LJNM ENVIROTECH SOLUTIONS

# Business Plan

## 1. TABLE OF CONTENTS

**ABBREVIATIONS and ACRONYMS**

| | |
|---|---|
| CCRS | Climate Change Response Strategy |
| DEA | Department of Environmental Affairs |
| DENC | Department of Environment and Nature Conservation |
| 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 |
| NC | Northern Cape Province |
| NCCRP | National Climate Change Response Policy |
| NDM | Namakwa District Municipality |
| NDP | National Development Plan |
| 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 Northern Cape (NC) Province. The objective of this phase of the strategy development is to take stock of existing information on climate change in NC and establish the status quo, which is accompanied by an initial vulnerability analysis of the causes of the problem (climatic and non-climatic). The NC 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 NC) 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) incorporating comments from the initial workshop and finalising the status quo for decision makers.

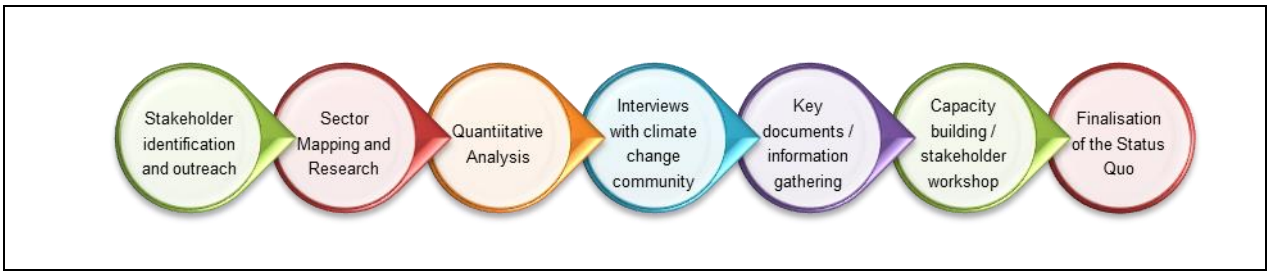



**Figure 0.1: Status Quo design process**

Furthermore, some aspects of social and sectoral / biophysical vulnerability factors have been discussed. 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.

Notably, the NC 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. Table 0.1 summarises the status quo of the NC Province

.

**Table 0.1: Summary of Status quo for Northern Cape Province**

| | |
|---|---|
| **Metereology** | • **Mainly semi desert.**<br>• **The eastern region of the province experience summer rainfall areas and thunderstorms. Afternoon temperatures are high, ranging from 34 to 40 ° C in the summer months.** |

| | |
|---|---|
| | • **Most of the province receives minimal summer rainfalls that reach 50 to 400mm per annum, with only a narrow strip along the west coast receiving winter rains.**<br>• **Differential warming between the coastal and inland areas will create strong temperature gradients, conditions favourable for strong winds and storms.**<br>• **Northern Cape is projected to become drier.** |
| **Vulnerability** | NC has fertile agricultural land in the Orange River Valley, especially at Upington, Kakamas and Keimoes, where grapes and fruit are cultivated intensively. The interior Karoo relies on extensive farming with small livestock (sheep and goats) as well as some cattle and a lot of game. The karakul-pelt industry is one of the most important in the Gordonia district of Upington. Agriculture, amongst all sectors, is the most vulnerable. Extreme weather is projected and will affect crop yield considerably.<br><br>The Northern Province depends on mining (diamonds, iron ore, etc.) for economic viability. The majority of the mines in the Province are underground and opencast - e.g. iron ore in Kathu, Sishen. Mining activities require enormous amount of water, and also discard huge amounts of water. The impacts of these activities result in severe degradation of the quality of surface and underground water, and have impaired the integrity of aquatic life in rivers. |
| **Adaptive Capacity** | The Northern Cape Province has also 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 such as Conservation South Africa, SAEON, etc.). |

## 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:
  - 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. Free State, Gauteng, Kwazulu Natal, Limpopo, North West and Western Cape have climate change responses embedded within other plans/tools or strategies e.g. 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 Northern Cape, the Department of Environment and Nature Conservation (DENC)), 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 Northern Cape 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 NC, 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 NC 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 Northern Cape 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)
    - **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 are items will be covered in this report:
- Taking stock of existing information on climate change in NC
- The Status Quo Analysis is accompanied by 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 will include reaching out to these through meetings and interviews
3. Consolidation of the above information into this status quo report.

In addition to the above; information gathered during the inception workshop that was held on the 27 November 2015, with key stakeholders was incorporated in this status quo report.

### 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 was 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.

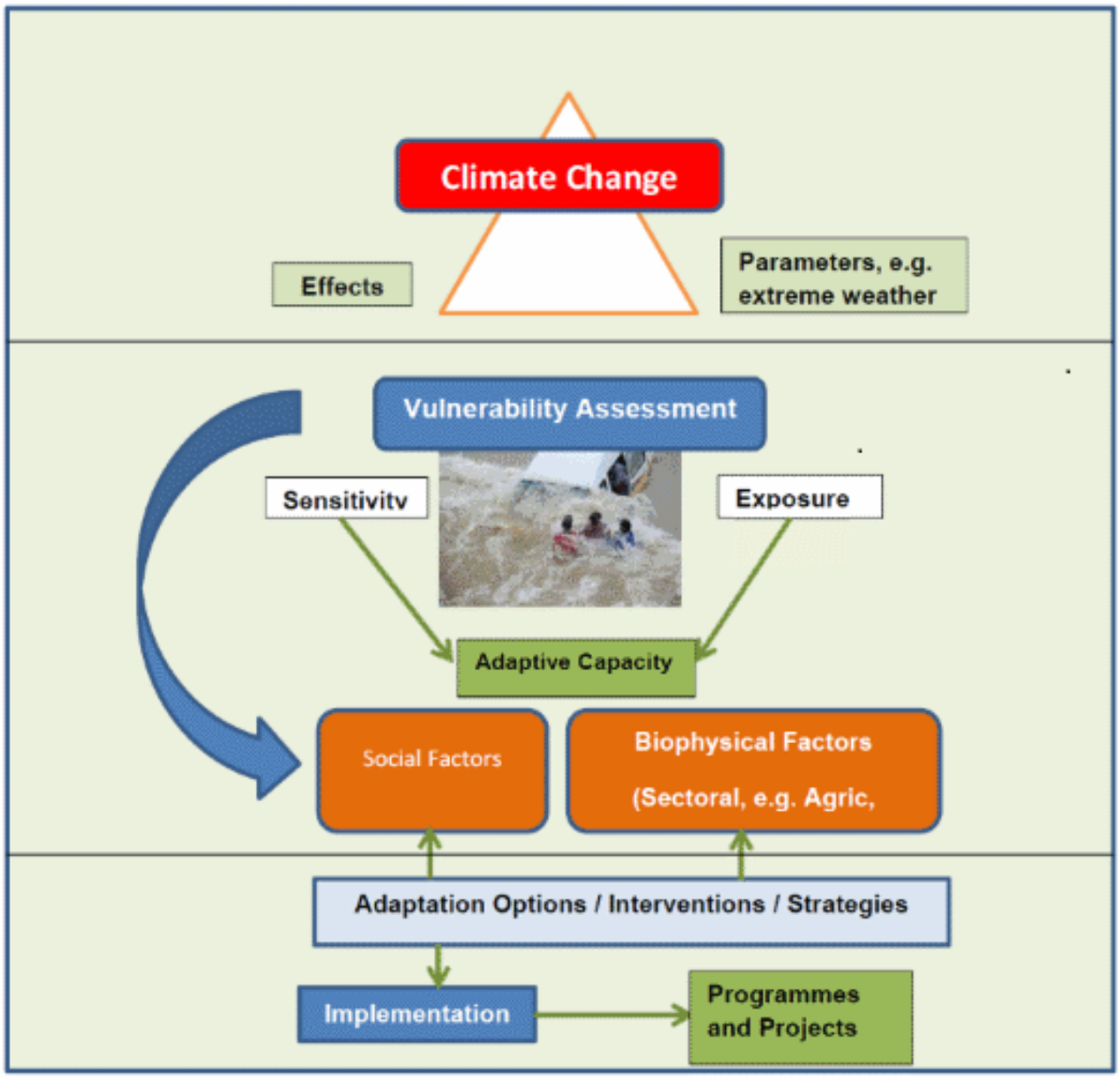



**Figure 3.1: Analytical Framework (See Annexure 1 for definitions of key elements of the Analytical Framework)**

## 4. Status Quo Analysis

### 4.1 Overview of the Northern Cape Province

The vast and arid Northern Cape is the **largest province in South Africa**, taking up nearly a third of the country's land area. It covers an area of 372 889km² and has a **population of 1 145 861**, and is the least populous of South Africa's provinces. It is bordered by Namibia and Botswana as well as the North West, Free State, Eastern Cape and Western Cape provinces. The cold Atlantic Ocean forms the province's western boundary. The map of NC is shown in Figure 4.1 (www.localgovernment.co.za).


**Figure 4.1: The map of Northern Cape Province**

The Northern Cape is divided into five district municipalities (see Table 4.1 below) that are subdivided into 27 local municipalities. The capital city of this province is Kimberley. Other important towns are Upington which is the centre of the karakul sheep and dried-fruit industries, and the most northerly winemaking region of South Africa; Springbok is located in the heart of the Namakwaland spring-flower country; Kuruman and De Aar are the second most important junction of South Africa's railway network. Sutherland is host to the southern hemisphere's largest astronomical observatory; where the multinational sponsored Southern African Large Telescope, Square Kilometre Array (SKA) is commissioned, by the Department of Science and Technology.

**Table 4.1: Northern Cape District Municipalities (Population and areas)**

| District Municipality | Frances Baard | John Taole Gaetsewe | Namakwa | Pixley ka Seme | ZF Mgcawu |
|---|---|---|---|---|---|
| **Population** | 382086 | 224799 | 115842 | 186351 | 236783 |
| **Area ($km^2$)** | 1835.66 | 27283.09 | 126836.34 | 103409.91 | 102524.38 |

The Northern Cape is **rich in minerals**. Alluvial diamonds are extracted from the beaches and the sea between Alexander Bay and Port Nolloth. The **Sishen Mine** near Kathu is the **biggest source of iron ore in South Africa**, while the copper mine at Okiep is one of the oldest mines in the country. Copper is also mined at Springbok and Aggeneys. The province is rich in asbestos, manganese, fluorspar, semi-precious stones and marble.

The **province has fertile agricultural land** in the Orange River Valley, especially at Upington, Kakamas and Keimoes, where grapes and fruit are cultivated intensively. The interior Karoo relies on extensive farming with small livestock (sheep and goats) as well as some cattle and a lot of game. The karakul-pelt industry is one of the most important in the Gordonia district of Upington. Wheat, fruit, peanuts, maize and cotton are produced at the Vaalharts Irrigation Scheme near Warrenton (www.localgovernment.co.za).

The major land uses in terms of area are agriculture (at least 50% of land use, perhaps as much as 80%, depending on how agriculture is defined) and conservation (around 15% of land use). There are currently 38,500 commercial farmers, and roughly 2 million subsistence and communal farmers in the province.

### 4.2 Information collected from stakeholders in the Northern Cape

Table 4.2 shows a summary of climate change vulnerability and adaptation related strategies, initiatives, studies, programmes and projects, etc. that are underway within the Northern Cape province. However, while the documents show the existence of the climate vulnerability and adaptation strategy and programmes at provincial and local levels, this seem to suggest that this is only limited to the responsible department but does not necessary cut across other departments within the province. It is interesting to note that in these documents there is an acknowledgement of the role played by civil society in particular NGOs and private companies. This shows the extent to which climate change stakeholders are working together towards a common goal.

**Table 4.2: Provincial departments that provided information for status quo assessments**

| Department | Information / Documents Provided | Initiatives currently underway |
|---|---|---|
| **Environment and Nature Conservation (DENC)** | • Draft Climate change Strategy for the NC<br>• National INDC Document for SA<br>• Scientific Research papers on NC<br>• Disaster Management Report for NC<br>• Research papers and presentations by CSA – Amanda Bourne | • Early warning systems<br><br>**Initiatives in Namaqualand:**<br><br>• The Namaqualand Wilderness Initiative: Building resilience and adapting to climate change<br>• The Biodiversity and Red Meat Initiative<br>• The Third Planet Enterprise wind energy project<br>• Disaster Management Plan for the NC Province |
| **Water and Sanitation** | Mr Gawie van Dyk presented at the project Inception Workshop, held on the 27 November 2015 | • Rain water harvesting<br>• Boreholes as a temporary measure since ground water will be impacted by increasing aridity in ways that are being observed in the current drought.<br>• Encourage water conservation, demand management, recycling and aartificial recharge (transfer of surplus surface water underground by injecting it into aquifers through boreholes) as response measure |
| **Agriculture, Land Reform and Rural Development** | Research papers | • Awareness Forums<br><br>• Early warning systems |
| **Cooperative Governance, Human Settlement and Traditional Affairs** | Disaster Risk Management document for NC has been published | • Disaster Risk Reduction<br><br>• Early warning systems |
| **Energy** | Documents to be obtained | na |
| **Health** | Documents to be obtained | na |
| **Roads and public works** | Documents to be obtained | na |
| **Education** | Documents to be obtained | na |
| **Social Development** | Research Report:<br><br>Possible effects and impacts of | na |

| | | |
|---|---|---|
| | climate change on the Human Settlements and social development in the Northern Cape | |
| **Sports, Arts and Culture** | Documents to be obtained | na |
| **Transport, Safety and Liaison** | Documents to be obtained | na |
| **Treasury** | Documents to be obtained | na |

*na – not available*

**Table 4.3: Other NC Stakeholders and their climate change related documents**

| Stakeholders | Information / Documents Provided | Initiatives currently underway |
|---|---|---|
| **Office of the Premier** | To be provided | na |
| **South African Weather Service (SAWS)** | To be obtained | Provides support to the Disaster Management Teams<br>Recent future climate change provincial projections (2015 study findings presented by DEA at the inception meeting) |
| **Academic Institutions (e.g. Sol Plaatjie University)** | To be obtained | na |
| **Conservation South Africa (CSA)** | Documents on previous research were provided | • Vulnerability assessment of Namakwa District<br>• Stakeholder engagement documents from meetings and workshops on this topic, based on Let's Respond Tool kit<br>• Climate change vulnerability assessment of the Coastline |
| **SAEON** | Documents to be obtained<br>Dr Joh Henschel; Manager: SAEON-ALN Kimberley; presentation at the Project Inception workshop held on the 27 November 2015, in Kimberly.<br><br>Title: Climate Change Observations by SAEON Arid Lands Node | Climate change related reports and research publications to be provided |
| **San Parks** | Climate change Strategy for CN parks exist and will be shared with the team | Climate change related projects are undertaken. Documents to be provided |
| **Scientific Services** | Documents to be obtained | na |
| **SALGA** | Documents to be obtained | na |
| **WWF** | Documents to be obtained | na |
| **Water Research Commission (WRC)** | Research reports published for the NC to be obtained from the province's Department of Water and Sanitation and downloaded from the WRC website | |
| **Keep Kimberly Clean** | Documents to be obtained | *na* |

| | | |
|---|---|---|
| **WESSA** | *na* | *na* |
| **Industry:**<br>***Mining***<br>***Cement (PPC and Kumba)*** | Documents to be obtained<br>Representatives from these sectors were invited to the Project Inception Workshop on 27 November 2015 | *na* |

*na – not available*

### 4.3 Meteorology of the Northern Cape Province

- Mainly semi desert.
- The western areas of the Northern Cape, including Namakwaland, and some parts of the section of the Upper Karoo fall into the winter rainfall area (April to September).
- The eastern region of the province experience summer rainfall areas and thunderstorms. Afternoon temperatures are high, ranging from 34 to 40 º C in the summer months.
- Most of the province receives minimal summer rainfalls that reach 50 to 400mm per annum, with only a narrow strip along the west coast receiving winter rains.
- Weather conditions are extreme, with cold frosty winters, and extremely high summer temperatures
- The highest incremental increase in temperature by 2050 is found in the desert region of the Northern Cape and the steppe arid regions of Free State and Mpumalanga.
- Warming by 4% compared to the 2% IPCC average aggravated by local positive feedback over the area extending from the **Northern Cape** towards Namibia (SAWS)
- Differential warming between the coastal and inland areas will create strong temperature gradients, conditions favourable for strong winds and storms.
- **Northern Cape** is 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 often results in flash flooding and land degradation.

### 4.4 Climate Change Vulnerable Sectors within Northern Cape Province

Climate change presents a significant challenge to human well-being. It is likely that climate change will exacerbate the existing vulnerabilities of people in South Africa, particularly in the semi-arid Northern Cape Province.

The latest IPCC[1] report completed in 2014 defines vulnerability as the propensity or predisposition to be adversely affected by changing climate conditions. The term vulnerability

[1] UNFCCC Intergovernmental Panel on Climate Change, 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Parts A and B: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

encompasses a variety of concepts and is made up of exposure (or the extent to which one is subjected to a hazard), sensitivity (or susceptibility to harm), and adaptive capacity (or ability to cope and respond).

South Africa's Long Term Adaptation Scenarios have focused on assessing vulnerability to climate change, and identifying adaptation responses, for the Water, Agriculture, Marine Fisheries, Biodiversity, Human Health, Human Settlements, and Disaster Risk Reduction sectors. Researchers such as Ziervogel et al. (2014) have also focused attention on these areas nationally. Understanding climate change impacts on these sectors is critical for the Northern Cape Province, if the region is to be able to effectively plan for and adapt to the anticipated changes. Locally, officials have identified water, agriculture, industry (e.g. mining) and the built environment, and disaster risk management as the sectors of most critical importance for climate change adaptation planning.

It is critical to acknowledge that healthy functioning natural ecosystems underpin healthy functioning water, agriculture, and social systems and are the foundation upon which social and ecological resilience to climate change must be built in order to reduce the vulnerability of the people living in the Northern Cape Province. Climate is a cross-cutting issue, with the potential to affect the built environment, service delivery, the natural environment, the economy, and human health and well-being in equal measure. It is important that climate change is seen not as a concern for the environment only, but one of sustainable development and integrated planning in the Northern Cape Province. Fundamentally, in the Northern Cape Province, sound management of natural resources will prevent or at least minimise risks posed by changes in surface water runoff, soil erosion, flooding, fire, storms, and sea level rise. The ecological infrastructure of the Northern Cape Province is its primary climate response asset and damage to it can significantly increase the risk that the Province faces.

### 4.4.1 Water

Water is crucial for drinking, health, sanitation and agriculture, and it is also important for industry, power generation, mining operations and tourism (Claassen, 2010:4). Irrigation in agriculture forms the largest single surface water user in the province. All large scale agriculture in the Northern Cape relies on irrigation. There are also small-scale farmers and the rural poor who practice rain-fed agriculture. The Northern Cape is extremely water scarce in general. Water quality and water availability is the primary challenge in the Northern Cape currently and is set to be exacerbated by climate change impacts.

Furthermore, the Northern Cape Province depends on mining for economic viability, for example the large iron ore mines at Kathu and Sishen. Mining activities require enormous amount of water, and also discard huge amounts of water. The impacts of these activities can result in severe degradation of the quality of surface and underground water, and can impair the integrity of aquatic life in rivers, and must be carefully managed.

The Northern Cape Province falls into, mainly, the Lower Orange and Lower Vaal Water Management Areas (DEA 2013 – water). In these areas water demand already matches (Lower

Orange) or exceeds (Lower Vaal) water availability. With water demand projected to increase in the near future as a result of development, and climate change in the longer term, current water use practices leave no room for water resources to be developed to meet the changing demand. Water demand management and recycling initiatives will have to be implemented. In addition, the Department of Water Affairs has also produced a climate change adaptation strategy outlining 6 water related climate change zones. The Northern Cape Provinces falls primarily into Zone 4, The Orange System, and also parts of Zone 3, the Vaal System. Climate change impacts projected for the water sector include:

- Highly uncertain future rainfall in the inland , summer rainfall areas
- Already a water scarce zone in the western winter rainfall and coastal areas and these are projected to become drier
- Likely increase in storm activity and large rainfall events.
- Significant increase in temperatures
- Increase in water demand from agriculture
- Increase in demand for power generation
- Increase in domestic demand

An increase in air temperature will lead to an increase in water temperature. Increased water temperatures could affect, inter alia, the quality of water for irrigation, dissolved oxygen content of water, the rates of chemical and biological reactions in water, and could have wide ranging repercussions on the health sector through the creation of favourable conditions for the incubation and transmission of water-borne diseases. On the other hand, heat waves can lead to short-term water quality impacts.

Increasing temperatures as a result of climate changes is also likely to lead to additional evaporation of water from open surface water storage bodies such as dams, wetlands, and the soil. Evaporation concentrates salts and other constituents in the remaining water and soil, resulting in the reduction in the quality, as well as the quantity of water / moisture available. Increasing salinity as a result of evaporation is likely to be a very serious impact of climate change in the Northern Cape with the mean annual temperatures increasing at twice the rate of the rest of the country, regardless of climate change impacts on actual rainfall patterns. Already dry areas will experience further water loss, and irrigation demand will increase.

A large proportion of water in the Northern Cape also comes from groundwater, Groundwater levels have been demonstrated to drop significantly during drought periods and this can be expected to be exacerbated by climate change. Increasing the number of boreholes and levels of abstraction of groundwater is unlikely to be a sound adaptation measure and adaptation must focus on water conservation, demand management, and recycling. Artificial recharge is a groundwater management technique that may play an increasing role in maintaining South Africa's water security. Artificial recharge is the transfer of surplus surface water underground by injecting it into aquifers through boreholes. The advantages include lower evaporation losses, which will become especially critical as higher temperatures increase evaporation of stored surface water.

### 4.4.2 Agriculture

The Northern Cape Province is well known for its extensive commercial livestock and game farming in the inland areas, and intensive irrigated crop farming in the fertile agricultural land along the Orange River valley (Jordaan et al., 2013) and Lower Vaal system. The Province is also home to roughly 1 million hectares of communal land, located in the ZF Mgcawu and Namakwa district municipalities. Communal lands are primarily utilised for small scale livestock production. According to the Northern Cape Department of Agriculture, Land Reform and Rural Development (Thuinesen, 2015), agriculture is a highly vulnerable sector in terms of climate change. Food security and water security are both fundamentally at risk from the impacts of climate change. All farming communities, whether private or communal, and no matter what the scale of their operations, are vulnerable to climate variability and change.

The following is a summary of projected changes in Northern Cape Province's livestock farming sector as a result of climate change:

- For every 1° that day time temperatures exceed 30°C, most breeds and varieties of livestock reduce their feed intake dramatically. In some case, feed intake has been observed to decrease by 5% per 1° above 30°C. Reduced feed intake reduces the productivity of all forms of livestock, and how an animal responds to heat stress may well come to influence breed and species choice for farmers
- While deaths from heat stress are rarely if ever observed, milk yield and conception rates have both been observed to decrease when temperatures are high. Negative impacts of increased temperatures can also include lower reproductive rates and weaning weights (Scholtz et al., 2013). Lower reproductive rates have enormous potential economic consequences as livestock production in South Africa's arid zone is only marginally competitive as it is (Meissner and Engelbrecht, 2013).
- Some projected spatial shifts in biome are likely to have severe consequences for the carrying capacity of the land for grazing livestock. Currently the Desert Biome and drier parts of the central Nama Karoo biome require as much as 60 hectares to support 1 large stock unit. Parts of the Green Kalahari can be relatively productive, requiring by contrast between 15 and 30 hectares per large stock unit. Should the Desert Biome expend into these areas, as is projected in the ZF Mgcawu and Namakwa Districts under the high risk climate change scenario, farmers will almost certainly see a dramatic reduction in the carrying capacity of their land. Although at the scale of the Northern Cape, biome stability modelling has only been carried out to 2050, the modelling work in the Namakwa District which extends to 2100 demonstrates that these impacts can be only expected to be more severe and widespread in the longer term. The nutritional value of natural forage is very likely to be impacted by climate change in all of the biomes.
- Climate change may also alter patterns of animal diseases. This may include the emergence of new diseases and/or changes in the prevalence of existing diseases, particularly those spread by biting insects. With increasing aridity, risks of livestock losses as a result of the ingestion of toxic plants increases.
- The Northern Cape is a location of severe temperature extremes. Emerging research from the winter rainfall regions suggests that sudden cold snaps at the end of long, hot dry seasons are the cause of the majority of livestock losses. Losses to exposure could increase if animal condition is increasingly compromised by longer, hotter, drier summers, where little forage is available and livestock must walk long distances for water.

- Although game farming is a serious industry in the Northern Cape, contributing more than 20% of all game farmed in South Africa's multi-billion Rand game ranching industry, there is no available information on the expected impacts of climate change on the game farming industry. This is a clear research need. However it is also an opportunity as many of South Africa's rare, and most valuable, game species are arid zone species and could prove more adaptive than livestock.

The following is a summary of projected changes in Northern Cape Province's crop production sector as a result of climate change:

- The Northern Cape is a large scale producer of irrigated fruit crops, particularly grapes, in the fertile river valley along the banks of the Orange River. Table grapes require a hot, dry climate and climate related changes to water availability for irrigation will be a much greater issue than rising temperatures. Increasing yields are possible in well-managed, irrigated vineyards, provided there is sufficient water (Shultze 2010, Hannah et al 2013).
- In South Africa, downy mildew, powdery mildew, Botrytis bunch rot and die-back are the most important fungal diseases found on grape vines; mealybugs, fruitfly and ants are the most important insect pests; and leafroll virus is the most important viral disease. Canopy density may be promoted by $CO_2$ fertilisations, and powdery mildew will be more severe under hot dry conditions with a low light intensity under the canopy. Increasing Botrytis bunch rot is also a risk under denser canopies and in warmer regions unless irrigation is carefully implemented to avoid soaking the leaves (Carstens and Vermeulen, 2010).
- Rising temperatures may lead to a change in plant phenology and thus agricultural work cycles. For example higher temperatures may lead to earlier bud break, ripening, a harvest for fruit crops
- There may be an increased need to cooling facilities, increased use of air conditioners, or purpose built storage facilities for longer periods of the year and more hours of the day, to ensure the quality of produce after harvesting, while it is stored and transported.
- A decrease in rainfall and/or an increase in pressure on limited water resources as temperatures rise and aridity increases, could lead to a reduction in water resources for irrigation that are already under severe pressure
- Higher temperatures could damage crops through 'crop burning'. Higher temperatures and longer dry periods could also directy stimulate and promote veld fires, presenting a direct threat to crops.
- The Northern Cape produces about 300,000 tonnes of wheat per year on irrigated lands at the Vaalharts irrigation scheme near Warrenton, in Frances Baard District on the border with the north-west. Water is supplied from the Vaalharts dam. Again, the long term availability of water will determine the fate of this irrigated food production system.

There will also be impacts of climate change on farm workers. DEA 2013 – Agriculture demonstrates that the Northern Cape, particularly along the Orange River, in the low-lying parts of the Richtersveld, and into the Kalahari, is likely to experience some of the highest levels of heat stress in the country, with 50-100 days a year classified as uncomfortably too hot and humid historically. Climate projections suggest that the number of thermally comfortable days is likely to decrease to fewer than 50 days per year by 2050. Thermal discomfort on more days of the year, and particularly in the summer months, implies a possible reduction in the productivity of farm

workers. This may be offset by an earlier start to the working day, or restructuring the working day into two distinct sessions with a longer midday break between them. Team need to refer to World Farmers Organisation (WFO)'s position on climate change issues in this sector.

### 4.4.3 Biodiversity

In 1997, a team of ecological economists led by Robert Costanza estimated the value for global ecosystems services for people at between US$16 and US$54 trillion per year, compared to the global total gross national product of US$18 trillion per year. South Africa has one of the richest biodiversity counts in the world, and ecological economists more conservatively estimated the value of ecosystems services in the country as roughly R73 billion, or 7% of gross domestic product (TEEB state of play report 2012). Water, food, shelter and energy are just some of the basic essential services derived from nature, and are the basis of all life and industry. Significant biodiversity losses are projected for the Northern Cape Province.

South Africa has nine biomes, six of which occur in the Northern Cape Province. These are the Nama Karoo Biome, the Succulent Karoo Biome, the Savanna Biome, the Desert Biome, and small areas of the Grassland Biome (to the south east), and the Fynbos Biome to the south west). Each biome has a characteristic climate envelope – a range and pattern of temperature and rainfall values – within which it occurs. Here, we identify areas of climate change risk and stability for vegetation biomes occurring in the Northern Cape.

The Northern Cape's portions of the Succulent Karoo, Fynbos, and Desert Biomes occur almost exclusively in the Namakwa District to that used in LTAS (biodiversity report) this assessment identified which of the biomes in the Namakwa District are likely to be most sensitive to projected changes in temperature and rainfall in the medium (50 year) and longer (100 year) term, using three different GCMs. The following is a summary of projected changes in the climate envelopes associated with NDM's four biomes.

- Conditions associated with the Desert Biome gradually push southwards in the short term and continue with this trend in the longer term. The Desert Biome envelope is projected to replace much of the northern sections of what is currently the Nama Karoo Biome envelope;
- Areas with a climate envelope characteristic of Fynbos persist in the medium term, but are largely displaced by Succulent Karoo in the longer term; and
- Areas with a climate envelope characteristic of the Succulent Karoo Biome are largely retained over both the short and longer term.

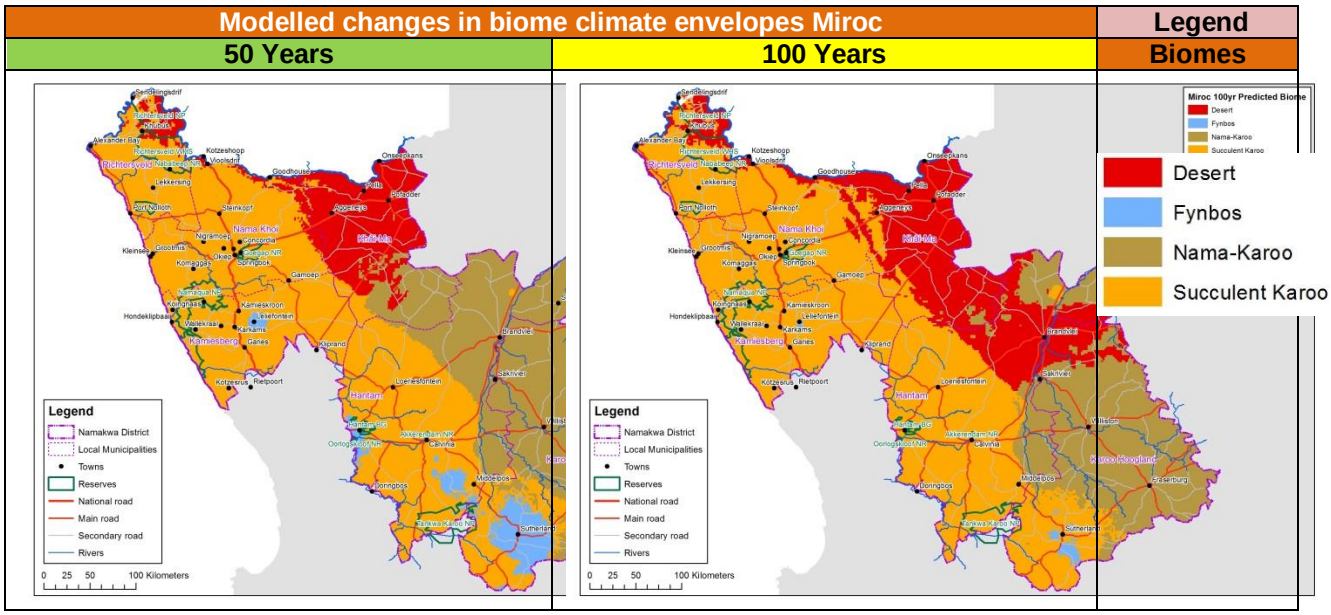



**Figure 4.2: Maps of biome impacts, clockwise from top left. 1) Projected changes in climatic suitability for the biomes in the Namakwa District Municipality (NDM), medium term, 2) projected changes in climatic suitability for the biomes on the NDM, long term (Bourne et al., 2015)**

It is important to note that some biomes, such as the Succulent Karoo, encompass a fairly broad range of climatic conditions. Therefore, a specific site could experience fairly large changes in precipitation and temperature while still remaining within the broad envelope of climate conditions currently associated with that biome. An area which is currently in the coolest and moistest portions of the biome may end up with a climate more similar to the hottest and driest parts of the biome currently. Additionally, the Succulent Karoo with its temperature extremes, aridity, and winter rainfall patterns, is unique and so even if conditions have changed significantly, new climate conditions are still likely to be closer to the Succulent Karoo climate envelope than to that of another biome. This likely explains the apparent stability in the Succulent Karoo biome reflected here.

For particular species, such changes may well result in local extinction. However, as the site is still within the envelope of conditions associated with that specific biome, the area as a whole is likely to remain structurally similar and retain a suite of biome specific species. This does not imply that the change will not be extremely serious for a very large number of species and therefore results presented here must be treated with caution and without complacency.

In areas where biomes are most at risk of ecological composition and structural change, it is particularly important to retain natural features in the landscape that will allow ecosystems and

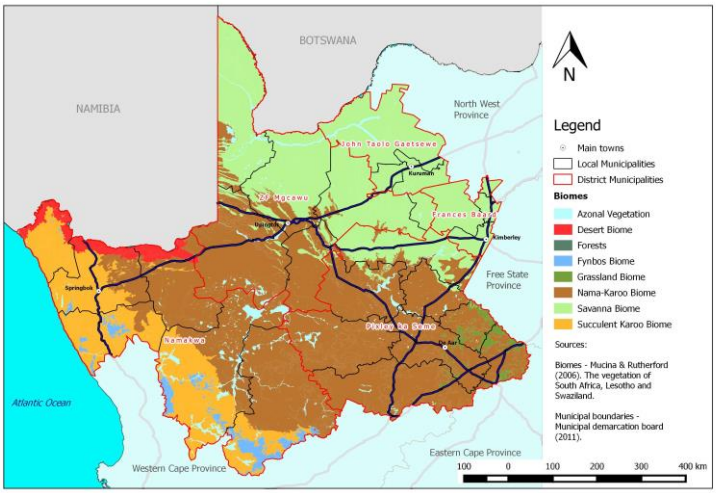
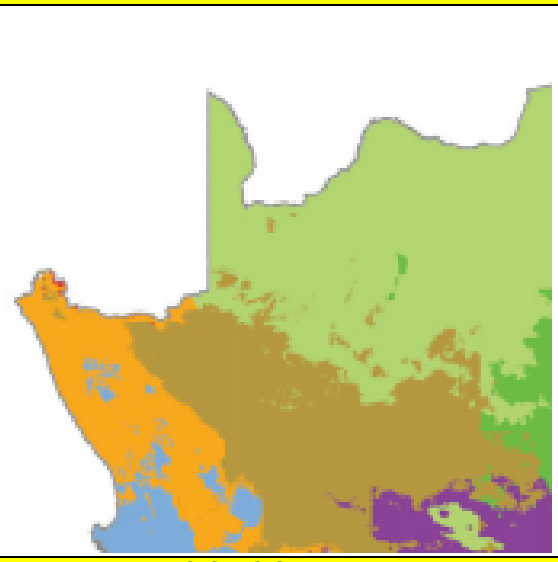
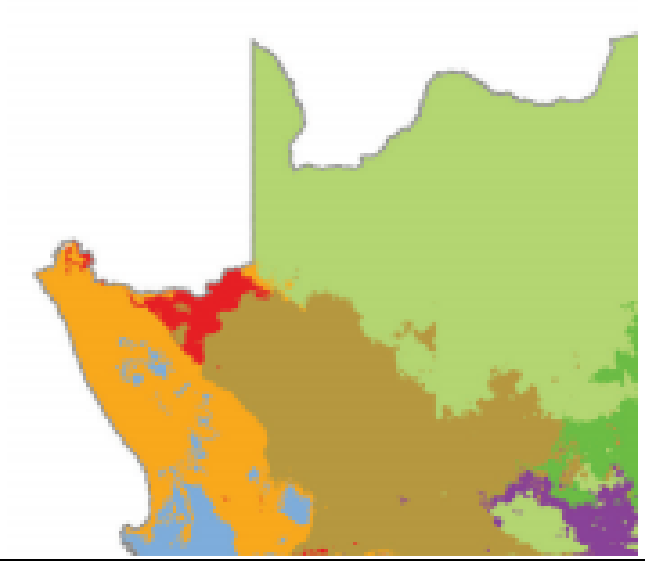
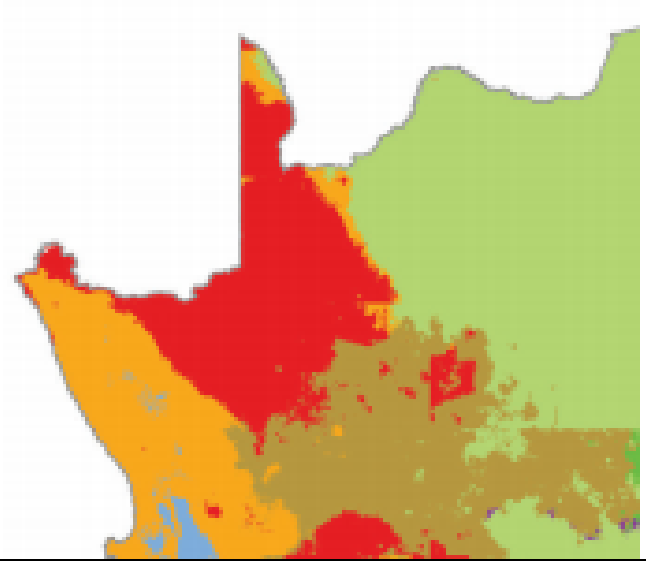
species to adapt as naturally as possible. An example of such a feature is corridors of natural habitat that enable species to move along an altitudinal gradient. Corridors have been used extensively in past conservation planning.

Areas where biomes are most likely to be stable in the face of climate change present good opportunities for the location of new or expanded protected areas. These areas are more likely to retain their current composition and structure and thus to effectively represent the ecosystems concerned.

LTAS used a similar approach to understand likely biome climate envelope stability at the national scale, which we have used to consider these impacts on the rest of the Northern Cape, where the level of assessment completed for the Namakwa District has not been undertaken. Using the 10$^{th}$ and 90$^{th}$ percentile changes and the medians for temperature and rainfall change projections from the same three GCMs, the LTAS team developed a low, medium, and high risk scenario for biome stability. For LTAS these analyses were only conducted for the medium term time period (to 2050). Clipped to the Northern Cape Province, the following is a summary of projected changes in the climate envelopes associated within the Northern Cape Province's six biomes (DEA 2013 – biodiversity)

- The Desert Biome climate envelope is likely to expand substantively under the high-risk scenario, encroaching on current areas of both the Succulent Karoo Biome and large parts of the northern Nama Karoo Biome, but shows no expansion in the Northern Cape in the low-risk scenario;
- The climate envelope found in large areas currently representative of the Nama-Karoo Biome is likely to resemble arid Savanna Biome under the low-risk and intermediate scenarios, and a Desert Biome climate envelope under the high-risk scenario;
- Although the climate envelope suitable for Savanna Biome is likely to expand significantly in the future, and specific savanna species are likely to benefit, this does not necessarily benefit existing habitats and species assemblages;
- The northern sections of the Fynbos Biome are likely to experience climate stress, with the climate envelopes in these areas becoming more like the Succulent Karoo Biome under all climate scenarios;
- Tree dominance is projected decline in the Northern Cape, where biome modelling suggests an expansion of desert type bioclimatic conditions;
- High potential rates of species richness loss is projected in the north central and north east of the Northern Cape, particularly around the Kgalagadi Transfrontier Conservation Area. This area is at risk of potential aridification and the expansion of the Desert Biome in the higher risk climate scenarios.

- As concluded in earlier studies (e.g. Kiker, 2000), the Grassland Biome appears to be the South African biome most at risk of significant change under all the scenarios. Although currently occurring only in small patches on the south eastern boundary of the Pixley ka Seme in the Northern Cape, areas with a climate envelope suitable for the Grassland Biome are projected to be greatly reduced under all scenarios.

| Modelled changes in biome climate envelopes – scenarios for Northern Cape | |
|---|---|
| **Current – map by Louise Geldenhuys** | **Low Risk – LTAS** |
|  |  |
| **Medium Risk – LTAS** | **High Risk – LTAS** |
|  |  |

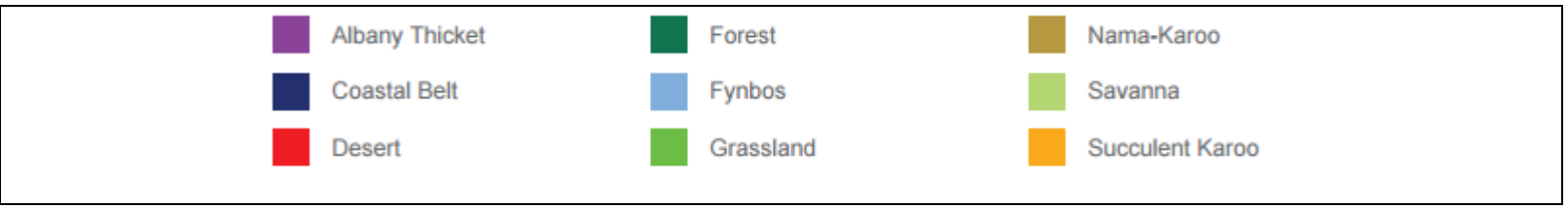



**Figure 5.3: Projections of climatic envelopes for Biomes in the Northern Cape under low, medium, and high risk climate scenarios, looking ahead to approximately 2050. The Low Risk map simulates the impacts on biome climate envelopes of a relatively wet and cool climate future; the Medium Risk map simulates the median temperature and rainfall projections; and the High Risk maps simulates the relatively dry and hot climate future.**

While there are no consistent records of past extreme events, the Namakwa District's 2010 Disaster Risk Reduction (DRR) Strategy identifies coastal storms, such as the one experienced at Port Nolloth in 2009, along with floods, strong winds and droughts as some of the greatest threats to the coastal areas in the Province. There is also a high risk of drought and veld fires in the summer rainfall areas of the Province which are likely to have significant impacts on rangeland and livestock health.

### 4.4.4 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. The basic requirements for maintaining health such as peaceful societies, clean air, sufficient clean drinking water, sufficient food and adequate shelter - may all be affected by a changing climate. Malnutrition and natural disasters, as well as non-communicable diseases, are important risks in the South Africa human health sector. South Africa must respond to health risks associated both with human development issues, such as nutrition and infant mortality, and lifestyle diseases more commonly associated with developed countries, such as cardiovascular disease.

Currently, roughly half of all deaths in the Northern Cape are the result of non-communicable disease, such as diabetes, heart disease, and cancer. Climate change will impact on morbidity and mortality associated with non-communicable diseases both directly, by aggravating symptoms as a result of air pollution and temperature extremes, and indirectly, by affecting food production and contributing to malnutrition and food insecurity. Studies from Europe and the United States show that extreme heat directly affects the number of hospital admissions for cardiac complaints. Increases ozone concentrations associated with higher temperatures are also associated with heart attacks. The areas are prone to increase in the frequency or intensity of heat waves, which increase the risk of mortality and morbidity among risks groups such as people with pre-existing health conditions, including cardio-vascular disease, young children and the aged. Notably, as intense heat puts strain on the heart and can lead to dehydration, the symptoms of diabetes and heart disease suffers can be significantly worsened by extreme temperatures. A predicted heat wave should prompt a rapid response to prevent heat-related deaths in vulnerable subgroups such as the elderly (by Blois et al., 2011)

People doing manual physical labour in non-cooled environments are also at risk of increased heat stress and dehydration. It is recommended that that physical activity be reduced during hot weather as an adaptation response; and exposed people be made aware of the symptoms of heat exhaustion and heat stroke; working people may well need to reduce their labour hours. Working in hot environments results in more workers being exposed to heat stress and excessive exposure to this environment can result in health effects such as heat fatigue and dehydration. Marked increases in thermal discomfort on more days of the year are projected for the Northern Cape, especially in summer months. This could become a serious economic loss as climate change brings on more hot days, particularly in the mining and agricultural sectors central to the Northern Cape economy.

The next largest category for cause of death in the Northern Cape is communicable disease, such as tuberculosis and diarrhoeal diseases, along with malnutrition. More than two thirds of infant deaths are the result of malnutrition and preventable communicable diseases. Precipitation in the Northern Cape 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 of 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.
The transmission of communicable diseases in South Africa is related to rainfall, temperature and wind. Non-climatic factors such as water insecurity, lack of proper sanitation and population density also influence cholera transmissions. Cholera is a well-known example of a communicable, diarrhoea and water-borne disease in South Africa. The transmission of cholera is linked to rainfall and temperature (air and sea surface) and, as such, it is likely that it will be affected by climate change-induced changes in rainfall and temperature regimes (DEA, 2013 - health).

HIV/AIDS is the leading cause of death for women under the age of 35, while injury is the leading cause of death for men under the age of 35. It is unclear how climate change might impact on risk-taking behaviours amongst others. Lastly, the frequency and intensity of natural disasters such as storms, floods, droughts, and veld fires, are likely to increase as a result of climate change (DEA 2013 – health). .Health impacts from natural disasters can be immediate (e.g. death) and direct (e.g. injury) and long-term (e.g. food insecurity/unavailability linked to impacts on agricultural production such as crop yields), or fairly indirect (e.g. changing vector abundance through habitat destruction or creation), and are difficult to project with the current knowledge base.

### 4.4.5 Oceans, Coasts, and Marine Fisheries

The Northern Cape has approximately 250km of cold-water Atlantic coastline, all in the western Namakwa District Municipality. A vibrant fishing industry is found along this stretch of the South African west coast, especially in Port Nolloth, the major resort town of the Namakwa District, and Hondeklipbaai. Much of the remaining coast has been closed to the public and mined for alluvial diamonds for many decades. The devastating footprint of these mining activities is clearly visible from Google Earth. The Orange River estuary at Alexander Bay, and the Groen and

Speog river estuaries further south in Namaqua National Park, are important ecosystems for marine and coastal biodiversity. The Orange River estuary is a Ramsar site.

The west coast fisheries focus on sardines, Cape hake, anchovy, mullet, linefish, and rock lobster. Cape hake, sardine, and anchovy catch rates have fluctuated dramatically in response to fishing and management practices. Fishing poses huge pressure on the marine biodiversity, and over-fishing the greatest threat to future fish production, sustainability, and resilience. Climate change is likely to have an impact on the productivity and diversity of these marine fisheries, by changing the abundance, distribution, and size of resources, their habitat extent, condition, and connectivity, their physiology and behaviour, and the catchability of resource species. Changes in sea surface temperatures, storm frequency, freshwater flow and runoff patterns, productivity, oxygen levels and wind will have impacts on estuarine, inshore and offshore ecosystems, affecting recruitment, fish behaviour and physiology; thus influencing fish size, and increasing fish mortalities. This could result in significant adverse impacts on subsistence fishing livelihoods as well as commercial and recreational industries. Directional shifts in the spatial distribution of several marine species, which are possibly attributable to climate change trends, have already been recorded around South Africa's shores, including on the West Coast. Poorly managed fishing activities leave exploited species more vulnerable to environmental variability and to climate effects.

Projecting climate change impacts on marine fisheries is difficult because of the complex relationships between species distribution patterns, variations in their abundance, distribution and productivity, and the impacts of overfishing and other stressors. Nonetheless, with increases in temperatures, it is hypothesised that it is likely that metabolism and consumption rates will increase in fish and invertebrates. Thus, increases in west coast rock lobster catches are possible if accompanied by sound management. While an increased abundance of west coast rock lobster has been observed on the south coast of the Western Cape, catch rates of west coast rock lobster in the traditional fishing grounds for this species along the west coast declined dramatically in the 1990s due to environmental factors. Should climate changes continue to drive distributional shifts like those observed, the west coast rock lobster industry in Namakwa could be negatively impactedSeveral climate models project an accelerated rate of sea level rise over the coming decades (Solomon et al., 2007). An assessment of sea level rise in South Africa, using available tide gauge data for the last 50 years, shows a 1.87 mm.y–1 rise on the west coast (Mather et al., 2009). In terms of sea level rise and storm surge, the Namakwa coast is usually viewed as characterised by relatively low vulnerability. This is because it is already a high intensity coastline, dominated by big swell, and it has evolved a steep and rocky profile as a result of this. This profile is less sensitive to erosion or damage by wave action than softer, flatter coastlines. Additionally, there is relatively little valuable infrastructure along the coastline close enough to the high water mark to be vulnerable to severe damage from coastal storms and sea level rise.

These assessments are relative to national levels of risk, determined according to the size and value of coastal settlements and infrastructure. While small relative to national, there are locally important coastal settlements and infrastructure that have greater potential to be impacted by sea level rise and storm surge. The obvious example of locally important coastal infrastructure at risk is that which was damaged in the 2009 and 2015 coastal storms at Port Nolloth. Sea level rise is, at the moment, very gradual.

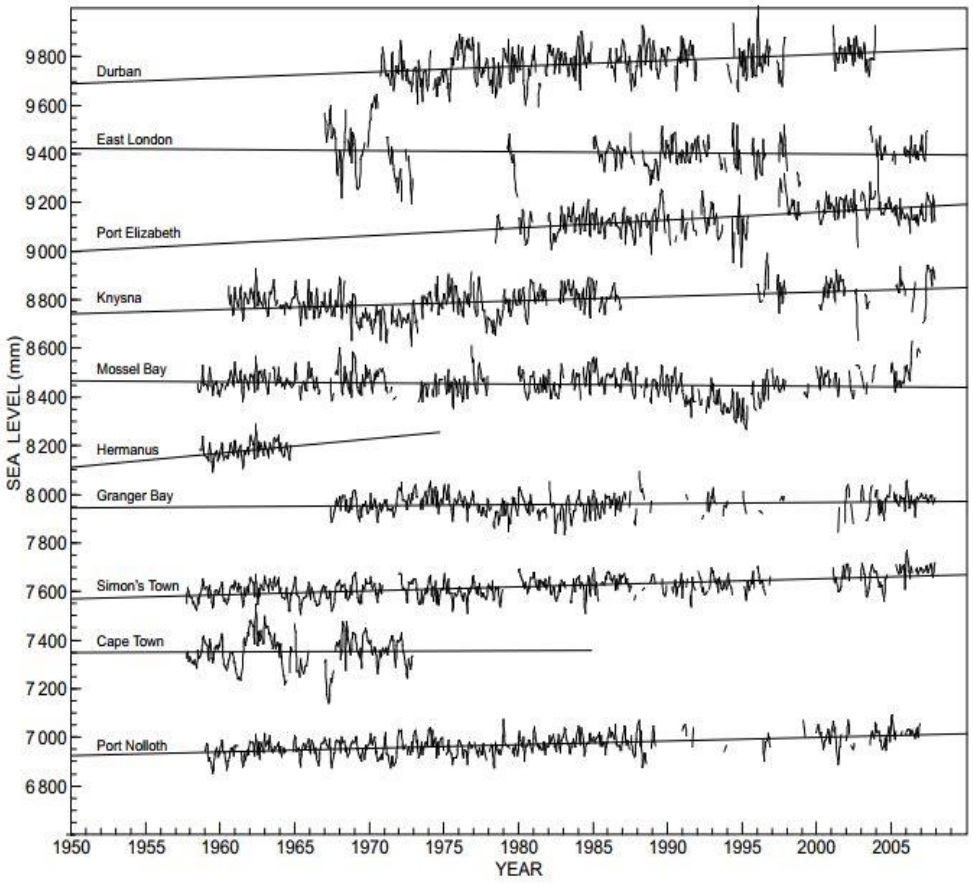



**Figure 4.4: Port Nolloth (bottom line on the above graph) has a long record of tides, dating back to the late 1950s. This graph shows fairly consistent tidal activity (not very variable), but there is a clear gradual trend demonstrating local sea level rise. This is likely linked to either an increase in the number or the intensity of low pressure cells off the coast causing a doming effect on the ocean surface (Mather et al., 2009).**

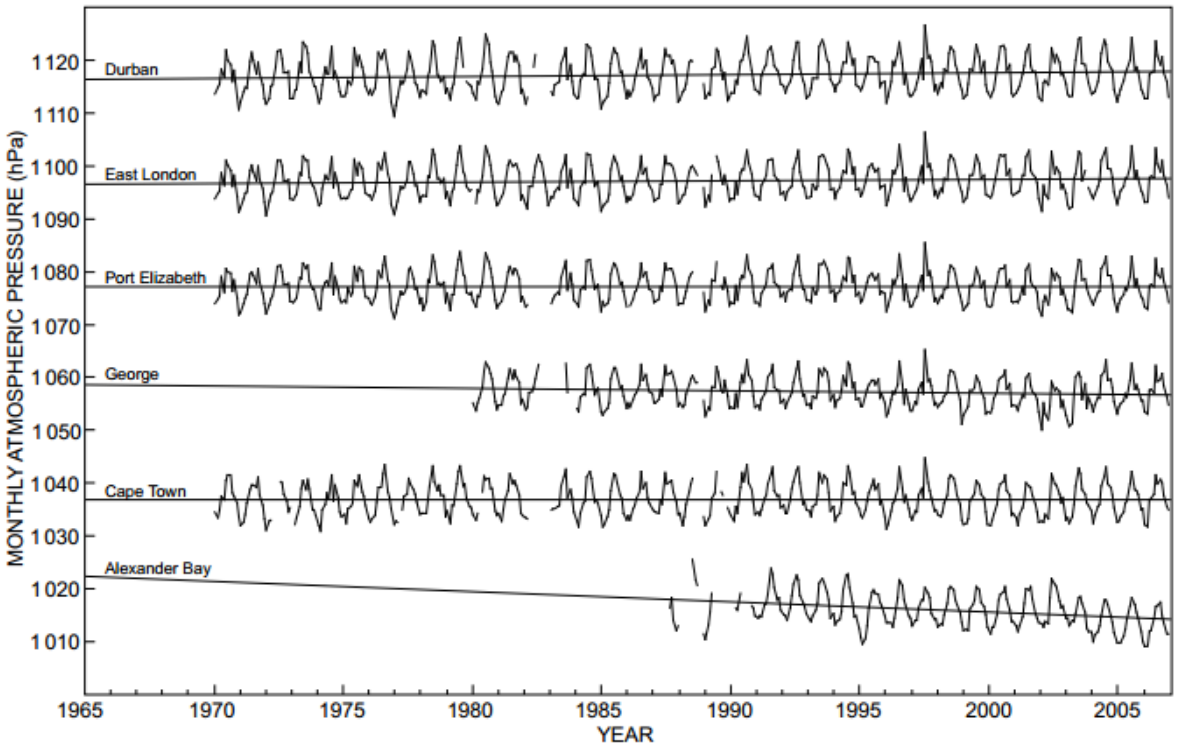



**Figure 3:** Monthly barometric pressure recordings for the different stations, 1970–2007

**Figure 5.4: This graph shows atmospheric pressure – Alexander Bay is at the bottom. Here, a clear trend of lower atmospheric pressure is noted. This would cause the recorded sea level rise shown for Port Nolloth on the previous page (and potential doming of the sea surface). In combination with high tides and strong northerly winds, these low pressure cells can cause storm surges and lead to coastal inundation (Mather et al., 2009).**

Atmospheric pressure near the Northern Namakwa coast is dropping. This has been predicted by climatologists as an impact of climate change caused by global warming and resulting changes to the Hadley cell systems. Mather et al (2009) suggest that low pressure systems off the west coast are shifting southwards and increasing in frequency and/or intensity. This is likely to affect rainfall as well as fewer cold fronts will make contact with the Namakwa coast.

The impact of sea level rise is also complicated at estuaries, where there may be an additional impact of inland rainfall and riverine flooding, and there is a very high risk of damage to estuaries caused by inundation with sea water. Salt water intrusion into coastal freshwater aquifers, a locally critical source of freshwater, is also a potential risk. Scenarios of more extreme rainfall and dry spells, coupled with sea level rise, could cause damage to or even the loss of nursery habitats essential for prawns and estuarine fish. It is projected that the west coast estuaries will display a decrease in primary production as well as a direct loss of nursery habitat as e result of

sea level rise. Seasonal shifts in rainfall could confuse behavioural cues at critical life stages such as migration or spawning.

Increased storm activity under a changing climate will have a significant impact on fishing activity by reducing the number of viable sea fishing days, increases risk for fishers, and damaging shore-based offloading facilities and fishing vessels, as has already been observed in Port Nolloth in 2009 and again in 2015.

### 4.4.6 Human Settlements

There are a number of environmental risks posed by climate change to human settlements. These also interact with existing socio-economic vulnerabilities. Rural, coastal, and urban settlements in the Northern Cape are all likely to be impacted differently by climate change. Environmental factors that drive vulnerability and are likely to be exacerbated by climate change include increased temperatures, extreme weather, sea level rise, and coastal storm surges. Pre-existing socio-economic drivers of vulnerability include access to basic services, type of dwelling, health, poverty and unemployment, and demographic factors such as age and gender.

In the urban centres of the Northern Cape, such as Kimberley, Upington, Springbok, and a host of smaller towns, impacts of climate change are complex and diverse, acting both directly and indirectly on inhabitants. Extreme weather impacts directly on infrastructure and buildings, such as damage to roads, dams, and houses by floods, and also on industry by reducing the productivity of construction or agricultural workers. Access to sufficient clean water is a primary vulnerability in human settlements, towns and cities. In the Northern Cape there are very few surface water resources. For example, in the Namakwa District, water is piped for a distance of over 120km from the Orange River to Springbok. Supplying piped water to those who do not have it is a serious challenge already, along with maintaining rapidly deteriorating existing infrastructure. Higher temperatures will increase demand and place increased pressure on water quality.

In general, poor households located in peri-urban settlements are likely to experience heightened vulnerability to climate change not only as an intrinsic consequence of socio-economic demographics, but also as a consequence of the distances wage earners need to travel, inadequate access to basic services, insecurity of tenure, and physical vulnerabilities of informal, unplanned or poorly planned housing. Informal settlements on the urban periphery are often located in areas that are unsuitable for human settlement due to local topographical features such as unstable soils, wetlands and flood risks. Low cost housing estates are also a feature of urban and peri-urban areas. These are often constructed on degraded lands and in some instances with low quality building material. Price has played a defining role in the design and construction of low cost housing and these structures are generally not “climate-proof”. They are structurally vulnerable to extreme weather, poorly insulated against temperature extremes, and prone to leaks and flooding during heavy rainfall (LTAS, 2012 – human settlements).

Rural economies are primarily dependent on agriculture and tourism, which are directly and indirectly vulnerable to climatic changes. Climate change related shifts in biodiversity and the productivity of ecosystems in terms of ecosystem services are a large source of potential risk for farming communities. Farming activities are often determined by and dependent on the climate

envelope, seasonal weather patterns, and associated biome type – for example extensive livestock farming is a large industry in the Nama Karoo that would come under immense pressure with the increasing desertification projected by the biome stability models presented in section 5.4.2. Rural communities in the Northern Cape live in isolated and remote settlements, where they can easily be cut off from health and emergency services as a result of roads being damaged by floods.

Lastly, as discussed in the preceding section on coastal impacts; coastal settlements are vulnerable to sea-level rise, storm surges and coastal flooding, and the impact of climate change on the marine environment and estuaries, including ocean acidification, higher sea temperatures, and changes to ocean currents. In addition, Dry spells and droughts are likely going to concentrate effluent discharges, potentially damaging coastal ecosystems and their dependent fishing economies.

# 5 Conclusion

The Northern Cape Province is prone to a myriad of extreme climate events because of its geographic location, which result in the high likelihood that inland areas will warm much more dramatically than coastal areas. The resultant risk factor for this region is the fact that it is already water scarce and extremely hot - and these current climatic risks are likely to be exacerbated by climate change. The NC is currently water scarce and extremely hot during the summer months. This province is already badly affected by recurrent severe droughts and other extreme events. In terms of the plausible climate futures for South Africa, the NC can be expected to suffer increasingly from extreme temperatures, aridity, and weather events.

The economic activities of the provinces are mainly in agriculture, mining and manufacturing, all of which are dependent on supplies of fresh water. According to projections, the agricultural and water sectors are the most vulnerable within the province (Theunissen, 2015 and van Dyk, 2015). Lack of sufficient and consistent rainfall during the rain season causes tremendous stress to the farming industry, as does persistent floods and hailstorms.

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 to be pursued by farmers. Rainfall is likely to be 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 as a result of temperature increases are an important climatic factor 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.

The documented research on the adaptive capacity to climate vulnerability in South Africa has been on analysing the impact of global climate change on the agriculture sector. To estimate the effects of climate change on the livestock sector, several approaches and simulations have been

used in South Africa to develop heat stress and humidity indices for livestock. Since dependence on water represents a significant current vulnerability for almost all agricultural activities, adaptation plans would benefit by considering water curtailments to irrigators in times of drought, in the light of food security and conditional upon irrigators using water efficiently.

## 6 References


Ziervogel G, New M, van Garderen EA, Midgley G, Taylor A, Hamann R, Stuart-Hill S, Myers J, and Warburton M, 2014. Climate change impacts and adaptation in South Africa, WIREs Climate Change 2014, 5, 605 – 620.

National Climate Change Response Policy (NCCRP), 2011

Situational Analysis and Needs Assessment (SANAs) Report, February 2015

National Development Plan, 2012.

Northern Cape Climate Change Strategy Draft: 2015

Carstens and Vermeulen 2010. Potential impact of climate change on grapevine diseases of economic importance to South Africa
http://www.sawislibrary.co.za/dbtextimages/Winetech2010_11.pdf

CSIR, 2010. A CSIR perspective on water in South Africa – 2010, CSIR Report No. CSIR/NRE/PW/IR/2011/0012/A, Pretoria.

Amanda Bourne, Dr Camila Donatti, Dr Stephen Holness & Professor Guy Midgley, 2012. Vulnerability climate change assessment for the Namakwa District Municipality.

Hannah et al 2013

Hewitson BC and Crane RG, 2006. Consensus between GCM climate change projections with empirical downscaling: Precipitation downscaling over South Africa, International Journal of Climatology, 26, 1315 –1337.

Mather, A, G. Garland, and D Stretch. 2009. Southern African Sea Levels: Corrections, influences and trends. Southern African Journal of Marine Sciences, 31(2).

Meissner Scholtz and Engelbrecht 2013 SAJAS

Midgley et al., 2007. Impacts, Vulnerability and Adaptation in Key South African Sectors: An input into the Long Term Mitigation Scenarios process, DEAT, Pretoria.

Gbetibouo GA and Ringler C, 2009. Mapping South African Farming Sector Vulnerability to Climate Change and Variability: A Subnational Assessment, International Food Policy Research Institute (IFPRI) Discussion Paper 00885

Madzwamuse M, 2010. Climate Change Vulnerability and Adaptation Preparedness in South Africa, Heinrich Böll Stiftung Southern Africa, Cape Town.

Jordaan AJ, Sakulski D, and Jordaan AD, 2013. Interdisciplinary drought risk assessment for agriculture: The case of communal farmers in the Northern Cape Province, South Africa, South African Journal of Agricultural Extension, 41, 01-16.

Theunissen Annette, 2015. The Northern Cape Agriculture – it's vulnerability to climate change. Presentation at the Project Inception Workshop held on the 27 November 2015, in Kimberly.

van Dyk Gawie, 2015. Climate change adaptation strategy for the water sector. Presentation at the Project Inception Workshop held on the 27 November 2015, in Kimberly.

.

## 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 .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. |