Catchment Management Agency, drought relief, and rainwater harvesting programmes aim to bolster the sector's adaptive capacity.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.1.1 Goals and Response Actions

To improve the ability of the water and sanitation sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 16. Goal: Water usage and losses reduced in Free State Province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Ensure that each Water Services Authority (Local Municipality) creates/ updates and implements its water conservation and demand-side management strategy and implementation plan to meaningfully take climate change adaptation into account and to address water losses and water use against its Water Use Licence Authorisation conditions and restrictions	Water services authorities (local municipalities)	SALGA), DWS (national)	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	DWS (national)	Each Water Services Authority has developed a water conservation and demand-side management strategy and implementation plan.
2	Implement a programme for each Water Services Authority in Free State Province to reduce water losses from leakages by reducing the water pressure in pipes while remaining sensitive to needs for human health and well-being	SALGA	Water Services Authorities (local municipalities), DWS (national)	Medium term (4–10 years)	ZAR 1 million– ZAR 5 million	SALGA	A water loss reduction programme is implemented.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
3	Upgrade bulk water supply infrastructure to monitor and curb water losses due to leakages, including through the introduction of leak detection and reporting technologies	Water services authorities (local municipalities), DWS (national)	SALGA	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	N/A	A bulk water supply infrastructure upgrading programme is implemented for each Water Service Authority in the province.
4	Review and update legislation that can impose water restrictions for certain activities, especially during drier periods	Free State Provincial Legislature	FSOTP, DWS	Short term (1–3 years)	< ZAR 1 million	Free State Provincial Legislature	Updated water restrictions legislation is promulgated.
5	Develop an application for cell phones to easily report water losses, leakages, and outages per water service authority area where no such platforms already exist	Water Services Authorities (Local Municipalities)	DWS (national), FSPDMC, Bloem Water, Water Research Commission, Free State Department of Public Works and Infrastructure (FSDPWI)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	DWS (national)	A functional application is developed for cell phones to easily report water losses and leakages.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
6	Raise awareness of existing platforms that can be used to report water losses, leakages, and outages per water service authority area	Water services authorities (local municipalities)	Bloem Water, DWS (national),	Ongoing	ZAR 0 – To be implemented by the staff of the local municipalities	N/A	Awareness-raising activities take place annually.
7	Research smart technologies that can more quickly identify and address water leaks	DWS (national)	FSPDMC, Bloem Water, Water Research Commission, FSDPWI	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	DWS (national)	A research report is available on smart technologies that can more quickly identify and address water leaks.
8	Implement a programme to reuse and recycle grey water for use in gardening and urban agriculture, as well as for suitable industrial purposes and in the design requirements for new residential buildings, such as the use of grey water for flushing toilets	FSDCOGTA, DWS (national)	Water Services Authorities (local municipalities), agricultural and industrial water users	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	FSDCOGTA	A programme is implemented to reuse and recycle grey water for use in gardening and urban agriculture.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
9	Conduct research to determine the use of water throughout the entire energy value chain and where water-use efficiency measures can be implemented	UFS's Department of Engineering Sciences	The private sector, DWS (National), water services authorities (local municipalities)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	UFS's Department of Engineering Sciences	A research report is available.

Source: Authors.

Table 17. Goal: The resilience of the water sector and related infrastructure is increased in the face of the projected and occurring effects of climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Conduct a detailed analysis and modelling exercise of rainfall and runoff projections for Free State Province and the implications for sectors that are heavy water users (agriculture, mining, domestic, etc.)	Free State Department of Agriculture and Rural Development (FSDARD)	DALRRD (national), Agricultural Research Council (ARC), research institutions, DWS (national), DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report is available on the analysis and modelling of rainfall and runoff projections for Free State Province.
2	Ensure regular cleaning of all stormwater management and drainage systems in Free State Province to ensure that there are no blockages, thereby reducing the risk of flooding and damage to infrastructure	FSDCSRT, local municipalities	SALGA, district municipalities, FSPDMC, Expanded Public Works Programme (EPWP), FSDESTEA	Ongoing	> ZAR 5 million	FSDCSRT	Regular cleaning of all stormwater management and drainage systems in Free State Province takes place.
3	Implement a programme to upgrade and maintain stormwater management infrastructure and sustainable drainage systems to avoid flooding during intense rainfall events and to reduce damage to infrastructure	FSDCSRT, water services authorities (local municipalities)	SALGA, District Municipalities, FSPDMC	Medium term (4–10 years)	> ZAR 5 million	FSDCSRT	A programme is implemented to upgrade and maintain stormwater management infrastructure and sustainable drainage systems.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Promote rainwater harvesting throughout Free State Province as a method of reducing (1) water insecurity (especially during droughts), (2) the projected and occurring effects of climate change, (3) water demand pressures on water service authorities, (4) stormwater runoff, and (5) the effects of flood events	SALGA, Water Services authorities (local municipalities), DWS (national)	FSDOH	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	SALGA	A rainwater harvesting programme is implemented.
5	Develop a fire protection implementation plan for the water and sanitation sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	DWS (national), local municipalities, DFFE (national), Working on Fire Programme	FSUFPA, FSPDMC, FSDESTEA	Ongoing	ZAR 1 million–ZAR 5 million	DWS (national)	A fire protection implementation plan for the water and sanitation sector is available.

Source: Authors.

Table 18. Goal: Improve the resilience of surface water, groundwater, and wetland resources to the projected and occurring effects of climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Implement a province-wide Working for Rivers programme for Free State Province that will be rolled out on a catchment-by-catchment basis	DFFE (national)	DWS (national), FSDESTEA	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	DFFE (national)	A Working for Rivers programme for Free State Province is implemented.
2	Implement a programme of conservation practices to reduce soil erosion and sedimentation in rivers	FSDARD	DWS (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A programme of conservation practices is implemented to reduce soil erosion and sedimentation in rivers.
3	Implement a programme to restore and protect aquatic ecosystems such as wetlands that improve streamflow and water quality	FSDESTEA	DFFE (national), DWS (national), local municipalities	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	A programme is implemented to restore and protect aquatic ecosystems.
4	Expand the Working for Wetlands Programme to cover more wetlands in Free State Province	DFFE (national)	FSDESTEA, South African National Biodiversity Institute (SANBI)	Medium term (4–10 years)	> ZAR 5 million	DFFE (national)	The Working for Wetlands programme works in more wetlands in the province compared to a baseline year.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Implement a programme to protect and restore riparian vegetation to protect the integrity of riverbanks and retain biological buffers against flooding	FSDESTEA	DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	A programme is implemented to protect and restore riparian vegetation to protect the integrity of riverbanks and retain biological buffers against flooding.
6	Develop a provincial implementation plan for Free State Province for the National Groundwater Resource Management Strategy	DWS (national)	FSDESTEA	Short term (1–3 years)	< ZAR 1 million	DWS (national)	A provincial implementation plan for Free State Province for the National Groundwater Resource Management Strategy is available.

Source: Authors.

Table 19. Goal: Improve water quality and reduce water pollution in Free State Province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Continuously monitor water pollution from wastewater treatment systems from all the domestic, mining, industrial, and agricultural activities in Free State Province	DWS (national)	Water services authorities (local municipalities), FSDESTEA, DFFE (national), DALRRD (national)	Ongoing	ZAR 0 – To be implemented by DWS staff	N/A	Annual report on water pollution monitoring activities in the province.
2	Identify gaps in the systems that monitor and regulate water quality in Free State Province	DWS (national)	Water services authorities (local municipalities)	Short term (1–3 years)	< ZAR 1 million	DWS (national)	A programme is implemented to improve systems that monitor and regulate water quality in Free State Province.
3	Conduct research to identify key knowledge gaps where further investigations are required to mitigate acid mine drainage and other pollutants that negatively affect surface and groundwater resources in Free State Province	FSDESTEA	DFFE (national)	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A research report is available on key knowledge gaps where further investigations are required to mitigate acid mine drainage and other pollutants.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Implement a programme to improve sanitation systems to minimise groundwater pollution from human settlements	SALGA	Water services authorities (local municipalities), FSDPWI	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	SALGA	A programme is implemented to improve sanitation systems to minimise groundwater pollution from human settlements.
5	Implement a programme to remedy all poorly functioning wastewater treatment works in Free State Province that are discharging sewage into water resources such as rivers and dams	SALGA	Water services authorities (local municipalities), FSDPWI, DWS (National)	Medium term (4–10 years)	> ZAR 5 million	SALGA	A programme is implemented to remedy all poorly functioning wastewater treatment plants in Free State Province.
6	Improve and ensure the compliance of wastewater treatment works in Free State Province with the relevant gazetted Resource Quality Objectives	SALGA	Water services authorities (local municipalities), FSDPWI, DWS (National)	Medium term (4–10 years)	> ZAR 5 million	SALGA	A programme is implemented to ensure the compliance of wastewater treatment works with the relevant gazetted Resource Quality Objectives.
7	Conduct research into new technologies to reduce water hardness and improve water quality for agricultural and domestic purposes	FSDARD	DALRRD (national), ARC	Medium term (4–10 years)	< ZAR 1 million	FSDARD	A research report is available on new water technologies to improve water quality for agricultural and domestic purposes.

Source: Authors.

5.2 Agriculture

Free State houses a significant portion of South Africa's arable land and plays a pivotal role in producing key crops and livestock. Despite the agriculture, forestry, and fishing sector contributing 4.4% to the province's GDP in 2019, it is of paramount importance for jobs, subsistence, and food security. Given the province's reliance on rain-fed agriculture, climate change may severely affect the socio-economic well-being of its inhabitants. Almost all (98.8%) of the province's agricultural land relies on dryland farming. Small-scale and subsistence farmers, more sensitive to climate change, are further challenged by poor land management, resource overuse, pollution, and land degradation. Such degradation compounds issues like soil erosion and sedimentation, which lead to the loss of fertile soils and the reduction of water quality.

Climate change hazards are expected to

- challenge livestock rearing and crop growing due to increasing average temperatures and heat waves,
- reduce productivity of certain crops (like maize) due to changes in temperature patterns, and
- expand the spread of pests and diseases affecting livestock, crops, and farm workers.

Commercial farmers typically possess greater adaptive capacity than their smaller and subsistence counterparts due to better resources and capital access. The FSDARD oversees sustainable agricultural development in the province, while agricultural bodies share knowledge and offer support, strengthening the sector's resilience.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.2.1 Goals and Response Actions

To improve the ability of the agricultural sector in Free State to respond to climate change, the following goals and implementable response actions are presented.

Table 20. Goal: Develop knowledge on climate change adaptation options in the agriculture sector

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Conduct research on affordable and suitable climate-smart agricultural practices that help commercial farmers in Free State Province to better conserve water and reduce their water usage	FSDARD	DALRRD (national)	Short term (1–3 years)	< ZAR 1 million	FSDARD	A climate-smart agriculture research report is available.
2	Include a module or learning programme at the tertiary level that includes climate change issues, impacts on the agriculture sector, and adaptation options	Free State Department of Education (FSDoE)	Colleges, academic and research institutions, FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	UFS	A university module or learning programme linked to climate change and the agriculture sector is taught at universities.
3	Conduct research on potential solutions to lost labour productivity in the agricultural sector as a result of high temperatures, heat waves, and heat stress	FSDARD	FSDESTEA, DFFE (national)	Medium term (4–10 years)	< ZAR 1 million	FSDARD	A draft research proposal is available on lost labour productivity related to increased heat.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Conduct research into the potential use of artificial intelligence to enhance climate change adaptation efforts in the agriculture sector	FSDARD	Academic and research institutions, FSDESTEA, DALRRD (national), DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report is available on the potential use of artificial intelligence to enhance climate change adaptation efforts in the agriculture sector.
5	Conduct research into the effects of projected and occurring climate change on pest outbreaks and disease control in Free State Province	FSDARD	DALRRD (national), DFFE (national), FSDESTEA	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report is available on the effects of projected and occurring climate change on pest outbreaks and disease control.
6	Ensure the regular dissemination of up-to-date agricultural and climate change adaptation knowledge to relevant agricultural end-users so that they can practice climate-smart agriculture	FSDARD	ARC, colleges, academic and research institutions, agriculture sector organisations	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDARD	Annual knowledge dissemination events take place.
7	Expand the network of functional agriculture-specific automatic weather stations within Free State Province	FSDARD	ARC	Medium term (4–10 years)	> ZAR 5 million	FSDARD	Additional agriculture-specific weather stations added in Free State Province on an annual basis.

Source: Authors.

Table 21. Goal: Improve crop production resilience

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Review the organogram structure of the FSDARD to include an agrometeorologist within the provincial department to improve the use of climate information to enhance and increase crop production	FSDARD	DALRRD (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A permanent agrometeorologist position is created and funded in the FSDARD.
2	Conduct research into alternative, drought-resistant crops that are more resilient to higher temperatures and lower rainfall	FSDARD	DALRRD (national)	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report is available on climate-resilient crops for Free State Province.
3	Prepare a report on the climate change adaptation benefits and best practices of climate-smart agriculture, conservation agriculture, and regenerative agriculture for Free State Province, including information on recommended implementable crop production techniques and technologies	FSDARD	DALRRD (national)	Short term (1–3 years)	< ZAR 1 million	FSDARD	A report is available that includes information on recommended implementable crop production techniques and technologies.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Implement a communication programme to ensure farmers use efficient irrigation techniques that consider soil type, crop type, soil water status, and weather conditions that are aligned with FSDARD's Programme 2: Sustainable Resource Management	FSDARD	FSDESTEA	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A communication programme is implemented for farmers on water-use efficiency measures. A programme rollout schedule is available.
5	Review current efforts to implement climate-smart technologies for high-value, crops and grains in Free State Province that are aligned with FSDARD's Programme 5: Research Technology and Development	FSDARD	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 0 – To be implemented by FSDARD staff	FSDARD	A review of the FSDARD's programmes aimed at implementing climate-smart technologies for high-value crops and grains is performed. A programme rollout schedule is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
6	Implement a communication programme on climate change-related interventions and adaptation techniques to improve crop production in Free State Province that is aligned with FSDARD's Programme 7: Structural Agricultural Education and Training	FSDARD	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A communication programme is implemented that targets farmers on different themes to improve crop production. A themed programme rollout schedule is available.
7	Undertake research in the implementation of agrivoltaic technologies on farms in Free State Province to facilitate the co-existence of solar photovoltaic installation and agriculture	FSDARD	Academic and research institutions, DALRRD (national), DFFE (national), ARC, UFS's Faculty of Natural and Agricultural Sciences, UFS's Department of Engineering Sciences	Ongoing	> ZAR 5 million	FSDARD	A report is released on the implementation of agrivoltaic technology on farms in Free State.

Source: Authors.

Table 22. Goal: Improve the resilience of livestock

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Implement the National Livestock Identification and Traceability System in Free State Province	FSDARD	DALRRD (national)	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDARD	The National Livestock Identification and Traceability System is operational in Free State.
2	Establish a programme to develop Commonage Management Plans for all public commonage areas in Free State Province	FSDARD	DALRRD (national)	Medium term (4–10 years)	> ZAR 5 million	FSDARD	Commonage Management Plans exist for all public commonage areas in Free State Province.
3	Establish a programme to create and manage communal livestock inventories in Free State Province	State veterinarians	FSDARD, DALRRD (national)	Medium term (4–10 years)	> ZAR 5 million	State veterinarians	Communal livestock inventories in Free State Province are available.
4	Implement a communication programme for farmers on climate change-related interventions and adaptation techniques, including how to reduce heat stress for livestock, to improve the resilience of livestock in Free State Province that is aligned with FSDARD's Programme 7: Structural Agricultural Education and Training	FSDARD	FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A draft communication programme is available that targets farmers on different themes to improve livestock resilience. A themed programme rollout schedule is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Facilitate research on environmentally friendly methods of dealing with pests and diseases that will affect agriculture and game farms that are aligned with FSDARD's Programme 5: Research Technology and Development	FSDARD	FSDESTEA, DALRRD (national), DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report on environmentally friendly agricultural pest and disease management is available.
6	Investigate breeding options for livestock using indigenous cattle breeds that are aligned with FSDARD's Programme 5: Research Technology and Development	FSDARD	DALRRD (national), FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report on indigenous cattle breeds is available.
7	Investigate livestock breeds that are more resilient to climate change and more sustainable to farm	FSDARD	DALRRD (national)	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDARD	A research report is available on livestock breeds that are more resilient to climate change and more sustainable to farm.
8	Test the use of biogas digesters using manure as an input	FSDARD	DALRRD (national), ARC	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	DALRRD	A pilot study into the use of biogas digestors is completed.

Source: Authors.

Table 23. Goal: Support strengthening the resilience to climate change of the agricultural sector, including subsistence, small-scale, and commercial farmers

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Enhance the capacity of agricultural extension services in Free State Province around the effects of climate change so that emerging farmers are given much-needed support that is aligned with FSDARD's progamme 7: Structural Agricultural Education and Training	FSDARD	FSDESTEA, DFFE (national)	Ongoing	ZAR 0 – To be implemented by FSDARD staff	N/A	A capacity-enhancing programme is implemented that targets agricultural extension officers. A programme rollout schedule is available.
2	Implement a programme to transfer technology to small-scale and rural farming communities that is aligned with FSDARD's Programme 5: Research Technology and Development	FSDARD	FSDESTEA, DALRRD (national), DFFE (national)	Ongoing	> ZAR 5 million	FSDARD	A draft programme outline is available for technology transfer in farming communities. A programme rollout schedule is available.
3	Implement a programme to support community food production in Free State Province	FSDARD	FSDESTEA, FSDSD	Ongoing	> ZAR 5 million	FSDARD	A programme is implemented that supports community food production. A programme rollout schedule is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Implement an awareness-raising programme throughout Free State Province on the adoption and use of eco-friendly, non-toxic pesticides	FSDARD	DALRRD (national)	Short term (1–3 years)	< ZAR 1 million	FSDARD	An awareness-raising programme is implemented that supports the use of eco-friendly, non-toxic pesticides. A programme rollout schedule is available.
5	Train farmers in agroecology to enhance their capacity to adapt more effectively to climate change	FSDARD	Academic and Research Institutions, FSDESTEA, DALRRD (national), DFFE (national)	Ongoing	ZAR 1 million–ZAR 5 million	FSDARD	Farmers receive training in agroecology to enhance their capacity to adapt more effectively to climate change.
6	Implement a communication programme to support the practice of small-scale organic precise farming that is aligned with FSDARD's Programme 7: Structural Agricultural Education and Training	FSDARD	FSDESTEA, DFFE (national)	Short term (1–3 years)	< ZAR 1 million	FSDARD	A draft communication programme is implemented that targets farmers and focuses on precision farming. A programme rollout schedule is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
7	Develop a fire protection implementation plan for the agriculture sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	FSDARD	FSUFPA, FSPDMC, FSDESTEA, DFFE (national)	Ongoing	ZAR 1 million–ZAR 5 million	FSDARD	A fire protection implementation plan for the agriculture sector is available.
8	Implement a climate-smart agriculture training programme for small-scale farmers in Free State Province to reduce their water use and adjust their practices to increase resilience to the impacts of climate change	FSDARD, ARC	UFS's Departments of Soil, Crop and Climate Sciences, and Sustainable Food Systems and Development	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	DALRRD (national), DFFE (national)	The training programme is operational.

Source: Authors.

5.3 Environment (Ecosystems and Biodiversity)

The Free State boasts three biomes, primarily consisting of the Grassland Biome. It also contains 40 national vegetation types, with three being endemic. Biodiversity priority areas encompass critical biodiversity areas, ecological support areas, and natural areas, among others. The province hosts 16 state-owned protected areas and the Golden Gate Highlands National Park. The Seekoeivlei Nature Reserve stands out as a Ramsar Wetland of International Importance. However, wetlands, vital for biodiversity and ecosystem services, are under threat due to various human-induced factors like land-use change, overgrazing, and pollution. Climate change could alter the bioclimatic envelopes of the province's biomes. The Grassland Biome, already vulnerable, is projected to see a significant reduction by 2050, while the Nama-Karoo Biome could disappear entirely from the province. The Savanna Biome, however, might expand. Many of the province's wetlands, crucial for biodiversity, are endangered or vulnerable. Their ecological condition is further compromised by water quality issues, pollution, invasive species, and overgrazing, making them even more susceptible to climate change impacts.

Climate change is expected to

- heighten extinction risks for flora and fauna that cannot adapt or relocate;
- intensify bush encroachment and the proliferation of invasive alien species, especially within the Grassland Biome; and
- amplify soil erosion and sedimentation, reducing water quality, which could detrimentally impact biodiversity, especially in wetlands and rivers.

Habitats and ecosystems in the Savanna Biome are expected to be more resilient to climate change compared to those in the Grassland Biome. While protected areas in the province enhance biodiversity and ecosystem resilience, their effectiveness is hampered by resource constraints and poaching. Recent efforts by the Free State Provincial Government, like the *Critical Biodiversity and Ecology Assessment* report, aim to bolster the province's adaptive capacity, but human activities continue to challenge the health and resilience of the province's ecosystems.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.3.1 Goals and Response Actions

To improve the ability of the environment (ecosystems and biodiversity) sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 24. Goal: Enhance and rehabilitate ecosystems for improved functionality and resilience

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Draft biome adaptation plans that can integrated into the departmental plans of key sector departments, including water, health, agriculture, and tourism, and municipalities	FSDESTEA	DFFE (national), district and local municipalities, CSOs	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A biome adaptation plan is drafted for each key sector department.
2	Set up a stakeholder structure to allow for collaboration with key sectors that affect biodiversity to develop strategies that help in the restoration and management of ecosystems	FSDESTEA	DFFE (national), FSDARD, CSOs	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A stakeholder structure is available.
3	Develop a Protected Areas Expansion Strategy for Free State Province in line with the in-situ protections detailed in the National Environmental Management: Protected Areas Act	FSDESTEA	DFFE (national), CSOs	Ongoing	> ZAR 5 million	FSDESTEA	The Protected Areas Expansion Strategy for Free State Province is available.
4	Implement a programme to protect urban ecosystems to support their ability to provide supporting, provisioning, regulating, and cultural services	FSDESTEA	DFFE (national)	Medium term (4–10 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	A programme is implemented to protect urban ecosystems to support their ability to provide supporting, provisioning, regulating, and cultural services.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Undertake a feasibility study on expanding the current programmes in the province that remove invasive alien plants and replace them with locally indigenous plants	FSDESTEA	DFFE (national), academic and research institutions FSDARD	Medium term (4–10 years)	< ZAR 1 million	FSDESTEA	A report on the feasibility of expanding the invasive alien plant removal programmes is available.
6	Implement a programme to integrate Indigenous Knowledge systems for specific biomes in the provincial conservation efforts	FSDESTEA	DFFE (national), FSPDMC, CSOs	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	An Indigenous Knowledge integration programme is implemented.
7	Undertake a feasibility study on expanding the Groen Sebenza Programme in the province to promote skills development and employment opportunities in the biodiversity sector	FSDESTEA	SANBI, DFFE (national), FSPDMC, academic and research institutions, district and local municipalities	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A report on the feasibility of expanding the Groen Sebenza Programme is available.
8	Develop a fire protection implementation plan for the environment sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	FSDESTEA	FSUFPA, FSPDMC, DFFE (national), Working on Fire Programme	Ongoing	ZAR 1 million–ZAR 5 million	FSDESTEA	A fire protection implementation plan for the environment sector is available.

Source: Authors.

Table 25. Goal: Preserve, restore, and enhance wetland ecosystems

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Undertake a feasibility study on expanding the number of wetlands rehabilitated by the Working for Wetlands programme in the province	FSDESTEA	DFFE (national) Working for Wetlands	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A report on the feasibility of expanding the Working for Wetlands programme in the province is available.
2	Conduct research using available wetland mapping data as a basis for identifying wetland areas to target for conservation and restoration	FSDESTEA	DFFE (national), SANBI	Ongoing	ZAR 1 million–ZAR 5 million	FSDESTEA	A wetland identification and targeting report is available.

Source: Authors.

Table 26. Goal: Research and innovation for sustainable biodiversity management

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Conduct research on ecosystem-based adaptation and how it can be used across the province in key sectors	FSDESTEA	DFFE (national), SANBI, FSDOH	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	An ecosystem-based adaptation research report is available.
2	Conduct research into the effects of generating energy from concentrated solar power on the flora and fauna in the immediate vicinity and surrounding areas	Academic and research institutions	FSDESTEA, DFFE (national), SANBI, FSDOH, CSIR	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	A research report on the effects of concentrated solar power energy generation on flora and fauna is available.
3	Implement a bio-monitoring programme to monitor the quality and diversity of species in the province, especially in high-risk areas	FSDESTEA	DFFE (national), SANBI	Medium term (4–10 years)	< ZAR 1 million	FSDESTEA	A bio-monitoring programme is implemented.
4	Engage Indigenous Knowledge holders on research and innovation for sustainable biodiversity management	FSDESTEA	CSOs, FSDCOGTA, SALGA, district and local municipalities	Medium term (4–10 years)	< ZAR 1 million	FSDESTEA	Meeting minutes are available from engagements with Indigenous Knowledge.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Conduct research into the impacts of climate change on key medical plants	Academic and research institutions	Academic and research institutions, SANBI, DFFE (national)	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	Academic and research institutions	A research report is available on the impacts of climate change on key medical plants.
6	Implement a programme to coordinate with communities to design and implement locally beneficial and affordable biodiversity conservation projects	FSDESTEA	DFFE (national), FSPDMC	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	A community biodiversity conservation programme is implemented.

Source: Authors.

Table 27. Goal: Increase the collection of air quality data and statistics

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Collect climate change-relevant health statistics relating to air quality and its impacts	FSDOH	FSDESTEA, district and local municipalities, environmental health practitioners	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDOH	A programme is implemented to educate employers and employees in all economic sectors about the dangers of heat stress and the adaptation measures that can be taken.
2	Increase the number of air quality monitoring stations operating in Free State Province	FSDESTEA	Mangaung Metropolitan Municipality	Medium term (4–10 years)	> ZAR 5 million	FSDESTEA	The number of operational air quality monitoring stations in Free State Province has increased compared to the number in a baseline year.
3	Develop a methodology to measure the total vehicle emissions and tyre particle pollution in Free State Province to better understand the impact of these on air quality levels in the province	Academic and research institutions	Free State Department of Community Safety, Roads and Transport	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	Academic and research institutions	A methodology for measuring vehicle emissions and tyre particle pollution in Free State is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Implement a programme to track the air quality impacts of vehicles in Free State Province in terms of vehicle emissions and tyre particle pollution	FSDESTEA	Department of Transport (national), DFFE (national)	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	Air quality impacts associated with vehicle emissions and tyre particle pollution are tracked.

Source: Authors.

Table 28. Goal: Functional waste management across Free State Province

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Implement a programme to ensure that all landfill sites in Free State Province are built and managed in such a way that they are up to standard, properly managed, and resilient to the projected and occurring effects of climate change	FSDPWI	FSDESTEA, local municipalities, FSPDMC, Municipal Disaster Management Centres (MDMCs), FSDCOGTA, DFFE (national), CSOs	Short term (1–3 years)	> ZAR 5 million	FSDPWI	A programme is in place to ensure that landfill sites in Free State Province are properly managed.
2	Implement a programme focusing on encouraging waste management practices related to the circular economy that minimises the quantity of solid waste generated and dumped in landfill sites in Free State Province	FSDESTEA	FSDPWI, local municipalities, DFFE (national), CSOs, The Private Sector	Ongoing	ZAR 1 million–ZAR 5 million	FSDPWI	A programme to reduce the quantity of waste arriving at landfill sites through the promotion of a circular economy is in place.
3	Implement a programme to manage hazardous waste in Free State Province that meaningfully considers the projected and occurring effects of climate change	FSDESTEA	SALGA, local municipalities, FSDHS, FSDPWI, DFFE (national), CSOs, FSDOH	Ongoing	> ZAR 5 million	FSDESTEA	A programme to manage hazardous waste in Free State Province is implemented.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Implement a communications programme on the five "Rs" of dealing with waste (refuse, reduce, reuse, repurpose, and recycle) that is aimed at factories, businesses, and households	FSDESTEA	SALGA, local municipalities, FSDHS, FSDPWI, CSOs	Short term (1–3 years)	< ZAR 1 million	FSDESTEA	A communications programme is implemented on the five "Rs" of dealing with waste.
5	Implement a litter management programme that reduces the amount of litter entering rivers, streams, and stormwater management systems to reduce the impacts of flood events	FSDESTEA	SALGA, Local Municipalities, FSDHS, FSDPWI, DFFE (national), CSOs	Ongoing	> ZAR 5 million	FSDESTEA	A litter management programme is implemented.
6	Implement an education and awareness campaign on the negative effects of burning waste in terms of pollution and air quality management	FSDESTEA	SALGA, local municipalities, FSDHS, FSDPWI, FSDOH, DFFE (national), CSOs, schools	Ongoing	ZAR 1 million–ZAR 5 million	FSDESTEA	An education and awareness campaign is implemented on the negative effects of burning waste.

Source: Authors.

5.4 Mining

The mining and quarrying industry in Free State Province is crucial, contributing 9.9% to the provincial GDP in 2019. The primary commodity is gold, with the province's Consolidated Goldfields being South Africa's largest gold mining complex. Free State houses 12 gold mines, producing about 30% of South Africa's gold output. Other mined commodities include coal, diamonds, and by-products of gold like uranium. The mining sector's sensitivity to climate change is heightened by its dependence on water for various operations, especially in gold and coal mining. The sector's significant water consumption makes it vulnerable to changing rainfall patterns. While economically and socially vital, the sector also contributes to water, air, and soil pollution. Mine workers, especially those in the field, face health risks from rising temperatures, such as heat-related illnesses.

Climate change hazards might

- lower mine worker productivity due to increased heat stress and affect mining equipment efficiency;
- compromise the structural integrity of mining infrastructure, including buildings, electricity supplies, stormwater systems, and transport infrastructure; and
- alter the availability of surface and groundwater essential for mining operations.

Adaptive capacity varies among mining operations based on their size, resources, and capabilities. While there are technologies to mitigate high-temperature effects, they are costly and dependent on strained resources like electricity and water. Land-use changes for mining disrupt the province's biodiversity, resulting in lost ecosystem services. However, the sector's significant economic contribution means larger mines can tap into considerable financial resources for adaptation. Industry organisations can assist mining operations in building the necessary adaptive capacity to address climate change impacts.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.4.1 Goals and Response Actions

To improve the ability of the mining sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 29. Goal: Enhance resilience in the mining sector

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Implement a programme with mining entities to incorporate climate change adaptation actions into mine operating, safety, and disaster response guidelines	FSDESTEA, DMRE (national)	Mining companies, DFFE (national)	Short term (1–3 years)	ZAR 0 – To be implemented by Mining Companies	N/A	Adaptation actions are incorporated into safety and disaster response guidelines in each mining company.
2	Conduct research to identify possible solutions for recycling mining tailings in Free State Province	Mining companies	DMRE (national)	Medium term (4–10 years)	ZAR 1 million– ZAR 5 million	Mining companies	A research report is available.
3	Develop a fire protection implementation plan for the mining sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	DMRE (national)	FSUFPA, FSPDMC, DFFE (national), FSDESTEA	Ongoing	ZAR 1 million– ZAR 5 million	DMRE (national)	A fire protection implementation plan for the mining sector is available.

Source: Authors.

Table 30. Goal: Reduce the impacts of the mining sector that reduce the ability of the province to adapt to climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Secure commitments from mining companies to minimise the risk of acid mine drainage and saline drainage	DMRE (national)	Mining companies, DWS (national)	Medium term (4–10 years)	R0– To be implemented by FSDESTEA staff	N/A	More than 50% of mining operations in Free State Province sign commitments to minimise the risks of acid mine drainage from their mining operations.
2	Conduct research into reducing the environmental impacts of mining linked to soil erosion; land degradation; water, soil, air, light, and noise pollution; and soil contamination from heavy metals	DMRE (national)	Mining companies	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	FSDESTEA	A report on environmental impacts linked to mining operations in Free State Province with recommendations on minimising the impacts is available.

Source: Authors.

5.5 Tourism

Free State Province boasts a robust tourism industry with an abundance of ecotourism assets, including numerous nature reserves, both public and private, and the Golden Gate Highlands National Park. The province's ecotourism destinations are sensitive to climate change, relying on environmental quality, wildlife, biodiversity, healthy ecosystems, and water resources. Most tourism activities in Free State are outdoors, like camping, hiking, fishing, and birdwatching, making them vulnerable to rising temperatures and varying rainfall. Climate change can also increase tourism-related costs such as ventilation, air-conditioning, transport, maintenance, insurance, and food and water supplies. Additionally, heightened fire risk days may escalate the wildfire frequency, further affecting the tourism sector.

Climate change is expected to

- reduce participation in outdoor tourism activities, impacting tourism revenue;
- diminish water availability, affecting landscape aesthetics and food tourism due to lowered agricultural productivity; and
- damage infrastructure at holiday resorts and access routes to tourist spots.

The responsibility for provincial tourism lies with FSDESTEA. However, there is no dedicated climate change unit within FSDESTEA, and climate change adaptation is not factored into their planning. While most tourist attractions have limited adaptive capacity to climate change impacts, recommendations from the 2011 National Tourism and Climate Change Action Plan offer potential strategies. FSDESTEA has initiated water conservation measures that benefit the tourism sector and aid in adapting to climate change impacts.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of medium concern with regard to the impacts of climate change.

5.5.1 Goals and Response Actions

To improve the ability of the tourism sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 31. Goal: Increase the climate resilience of the tourism sector

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Embed the climate change response measures for the tourism sector in the province's Tourism Master Plan	FSDESTEA	FSGLA, Department of Tourism (DT) (national)	Short term (1–3 years)	ZAR 0 – To be implemented by FSDESTEA staff	N/A	The tourism sector climate change strategy is embedded in the province's tourism master plan.
2	Implement a programme within the tourism sector in Free State Province to green tourism infrastructure so that it is better adapted to the projected and occurring effects of climate change	DT (national)	FSDESTEA, DFFE (national)	Medium term (4–10 years)	> ZAR 5 million	DT (national)	A programme exists to increase the resilience of tourism infrastructure in Free State Province.
3	Develop a fire protection implementation plan for the tourism sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	FSDESTEA	FSUFPA, FSPDMC, DFFE (national), DT (national)	Ongoing	ZAR 1 million–ZAR 5 million	FSDESTEA	A fire protection implementation plan for the tourism sector is available.

Source: Authors.

5.6 Energy

It should be noted that the focus of this vulnerability assessment is on adapting to the impacts of climate change, or climate change adaptation. The study does not consider the processes and steps needed to reduce carbon emissions from the energy sector or climate change mitigation.

Free State Province only houses one coal-fired power station (Lethabo power station), but the province plays a pivotal role in Eskom's electricity transmission grid, ensuring power distribution throughout South Africa and even into neighbouring countries. As of June 2017, the province had operational commercial solar photovoltaic projects with a combined capacity of 196 MW and a commercial hydropower project of 4 MW. Due to increasing load shedding since 2017, the capacity of small-scale embedded solar photovoltaic systems has likely seen substantial growth. Most electricity consumed in Free State Province is produced outside its boundaries. Therefore, climate change impacts in other provinces, especially Mpumalanga Province, will influence the energy sector in Free State Province. The province's water-stressed status, with potential increases in droughts and temperature-induced evaporation, may affect the five hydropower stations within or bordering the province. Lethabo power station's efficiency could decrease with rising water temperatures. Ongoing load shedding by Eskom has prompted some businesses and households to install backup electricity systems like solar photovoltaic systems or diesel generators.

Anticipated climate change hazards for the energy sector in Free State Province include

- higher average annual temperatures that might escalate summer energy demand for cooling but might reduce winter heating demand if conditions moderate,
- increased average temperatures that could diminish the efficiency of fossil fuel power stations due to concurrent water temperature rises, and
- a drier province due to temperature rise, variable rainfall, and frequent droughts that may impact the operation of water-intensive power stations.

The adaptive capacity of the energy sector in Free State Province is influenced by the constitutional mandate and regulations that focus on the role of the national government in controlling electricity generation and transmission and the role of most municipalities in the distribution of electricity within their boundaries. (In some areas, Eskom is the electricity distributor.) This centralised approach to electricity generation and transmission limits the role of the provincial and municipal spheres of government. However, despite the limited mandates municipalities and the provincial sphere of government have relating to electricity generation and transmission, they can play a role in increasing the adaptive capacity of the electricity distribution network. Collaboration between stakeholders in the energy sector in Free State Province must be encouraged as it can increase the sector's adaptive capacity.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.6.1 Goals and Response Actions

To improve the ability of the energy sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 32. Goal: Electricity distribution infrastructure is resilient to the projected impacts of climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Develop a toolkit on how to assess climate change risks and vulnerabilities, and adaptation options that are specific to the energy sector	DMRE, DFFE (national),	District and local municipalities, FSDESTEA, FSPDMC, SALGA, academic and research institutions, Eskom	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	Eskom	A toolkit exists and is used by entities operating in the energy sector.
2	Design a set of standards for incorporating climate change response measures into the design, rollout, and maintenance of electricity distribution infrastructure in the province	Eskom	FSDESTEA DMRE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	A set of standards is available for incorporating climate change response measures into electricity distribution infrastructure.
3	Conduct research into possible maladaptation in the energy sector in Free State Province	SALGA	DFFE (national)	Short term (1–3 years)	< ZAR 1 million	SALGA	A research report on the possible maladaptation in the energy sector in the province is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Develop a fire protection implementation plan for the energy sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	SALGA	District and local municipalities, FSUFPA, FSPDMC, FSDESTEA, DFFE (national), DMRE (national)	Ongoing	ZAR 1 million–ZAR 5 million	SALGA	A fire protection implementation plan for the energy sector is available.
5	Develop a feasibility study on the rollout of electricity micro-grids in Free State Province to decentralise energy provision and enhance the resilience of electricity supplies in the face of disaster events	SALGA	District and local municipalities, FSDESTEA, academic and research institutions, CSOs	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	SALGA	A feasibility study is available.

Source: Authors.

5.7 Health

The province is home to 209 primary clinics, mainly serving rural communities. There are also 11 district hospitals, three regional hospitals, a tertiary hospital, and a central hospital with ideal clinic status. Key health challenges in the province include HIV/AIDS, injuries, tuberculosis, maternal and child mortality, and communicable diseases. The private health care sector complements the state's health care services, but data on private facilities are not readily available. The COVID-19 pandemic added strain to the already burdened health care system. The province ranked lowest in South Africa for risk exposure to natural forces from 2012 to 2017 due to issues like dysfunctional wastewater treatment and air quality challenges. The demand for public health care services outweighs the resources available, making the health sector vulnerable to major climate-related events. The current condition of health facilities is described as fair and satisfactory, but they face challenges like outdated data management systems, reliance on paper-based reporting, and threats from diseases like cholera due to poor sanitation and water quality.

Potential climate change effects on the health sector in Free State Province include

- a rise in heat-related diseases and mortalities during very hot days and heat-wave events;
- increased prevalence of communicable diseases, such as malaria and cholera; and
- elevated cases of cardiovascular and respiratory illnesses among vulnerable groups.

The Free State Department of Health faces service delivery challenges rooted in staffing and resource allocation issues. The department has not identified climate change as a core responsibility, indicating a potential risk in disaster response. However, the reallocation of pandemic response measures to the district level has improved coordination and vaccination rollout.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.7.1 Goals and Response Actions

To improve the ability of the health sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 33. Goal: Increase awareness and understanding of diseases and health risks related to climate change and improve the enforcement of health-related regulations and by-laws

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Establish a structure within the health sector in Free State Province with the purpose of better understanding how health is likely to be impacted by the projected and occurring effects of climate change	FSDOH	DOH (national), FSDESTEA, DFFE (national), district and local municipalities	Ongoing	ZAR 1 million–ZAR 5 million	FSDOH	A functional structure is established within the health sector in Free State Province to better understand the impacts of climate change on health.
2	Conduct research to understand climate change-related diseases and health risks facing Free State Province and how these impact women, men, people with disabilities, the elderly, and young children	FSDOH	FSDESTEA, Mangaung Metropolitan Municipality, environmental health practitioners	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDOH	A research report is available on climate change-related diseases and health risks facing Free State Province.
3	Enforce municipal by-laws related to health and promote compliance with these by-laws in the face of the projected and occurring effects of climate change on health	FSDOH	FSDHS, FSDESTEA, district and local municipalities, Department of Justice and Constitutional Development (national), DFFE (national)	Ongoing	> ZAR 5 million	FSDOH	A municipal unit is in place in each municipality that deals with the enforcement of municipal by-laws and issues of compliance related to health.

Source: Authors.

Table 34. Goal: Strengthen public health infrastructure to better address the health impacts of climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Set up and monitor climate change-related health indicators	FSDOH	FSDESTEA	Ongoing	ZAR 0 – To be implemented by FSDOH staff	N/A	An annual report on climate change-related health indicators is available.
2	Review and improve the rollout of vaccines for communicable diseases, especially in low-income areas	FSDOH	DOH (national)	Ongoing	ZAR 0 – To be implemented by FSDOH staff	N/A	A reviewed and improved rollout of vaccines for communicable diseases takes place.
3	Equip health care practitioners, including emergency response personnel, with resources and training that increase their preparedness to respond to disease outbreaks exacerbated by climate change impacts	FSDOH	FSDESTEA, DOH (national)	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	FSDOH	Attendance registers of training sessions with health practitioners are available.
4	Fill vacant posts in the health sector in Free State Province to enable a fully staffed and capacitated health sector to better be able to respond to all health impacts related to the effects of climate change	FSDOH	DOH (national)	Ongoing	ZAR 0 – To be implemented by FSDOH staff	FSDOH	Vacant posts are kept to a minimum in the health sector in Free State Province.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Develop a fire protection implementation plan for the health sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	FSDOH	FSUFPA, FSPDMC, FSDESTEA, DFFE (national), district and local municipalities	Ongoing	ZAR 1 million– ZAR 5 million	FSDOH	A fire protection implementation plan for the health sector is available.
6	Develop an Indigenous Knowledge systems programme aimed at synchronising Indigenous and Western medical health systems for stronger outcomes against prevalent ailments in Free State Province	FSDOH	DFFE (national), DOH (national), FSDARD (for bioprospecting)	Ongoing	ZAR 0 – To be implemented by FSDOH staff (Additional budget may be required for the organisational review process)	FSDOH	An Indigenous Knowledge systems programme is established.
7	Establish a programme for the integration of phytomedicine (medicine from plants) and ethnomedicine (traditional medicine based on bioactive compounds in plants and animals) into the Free State Province health system	FSDOH	DFFE (national), DOH (national), FSDARD (for bioprospecting)	Ongoing	ZAR 1 million– ZAR 5 million	FSDOH	A programme is established to integrate phytomedicine and ethnomedicine into the Free State Province health system.

Source: Authors.

5.8 Human Settlements

There are around 863,204 households in the province, with the majority (83.6%) residing in formal dwellings, 14% in informal dwellings, and a smaller 1.6% in traditional homes. There are 161 informal settlements that are recognised within Free State Province. Furthermore, significant mining activities are evident, with initiatives like the National Mining Town Revitalising Programme aiming to rejuvenate mining towns. Challenges in essential services have been observed over time, with a slight decline from 2002 to 2018 in the number of households with access to piped water. Nevertheless, sanitation services improved over the same period. The province grapples with disruptions in water, sanitation, and electricity, often attributed to ageing infrastructure, maintenance lapses, and load shedding. Such challenges amplify the province's vulnerability to climate-induced impacts. Historically marginalised regions continue to face inequalities, emphasising the need for prioritised basic service delivery, especially in flood-prone informal settlements.

The consequences of climate change are multifaceted for the province:

- Rising temperatures could lead to an increase in hot days and heat waves, intensified by urban heat islands in densely populated zones like Bloemfontein.
- Those residing in informal settlements might face adverse health and well-being impacts due to inadequate insulation and a lack of cooling mechanisms.
- Variability in rainfall patterns, encompassing droughts and floods, might induce soil shifts, making infrastructure like water and sewerage pipes more prone to damage, necessitating repairs or replacements.

Several strategies, programmes, and financial grants are in place to fortify infrastructure, cater to informal settlements, and develop new residential spaces. The Free State Provincial Government is also proactive in supporting flood-prone communities, endorsing water recycling and launching green initiatives like solar geysers and energy-efficient retrofitting. However, challenges remain, particularly in coordinating efforts, securing adequate funding, and ensuring smooth project execution.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.8.1 Goals and Response Actions

To improve the ability of the human settlements sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 35. Goal: Human settlement planning takes climate change into account

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Enhance the capacity of officials in the provincial and municipal spheres of government who are responsible for the planning and management of formal and informal settlements on the projected and occurring impacts of climate change and adaptation responses that are appropriate for settlements	FSDHS	FSDESTEA, DFFE (national), SALGA, district and local municipalities	Short term (1–3 years)	< ZAR 1 million	FSDHS	A capacity-enhancing programme is implemented for provincial and municipal officials who are responsible for the planning and management of formal and informal settlements.
2	Conduct climate change risk assessments in all new settlements	FSDHS	FSDESTEA, district and local municipalities, CSOs	Ongoing	ZAR 0 – To be implemented by FSDHS staff in conjunction with FSDESTEA staff	N/A	All approvals of new settlements include a climate risk assessment.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
3	Develop and implement standards for the development of human settlements relating to flood lines, sensitive areas, etc., that meaningfully take the occurring and projected effects of climate change into account	FSDHS	Engineering Council of South Africa, DHS (national), DWS (national), FSDESTEA, the private sector	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDHS	The standards for the development of human settlements are implemented throughout Free State Province.
4	Implement a programme to integrate climate change adaptation measures into land-use planning and decision making	FSDCOGTA	FSDHS, FSDESTEA, district and local municipalities	Medium term (4–10 years)	> ZAR 5 million	FSDHS	A programme exists to promote the integration of climate change adaptation measures into land-use planning and decision making.
5	Research the potential use of nano and other novel technologies to improve the resilience of human settlements against the predicted and occurring effects of climate change	FSDHS	FSDESTEA, district and local municipalities, DFFE (national), the private sector	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDHS	A research report is available on the potential use of nano and other novel technologies to improve the resilience of human settlements.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
6	Research and develop local geopolymer materials that comply with South African energy efficiency standards and that are suitable for the construction of human settlements	FSDHS	FSDESTEA, district and local municipalities, UFS's Department of Engineering Sciences, the private sector	Long Term (10 years or more)	> ZAR 5 million	FSDHS	Local geopolymer materials that are energy efficient and suitable for constructing buildings.
7	Develop partnerships between researchers who specialise in human settlements and the FSDHS to better understand what research with real-world applicability has been produced that could increase the climate resilience of human settlements in Free State Province once implemented	FSDHS, UFS's Department of Urban and Regional Planning	Academic and research institutions, FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	UFS's Department of Urban and Regional Planning	Viable, ongoing partnerships are established.
8	Conduct a feasibility study on the use of waste materials in the building of dwellings, including water reuse and the use of waste materials to enhance heat insulation	UFS's Department of Engineering Sciences	FSDHS, DHS (national), DWS (national), academic and research institutions, FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million– ZAR 5 million	UFS's Department of Engineering Sciences	A feasibility study is available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
9	Based on the results of the feasibility study, develop standards for the use of waste materials in the building of dwellings	FSDHS	DHS (national), DWS (national), academic and research institutions, FSDESTEA, DFFE (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDHS	Standards are available for the use of waste materials in the building of dwellings.
10	Develop a fire protection implementation plan for the human settlement sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	FSDHS	FSUFPA, FSPDMC, FSDESTEA, DFFE (national), district and local municipalities	Ongoing	ZAR 1 million–ZAR 5 million	FSDHS	A fire protection implementation plan for the human settlements sector is available.

Source: Authors.

5.9 Roads and Transport

The Free State Province's strategic location facilitates the interlinking of various provinces and economic hubs. The province's agricultural and manufacturing industries rely heavily on transport networks for goods delivery and services. The transport, storage, and communication sector is a significant contributor to the province's GDP, accounting for 9.4%, or approximately ZAR 23.6 billion, in 2019. Despite its importance, the province's roads and transport sector faces challenges. The condition of paved provincial and municipal roads across South Africa, inclusive of Free State Province, is "at risk of failure" (FSDESTEA, 2018). Poor road conditions can hamper logistics operations crucial for the province's economic development. Current road designs do not factor in changing climatic conditions, making them particularly vulnerable. The drainage and stormwater management systems, based on outdated rainfall data, fail to account for potential climate change impacts, further exacerbating the situation.

Climate change presents several challenges to the transport sector:

- Rising temperatures may lead to the rapid deterioration of road surfaces, leading to the forming of cracks and potholes and reducing the lifespan of the road surfaces.
- Transportation infrastructure might suffer substantial damages, demanding significant financial resources for repair, maintenance, and modernisation.
- Transportation services could face disruptions, posing socio-economic challenges.

Free State Province has ongoing road upgrade projects with more in the pipeline. The province's multi-modal transport system acts as a pivotal logistics hub, linking surrounding provinces and Lesotho. However, the budget for maintaining and upgrading this infrastructure remains insufficient. The province's central position also means an increase in South African freight, which adds more strain on the transport networks, potentially reducing the sector's adaptive capacity.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.9.1 Goals and Response Actions

To improve the ability of the roads and transport sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 36. Goal: Increase the resilience of transport infrastructure to the impacts of climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Conduct research on durable and sustainable materials that can be used to construct roads that are resilient to the impacts of climate change	Free State Department of Police, Roads and Transport (FSDPRT)	FSDESTEA	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDPRT	Report on road construction using material resilient to climate change impacts is available.
2	Research and develop climate-resilient geopolymer materials made from waste materials, such as glass bottles and cans that can be used in road construction	FSDESTEA	Academic and Research Institutions	Ongoing	> ZAR 5 million	FSDESTEA	Research reports are available on climate-resilient geopolymer materials that can be used in road construction.
3	Conduct an assessment of all bridges in Free State Province to determine their vulnerability to floods and key actions required to upgrade priority bridges	FSDPRT	FSDPRT, UFS's Department of Engineering Sciences	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDPRT	A bridge vulnerability assessment report is available.
4	Develop design standards for climate-resilient transport infrastructure (roads, bridges, railways, etc.) to increase the resilience of this infrastructure to climate change	FSDESTEA	FSDPRT	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDESTEA	Design standards for climate-resilient transport infrastructure are available.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
5	Implement a programme to upgrade and maintain roads to minimise damage caused by the impacts of climate change, such as flooding	FSDPRT	District and local municipalities	Ongoing	ZAR 0 – To be implemented by FSDPRT staff	FSDPRT	Roads in the province meet minimum quality standards.
6	Develop a fire protection implementation plan for the roads and transport sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province. This plan should include planning for temporary road closures during wildfire events to prevent the spread of wildfire through the airflow behind moving trucks	FSDCSRT	FSUFPA, FSPDMC, FSDESTEA, DFFE (national), district and local municipalities	Ongoing	ZAR 1 million–ZAR 5 million	FSDCSRT	A fire protection implementation plan for the roads and transport sector is available.

Source: Authors.

5.10 Public Works and Infrastructure

The public works and infrastructure sector includes government-owned buildings such as municipal offices and social and economic infrastructure such as solid waste, water, and wastewater infrastructure, etc. Water and wastewater infrastructure is covered in more depth in the Water and Sanitation section of this report.

The FSDPWI is the custodian of all immovable assets that are registered under the Free State Provincial Government. In 2020, there were 4,867 registered properties and/or land parcels, including schools, hospitals, clinics, libraries, functional office accommodations for client departments, residential accommodations, and vacant land. The FSDPWI is the custodian of 1,506 capital assets. In 2017, the FSDPWI spent over ZAR 1.8 billion on the disposal of solid waste. There are 97 licensed waste management facilities in Free State Province. Of the 1,506 investment buildings that the FSDPWI is responsible for, 1,226 (about 81%) are in fair condition and require some maintenance work, 157 (10%) are in good condition, and 123 (8%) of the properties are in bad condition. The FSDPWI does not have enough financial resources to refurbish and maintain its ageing buildings that are in a bad or fair condition. The FSDPWI has a large maintenance backlog, which in 2018 would have cost around ZAR 161 million to address. The prevalent practice of relying on landfills to dispose of solid waste is unsustainable. The state of waste disposal procedures at landfill sites in the province is poor. None of the landfill sites in the province complied with the minimum standards for landfilling.

Climate change presents several challenges to the public works and infrastructure sector:

- Rising temperatures may affect the decomposition rate of waste in landfill sites, as well as the productivity of workers.
- Climate change could lead to the rapid deterioration of landfill sites, reducing their lifespans.
- Public works infrastructure might suffer substantial damages, demanding significant financial resources for repair, maintenance, and modernisation, and increasing insurance costs.

The FSDPWI is aiming to implement several energy and water efficiency interventions in its building. Despite increasing regulatory obligations for solid waste management, municipalities in Free State Province either do not have a solid waste management plan, or they have a plan that is not prioritised, contains unattainable objectives, and does not address all relevant impacts and challenges. The Expanded Public Works Programme (EPWP) has many programmes that create employment opportunities related to the public works and infrastructure sector.

As a result of the factors above, the Climate Change Risk and Vulnerability Assessment conducted to inform this climate change strategy identified this as a sector of high concern with regard to the impacts of climate change.

5.10.1 Goals and Response Actions

To improve the ability of the public works and infrastructure sector in Free State Province to respond to climate change, the following goals and implementable response actions are presented.

Table 37. Goal: Public infrastructure resilient to the projected effects of climate change

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
1	Design standards for water and wastewater management infrastructure that increase the resilience of such infrastructure to climate change	FSDPWI, South African Bureau of Standards	DWS (national), FSDESTEA	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	FSDPWI	Standards are available for water and wastewater management infrastructure that increase the resilience of such infrastructure to climate change.
2	Implement a programme to enhance the capacity of stormwater management systems in urban areas to accommodate increased water flows during flood events	FSDCOGTA, Local Municipalities	District and local municipalities, FSDESTEA	Short term (1–3 years)	ZAR 0 – To be implemented by FSDCOGTA and local municipality staff	N/A	A programme is implemented to enhance the capacity of stormwater management systems in urban areas.
3	Implement a green building programme in government buildings in Free State Province to improve resilience to climate change and address issues such as heat mitigation and water conservation	FSDPWI, UFS's Department of Engineering Sciences	FSDESTEA, district and local municipalities, DFFE (national), Green Building Council of South Africa, the private sector	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDPWI	A selection of government buildings is certified as green buildings annually.

	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
4	Develop a fire protection implementation plan for the public works and infrastructure sector that can be incorporated into the proposed implementation plan linked to the Wildfire Management Framework of Free State Province	FSDPWI	FSUFPA, FSPDMC, FSDESTEA, DFFE (national), district and local municipalities	Ongoing	ZAR 1 million–ZAR 5 million	FSDPWI	A fire protection implementation plan for the public works and infrastructure sector is available.

Source: Authors.

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Appendix A. Possible Climate Change Mitigation Response Actions

Below are a few possible climate change mitigation response actions that could be included in Free State Province's Climate Change Mitigation Strategy and Implementation Plan when it is next updated. These response actions were suggested by stakeholders during the stakeholder consultation process for this climate change adaptation strategy; however, as these response actions focus on climate change mitigation actions, they do not fit into the *Free State Province Climate Change Adaptation Strategy and Implementation Plan*.

Table A1. Possible climate change mitigation response actions

Sector	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
Finance	Research the feasibility of generating and selling carbon credits in Free State Province	Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA)	Department of Forestry, Fisheries and the Environment (DFFE) (national)	Medium term (4–10 years)	< ZAR 1 million	FSDESTEA	A feasibility study is available.
Public works and infrastructure	Undertake a preliminary assessment of all provincial government buildings in Free State Province to identify those over 1,000 square metres in size, as these buildings are required to display an energy performance certificate (EPC). The assessment should also include a readiness review of the buildings that require EPCs	Free State Department of Public Works and Infrastructure (FSDPWI)	University of the Free State's (UFS's) Department of Engineering Sciences, The Private Sector	Medium term (4–10 years)	> ZAR 5 million	FSDPWI	A report is available on the number of provincial government buildings that require EPCs and their readiness for EPCs.

Sector	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
Public works and infrastructure	Develop a programme to undertake regular energy audits of provincial government buildings in Free State Province	FSDPWI	Provincial sector departments	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDPWI	Audit reports completed annually with energy efficiency recommendations that result in energy and cost savings.
Roads and transport	Develop networks of electric vehicle and green hydrogen vehicle infrastructure, such as charging or fuelling stations, in Free State Province	Free State Department of Police, Roads and Transport (FSDPRT)	Private sector	Long term (10 years or more)	> ZAR 5 million	FSDPRT, Private sector	Networks of electric vehicle and green hydrogen vehicle infrastructure are operational in the province.
Water and sanitation	Conduct research to determine the use of energy throughout the entire water value chain and where energy efficiency measures can be implemented	UFS's Department of Engineering Sciences	The private sector, Department of Water and Sanitation (National), Water services authorities (local municipalities)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	UFS's Department of Engineering Sciences	A research report is available.

Sector	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
Communication, education, and awareness	Create a regularly run training programme on the fundamentals of energy use and management, including energy efficiency	UFS's Department of Engineering Sciences	Free State Department of Human Settlements	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	UFS's Department of Engineering Sciences	A training programme is implemented.
Energy	Develop a training programme to raise awareness about energy fundamentals, management, and efficiency	UFS's Department of Engineering Sciences	Department of Mineral Resources and Energy (DMRE) (national)	Short term (1–3 years)	ZAR 1 million–ZAR 5 million	UFS's Department of Engineering Sciences	Number of people trained
Energy	Implement a waste-to-energy programme involving all landfill sites in Free State Province	FSDESTEA, DMRE (national), DFFE (national)	District and local municipalities, South African Local Government Association (SALGA), Eskom, FSDPWI, the private sector	Short term (1–3 years)	> ZAR 5 million	FSDESTEA, DMRE (national), DFFE (national)	A waste-to-energy programme exists.

Sector	Response action	Lead	Partners	Time frame	Budget	Budget source	Indicator of success
Energy	Develop and implement an integrated energy master plan for Free State Province	FSDPWI	SALGA, district and local municipalities, FSDESTEA, academic and research institutions, CSOs	Medium term (4–10 years)	ZAR 1 million–ZAR 5 million	FSDPWI	An integrated energy master plan is implemented.

Source: Authors.

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department of
economic, small business development,
tourism and environmental affairs
FREE STATE PROVINCE