LJNM ENVIROTECH SOLUTIONS

Business Plan

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ABBREVIATIONS and ACRONYMS

CCRS	Climate Change Response Strategy
DEA	Department of Environmental Affairs
DESTEA	Department of Economic Development, Tourism and Environmental Affairs
FS	Free State Province
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFPRI	International Food Policy Research Institute
INDC	Indented Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
LTAS	Long Term Adaptation Strategy
LTMS	Long Term Mitigation Scenarios
MEC	Member of Executive Committee
NA	Not Available
NCCRP	National Climate Change Response Policy
NDP	National Development Plan
RCP	Representative Concentration Pathway
SANAS	Situational Analysis and Need Assessments
SAWS	South African Weather Service
UNFCCC	United Nations Framework Convention on Climate Change
VA	Vulnerability Assessment

Executive Summary

This report presents the Status Quo Analysis for the Free State (FS) Province. The objective of this phase of the strategy development is to take stock of existing information on climate change in FS and establish the status quo, which is accompanied by preliminary vulnerability analysis of the causes of the problem (climatic and non-climatic). The FS province comprise of a number of departments that have policies, plans, frameworks, projects, etc. that are linked to climate change adaptation.

The Status Quo design was based on key engagement principles and followed this analytical approach (Figure 0.1): 1) Identification of who the key players are within and outside the Province 2) undertaking an overview of the Province, sector mapping and research exercise, which informs the conceptual approach, 3) analysing the data quantitatively, 4) reaching out to the climate change community (within and outside FS) and engaging in interviews, 4) requesting sector specific documents from key stakeholders, 5) undertaking an initial capacity building and/or stakeholder engagement workshop and 6) preparing this draft report. *The next steps in validating the status quo analysis would be 7) to undertake an initial capacity building and/or stakeholder engagement workshop and 8) incorporating comments from the initial workshop and finalising the Status Quo report.*

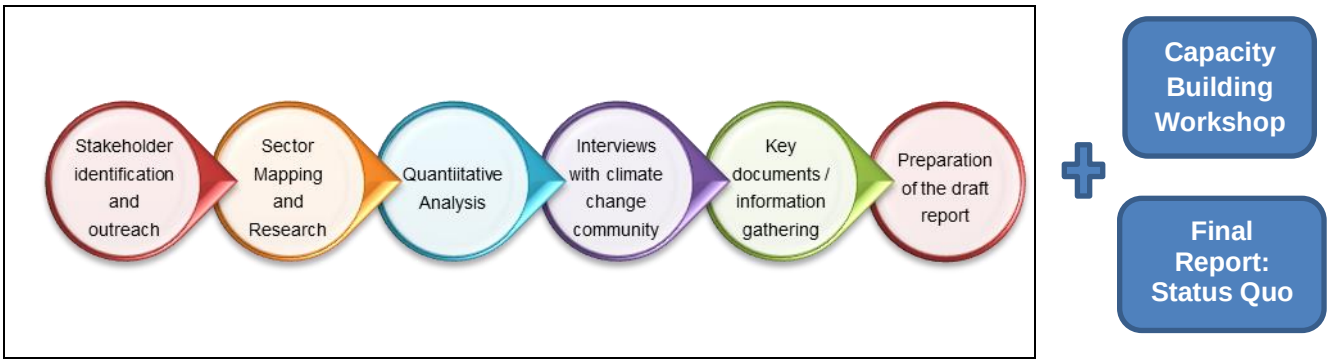

Figure 0.1: Status Quo design process

Certain aspects of social and sectoral / biophysical vulnerability factors are discussed in this report. Importantly, in the next stage of the project, which focuses on climate change vulnerability assessments – in-depth vulnerability analysis will be undertaken to assess existing adaptation/response measures and support the development of the response strategies for the province.

The FS province is prone to a myriad of extreme climate events because of its geographic location. These events are classified under the three climatic conditions that are plausible to affect South Africa in the future due to climate change; namely extreme temperature, extreme rainfall and extreme weather (LTAS, 2012; SAWS, 2015). Table 0.1 summarises the status quo of the FS Province.

Table 0.1: Summary of Status quo for Free State Province

Meteorology	• Almost uniformly at about 1,300m above sea level, the Free State climate is typical of the interior plateau with rain falling in summer, cold winters and lots of sunshine. Almost all precipitation falls in the summer months, with aridity increasing towards the west. Frost occurs throughout the region usually from May to early September in the west and up to early October in the east. To the north, the Vaal irrigation area nourishes the small assortment of farming towns below it, and the hue of the Free State countryside is often green. • Areas in the east experience frequent snowfalls in winter, especially on the higher ranges, whilst the west can be extremely hot in summer. The south brings hot, dry summer days and long, cold winter nights. This semi-desert area also brings fluctuations of temperature from day to night. The west is warm and cold in equal measure, its inhabitants making use of the many man-made water recreation facilities to endure the heat as much as using heating facilities in winter's low temperatures. • FS has a generally hot, arid climate. • The strongest warming is projected in Free State Province (plus all other inland provinces) • The rain season is likely to shift and start later, characterised by a shorter rainy season, with the duration of the dry spell likely to increase resulting in drought and negative implications for agriculture, and water sector. At the same time intensified rainfall is projected to increase, with the likely-hood of heavy downpours punctuated by longer dry spells. The heavy rainfall often results in flash flooding and land degradation.
Vulnerability	The FS economy is dominated by agriculture, mining and manufacturing, and is known as the 'bread basket' of South Africa, where about 90% of the province is under cultivation for crop production. It produces approximately 34% of the total maize production of South Africa. Therefore, Agriculture is the most vulnerability sector in the FS from a food security and water availability and usage point of view. The impacts of climate change on water resources in the country indicate a reduction in soil moisture and a runoff. In the Free State province, large-scale agriculture as well as small-scale farmers and the rural poor who practice rain-fed agriculture rely on water for irrigation purposes. There is likely going to be incidences of dry spells in the Free State due to increase in temperatures, or extreme floods and hailstorm which could damage agricultural goods (www.freestate.gov.za)
Adaptive Capacity	The Free State Province has enhanced its capacity to adapt to extreme climate events, by preparing for disaster risk reduction and management (i.e. Disaster management plan in place, Early warning systems available, Disaster Management Centre and Research input from University of Free State and other research institutions).

1. Introduction

Adapting to climate change requires both human and natural systems to adjust to actual or expected changes in climate and associated effects and build resilience through better decisions about managing our built and natural environment and taking advantage of opportunities (UNFCCC, 2014). It requires an understanding of and planning for the current risks and vulnerability as well as the projected changes / risks in the future. Developing sustainable adaptation options also relies on information of past events, their effects and measures put in place to respond which illustrates a system's adaptive capacity.

At national level there has been a concerted effort to deal with issues of climate change. Notable among these efforts are the following key milestones:

- The National Climate Change Response Policy highlighted the need for all government departments to review all policies, strategies, legislation, etc. within their jurisdiction to ensure full alignment with this policy. This alignment will allow for more effective interaction between municipal, provincial and national government. It will further ensure that there is alignment between national flagship programmes, provincial and municipal focus areas, enabling the provincial and municipal programmes to contribute to national targets. This also allows for access to national and international funding streams that will benefit South Africa as a whole.
- The National Development Plan (NDP) further recognises that in the long-term the country should be able to manage its transition to a low-carbon economy without negative consequences for economic growth (RSA, 2011b).
- The Long Term Adaptation Scenarios (LTAS) research programme provided national and sub-national adaptation scenarios for South Africa as well as evaluating the socio-economic and environmental implications of potential impacts of anticipated climate change across three time frames, namely short (<2030), medium (<2050) and long term (<2100) for the water, agriculture and forestry, human health, fisheries, biodiversity, disaster risk reduction and human settlements (urban, rural and coastal) sectors at a national level. In addition, this project developed a logical view of South Africa's climate change trends, current variability and future projections to provide a set of climate change scenarios based on the latest available methodologies, downscaled for the South African context. The scenarios considered climate trends and variability, climate change projections and impacts in selected sectors and the development growth pathways for these sectors.
- During the past ten years, modelling scenarios have predicted that there will be significant climate change impacts in South Africa (Hewitson et al., 2006). Recent studies done by the South African Weather Service (SAWS) to develop national and provincial climate change scenarios focusing on the 21st century changes demonstrate some of these probable trajectories (SANAs, 2015). According to the SAWS the following are likely to happen to the South African climate:
  - The strongest warming is projected over inland areas including the Northwest, Northern Cape, Limpopo, Mpumalanga, Gauteng and **Free State** Provinces.
  - Warming by 4% compared to the 2% IPCC average aggravated by local positive feedback over the area extending from the Northern Cape and Northwest Provinces towards Namibia.

- Differential warming between the coastal and inland areas will create strong temperature gradients, conditions favourable for strong winds and storms.
- Despite disagreement on climate modelling and probable variability, much of South Africa, notably the Western Cape, Northern Cape, North West, Limpopo and **Free State** are projected to become drier.
- The rain season is likely to shift and start later, characterised by a shorter rainy season, with the duration of the dry spell likely to increase resulting in drought and negative implications for agriculture, and water sector. At the same time intensified rainfall is projected to increase, with the likely-hood of heavy downpours punctuated by longer dry spells. The heavy rainfall is likely to result in flash flooding and land degradation.

Variability in climatic conditions is already being observed (e.g. the recent heat waves, drought, and severe floods (in some parts of the country) coupled with wide ranging impacts are likely to continue into the future. The changing parameters, whether it is extreme temperature, rainfall, or climatic events, will impact upon wide ranging sectors, and across the spectrum from social to biophysical. Unless, there are innovative adaptation measures put in place this will have dire consequences for human, socio-economic, environmental and physical infrastructure. Even more challenging is variable nature of climate change and its impacts. Thus South Africa's nine provinces are likely to experience different climate change impacts depending on their exposure, sensitivity and adaptive capacity, exacerbated by social, biophysical characteristics and adaption mechanisms. This will most likely put the country on a negative developmental trajectory, joepardising the aspirations of the National Development Plan.

Notwithstanding these efforts, research shows mixed outcomes at provincial levels. Thus, whilst some provinces have shown progress in addressing climate change issues, a lot remains to be done in others The recent Situational Analysis and Needs Assessment (SANAS) study that was conducted by the Department of Environmental Affairs (DEA) at the sub-national level in order to better understand the needs and levels of capacity in terms of climate change response in the provinces presents the following provincial climate change response status quo (SANAS, 2015):

"Only three out of the nine (9) provinces, i.e. Eastern Cape (2011), Gauteng (2011), and Western Cape (2014) have developed Climate Change Response Strategies (CCRS). Kwazulu Natal, Northern Cape and Mpumalanga have CCRS in draft form pending input and stakeholder consultation to be finalised. The **Free State**, Gauteng, Kwazulu Natal, Limpopo, North West and Western Cape have climate change responses embedded within other plans/tools or strategies within various provincial departments e.g. Integrated Development Plan (IDP) , Provincial Spatial Development Framework, Provincial Environmental Outlook etc." (SANAS, 2015).

The ability to overcome climate change variability effects can only be achieved through effective climate change response strategies at national, provincial and local levels based on evidence and a good understanding of the status quo. Whilst this has been done at national level and in some provinces, in other provinces there is still work to be done.

Therefore, the Department of Environmental Affairs (DEA) and its technical partner GIZ, (in collaboration with the provincial department in the Free State, Department of Economic, Small Business Development, Tourism and Environmental Affairs (DESTEA) recognise the need to provide technical support to the Province to develop adaptation response strategies in order to

contribute to both national and global efforts to adapt to the impacts of the unavoidable climate changes occurring in both the shorter and longer term. The development of the response strategies aims to build on the LTAS project by implementing findings at a provincial level covering the Free State Province. Planning, preparedness, and innovation will therefore be required to maximise the Province's adaptive capacity to this global threat. Taking action now will limit damages, loss of life, and costs over the coming decades and, if strategically well considered, will add to the Province's national competitive edge into the future.

As part of the development of the comprehensive climate change adaptation response strategy for FS, it is important that the current climate change status quo of the province is adequately described and understood. This document presents the Status Quo Analysis focusing on the findings of the initial mapping exercise (desktop / literature review) and stakeholder consultation (i.e. visits to different departments within the province), to determine the current status quo of FS in an effort to highlight key areas of opportunities and threats for the Province in the context of a changing climate.

2. Objectives

The main objective of this proposed study is to **develop a comprehensive climate change adaptation strategy for the Free State Province.** Specifically, the following activities must be carried out to realise the above objectives, as per the terms of reference outlined in the tender document:

- **Conduct a Climate Risk and Vulnerability Assessment** in the province for near and medium (i.e. from 2020 to 2050) terms,
- **Evaluate existing adaptive capacity** of the province,
    - **Examine best practices** and **case studies,**
    - **Identify effective strategies for resilience and preparedness** (including early warning systems and disaster management, etc.),
    - **Recommend appropriate new adaptation responses and strategies**; and
- Facilitate **capacity building and knowledge-transfer** throughout the process so as to enhance implementation of the prioritised adaptation options.

2.1 Scope of work

The first step towards developing the Adaptation Response Strategy will be to undertake a Status Quo Analysis of the Province. The following items will be covered in this report:

- Taking stock of existing information on climate change in FS;
- An initial vulnerability analysis of the causes of the problem (climatic and non-climatic) as well as main barriers impeding implementation of immediate adaptation strategies and measures;
- Adaptation opportunities and alternatives are highlighted as this will constitute the basis on which the strategies will be built;

- The analysis is supported by all necessary data and information, where possible.

3. Methodology

3.1 Approach

The approach that was undertaken in the development of this status quo report was based on the following (Figure 3.1):

1. Identification of key climate change stakeholders from various sectors within the province,
2. Requesting sector specific documents from key stakeholders that will be used to describe the current climate change status / situation of the province. This included reaching out to these stakeholders through meetings and interviews,
3. Consolidation of the above information into this Status Quo Report.

In addition to the above; input that will be gathered from the project inception workshop that will be held with all stakeholders in January 2016 will also provide additional information about the FS province, that will guide the entire strategy development process.

3.2 Analytical Framework

The analytical framework provides a lens of analysis on how the information and data on climate change vulnerabilities and adaptation plan / strategy will be captured, analysed and presented for the province. Figure 3.1 represents the process of analysing data with the intention of providing a framework for strategy development and implementation.

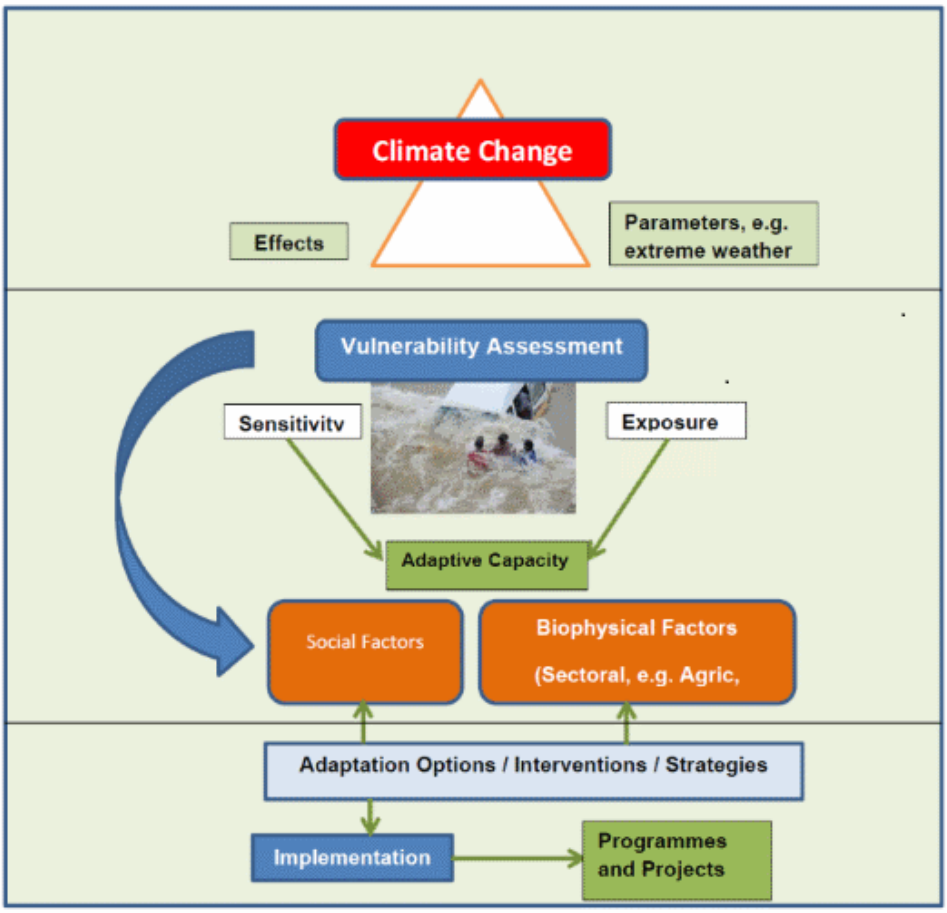

Figure 3.1: Analytical Framework (See Annexure 1 for definitions of key elements of the Analytical Framework)

4. Status Quo Analysis

4.1 Overview of the Free State Province

The Free State is located in the **geographical centre of South Africa**, bordered by the Northern Cape, Eastern Cape, North West, Mpumalanga, KwaZulu-Natal and Gauteng provinces, as well as Lesotho. The Free State is a rural province of farmland, mountains, goldfields and widely dispersed towns. Although the Free State is the third-largest province in South Africa, it has the second-smallest population and the second-lowest population density. It covers an area of 129 825km² and has a **population of 2 745 590 – 5.3% of the national population**. Its capital is Bloemfontein, which is South Africa's judicial capital. Other important towns include Welkom, Kroonstad, Sasolburg and Bethlehem.

Figure 4.1: Map of the Free State Province (Source: www.municipalities.gov.za)

The **economy is dominated by agriculture, mining and manufacturing**. Known as **the 'bread basket' of South Africa**, about **90% of the province is under cultivation for crop production**. It produces approximately 34% of the total maize production of South Africa, 37% of wheat, 53% of sorghum, 33% of potatoes, 18% of red meat, 30% of groundnuts and 15% of wool. The province is the world's fifth-largest gold producer and the major employer in the mining sector. It is a leader in the chemicals industry, being home to the giant synthetic-fuels company, Sasol. The Vredefort Dome, 10km in diameter, about 100km south-west of Johannesburg, is South Africa's seventh World Heritage Site.

The Free State is divided into one metropolitan municipality (Mangaung Metropolitan Municipality) and four district municipalities; namely Fezile Dabi, Thabo Mofutsanyana, Lejweleputswa, and Xhariep. Table 4.1 provides an outline of these municipalities, population size and area coverage. These district municipalities are further subdivided into 19 local municipalities.

Table 4.1: Free State District Municipalities (Population and area coverage) – census 2011

District Municipality	Mangaung	Fezile Dabi	Thabo Mofutsanyana	Lejweleputswa	Xhariep
Population	850 000	466750	725 932	657 019	146,259
Area (km^2)	6 263	240,190	33,269	31,930	37,674

4.2 Information collected from key stakeholders in the FS Province

The Free State Provincial government has 11 departments and some of them have policies, plans, frameworks, and projects, etc. linked to climate risk and resilience, and adaptation perspective. These policies, action plans and projects focus on the water, biodiversity, human settlements, health, livelihood, infrastructure and other related social and biophysical activities within the province. Table 4.2 shows climate change related initiatives undertaken by departments within the province to either mitigate greenhouse gases or adapt to the currently climate variability and extreme events.

Table 4.2: Documents from departments in Free State Province

No:	Department	Information / Documents Provided	Initiatives currently underway
1.	**Office of the Premier**	Position Paper on the Environment. Draft 3 Document – Environmental Context for Growth and Development (2010)	Outline of the strategic direction with regards to environmental sustainability in the province.
2.	**Economic, Small Business Development, Tourism & Environmental Affairs (DESTEA)**	Indented Nationally Determined Contributions (INDC) Report / Pre COP21 Stakeholder Engagement Workshop report MEC Speaking Notes – INDC Workshop	• Initiative that is aimed at partly raising awareness on climate change issues and how communities can play a role in responding to the climate change challenge; as well as facilitating consultation on Indented Nationally Determined Contributions (INDCs), that is integral to preparations for the Conference of the Parties (COP21) in Paris in December 2015. The workshop was funded by GIZ and the DEA • Intended primarily for those involved in the technical and operational aspects of implementing climate change mechanisms to profile the policy imperatives of the Free State Provincial Government into the national collective
3.	**Health**	Climate Change Adaptation Response Plan (National)	**Programmes:** **Research** Studies findings guided areas to focus such as strengthen human capacity

No:	Department	Information / Documents Provided	Initiatives currently underway
			building **Droughts**: Programme: *malnutrition:* by providing vitamin A to children less than 4 years old *Communicable* diseases such as *Diarrhoea*- Provide Rota vaccine *Malaria* Ward Based Outreach Teams (WBOT) – Family Physician, Environmental Practioner and Nurse) – conduct assessments in communities *Water Quality Monitoring*- Free State water quality forum and produces a monthly report for municipalities Water availability
4.	**Police, Roads, Transport and Infrastructure**	No specific climate change related documents but use Environmental management plans for compliance purposes (NEMA and Minerals Act)	Environmental Management of Borropits – Environmental consultants report exist Risk Management Section exists responsible for documenting all risk for the department.
5.	**Cooperative Governance, Traditional Affairs & Human Settlements (COGTA)**	*to be provided* Human Settlements Plan (was provided for Mangaung Municipality)	• Provides support to communities living along flood planes • Disaster Management Centre • Mangaung Metropolitan Municipality Disaster Management Plan in place • Disaster Management Training and Education Centre of SA (UFS) • Early Warning Systems (SAWS)
6.	**Social Development**	*Info to be provided*	
7.	**Agriculture Rural Development and Land Reform**	*Info to be provided*	• Drought and floods relief programme for farmers • Water Shedding and Conservation
8.	**Education**	*Info to be provided*	na
9.	**Sport, Arts, Culture and Recreation**	*Info to be provided*	na

According to Nkoe, (2015) the Free State province's position on climate change is as follows (Nkoe, 2015):

- Climate Change causes enormous impacts on the Free State province, particularly in the Agricultural sector.
- FS is the biggest producer of crops such as maize, wheat, sunflower, etc. in South Africa
- Wheat production in FS has recently declined due to droughts and volatile price exposure

- The Province is currently experiencing water shortages, and has been declared a disaster area by the national Department of Environmental Affairs.

Table 4.3 provides an outline of climate change related initiatives / projects undertaken by the FS province, as presented at the SALGA stakeholder engagement workshop that was held on the 26th November 2015 in Bloemfontein, Free State Province.

Table 4.3: Climate change related initiatives/projects within the Free State Province presented by Ms Nozi Mabafokeng Nkoe at the SALGA Stakeholder Workshop, held on the 26 November 2015 (SALGA, 2015).

Category	Projects / Initiatives
Climate change related initiatives	1. 19 August 2015 Pre-COP 21 Workshop was hosted by the province at President Hotel, Bloemfontein 2. Risk & Vulnerability Assessment study aimed at developing a climate change response strategy for the province is currently undertaken between July 2015 - September 2016 3. The province is currently in a process of integrating climate change response into Municipal Integrated Development Plans (*Using Lets Respond Toolkit*) • Preparation • Analysis • Strategy • Projects • Integration Implementation 4. Alignment of Climate Change Policy process with municipalities i.e. Agriculture and Tourism sectors. 5. Eco-schools and Environmental Management are being encouraged by the province. 6. Forum process is in progress. 7. DEA in collaboration with the DESTEA are currently conducting climate risks and vulnerability assessments. 8. Environmental Awareness & Capacity Building activities are underway. 9. Celebrations of Environmental Days (e.g. World Environment Day, Wetland Day, Ozone Day, etc.) is being undertaken and taken to *the communities to raise awareness.* 10. Cleaning & Greening Programmes are in place. 11. Currently, a total of 20 landfill sites are licensed in the FS to address waste management issues *(and to address the methane greenhouse gas issue).* 12. Personnel are being trained at waste management facilities on waste management *(to address the methane issue)* 13. Environmental Management Inspectors are employed by the province. 14. Terms of Reference (ToRs) have been developed for the Feasibility Study for Network Monitoring System with some facts being derived from FS Air Quality Management Plan (AQMP). 15. FS is encouraging research and development (R&D) in the climate change field.

Green Economy related interventions	1. Solar geysers & lights in townships (advise more on Human Settlement Projects)- Continuous 2. Letsatsi Solar Energy Plant in Xhariep (Operational) 3. Research on Methane gas is currently being undertaken at 2 Landfill sites (Setsoto and Matjhabeng Municipalities) in the FS province

4.3 Meteorology of the Free State Province

- FS Generally experiences hot, arid climate.
- The Northern FS region experiences summer rainfall, cold winters and plenty of sunshine,
- The Eastern FS is characterised by mountain snows,
- The Southern region experiences dry summer days and long, cold winter nights.
- FS experiences an annual summer rainfall which range from 600mm to 750 mm, mostly during spring seasons towards summer. During rainy season the area receives an overall 80% of rain, which often last for about 181 to 240 days, resulting in high crops and plantation production.
- This province experiences unanticipated hail storms and other climatic hazards during this season, which often have a huge impact on crop production in the area (Moorosi, 1999).

4.3.1 Future Climate Projections for the Free State Province

Figure 4.2 shows the 21st century temperature changes future projections for modelled for the Free State Province (SAWS, 2015). These projections show that under the aggressive mitigation scenario, warming in the Free State is projected to remain below 2.5°C above the 1986-2005 reference period (under RCP 2.6 Scenario). In the business-as-usual case (RCP 8.5) warming is projected to reach 6°C towards the end of the 21st century (magenta segments in the last column).

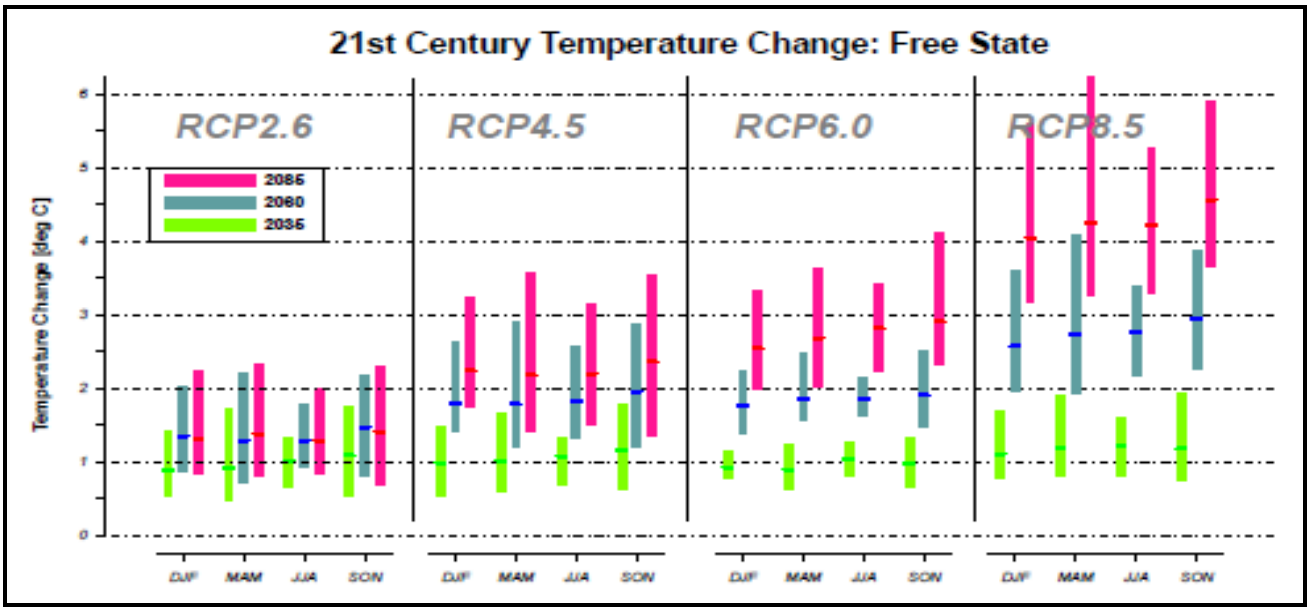

Figure 4.2: Projected 21st century temperature change in the Free State province (Source: SAWS, 2015).

Figure 4.3 shows the 21st century precipitation (rainfall) changes future projections for modelled for the Free State province (SAWS, 2015). The projected changes indicate that in total seasonal rainfall have large uncertainties with no clear sign, an exception being under the highest representative concentration pathway (RCP8.5). In addition, the FS Province's rain season is likely to shift and start later, characterised by a shorter rainy season, with the duration of the dry spell likely to increase resulting in drought and negative implications for agriculture, and water sector. At the same time intensified rainfall is projected to increase, with the likelihood of heavy downpours punctuated by longer dry spells. The heavy rainfall often results in flash flooding and land degradation.

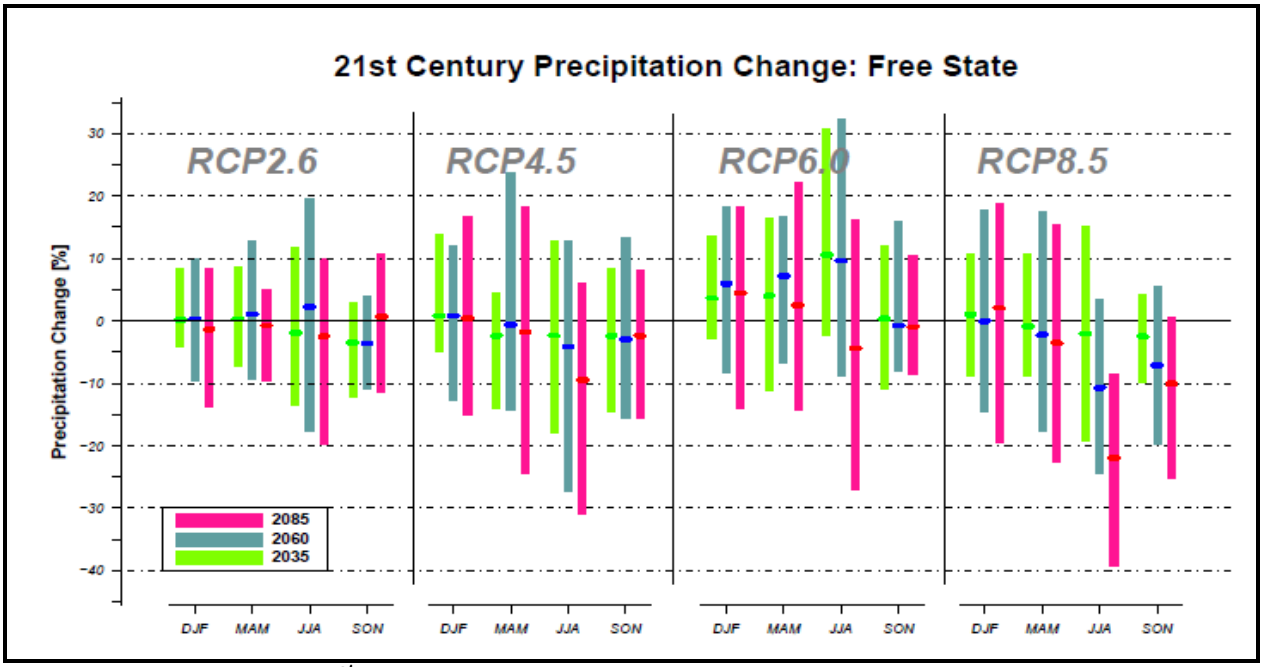

Figure 4.3: Projected 21st century precipitation change in the Free State province (Source: SAWS, 2015).

4.4 Vulnerability Assessment of the Free State Province

The vulnerability assessment framework considers vulnerability as a function of exposure, sensitivity and adaptive capacity of the population and the sectors affected. Therefore, the susceptibility and capacity of different sectors were analysed using available data and data obtained during this work. The sectors are divided into two main categories, social and biophysical.

4.4.1 Social Vulnerability

Social vulnerability entails many factors that affect the socio-economic well-being of characterised people for the study. Importantly, economic dependency (comparison of the population between the economically active population and the young and the old population) and physiological factors (the population of the young and the old) are critical.

Climate-related risks are generally greater for disadvantaged, rural and poor communities because of limited adaptive capacity and greater sensitivity to climate-driven impacts. Free State Province is characterised by the prevalence of rural, poor communities vulnerable to the impacts of climate variability and change.

It is important to note that due to lack of sufficient information on social vulnerability, the focus of this report was mainly on the biophysical factors. The next stage of the project will cover climate

change vulnerability assessments that will provide an in-depth vulnerability analysis of the various sectors and social aspects in the FS province that will be incorporated in the climate change response strategy.

4.4.2 Vulnerability assessment of the sectors

Free State is the largest province in South Africa with agricultural activities. Irrigated agriculture contributes to the degradation of water quality, but at the same time, successful irrigation requires water of good quality. Research by CSIR (2010) indicate that the current poor state of wastewater treatment plants in South Africa poses an increasing risk to agricultural crops, due to generally deteriorated quality of water available for irrigation. Irrigation water may at times have heavy metal contamination from industries and result in seepage into water body, bio-accumulate and bio-concentrate in some fresh-water fish species.

4.4.2.1 Water

Results on the Climate Change Scenarios for South Africa projected future warming across the region, and the warming is greatest over the interior and semi-arid areas. The impacts of climate change on water resources in the country indicate a reduction in soil moisture and a runoff. Considering the hierarchy of human needs, water is crucial for drinking, health, sanitation, agriculture, industry, power generation, mining operations and tourism (Claassen, 2010:4). Free State Province was recently (October / November 2015) declared a disaster area due to drought experienced / severe water shortages in the Province.

Irrigation in agriculture forms the largest single surface water user in the country. In the Free State province, large-scale agriculture as well as small-scale farmers and the rural poor who practice rain-fed agriculture rely on water for irrigation purposes. There is likely going to be incidences of dry spells in the Free State due to increase in temperatures, or extreme floods and hailstorm which could damage agricultural goods.

4.4.2.2 Agriculture

Rainfall is one of the most important factors in agriculture as it determines the types of agricultural activities and suitability of the type of farming. Rainfall is also the factor to be most affected by climate change, posing a threat to the sector and livelihoods that depend on it. Rainfall further has a direct impact on the dependence of agriculture on water, resulting in high vulnerability. Approximately 60% of the country's water resources are channelled for irrigation, while all the other activities in support of agriculture consume at least 65% of water. Evaporative losses are a climatic factor influenced by the unreliable rainfall especially in arid and semi-arid conditions (DEA, 2013 – agric). Other climate related conditions that affect agriculture are related to temperature variations and these include heat waves, cold spells and crop evaporation (DEA, 2013 – agric). Rainfall variability further exacerbates agriculture, all affecting crop potential and yield. In South Africa, communal and small-scale farmers are vulnerable to drought shocks, often experiencing normal dry periods as drought disasters. Net water requirements for crops in the summer rainfall region are projected to increase throughout southern Africa. Predicted increase of net water requirements for crops in Free State area is around 30% (LTMS).

Climate change impacts on crops in the Free State

In the Free State Province, climate change poses significant impacts on crops, livestock, soil patterns as well as agricultural finances. Free State province is considered the food basket of the country as it provides the country with its agricultural products and mainly crops. In the Free State province climate change has affected the crop production over the past years; surprisingly farmers had already foreseen this event and had already adaptation measures in place. Research studies found that there is correlation between rainfall patterns and crop production. However maize is mostly sensitive to climatic changes (particularly rainfall) than wheat. For instance, a 1% drop in rainfall has resulted in a gross loss of more than 1% gross loss of maize production as observed since 1997 till 2007. In addition, insects, pests and diseases are expected to thrive as the ecological balance is disrupted by the changing climate (Nayamuth et al., 2002). Insect's colonies in new areas and new species move into wheat and Maize growing areas and destroy the crops.

Climate change impacts on livestock in the Free State

Changes in climatic conditions affect livestock numbers in the province. For instance, continuous increase in temperature have direct and indirect effects on animal production industries, through the reduction in livestock grazing space/land and decreased grazing time since the livestock will be seeking shade to be protected from high temperature (e.g. heat waves); thus reducing the livestock grazing time, since many of them do not graze during midday.

Furthermore, water shortages due to low rainfall patterns in the province affects livestock production indirectly. As the heat increases most animals are subjected to sweating, which means that the amount of water intake increases. The need for water increases and with low rainfall most animals die because of thirst. Climate change also affects the ecosystem as well as biomes. This results in invasion of alien species into the grazing area, consequently affecting the grazing potential as well as feed supply. Over recent months the Free State area has experienced droughts which resulted in poor crop production as well as impacts on the grazing land and killed many livestock in the area. This severely affected the finances of farms in the area and also affected the gross agricultural production in the province. This among others resulted in the Free State Province being declared a disaster province by the National Department of Environmental Affairs this year.

4.4.2.3 Biodiversity

Global ecosystem services have been classified to have the highest value of global gross national product. Significant loss of geographic range and high rate of species extinction risks have been projected for a remarkable proportion of South Africa's endemic fauna and flora. The early evidence for negative impacts of observed The Long Term Adaptation Strategy (LTAS) findings indicates that the grassland biome is mostly vulnerable to structural changes.

4.4.2.4 Human health

The global state of health includes physical, social and psychological wellbeing (IPCC, 2007). Human beings are being exposed to changing weather patterns such as temperatures, flooding, rising sea-level, droughts and extreme events. These direct and indirect exposures can cause death, disability and suffering. For example, increased temperatures, coupled with frequent episodes of flooding and storms, create breeding grounds for mosquitos. Mosquitos carrying malaria parasites are the biggest sources of adult and infant mortality in most parts of Africa, including South Africa. The Free State climatic conditions present semi-arid to arid climate, making it an area that is prone to increase in the frequency or intensity of heat waves, which increases the risk of mortality and morbidity, principally in older age groups and among the urban poor.

The pattern of increasing extreme rainfall events and rising temperature favour the geographical expansion of the borders of vector borne disease such as malaria in the FS (Mokgatlhe, Personal Communication, 2015). Climate impacts on human health will interact with those on rural livelihoods, in particular. Human beings are being exposed to changing weather patterns such as temperatures, flooding, droughts and extreme events. These direct and indirect exposures can cause death, disability and suffering. For example, increased temperatures, coupled with frequent episodes of flooding and storms, create breeding grounds for mosquitos carrying malaria parasites, which are the biggest sources of adult and infant mortality in most parts of Africa, including South Africa. The FS climatic conditions make it an area that is prone to increase in the frequency or intensity of heat waves, which increase the risk of mortality and morbidity, principally in older age groups and among the urban poor.

Precipitation in this province is generally low. The direct impacts of reduced precipitation lead to drought, vegetation loss and altered food production. This leads to poor nutritional status children and adults, which increases vulnerability and reduces the capacity of individuals and groups to adapt to climate change. Communicable diseases gain entry into public health, despite immunisation campaign programmes and many other measures that aim to improve the control of human infections. Health impacts also, of increased risk of heat wave-related mortality and increased ozone-related exposure prevail.

5 Conclusion

Free State province is prone to numerous of extreme climate events because of their geographic location. This province is currently water scarce and extremely hot in the summer months, and it is badly affected by recurrent severe droughts and other extreme events. In terms of the plausible climate futures for South Africa, this province can be expected to suffer increasingly from extreme temperatures, aridity, and weather events (such as heat waves, floods, droughts, etc.). The economic activities of the province are mainly in agriculture, mining and manufacturing, all of which are dependent on supplies of fresh water. According to projections, agriculture and water resources are the most vulnerable sectors within the province. Lack of sufficient and

consistent rainfall during the rainy season causes tremendous stress to the farming industry, as does persistent floods and hailstorms (SAWS, 2015).

Rainfall is one of the most important factors in agriculture as it determines the types of agricultural activities that can be undertaken, and the suitability of the type of farming for the province to be engaged in. Rainfall is likely to be affected by climate change, posing a threat to the sector and livelihoods that depend on it. Approximately 60% of the country's water resources are channelled for irrigation, while all the other activities in support of agriculture consume at least 65% of water. Evaporative losses as a result of temperature increases are an important climatic factor especially in arid and semi-arid conditions (DEA, 2013). Other climate related conditions that affect agriculture are related to temperature variations and these include heat waves, cold spells and evaporation (DEA, 2013). Rainfall variability further exacerbates agriculture affecting crop potential and yield.

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ANNEXURE 1

The Intergovernmental Panel on Climate Change (IPCC, 2013) defines the key elements in the analytical framework accordingly:

Table 1: Key Elements in the Analytical Framework

Effects	The observable and projected trajectory changes in climate and weather patterns
Parameters	The observable effects of climate change variability such an extreme temperatures, rainfall and events.
Vulnerability	The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and climate related extremes
Sensitivity	The extent at which a system is affected, either negatively or beneficially by climate-related stimuli.
Exposure	The extent of climate stress upon a particular unit of analysis and may be represented as either long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events.
Adaptive capacity	The ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences of climate change
Sectors	These are the areas, human activities or bounded contexts which could be social such as poverty level and/or biophysical refereeing to agriculture, water, and infrastructure, etc.
Adaptation Options / Strategies	The actual or intended response to climate change vulnerability for example guidelines, action plans, projects and methods such as disaster response mechanisms.