The role of the National Water Act on the adaptive capacity of commercial farmers, investigating climate in the Fezile Dabi District Municipality in the Free State Province.

by

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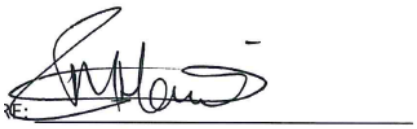
DECLARATION

I hereby declare that *"The role of the National Water Act on the adaptive capacity of commercial farmers investigating climate in the Free State"* is my own research work and that all sources that I have used have been indicated and acknowledged by means of complete in-text referencing and inclusion in the list of references.



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Abstract

Climate change is a global phenomenon, which will continue to affect us in the near future. Studies show that climate will rapidly change as compared to previous years. This rapid change will have a great environmental, societal and economic impact on communities around the world, especially developing countries such as South Africa with limited adaptive capacity and resources. The adaptive capacity of commercial farmers can further be restricted by the ongoing amendments to the National Water Act. The main aim was to investigate the role that the National Water Act plays concerning the adaptive capacity of commercial farmers with reference to climate change in the Fezile Dabi District Municipality in the Free State Province. Questionnaires and semi-formal interviews with Government officials and commercial farmers were used to investigate the adaptive capacity within the context of the Sustainable Livelihood Framework, National Water Act and climate change. A critical finding showed that failed water policy implementation strategies have a huge impact on the adaptive capacity of commercial farmers regarding climate change.

Keywords: *Adaptive capacity, farmers, National Water Act, Climate Change*

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List of Acronyms

ARC **:** Agricultural Research Council

CSIR **:** The Council for Scientific and Industrial Research

DEAT **:** Department of Environmental Affairs and Tourism

DWS **:** Department of Water and Sanitation

DRDLR : Department of Rural Development and Land Reform

ENSO : El Niño -Southern Oscillation

GCM : Global Circulation Models

GDP **:** Gross Domestic Product

GHGs **:** Greenhouse Gases

GPCC **:** Global Precipitation Climatology Centre

GVA : Gross Value Added

IPCC **:** Intergovernmental Panel on Climate Change

NEMA **:** National Environmental Management Act

NOAA **:** National Oceans Atmosphere Administration

NWA **:** National Water Act

RCM : Regional Circulation Models

SAWS : South African Weather Service

SLF **:** Sustainability Livelihood Framework

UNEP : United Nations Environmental Program

UNFCC **:** United Nations Framework on Climate Change

UNICEF **:** United Nations Children's Fund

WUL : Water Use Licences

WUS : Water Use Associations

CHAPTER 1

1. INTRODUCTION

Climate change is a global phenomenon which will continue to occur in the near future. Recent studies by the International Panel of Climate Change, 2013 (IPCC, 2013) show that climate will rapidly change as compared to previous years when only gradual changes were observed. This rapid change will have a great environmental, societal and economic impact on communities around the world, especially in developing countries with limited resources. It has led to water scarcity problems that have become critical, as drinking water and water for agricultural purposes have become increasingly scarce over the years. Agricultural production has been reduced as a result of the recent drought and water shortages (STATSA, 2016). Furthermore, the increase in population from 40.6 million in 1996 to 51.7 million in 2011, and recently 55.6 million in 2016, puts more stress on the agricultural sector to provide food (STATSA, 2016). Water is one of the most valued resources that commercial farmers depend heavily on. They have adopted strategies such as accessing borehole water from aquifers as well as building dams as a way of accessing and storing water. This strategy will assist them to adapt to the water crises that may arise as a result of climatic changes (Thiam *et al.,* 2014).

The National Water Act no 36 of 1998 is one of the most important sections of legislation South Africa has, which aims at protecting, managing and controlling the use of the country's water resources. The Act was formed in 1956 as a result of the growing water pollution crisis which was caused by an increase in the number of industries after World War II (Thiam *et al.,* 2014). Most research is focused on mitigation measures to climate change as well as on solving the water crisis in the country. However, little focus is given to the possibility that the National Water Act can restrict commercial farmer's adaptive capacity in dealing with climate change. The reason being is that there are vertical and horizontal challenges in the water sector, which add to its complexity. These challenges shift focus from the possible restrictions which arise from the Act itself. The main focus in solving or at least managing these problems include

working across both internal and external Government organisational boundaries and engaging citizens and stakeholders in policymaking and implementation (Woodhouse, 2012). The National Water Act (NWA) and the National Water Resources Strategies (NWRS) are ground-breaking attempts to face the issue of complexity; however, little attention is given to them.

This lack of focus has led to the phenomenon of misinformed farmers. One example is the case of the installation of the water meters along the Vaal River in the Vaal catchment area of the Free State Province; this was done as a result of the water shortages, and in accordance with the National Water Act stipulations. However, farmers resorted to protest action against the installation of water meters because the river was their main source of water. The farmers argued that the water meters would restrict their abstraction rate of water, thus affecting their crop-production (Woodhouse, 2012). This emphasises the importance of this study which is to understand the role that the National Water Act plays in the adaptive capacity of farmers towards climate change, in the Fezile Dabi District Municipality in the Free State Province.

1.2 THE RESEARCH PROBLEM

The study aims to investigate the role of the National water Act on the adaptive capacity of commercial farmers-investigating climate change in the Fezile Dabi District Municipality. The study will look at how the National Water Act impact the livelihood assets of commercial farmers; how do farmers manage the restriction on their livelihood assets by the Water Act and how does the Water Act impact the farmer's ability to adapt to climate change.

1.3 RESEARCH AIMS AND OBJECTIVES

The primary aim of this research is to investigate the role of the National Water Act on the adaptive capacity of commercial farmers with reference to climate change in the Fezile Dabi District Municipality in the Free State Province.

The specific objectives are:

- Understanding the impact that the National Water Act has on livelihood assets of commercial farmers;
- Evaluating how farmers manage restrictions placed on their livelihoods as a result of the National Water Act; and
- Evaluating the impact that the National Water Act has on farmers' abilities to adapt to climate change.

1.4 BACKGROUND OF THE STUDY AREA

1.4.1 Location

Fezile Dabi District Municipality, which is situated in the northern part of the Free State Province (Figure 1) covers only 16.4% of the province, which is approximately 121 301 Km^2 (Walton & Webster, 2010). It is made up of four local municipalities, which are Mafube, Moqhaka, Metsimaholo and Ngwathe. Fezile Dabi District Municipality is known as the provincial agricultural hub (Walton & Webster, 2010) with important agricultural towns like Kroonstad and Parys (Figure 1).

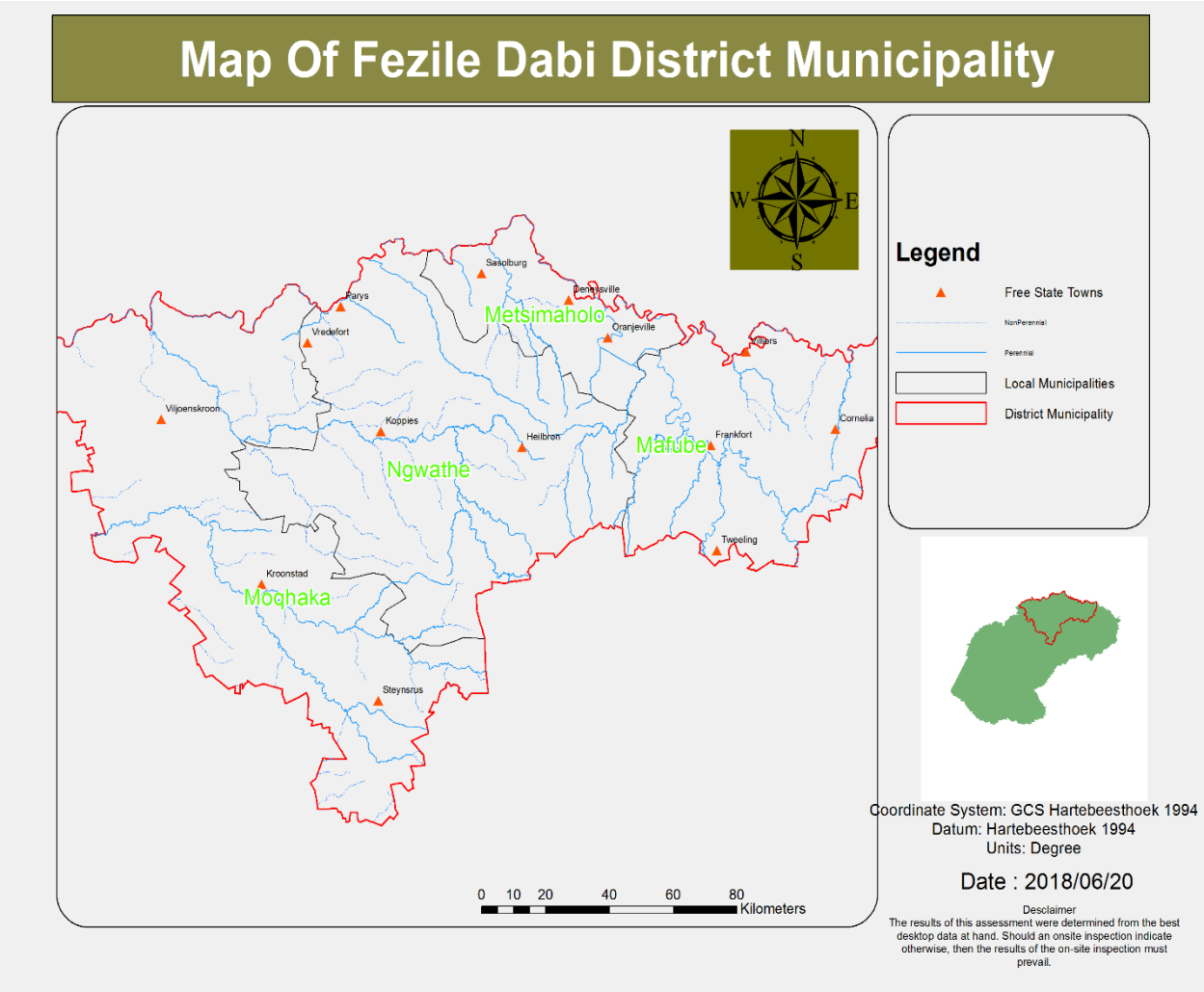

Figure 1: Study area Fezile Dabi District Municipality, showing rivers, towns and local municipalities (Source: Mhlomi, 2018).

Both towns are situated on the riverbanks of the Vaal River which meanders through the province. This makes the municipality well-suited for agriculture, as most of water used for agriculture is drawn from this river. The petrochemical industrial town of Sasolburg is also situated in this municipality; and produces 49% of the country's petrochemical products. This shows the vast significance of this municipality in the province as well as in the country (Walton & Webster, 2010).

1.4.2 Agriculture

Fezile Dabi District Municipality consists of cultivated land (Figure 2) which provides a fertile location for the agricultural activities. Most of the agricultural activities in the province consist of crop yields making up 70% of the gross agricultural production (SA Yearbook, 2007). Major crop productions in the province include potatoes, sunflowers and wheat. Pearl Millet (sorghum grain) used for bread production and non-alcoholic beverages, are also produced. Based on the products Fezile Dabi produces, it is evident that the municipality produces grains and crops which are essential to the country's agricultural output (SA Yearbook, 2007). Maize production (used also for maize-meal products) is also one of the province's top agricultural activity. There are other agricultural products which are produced in the area: peanuts, tobacco, peaches and grapes.

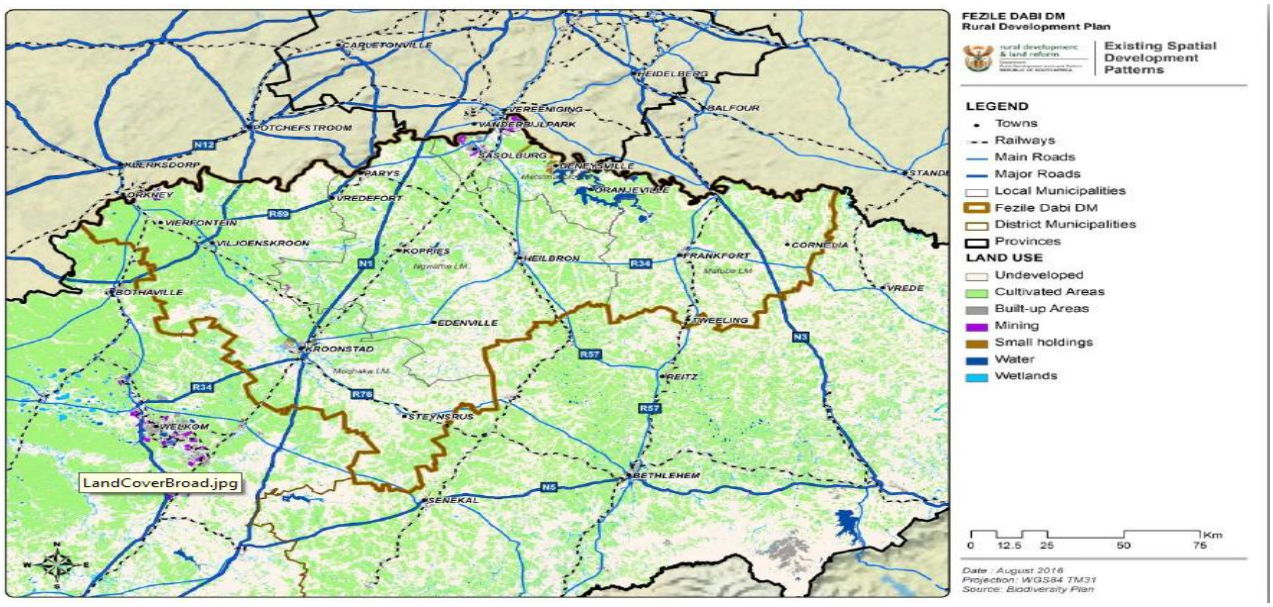

Figure 2: Map of the study area (DRDLR, 2013)

The Highest contributing municipality in the District is Metsimaholo Local Municipality with 68.1% of the contribution in all sectors (SPLUMS, 2016). Agriculture contributes 12.2% to the GDP of Metsimaholo Local Municipality. It is the largest contributor in comparison to the other

local municipalities such as Moqhaka Local Municipality. Agriculture in the Fezile Dabi District contributes 2.5% (Table 1) to the total district municipality GDP (DRDLR, 2013).

Based on the above, it is evident that agriculture is the major economic sector within the following economic nodes: Frankfort in Mafube Local Municipality, Kroonstad in Moqhaka Local Municipality, and Koppies in the Ngwathe Local Municipality. However, mining is predominant in the economy of Kroonstad, whereas manufacturing is the main contributor to the GVA of the Sasolburg economy (SA yearbook, 2007).

Table 1: The economic contribution per Industry in Fezile Dabi District Municipality (adapted from DRDLR, 2013).

Municipality	**Agriculture**	**Mining**	**Manufacturing**	**Electricity**	**Construction**	**Trade**	**Transport**	**Finance**	**Community Services**	**Total Industries**
Moqhaka LM	4.7%	24.0 %	3.3%	0.3%	1.3%	11.1 %	8.5%	18.2 %	28.7 %	100.0 %
Ngwathe LM	9.4%	1.1%	3.9%	1.1%	2.0%	12.2 %	9.6%	24.0 %	36.8 %	100.0 %
Metsimaholo LM	0.5%	3.0%	52.3 %	8.6%	1.9%	6.2%	5.0%	17.2 %	5.3%	100.0 %
Mafube LM	16.8 %	0.0%	3.6%	0.2%	1.7%	17.0 %	5.1%	17.5 %	38.0 %	100.0 %
Total	2.5%	7.3%	36.7 %	6.0%	1.8%	8.0%	6.1%	17.9 %	13.7 %	100.0 %

Most of the farmers in the area are commercially-orientated and thus contribute largely to the agricultural sector. The primary activities of any farming enterprise are growing crops and tending livestock for the purpose of selling or subsisting. Commercial farming can be defined as farming for the purpose of selling produce. These farmers contribute towards a huge

percentage of farm employment, in addition to using a variety of heavy machinery to farm on hundreds of hectares of land. Commercial farming is characterised by high yields per unit of the cultivated land. These large scale inputs yield fruit, vegetables as well as dairy products. Also, commercial faming can involve livestock-grain farming, which involves growing grain for livestock feed, thus precipitating corn and livestock sales as means of production (Smalley, 2013).

1.4.3 Climate

The Free State Province is located high above sea level (1396 meters), this makes the province to experience a climate characterised by warm summers and cold winters. In general, the whole Fezile Dabi Municipality experiences an average annual temperature between - 5^0 C (winter) and 30^0 C (summer), with the mean of 15^0 - 30^0 C in summer and -5^0 -15^0 C in winter (Free State Provincial Report [FSPR], 2013). The eastern part of the Fezile Dabi District Municipality experiences extremely cold winters as a result of being close to the high Drakensberg Mountains seen in the eastern part of the Free State (Free State Provincial Report [FSPR], 2013). The annual summer rainfall ranges from 600 mm to 750 mm. Rainfall occurs during the spring season more towards summer (Figure 3). During this period, the farmers receive most of their rainfall. During the rainy season this area receives an overall 80% of rain, which often lasts for about 181 to 240 days. However, Fezile Dabi District Municipality also experiences unanticipated hail storms and other inclement weather conditions during this season which have a huge impact on crop production (Moeletsi, 2010).

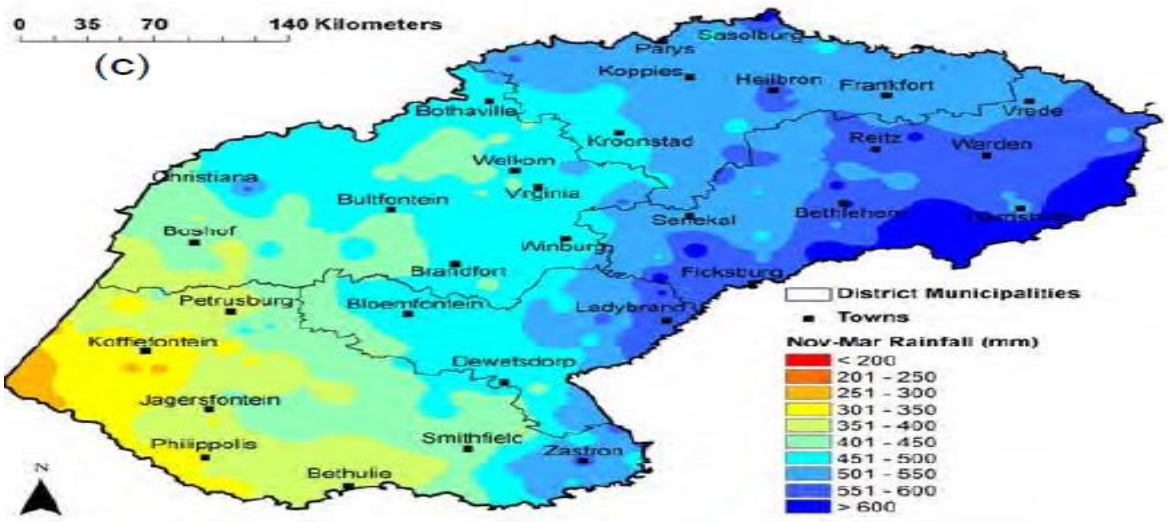

Figure 3: Annual rainfall between November and March in the Free State (Moeletsi & Walker, 2012)

1.4.4 Rationale for Site Selection

Agriculture makes up a significant percentage of South Africa's economy and contributes 21% to the gross domestic product (GDP). It is also an important sector in both the formal economy and in sustaining local livelihoods. However, it is currently constrained by biophysical and socio-economic problems that include land-degradation, poor infrastructure, lack of resources, poor access to information, and insecurities around water resources. These are often associated with poor infrastructure and long periods of climate stress (Vogel, 2005). The reasons for these challenges include policies implemented in the past and those being implemented at present, including the difficulties arising from uncoordinated or vague policies (The Strategic Plan for South African Agriculture, 2001).

Agricultural activities contribute up to 70% of the gross agricultural production in the Fezile Dabi District Municipality. However, due to climate change, Fezile Dabi District Municipality has undergone several drastic changes in recent years (SA yearbook, 2007). A number of policy shifts have taken place including liberalising agricultural trade and the deregulation of the marketing of agricultural products (SA yearbook, 2007). This legislation shift has led to the need to evaluate the impact of the National Water Act on the agricultural sector, particularly in the

municipality (SA yearbook, 2007). In the study area under investigation, the municipality has initiated strict water by-laws which aim at properly managing the use of water resources including pollution-control. However, the tightening of water usage contained in by-laws has left a bitter pill to swallow among farmers in the area. This has resulted in farmers appealing to the Ministry of Water Affairs to consider farmers' production lines when drafting policies and amending the Act (SA yearbook, 2007). As a result, there is a need to look at the role that the National Water Act plays in the adaptive capacity of commercial famers.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

With an increase in global greenhouse gas outlets over the past years, changes in global rainfall and temperature patterns have been witnessed (IPCC, 2014). Due to this increase, the Kyoto Protocol was adopted in 1997. Developed countries, as well as developing countries, committed themselves to adhere to a reduction in greenhouse gas emissions by 5% below the 1990 levels, from 2008-2012 (IPCC, 2014). This Protocol took effect in 2005 with inclusion of developing countries like South Africa in 2002. The main objectives of the Kyoto Protocol are to promote sustainable development by implementing policies on greenhouse gas emissions. Also, to promote sustainable agriculture around the world, this Protocol is still in place (IPCC, 2014) as climate change is still occurring and is projected to continue over coming the years (as had been the case during the past years).

The picture of global climate change during the past years is much clear as a result of research done over the years. Due to concerns and awareness of climate change, interest surrounding the phenomenon has increased over the years (IPCC, 2014). An increase in the studying of patterns associated with global climate change, predictions and projections of future climate change, has been seen. The IPCC (2014) uses examples of case studies such as the Sahel drought of 2010 where the area experienced extremely low rainfall which resulted in the decreased production of agricultural products; this provides evidence of climate change on a global scale. It has also been found that climate change contributed to global climate extremes such as the 2003 European heat wave, 2007 United Kingdom floods, 2011 East Africa droughts, and most recently the 2016 Southern Africa tropical cyclones (IPCC, 2014). These climatic extremes become threats to many livelihoods and to the environment. This chapter will provide an overview of global and regional climate change and how it essentially will contribute to

climatic changes that may impact on the adaptive capacity and sustainable livelihoods of vulnerable communities, particularly commercial farmers.

2.2 CONCEPT OF CLIMATE CHANGE

Climate change is described by the IPCC as the change in the state of climate over a period of time which can be caused by human activities and natural activities such as emission of greenhouse gases from volcanic eruptions (IPCC, 2014). Furthermore, it can be characterised by changes in weather patterns experienced globally which are more likely to continue into the future (IPCC, 2014). This change can be identified using scientific tests that measure the mean changes and variability of its properties over a long period of time (IPCC, 2014). The United Nation Framework on Climate Change (UNFCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activities that alter the composition of global atmosphere, and which is in addition to natural climate variability observed over comparable time period" (UNFCC, 2002:7).

Climate change has a huge impact on the natural and human systems, such as increasing temperatures and low precipitation which will place more pressure on the limited water resources. This has serious implications for agriculture, employment and food security (IPCC, 2014).

2.3 OBSERVATION OF CLIMATE CHANGE

The International Panel of Climate Change (IPCC) has analysed trends of climate change since 1880 till 2018, with the aim of looking at multi-decadal changes in climate (IPCC, 2014). There have been changes observed in the atmospheric gas composition, particularly the Greenhouse gases (GHGs), with a 9% increase observed from 1998 to 2005 (IPCC, 2014). Observations also show that the composition of GHGs in the atmosphere has increased by 7.5% since 2005 to 2011. This shows a decline of 1.5% from the observations made in 2005; but it is still high as compared to the observations made during previous years.

The carbon concentration can be analysed together with temperature patterns and rainfall data to see the connection among them (IPCC, 2013). The fifth assessment report of the IPCC (2013) showed a 0.74^{o} C increase in temperature for the years 1962 -2009, which was higher than the increase observed in 1901-2001 of 0.6 ^{o} C. The report later provided the projections for future trends with an increase of about 0.13 ^{o} C per decade over the years 2005 -2105 (IPCC, 2013).
The IPCC 2013 data analysis is not far from the projected data provided by the panel in 2007. Temperature data analysis shown in figure 8 indicates a rise in temperatures over the period 1850 - 2000. Using the data, Rohde *et al*. (2013b) observed an increase of about -0.04 to ± 0.01 ^{o}C per decade since 1950 to 2011. This increase might seem low, but compared to average temperatures of previous years, it is much higher (IPCC, 2007).

These observations provide evidence that climate is indeed changing and that there is a rise in temperature conditions which is indirectly propositional to rainfall (IPCC, 2013). Another factor which needs to be discussed when looking at climate change is precipitation since rainfall figures vary over the years as a result of changes in heat produced by the sun's radiation which influences evapo-transpiration from the earth's surface (IPCC, 2013). Observations from the hydrological cycle can also be used to observe climatic changes, because extreme hydrological events such as floods can result from climate change (IPCC, 2013). Infrastructures such as buildings plays a huge role in this case because large areas of vegetation have been removed to make way for buildings (IPCC, 2013). Pavements also influence the rate of infiltration, which consequently influences the hydrological cycle.

2.4 EVIDENCE OF RECENT CLIMATE CHANGE

The most recent observation of climate change is the warming of the earth's climate systems which has been the most recent outcome of the IPCC 2007, 2008, 2013, 2014, and 2017 observations. The warmest year was 2015 when we experienced a recorded temperature of 0.76 ^{o}C above the observations made in the period 1961-1990 which was considered to be the warmest period (WMO, 2016). It was followed in 2014 with 0.61 ^{o}C above the 1961-1990 global average (WMO, 2016). This was due to the El Niño and La Nina events which took place during

the period 2014-2015. Nine of the warmest years were recorded between 2007 and 2015. These years experienced temperature readings above the 1998 threshold, which was the warmest year on record (WMO, 2016).

The events of El Niño and La Nina that occurred in the period 2015-2016 resulted in the rise of temperatures both on-land and on-ocean surfaces (IPCC, 2014). These events were preceded by a rise in temperatures in most parts of the globe such as Europe, Asia and Southern Africa during the period of 2011-2015 (IPCC, 2014). In these countries, surface temperatures increased by 1^{o} C above the average of the period 1961-1990, making the period the warmest period in recent times. The trend showing the increase in surface temperatures began between 2006 and 2010, where temperatures were 0.56^{o} C above average, later rising to 1^{o} C above the average in the period 2011-2015 (IPCC, 2014). Sea surface temperatures also increased during the periods 2006-2015 whereas 2011-2015 recorded the warmest sea and ocean temperatures (IPCC, 2014). The warmest region recorded were the Southern Ocean of Australia, Pacific Ocean, Mediterranean Sea, South Indian Ocean region and South Atlantic Ocean region (IPCC, 2014). The rise in ocean temperatures affects the weather and climate of the surface regions and often results in intense rainfall as well as tropical storms (IPCC, 2014). This became evident when the increase of extreme weather events such as heat waves, hurricanes, droughts and wild fires were seen over the recent years (IPCC, 2014).

The issue now is no longer whether climate will change, but rather how rapid will climate change, and what catastrophes will result from future climatic conditions. With simulations used by the IPCC, future climate changes can be estimated and simulated (IPCC, 2014). The projections of future precipitation patterns, as well as projections of future surface temperature, are being produced by these simulations (IPCC, 2014). Projections show that from the year 2016 to 2035, the mean global surface temperatures will increase from 0.3^{o} C to 0.7^{o} C. In the subtropical regions of the world, precipitation will decrease during winter seasons and severe drought conditions will be evident throughout the summer season. In general, the

northern hemisphere will experience rainstorms and the southern hemisphere will experience dry conditions resulting in droughts (National Research Council, 2012). The increase in temperature and evaporation will lead to drought conditions and this will lead to most of the dry regions being fire-prone. This is important to take note for this study because it impacts on the adaptability to use less water in the southern hemisphere, especially in the South African context.

2.6 SOUTH AFRICAN AND REGIONAL PERSPECTIVES

Attention will now turn to examine observed climatic changes in South African and regional perspectives.

2.6.1 South Africa Perspective

South Africa is dominated by the semi-arid and humid coastal climatic conditions, and rainfall patterns in these areas differ, resulting in complex and distinctive climate patterns. South Africa's climate is generally described as having warm summer days and cold winter days. The average temperatures in South ranges from 20^{o} C to 30^{o} C. The maximum average temperature in South Africa is between 30^{o} C and 40^{o} C in summer, and the minimum temperature ranges from 6^{o} C and 20^{o} C in winter (MacKeller *et al.*, 2014). Rainfall mainly occurs in summer in most of the interior regions, with the coastal regions receiving most of rainfall during winter seasons (June to August) (UNICEFF, 2011). These various climatic regions are categorised according to rainfall patterns and altitude above sea level (UNICEFF, 2011).

The variability in climatic conditions across the country is mainly driven by the EL Niño-Southern Oscillation (ENSO), based on reasons that the ENSO is mainly associated with the below-average summer rainfalls, which is the case in recent years in South Africa.

The EL Niño-Southern Oscillation (ENSO) is defined as an ongoing climatic pattern which includes changes in temperatures of waters in the Central and Eastern Pacific Ocean. It affects the patterns of sea level pressure and tropical rainfall across the Pacific. It is characterised by EL Niño and La Niña where EL Niño conditions are characterised by low pressure conditions in the

Pacific Ocean. The low-pressure conditions result in wet and cool weather conditions across the surface. La Niña conditions on the other hand, are the opposite of EL Niño conditions. La Niña conditions result in a high pressure system in the Pacific, which results in dry and warm conditions on the surface of the earth.

Moreover, ENSO has long been known to have impacts on the seasonal to inter-annual rainfall variability of South Africa. For example, during most of the strongest El Niño events (1982-1983, 1991-1992 and 2006-2007), drought conditions occurred, while La Niña events caused excessive seasonal flooding. As a result of ENSO-associated temperatures and rainfall variability, drought conditions are currently occurring in large parts of the country. However, it is not cast in stone that the variability in temperatures and rainfall across the country are mainly driven by ENSO. There are regions in the country which are affected by the ENSO; however, stations in these regions do not show records of extreme rainfall or unnatural temperature variations. This shows the complexity of the relationship between ENSO and temperature/rainfall variations (Mackellar *et al.*, 2014). In South Africa, much research effort is focused on predicting future climatic conditions, including patterns of rainfall and temperature. Global Circulation Models (GCM), for example, are used to obtain indications of projected climate conditions. Both historically, and from the projected change, the expected temperature changes are cohesive and clear in that most areas are experienced unprecedented warming (Hewitson *et al*., 2005).

2.6.1.1 Temperatures

The Minister of Environmental Affairs and Tourism issued a press release in 2004 stating that "the temperatures could rise between one and three per cent by the middle of the 21st century in South Africa" (Alexandre, 2009: 6). Furthermore, this increase in temperature will result in the decrease of rainfall, which will eventually result in strict water restrictions. This was a wake-up call from the Minister that these climatic changes may have great societal and environmental impacts on South Africa (Alexandre, 2009). Temperatures are very important in

agriculture as they are vital limits in nature: high temperatures limit crop production and decreases the crop yield, while the increase in the evaporation rate decreases dam levels as well as create the ideal conditions for increase in the number of pests (WMO, 2015). However, it is impossible to be absolutely certain about the predictions regarding future temperature patterns. Therefore, in order to prepare for future changes in temperature conditions, observational (statistical studies) and simulation mechanisms have been used. Mechanisms used in predicting the future temperature conditions are the Global Circulation Models (GCM) and the Regional Circulation Models (RCM).

Temperature changes were observed over time; the most recent was based on the temperature changes between the period 1962 to 2010. Research by Kruger and Sekele (2013) showed a trend indicating increasing temperatures for most of the weather stations in South Africa. The South African Weather Service (SAWS) also reports that the annual temperature increased by 0.3° C with reference to the period of 1961-1990 (Figure 4). Furthermore, the IPCC indicated that South Africa has experienced an increase in annual temperatures, with the 21st century displaying a rapid increase as compared to the 20th century.

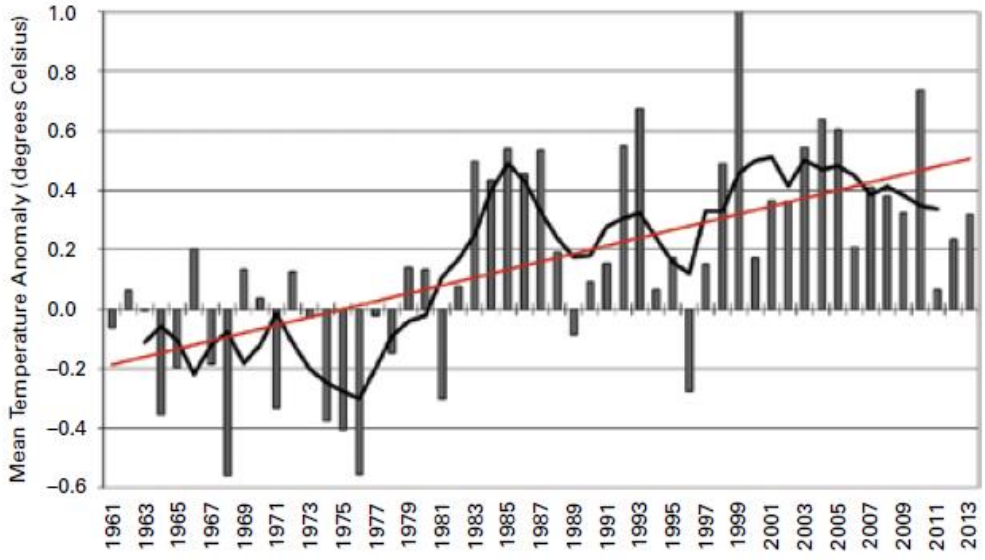

Figure 4: Observed increase in average temperatures between the years 1961 to 2013 (McSweeney et al., 2010)

2.6.2.2. Rainfall

In South Africa rainfall varies from region to region. In the north western parts of the country, the annual mean rainfall is below 200 mm, while the eastern part of the country receives between 500 mm and 900 mm. The central parts of the country receive on average 400 mm of rainfall, and this is similar to the mean annual rainfall received in the coastal areas (Kusangaya *et al*., 2013). This is why the interior of the country is suitable for agricultural purposes (ARC, 2016). Seasonal rainfall is a very important factor when looking into the country's rainfall figures. Links have been found between South African rainfall variability and the El Niño - Southern Oscillation [ENSO] (Mackellar *et al*., 2014). These studies refer to the 1982 and 1983 seasons, where below average rainfall resulting in severe droughts occurred over many parts of the country. The droughts (and below average rainfall) resulted from a strong El Nino event (Mackellar *et al*., 2014). Furthermore, research shows that rainfall patterns over South Africa continue to change over the years which result in meteorological droughts (drought that result from abnormally low rainfall).

Meteorological droughts lead to hydrological droughts which occur when the water supply is less than the regional supply (Van Lanen, Wanders, Tallaksen & Van Loon, 2013). As a result of meteorological droughts, agricultural drought conditions occur. Agricultural drought is when the soil moisture is depleted and this reduces crop yields and affects agricultural production. This shows that climate change has a serious impact on agricultural production (Van Lanen *et al*., 2013).

Moreover, rainfall pattern observations by IPCC show there is decline in annual rainfall in South Africa, and a change in the intra-seasonal rainfall (IPCC, 2013). Also, there has been a change in rainfall duration as well as rainfall intensity over the years (IPCC, 2013). In most parts of South Africa an increase in dry spells has been observed, and this means that a decrease in precipitation is evident (IPCC, 2013). As a result of these events, a drought season was observed in South Africa during 2007-2011 (Figure 5). The dry spells are often followed by high intensive

rainfall periods which results in surface run-off. This means that less and less water infiltrates the ground resulting in the lowering of the water table (Van Lanen *et al*., 2013)

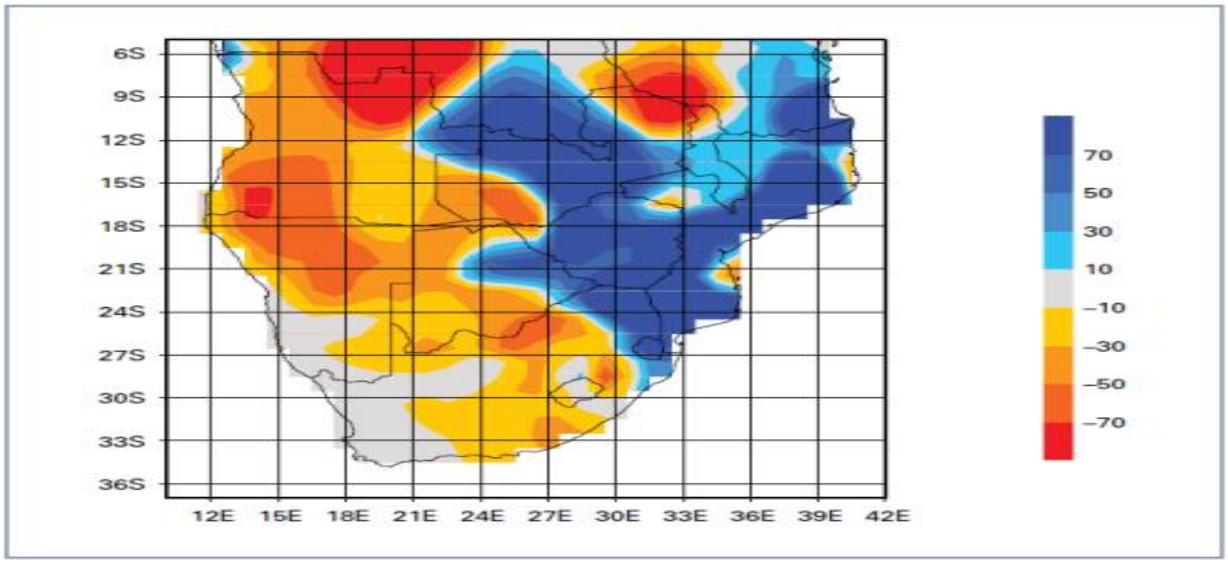

Figure 5: South African precipitation - deviation from normal (mm/month) for January 2013 with respect to 2007–2011 (IPCC, 2013)

More recently, the ARC reports that over the period of 9 months - June 2015 to May 2016 - (Figure 6) the country has received less rainfall of about 25 mm. However, there has been wet seasons in which a reasonable rainfall was experienced in the country, particularly in the coastal regions (ARC, 2016). Most parts of the country received more rainfall during the beginning of 2016 as compared to the rainfall of 2015 (ARC, 2016). This provides evidence of changes in rainfall patterns over the years, showing that the rainfall seasons have shifted (e. g. rainfall is no longer experienced in October-December, but now in the January-March period) and this will affects the agricultural production in the country (ARC, 2016)

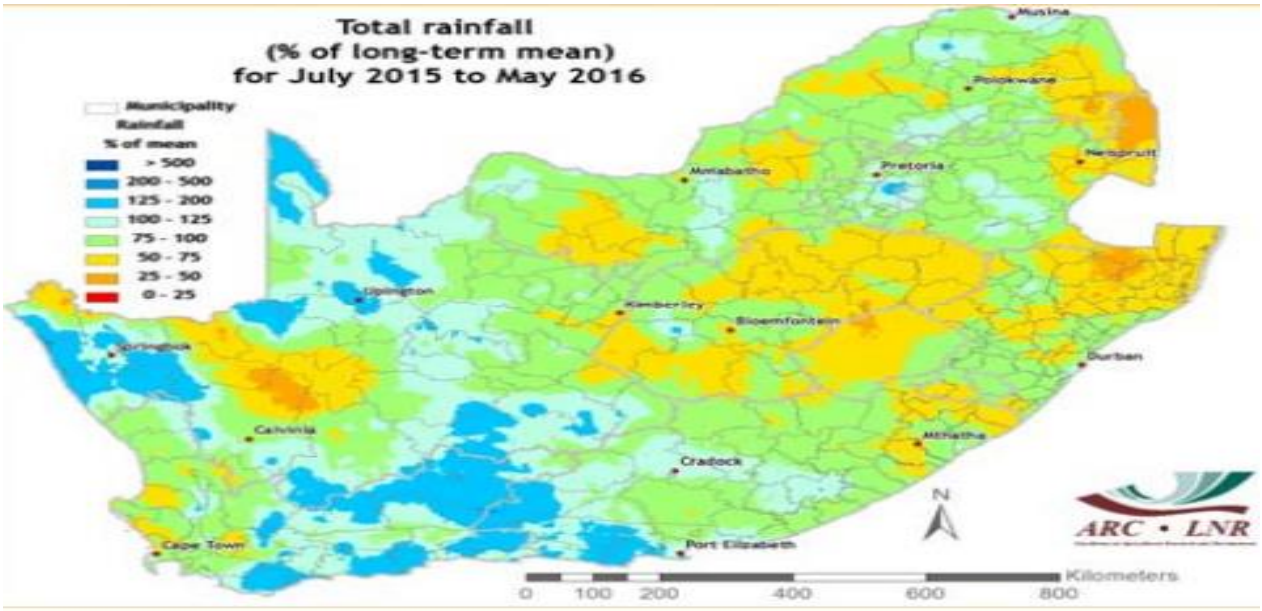

Figure 6: Rainfall in South Africa from July 2015 to May 2016 (ARC, 2016)

2.6.3 The Free State Province

The Free State province is a semi-arid region that receives summer rainfall, November to March. However, rainfall patterns and the amount of rainfall per annum differs over various regions in the Free State (Ziervogel, 2010). In the north-eastern parts of the province, the amount of rainfall is normally less than 200 mm per annum. The central region of the province receives about 350 mm of rainfall annually, with the northern and the eastern regions of the province receiving 400 mm of rainfall annually (Figure 7), hence these regions have the potential for high crop production (Ziervogel, 2010).

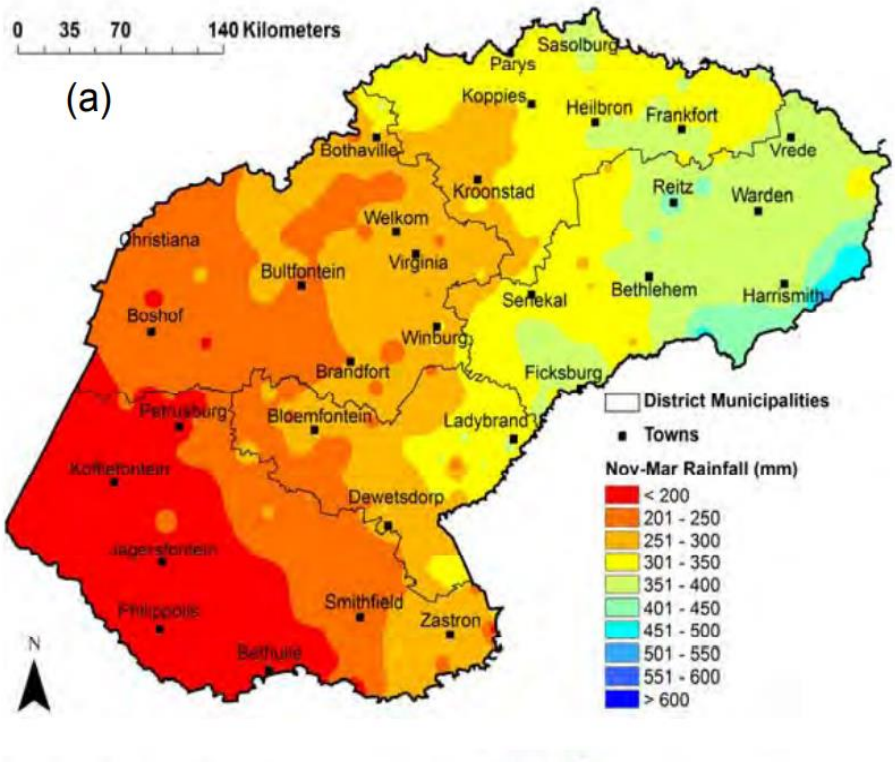

Figure 7: Rainfall in the Free State Province from 2011 to 2015 (Ziervogel, 2010).

The recorded number of rainy season days is over 120, 140 and 200 days in the north western, central and northern regions respectively. However, due to climatic changes rainfall days have been reduced to 60, 80 and 130 days respectively (Ziervogel, 2010). The atmospheric temperature around the Free State Province increases from 2 to 4.5^{o} C per annum, and as a result of increasing temperatures and low rainfall, heat wave conditions occur in the area (Ziervogel, 2010).

Consequently, the overall annual probability of rainfall in the province has decreased from 90 - 95% in the year 2005 dropping to 60 -70 % in the year 2015 (Ziervogel, 2010). The increasing dry conditions across the province resulted in droughts across the entire province, but mostly affecting the farmers in the Fezile Dabi District Municipality (Ziervogel, 2010). Also, high frost conditions occurred here as temperatures dropped below -3^{o} C in 2015 (Ziervogel, 2010). High temperatures and dry conditions in the northern Free State allowed disease-carrying insects to

invade the regions resulting in the drop in crop production and the death of livestock in the area (Ziervogel, 2010). This had a huge impact on farmers' production in the area (Ziervogel, 2010). Farmers are very dependent on water resources for production purposes; however, rainfall and temperature can influence these resources (e.g. dams, rivers, wetlands, catchments etc.). Accordingly, the following section will look at main water resources (river catchments) that are available in the Free State and study area.

2.6.3.1 Commercial farmers and water resources

The study mainly focused on commercial farmers in the Fezile Dabi District Municipality in the Free State Province. Commercial farmers are defined as farmers who grow crops and rear livestock for sale. In commercial farming, the area cultivated and the amount of capital invested is large in order to grow the farming business. There are large scale and medium commercial farming which creates jobs for farm labourers and other workers who are trained to be able to accumulate skills and knowledge to work somewhere else (World bank, 2009).

Commercial farmers were chosen for this study because they are one of the main economic contributors in the province. In the area of Fezile Dabi District Municipality, the planting season is during spring and autumn with harvesting taking place from March to April. The District Municipality is one of the organs which contributes more towards the GDP of the country and is regarded as part of the Free State Province which is considered to be the country's food basket (Vos, 2016).

Over the past decades the use of surface water for irrigation has generally increased in conjunction with the ever-increasing demand for agricultural products. This means that for high returns on large area production, the demand for irrigating water will increase. Research done in the Fezile Dabi District Municipality shows that in order for specific crops to provide a return of R60 000 per year (amount required for a commercial farmer to sustain a farm), the specific volume of water in cubic metres (m^3) is required as shown in Figure 8 (Vos, 2016).

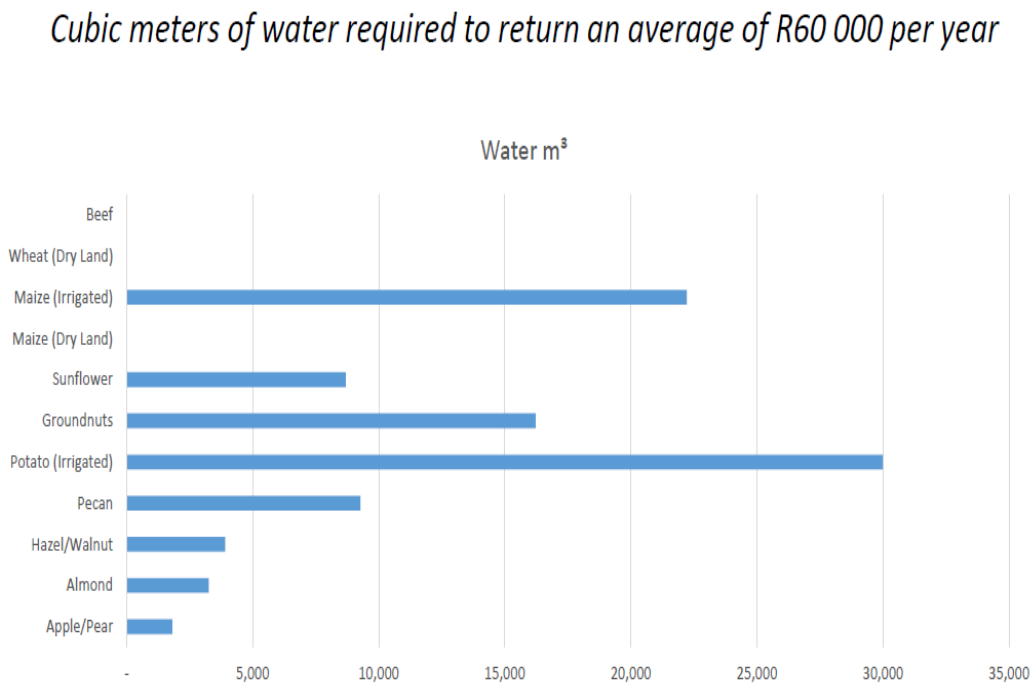

Figure 8: Amount required for a commercial farmer to sustain a farm (Vos, 2016).

The Free State Province is bordered by the Vaal River in the north and western part of the province. Also, the Caledon River forms part of the eastern border, and the Orange River forms the southern border. These rivers have major tributaries which are the Wilge, Renoster, Vals, Sand, Modder and Riet rivers which form part of the two main catchments in the Fezile Dabi District Municipality, which are the Upper Vaal catchment as well as the lower Vaal catchment areas. The main supplier of the water resource in the municipality is the Vaal River and its tributaries (shown in Table 2). The most important dam in the area is the Koppies Dam, which supplies most of the towns in the municipality with water (Ziervogel, 2010).

Table 2: Major rivers in Fezile Dabi, as well as municipalities and towns they service (adapted: DRDLR, 2016).

River	Dams	Municipalities	Towns
Vaal	Vaal Dam	Moqhaka LM, Ngwathe LM, Metsimaholo LM, Mafube LM	Villiers, Oranjeville, Deneysville, Sasolburg, Parys
Renoster River	Koppies	Moqhaka LM	Adenville, Koppies
Vals River		Ngwathe LM	Steynsrus, Kroonstad
Wilge River		Metsimaholo LM	Frankfort
Liebenbergsvlei River		Mafube LM	

A qualitative analysis shows that the municipality consists of 8 catchment systems which are the major contributors of irrigation water in the area (Vos, 2016). With the annual rainfall in the Fezile Dabi District ranging from 300 to 900 mm, 45% of the water is found in catchment 1 in the Renoster River catchment. The second largest catchment in the area is catchment 2 which consists of Kromelboogspruit, Elandspruit, klipspruit and Taaibosspruit Rivers which collect 25% of the water in the area. Catchment 2 stores about 7% of the water, while catchment 6 collects about 4% of the water resource in the area. The rest of the catchments collects below 4% of the water resource in the area (Figure 9).

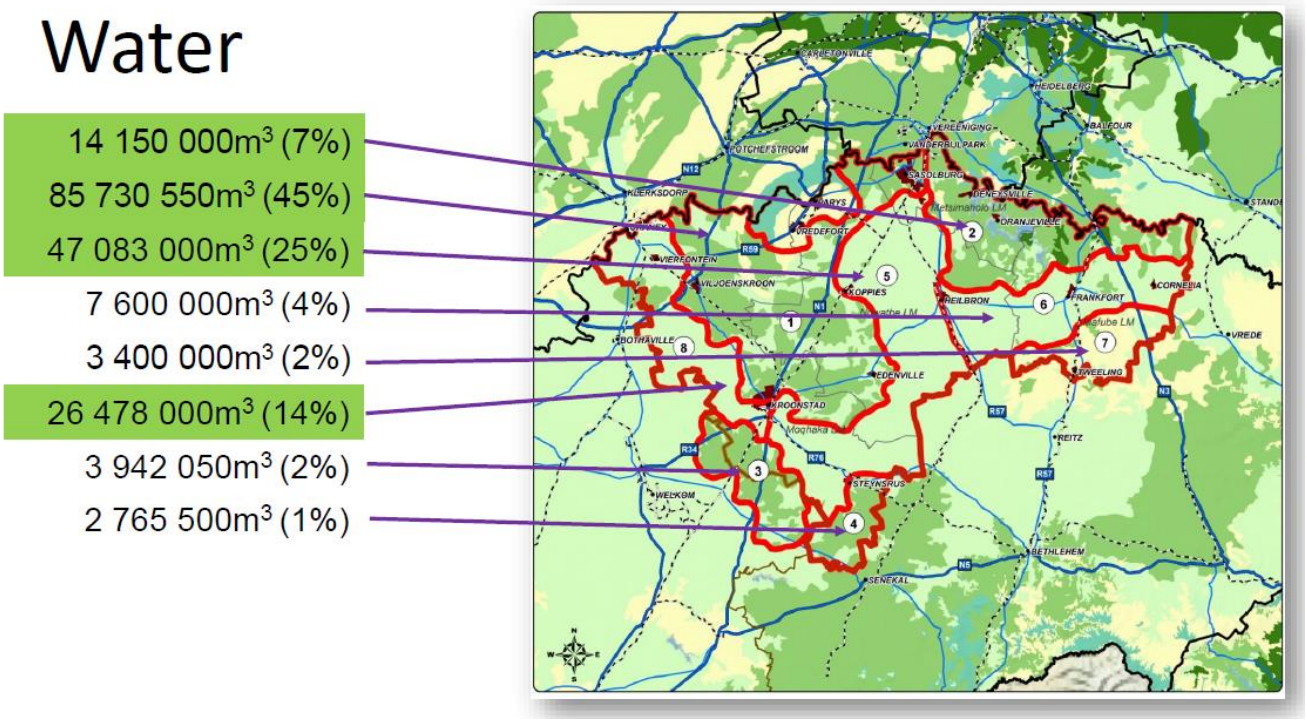

Figure 9: Catchment data in the Fezile Dabi District Municipality and their respective volumes of water per catchment (Vos, 2016).

Due to high evaporation as a result of high temperatures, dry conditions have occurred in most of the regions in Fezile Dabi District Municipality. The municipality has been declared as disaster area as it experienced crippling drought conditions. With the ongoing drought conditions, there has been an increase in the demand for water resources. In most of the small towns in the municipality as well as the neighboring farms, there is inadequate water supplies from the municipality; therefore, ground water has been used to address shortages of water resources in those areas (Ziervogel, 2010). Access to water for agricultural purposes is mainly limited to artificial stream-channelling in the Wilge, Vlei and Vaal Rivers and 80% of available water for irrigation is only from the groundwater (Ziervogel, 2010). Due to low rainfall the availability of water for irrigation is decreasing annually due to the high demand (Ziervogel, 2010).

In the year 2000 the availability of groundwater in the Upper Vaal catchment area and the Middle Vaal catchment was 32 million m^3 and 54 million m^3 respectively (Ziervogel, 2010). However, the availability of ground water has decreased significantly in recent years from 32 million m^3 to 11 million m^3 in the Upper Vaal catchment, and from 54 million m^3 to 38 million m^3 in Middle Vaal catchment (Ziervogel, 2010). The following section will examine firstly, the perception and knowledge of farmers towards climate change, and secondly the theoretical framework of adaptive capacity of commercial farmers in relation to climate change.

2.7 FARMERS' ADAPTIVE CAPACITY TOWARDS CLIMATE CHANGE

Adaptation to climate change is defined as changing both natural and human systems in order to deal with recurring and expected impacts of climate change (IPCC, 2014). However, in this study the focus falls more on the adaptive capacity which is defined as the ability of a human system to adapt when dealing with the impacts of climate change or preparing for the expected impacts of climate change. Researchers explain that the more vulnerable socio-economic and environmental systems are to climate change, the lower the adaptive capacity of that system (Smith & Pilifosova, 2003). This means that the vulnerability of the system is a result of exposure and its adaptive capacity in dealing with climate change (Smith & Pilifosova, 2003).

The agricultural sector is one of the most important contributors to the country's economy. It is also the source of livelihoods for many South African communities. However, this important sector is threatened by climate change which results in extreme conditions such as droughts and floods (Gbetibouo *et al*., 2010). The perception and knowledge of farmers regarding climate change is very important as it allows farmers to develop strategies to adapt to severe conditions (Zwane & Montmasson-Clair, 2016). However, many studies found that there is a disconnection between farmers' perception of climate change and adaptation responses (Gbetibouo *et al*., 2010). It is stated that perception of climate change and the threats differ according to each individual, dependent on values, trust and personal experiences. Farmers have inherently first-hand experience of how climatic changes impact their day-to-day practices (Wiid & Ziervogel, 2012). Other factors also determine how farmers respond and adapt to

certain climate conditions, such as climate information which is a key component for adaption planning. Studies have shown that farmers delivered better yields by using seasonal climate forecasts but farmers with limited access to information will likely be less adaptive (Wiid & Ziervogel, 2012).

In South Africa, much of the focus is based on access to land; however, access to water is also as significant as the access to land, because it is an instrument of social control (Merrey *et al*., 2009). Through the process of dismantling the apartheid system, the Government embarked on land and water reform processes throughout the country (Merrey *et al.*, 2009). Commercial farmers then organised and formed institutions that represented their interests. This can be viewed as evidence of the "social capital asset" of the Sustainability Livelihood Framework (SLF) aspect that the study is looking at. The concern raised by famers at institutional level was water-scarcity due to low precipitation, as well as governmental policies restricting water usage, which affects the agricultural production and their profits (Merrey *et al.*, 2009).

Most famers in South Africa rely on farm knowledge and experience when dealing with water scarcity resulting from climatic changes based on the exposure to climate variability and meteorological observations over time. In dealing with water scarcity, most of the commercial farmers in South Africa have used shifting crop plantation dates to increase their adaptive capacity in recent years. For example, maize and beans have been planted in September and October over the years. However, as part of implementing the planting date shifting mechanism, these crops are being planted in November (Botha & Walker, 2013). The farmers in South Africa strongly believe that the long-term effects of climate change have been viewed through a short-term lens by the Government and this affects their adaptive capacity and increases their vulnerability to climate change (Botha & Walker, 2013).

In order to assess adaptive capacity and understand the internal dimension of vulnerability, one must examine the livelihood assets available to, and used by, farmers with the aim of increasing

their adaptive capacity. These assets are investigated under the Sustainability Livelihood Framework (SLF) which forms the research framework of this study. The adaptive capacity of a system depends mainly on how an individual can access these assets. The ability of people to properly organise socially is influenced by financial status, and financial status in turn is influenced by human capital, natural and physical capital (Smith & Pilifosova, 2003). An examination of these on-farm and off-farm threats and stressors assists in exploring the external side of vulnerability in this study area.

The SLF consists mainly of the traditional five forms of assets: natural, social, human, financial and physical.

a. ***Natural capital*** is the natural resources farmers get that they use for agricultural activities. The resources that are available show the characteristics of the local resource base and the extent to which the farmer can gain access. The access and availability of technology that makes use of the resources possible, is also important (Morse & McNamara, 2013).
b. ***Social capital*** which includes a range of networks, contacts, membership of groups and organisations which the farmers belong to, as well as relationships of trust regarding wider institutions that are needed in agricultural operations. These strategies and activities can be determined in terms of access to markets, credit availability, government services, and other production-aid situations.
c. ***Human capital*** includes skills, labour, knowledge (to a limited extent), good health and the ability to do vigorous work. This includes both the quantity and the quality of human resources within the agricultural environment. It includes knowledge and skills from both formal education and experience within non-formal education sectors (Morse & McNamara, 2013).
d. ***Physical capital*** assets include basic infrastructure such as transport, buildings, water management, energy, communication, and productive capital (tools, machinery etc.).

This also includes what farmers own and what they have access to; for example, roads, irrigation and telephone networks. These may be provided by Government or by the private sector (Morse & McNamara, 2013).

e. ***Financial capital*** is the financial resources available to farmers. These may be savings, credit supplies, monetary aid and grants, insurance or other Government assistance. These provide farmers with different livelihood options including finances for investment in new productive assets for responding to the effects of shocks, such as recovering and reconstructing farms and agricultural strategies (Morse & McNamara, 2013).

These livelihood assets indicate how livelihood strategies work; however, some assets are more important than others at different times and in different situations. They can be used against each other and substituted, or they can also be capitalised to generate future resources. The adaptive capacity of a system depends mainly on how an individual can access these assets. The ability of people to properly organise socially is influenced by financial status. Assets are also affected by both political and economic policies, as well as institutions and processes. Limited access will restrict the use of these assets and result in restricting the adaptive capacity of communities (Morse & McNamara, 2013).

Limited information is available on climate change and its impact on farming in the Free State Province. Also, responses to future climatic change is expected to affect farming in a number of ways. The agricultural phenology is expected to change which will bring with it varying effects on productivity. An eventual yield reduction will affect breeding programmes, crop yields and the industry as a whole (Nayamuth *et al*., 2002).

Insects, pests and diseases are expected to thrive as the ecological balance is disrupted with the change in climate (Nayamuth *et al*., 2002). Insects may colonise new areas and new species could move into sugarcane and other crops' growing areas. Disease boundaries could shift, and diseases may develop as the climate becomes more favorable towards these threats. A number

of weed species will benefit from carbon dioxide fertilization, completing their cycle more rapidly. The distribution and weed mix could change, affecting chemical control on crops (Nayamuth *et al*., 2002). Land suitability may change resulting in the shift of sugarcane areas thus competing with other crops for appropriate arable land and growing areas. Land use changes will have to be analysed in relation to the proximity of mills, infrastructure and the surrounding communities. A deterioration of sugarcane quality will potentially reduce milling efficiencies and the cost of production and evolution in the world market agricultural prices could play on the variability of the industry (Nayamuth *et al*., 2002). A decrease in crop yield will need to be countered by mass irrigation, the growing of drought resistant varieties, and a change in crop cycles. Some negative effects of climate change may be countered by a rise in atmospheric carbon dioxide, which is essential for plant growth.

It must again be emphasised that the focus of this dissertation is on the adaptive capacity of farmers and the role that the National Water Act plays. The next chapter examines elements or concepts embedded in the National Water Act, therefore discussion concerning the National Water Act and adaptation to climate change is the thrust of this research project.

CHAPTER 3

LEGISLATURE AND POLICY ANALYSIS

3.1 INTRODUCTION

The National Water Act (NWA) of 1956 is one of the Acts that plays a huge role in regulating and managing the water sector. Its aim is to ensure sustainable water use in the country, reducing of pollution, and equal distribution of water resources. However, the Act may affect the adaptive capacity of commercial farmers; in particular, adapting to water shortages. The increasing demand for water resources around the country, and pressure from the cost of ensuring the effective use of the water resources, has increased the insecurity of consumers. That is why the sustainable use of our water resources is very important. This can be possible only with the astute implementation of legislation and policies in the both the agricultural and water conservation sectors. One of the management strategies is the effective and efficient implementation of the National Water Act 38 of 1998. This chapter will analyses the National Water Act 39 of 1998 by examining the historical background of the Act, providing an overview of the Act as well as interrogating the implementation of the strategies and policies in line with the Act. Thereafter, case studies relating to the effects of the Water Act on commercial farmers will be highlighted.

3.2 LEGISLATIVE AND POLICY ANALYSIS

3.2.1 National Water Act (1956)

Environmental concerns are growing both internationally as well as nationally. This resulted in the inclusion of environmental issues in major global planning decisions. Environmental concerns are not modern concerns but began in the early 1800s (Fuggle & Rabie, 1999). However, most of the important events took place between 1950s and 1980s. This was the period that saw the formulation of the current Water Act. The formulation of the NWA in 1956 was as a result of growing governmental concerns regarding the increase in water pollution.

Water pollution at that time was caused by high levels of industrialization linked to increased levels of pollution (industrial waste), which began after the Second World War. In 1956 the NWA 54 was introduced with the aim of reducing water pollution in the country (Fuggle & Rabie, 1999). Water pollution reduction was not the only mandate of the Act, but it also ensured conservation and sustainable water use in the country. It is important to note that the introduction of the Act did not replace the rights which had already existed, whereby water was allocated among the owners of the land along the path in which the water moves.

During the days of apartheid, Black South Africans denied large land ownership and as a result they could not access water. This resulted in a separation between “private water” and “public water”. Private water was described as “all water which rises or falls naturally on any land, or naturally drains, or is led onto one or more pieces of land which is subjected to separate original grants, but not capable of common use for irrigation purposes” (Kidd, 2011:70). The Act includes all surface water as well as groundwater. Public water was described as “any water flowing or found in or derived from the bed of a public stream, whether visible or not” (Kidd, 2011:70). Public water could only be used for three purposes which are agricultural, urban and industrial purposes. In the case of industrial use, the owner of the industry had to get permission via a licence to use public water. Permission of use is granted by the Minister as

stated in the Act, but in most cases the municipality was responsible for granting permission to use public water for industrial purposes (Kidd, 2011).

3.2.2 Overview of the National Water Act 38 of 1998

The NWA is one of the most important areas of legislation. The Act is aimed at protecting, managing and controlling the nation's water resources while ensuring that using water resources remains sustainable. Just like any other act, the NWA begins with the preparatory statement or "permeable", which states the reason for the necessity of the Act which is divided into 17 chapters, with the first chapter providing definitions and interpretations of the Act including the explanations of the core principles of the Act which are sustainability, equality and efficiency.

The main purpose of the Act was to control water usage in a sustainable and manageable manner. This ensures that water resources are used in an equitable manner so that everyone can benefit from it. This chapter goes on to elaborate on who is responsible for the control of water resources - the "public trustee" or the Minister who is responsible in executing all tasks (with delegation) as far as the Act is concerned. Chapters two to six (NWA) describe how the water resource will be used, protected and managed with reference to the purposes which are dealt with in the first chapter of the Act.

Chapter two focuses on the water management strategies, which is one of the main purposes of the Act. This chapter is divided into two parts with the first part discussing the national water resource strategy which provides ways for managing our water resources over the period of 20 years; hence it includes strategies, plans, guidelines and procedures under the guidance of the Minister. In addition, it encompasses institutional arrangements, which are related to the protection, use, development, management and control of the water resource within the framework of the existing policy. The chapter also explains in detail how the national water resource strategy is formed, as well as the procedure to follow before establishing the

strategies. The second part of the chapter deals with catchment management strategies on how to manage the catchment, principles of managing and allocation of water in the catchment, as well as cooperation between all relevant parties in the catchment area. The contents of the strategy, as well as the Minister's responsibilities which give clarity on catchment strategies, are highlighted in this chapter.

Chapter three deals with the protection of our water resources. It is divided into five parts: classification systems for water resources, classification of water resources, resource quality objectives, reserves, and pollution prevention and emergencies. Parts 1, 2 and 3 focus more on the protection of our water resources in relation to the national water resource strategy as well as the catchment management strategies. The guidelines and procedures of classifying water systems in the country is examined in the first part of the chapter. The second part deals with determining the quality objectives of these classes of water. The third part focuses on determining the reserves of these classes (reserves for basic human needs and reserves for ecological needs).

The determination of human needs reserves focuses on the important aspects of drinking water and water for human needs (such as for cleaning). Ecological reserves focus on the preservation of aquatic environments. Part four of the chapter focuses on how to prevent pollution of our water resources on both private and public water resources. It provides measures to prevent pollution and binds the catchment management agency as the responsible party. This means that the catchment management agency is responsible for cleaning up pollution and recovering the cost from the party or person(s) responsible for the pollution.

Lastly, the chapter ends with part 5 which focuses on pollution that may result during emergency incidents; for example, spilling of harmful chemicals or substances which may result in the pollution of drainage systems. This part of the Act provides measures of controlling

emergency incidents, as well as binding the person or party responsible for the incident who is liable for the remediation.

Chapter 4 deals with the general use of water resources in the country and is divided into 10 parts. Parts 1, 2 and 3 of the Act deals with general principles of water use which covers topics such as permissible water use, licensing of ground water and regulations concerning water use. Also, included are considerations and conditions of issuing of licences, control of existing lawful water use, and verification of existing water use – all topics covered in part 2. The remaining parts of the chapter cover institutional related topics such as applications for water licence use, general authorisation to water resource use, renewal of licences as well as punishment if the person transgresses the rules. These parts set the scene for chapter 5 and 6 which focus mostly on the institutional arrangements.

Chapter 5 focuses on paying for our water usage, and how water pricing is set out by the Government, as well as the pricing strategy. The main aim of the water pricing strategy is to be able to fund water management, and developments that improve water provision in terms of building new and better infrastructure. This is done with the aim to provide equal distribution of water resources. The strategy's priority is to minimise the wasting of the water and reduce the pressure on the resource.

Chapter 6 give a description of the powers of the Minister and Director-General. Further, it gives a list of regulations and powers in relation to catchment management agencies.

Chapters 7 to 10 focus more on institutional arrangements, which are all the plans and systems put in place to manage the use of the water resources. Chapter 7 deals with the management of catchment management agencies, explaining the powers of catchment management agencies, as well as a general description of the board of the catchment management agencies. Similar to the catchment management agencies are Water Use Associations (WUAs) which are

discussed in chapter 8. These are associations which are established to work together with the Government in order to promote sustainable water use. The purpose of these organisations is to protect other water resources, promote sustainable use of the water resource, and prevent unlawful use of water.

Also, included in water management bodies are advisory committees which are formed by the Minister, whereby the Minister can delegate certain tasks to be done by them. The establishment of the advisory committee as well as regulations governing the advisory committee is discussed in chapter 9 of the Act. Additionally, the country has to implement international agreements due to water resources being shared with neighbouring countries. The Minister establishes bodies that will implement these agreements - the establishment of these bodies is discussed under chapter 10 of the Act.

Chapters 11 to 13 shift focus towards issues regarding infrastructure and land. Chapter 11 looks at the water resources of the Government where the Minister has the power to make changes to public water systems concerning all constructions, alterations and control of dams. It highlights the regulations which the Minister must adhere to before starting constructions, such as preparing an EIA and publishing details of plans in the Government Gazette, to name a few. It also allows the Minister to access funds from the Government accumulated through water charges in terms of chapter 5 of the Act.

Chapter 12 of the Act focuses on the safety of dams, ensuring that no harm comes to the people. First, it provides the definitions of a few terms such as “dam with safety risk” which means any dam that contains more than 50 000 cubic metres of water. The chapter also provides the measures which are used to manage and control the safety of dams. The dam with safety risks should be registered according to section 120 (I) of the Act. This section provides all the procedures that one can follow in registering the dam. Before the dam can be registered (as the dam) with safety risks, is has to be declared as such and meet the criteria for this

categorisation first. The factors which need to be considered in order to declare the dam a safety risk are discussed in section 121 of the Act. Some dam owners can be exempted and in such a case, the Minister must provide an exemption letter based on conditions determined by the Minister. The Minister is allowed to withdraw the exemption due to conditions (e.g. transgression of the rules) determined by the Minister.

Chapter 13 of the Act shifts from infrastructure issues to land issues by looking at access to land as well as rights over land. It gives the Minister power to appoint people who are authorised to perform tasks indicated by section 125 of the Act. The authorised people have power to enter any property with the aim of completing a task given by the Minister as required by the Act. Amongst the tasks that may be carried out, is cleaning and repairing any waterworks which fall under Government jurisdiction. They are also permitted by the Act to build or erect any structure that can monitor and provide useful information about the water resource. Chapter 13 also provides rights which one can exert over the landowner called “servitudes”. These rights allow the servitudes to function within the Act in order to protect our water resources to promote the sustainability of our water resources.

Data collected by authorised people who are appointed by the Minister needs to be recorded, assessed and monitored. This is discussed in chapter 14 of the Act which deals with the safety, monitoring and assessing of all collected information. This gives the Minister powers to establish the National Monitoring System (NMS) focusing on the assessing and monitoring of the quality of the water resource, uses of the water resource, and conditions that can influence water resource management, amongst others. The guidelines in this chapter compels the Minister to consult with other State organs and other water management institutions when establishing the NMS.

Chapter 15 deals with the establishment of bodies that will deal with all the appeals, disputes, resolutions, offences and other general queries. Also, the chapter outlines the tasks of these

bodies and outlines the procedure in terms of the various Sections dealing with the appeal process. After the appeals have been considered, the decisions can be taken by the body. Thereafter, it can be taken to court if the other party is not satisfied. After all these steps, the mediation process can start. Before the appeal can be heard the person needs to be charged first, but there should be a serious offence that the particular person is alleged to have committed. Section 151 in Chapter 16 of the Act provides the list of offences that should not be broken regarding the use of our water resources. Sections 153 and 154 deal with compensation in case of damages or injuries to an employee or any other person who has suffered trauma at the Government facility. The last chapter of the Act deals with the general provisions which are important but are not well-suited for other chapters. Such provisions include limitations to liability which exonerates the State or any person for any damages caused by person(s) in the act of carrying out duties of the Act.

3.3 COMMERCIAL FARMERS AND THE NATIONAL WATER ACT: CASE STUDIES

After highlighting the sections of the National Water Act, the focus now shifts to how the Act currently influences commercial farming in South Africa. Although the National Water Act directly aims at redressing the water distribution fairly and in context of the water source, inequities in access to water still exist. This has been linked to the lack of correct implementation of the Act and its policies by the authorities (Woodhouse, 2012).

Case Study 1

One of the critical examples is the installation of water meters along the Komati River in the Komati Catchment area. The famers along this river received huge fines for extracting water from the river and they raised concerns through the Farmers' Institution (Woodhouse, 2012).

The institution investigated the matter and the outcome was that most farmers in the area displayed a lack of understanding of the Act. The challenge was that farmers had no access to simplified (reader-friendly) materials which will enable them to understand the Act and operate within the regulations. It was also found that key institutional organisations were mandated to set up capacity-building initiatives in the area; however, meetings with the farmers were never

arranged. The Farmers' Institution wrote to the Ministry of Water Affairs stating the lack of understanding amongst the farmers when it came to the National Act and its implementation (Woodhouse, 2012). The Institution highlighted in a report to the authorities that the Act does not separate regulations and enforcement issues, which makes it tricky for them to also explain it to the farmers. The report also raised the issue of water use versus water resource management and protection as the challenging issue that the famers battle with (Woodhouse, 2012). The control and issuing of water-use licences, effective planning, pricing and implementation regulations of the water use licenses were amongst the key issues raised by the report (Woodhouse, 2012). The Ministry of Water Affairs noted the concerns raised by the farmers and agreed to meet with the institution to address these issues. This provides evidence for grounds to look at the holistic role that the National Water Act plays in the adaptive capacity of commercial farmers in South Africa. The South African National Water Act 36 of 1998, like any other law in the country, is not simple or straightforward. There is still a high degree of uncertainty amongst water users, especially concerning the understanding of their rights to accessing water.

Case study 2

Farmers were convicted for extracting water for irrigation from Lomate River. The farmers were convicted on charges of fraud and theft by the State, and this case exposed various contradictions in the National Water Act 36 of 1998. The State argued that the farmers were taking water from restricted sources. Although they got convicted, the farmers argued that they were not aware of the contradictions to the National Water Act (JPC Mostert SNR and others versus The State, 2013).

This case study refers to Chapter 4 of the Act, highlighted in the previous section which deals with the general use of water resource in the country. This chapter focuses on the general principles of water use, which covers topics such as permissible water use, licensing of ground water and regulations of water use. The lack of understanding (and clarity) in this chapter by farmers along the Lomate River, resulted in them transgressing, and extracting water from the

restricted source according to the Act. This supports the concerns raised by farmers in the Komati Catchment area where the lack of knowledge of the National Water Act by farmers, affected the adaptive capacity of farmers in the area.

Case Study 3

The *Mail and Guardian* newspaper reported the case of Eerste River which runs down to the town of Stellenbosch. The river has a very rich river base which supports gardening ventures below the town. Farmers who own land next to this river did not have an adequate supply of water for their gardening ventures. Although they did not have permits, they continued to extract water from the river. This was the subject of several contested actions in the Water Court and a commission of inquiry was set up. The State argued through the National Water Act 36 of 1998 that the Government had the absolute right to grant water usage provided one has a permit where the water resource authority required one. Most farmers were forced to pay fines and apply for Water Use Licences depending on the volume of water required (Mail and Guardian, 2013).

Case Study 4

The Western Cape Province has experienced severe droughts over the recent years which resulted in water restrictions in the province. Through the National Water Act, the City of Cape Town Municipality noticed that most farmers were extracting and using water unlawfully. The City of Cape Town in collaboration with the Department of Water and Sanitation, gave out server compliance and enforcement fines to most farmers who was convicted of unlawful water use (ENCA, 2018).

Case study 2 and case study 3 also display the lack of clear interpretation of the National Water Act and how it should be debated at various points. The Act defines that water required to meet basic human needs is guaranteed as a right and all other water uses by humans are divided into priority categories as highlighted in previous section of the study (RSA, 1998a). However, commercial farmers depend largely on the water resource for their livelihood, and it can therefore be debated how water for subsistence farming should be included in the basic human

needs (Peters, 2009). Large-scale water users such as commercial farmers, mining industries and electricity companies receive water on economic grounds. As a result, the highly stratified division of economic power along racial lines, and the status of the "previously disadvantaged" to access water resources, negatively influence most of the commercial farmers, particularly in the Fezile Dabi District Municipality (Peters, 2009).

Currently the Government focuses on the need to 'balance' equality between productivity and profitability and it is cautious about large-scale re-allocations particularly to commercial farmers. This approach is supported by the commercial farmers in the Fezile Dabi District Municipality whose position is that commercial farmers invest capital and take financial risks to produce food to feed the rural population (Peters, 2009). Additionally, the high illiteracy rates in the District Municipality seriously hampers the involvement and participation of farmers during meetings, despite the often "no show" of relevant institutions. Within the participation process, the farmers are often erroneously categorised as one single interest group and therefore represent the whole Farmers Institution. The farmers in the catchment area are faced with the challenge that they are often expected to act on a communal basis in participation processes while they are strongly divided amongst themselves. The underlying causes of the difficulties for farmers to act collectively result in their inputs concerning policy issues having little or no impact (Swatuk, 2008).

The Water Act provides equal opportunities for citizens to contest unequal access to water resources through a bottom-up approach (Swatuk, 2008). However, farmers in the case studies face various challenges that reduce their adaptive capacity to climate change. These can be summarised as the institutional chaos that emanates out of a plural governance structure which directly influences the executive power and the legitimacy of the various authorities (Swatuk, 2008). This situation creates room for the study to look into other challenges exacerbated by the National Water Act which affects the farmers' adaptive capacity in the Fezile Dabi District Municipality.

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

This chapter examines the data gathered from the primary and secondary research sources relevant to this study. It also examines the ethical considerations observed during the study, in addition to interrogating the main threats and stressors in relation to the coping and adaptation skills of commercial farmers in the Fezile Dabi District Municipality.

Both qualitative and quantitative methods were used in this study in an attempt to establish a link between commercial farmers' adaptive capacity and climate change in relation to the National Water Act in dealing with the impact of adverse climatic conditions. The primary data collection used both qualitative as well as quantitative measures. Thereafter, secondary data was obtained from primary sources which had already been collected (e.g. Statistics SA in the case of climatic data).

4.2 DATA SOURCES

The following data sources were required:

Primary data

1. Qualitative data from interviews with farmers
2. Literature regarding the National Water Act
3. Personal observations

Secondary data

1. Statistical data on climate change
2. Transcripts of previous interviews from the Provincial Literature Library

4.3 SAMPLE SELECTION TECHNIQUES

There are two types of techniques for selecting a sample. The first is probability sampling which refers to techniques such as simple random, systematic, stratified and cluster sampling. This ensures that every member of the community has a known probability of being selected as part of the sample set (Alvi, 2016). In the case of this study, resource constraint dictated the use of probability sampling. Respondents were approached (randomly) and asked if they were willing to participate in the study (Alvi, 2016).

Next, testing of the pilot questionnaire was undertaken with key individuals. The purpose of the pilot questionnaire was to ascertain whether the time it would take to fill out the questionnaire and its length were appropriate. Further, testing was done to see whether it was understandable, free from bias, and that it was able to elicit all the information to answer the research questions effectively. The pilot survey tested the methodology and checked that the questionnaire tool was working correctly (Mathers, Fox & Hunn, 2009).

Semi-structured interviews were also undertaken with some key individuals at this stage in order to fine-tune the methodology and research design. These interviews were mainly undertaken with institutions and extension officers who knew the area, the agricultural sector and the farmers, as well as being familiar with climate change assessments. Fifty (50) farmers were randomly selected for the semi-formal interviews, including one local government official in each local municipality. A standard questionnaire was issued to the sample of farmers (Appendix A). Also, personal (face-to-face) interviews with a sub-sample of farmers, using a semi-formal interview approach was conducted. Appointments with the local government officers were made to secure formal interview sessions (Appendix B) regarding the National Water Act.

The questionnaires were set up and guided by the primary aim and with the main objectives of this research study. Personal observations were also noted and included in the data that was

later analysed. Secondary data was collected from the IPCC 2014 and Agriwiz Agricultural economics data reports, which outlines the extent and implications of climate change in the municipality and the cost, including the amount of water required for agricultural purposes in the area. Local data was requested from Statistics SA which assisted in giving the local perspective of climate changes. Old transcripts from previous interviews were also requested from the Provincial Literature Library.

With the information gathered, the methodology and research design were reviewed. Some elements of the research design needed to be adjusted, particularly some of the questions in the questionnaire and the semi-structured interviews. A number of questions needed to be rephrased as they were ambiguous and misunderstood because the context was not clarified. A further literature review was also done to pick up on some of the adaptation and climate elements raised by the key participants in the semi-structured interviews and (to some extent) the questionnaires. An initial analysis was done of the primary data gathered in the field. Additional key informants were identified through the analysis of the information gathered and from the redesign of the research framework (Mathers *et al.*, 2009). Additional questions were added to the pilot questionnaire in order to gather information that is more detailed on assets and the farmers' access to these assets, in addition to identifying the institutions and Government processes that they interact with. This is directly in line with the elements of the Sustainable Livelihood Framework (SLF) assessments, as well as relevant to answer the research questions.

This forms the main body of the field research that was undertaken with farmers as key informants, institutions and Government workers, extension officers and others involved in the sugarcane industry. It took the form of questionnaires, semi-structured interviews, focus groups, farm visits and walks. This research was undertaken using participatory research techniques drawing on indigenous and local knowledge. Participatory research is essential in

the context of the research paradigm because of the nature of the area, its vulnerability and adaptation in line with the Suitability Livelihood Framework (Mathers *et al.*, 2009).

4.3.1 Data Collection Techniques

There are many methods of participatory research. These can be used together and in different contexts. Two of these methods are Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA). They are most appropriate for this research context and are complementary to the Sustainable Livelihoods Framework and the enquiry into the vulnerability and adaptation strategies of commercial farmers in the research area through a vulnerability assessment (Bergold *et al.*, 2012).

The RRA is an efficient and a cost-effective way of research by outsiders, particularly about different agricultural systems as it highlights the significance and the relevance of knowledge (particularly situational knowledge), as well as the importance of ensuring that one gets the big things largely right as opposed to gathering sometimes deceptive statistical accuracy. Its main techniques are reviewing of secondary data, direct observations, transect walks, participation in activities, interviews with key informants, group interviews, workshops, mapping, documenting biographies, local histories and case studies (Muller *et al.*, 2010).

While the methodology is informal and constrained by time, it is nevertheless rigorous in its design (Muller *et al.*, 2010; Bergold *et al.*, 2012). The PRA is useful in solving problems requiring some spatial or temporal ordering of livelihoods and communities. It also assists in enhancing rapport and limiting the interview role of the fieldworker (Bergold *et al.*, 2012). However, one must be careful of two important pitfalls when using RRA techniques: the first is statistical in terms of non-representivity; the second is one that stems from a situation where information is either intentionally or unintentionally distorted or incorrect (Muller *et al.*, 2010). As far as possible these pitfalls were avoided in this research by using multi-methods such as personal involvement with the farmers, carefully structured questions during semi-structured interviews

and focus groups, confidentiality guarantees and the use of both written and electronic recording techniques to ensure that a true and fair representation of what people said during interviews was given.

4.3.2 The Gathering and Use of Secondary Data

Secondary data plays an important role in guiding the geography of the topic and shows the current understanding of various issues. Using the secondary data in a comparative context is useful in understanding the spatial, historical and social differences and trends (Victor, 2017).

Secondary information was gathered from Government departments and local councils, academic researchers, international and local NGOs, Government Gazettes, websites, historical information from archives, and information from key informants. The strength of this form of research is that it is often easily found and gathered when compared to primary data. Although it provides contextual material, the data can be inflexible and often cannot be customised to the study. The secondary data is used in conjunction with the primary data to assist in validating and analysing the research results (Victor, 2017).

4.3.3 Interpretation of Data

The interpretation stage was to organise all the data that was gathered and begin with an analysis of the data under the Sustainable Livelihoods Framework and concepts of adaptation that underpin this work. Principles of political ecology and entitlement approaches were also used to assess adaptive capacity. Further testing of results against secondary information was done and conclusions and recommendations were drawn. The survey data was analysed only for trends and not to define absolute values.

4.4 ETHICAL CONSIDERATIONS

In this study all individual participants were treated with fairness and respect. All the participants were given pseudonyms to protect their identity unless the participant gave consent that his/her identity can be revealed in the report. Based on the Data Protection Act of

1998, if sensitive and discreet data is collected about the individual participants, that data will be treated with confidentiality. Full disclosure of the nature of the study, its risks, benefits and alternatives, were provided to the participating individuals. The selection of participating individuals will be equitable and will not be biased on gender, race or any other nature of classification.

Due to the nature of the study, no reciprocity will be offered to the participating individuals, but once the study is concluded, all participants will be able to get access to the full report if they require it. Should the participant require any additional information regarding the study, all means will be provided if possible. During all interviews, semi-formal and formal, all participants were provided with an opportunity to ask questions on issues that needed clarification.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 INTRODUCTION

This chapter examines the data gathered from the primary and secondary research processes undertaken in the study area. Data collected using tools and techniques described in the preceding chapters were collated and analysed. It also examines the livelihood assets available to, and used, by the farmers, as well as the enabling mechanisms used to cope and adapt to climate change

5.2 COMMERCIAL FARMERS IN THE FEZILE DABI DISTRICT MUNICIPALITY

Fifty (50) famers were randomly selected from the Fezile Dabi District Municipality. All the 50 questionnaires were completed and returned, although some questions were not answered while some of the questions were answered in Afrikaans but later translated to English. The reason that led to some of the questions not being answered was that some questions were not applicable to certain farmers (e.g. questions on livestock management were only applicable to livestock farmers and those practicing mixed farming, and not to crop farmers). The following data was collected from the semi-formal interviews as well as from the questionnaire:

5.2.1.1 Gender

Out of the 50 farmers that participated, **43** of the farmers were males and only **7** females. The semi-formal interviews revealed that most of the female farmers in the area have inherited the farms from their deceased husbands.

5.2.1.2 Race

Based on the received questionnaires the following results were evident: Out of the 50 respondents, 39 % of farmers were white, 6% percent of farmers were Black/African while 2% of them were Asian farmers (see Table 3).

Table 3: Race distribution of farmers in the Fezile Dabi District Municipality (Source: Mhlomi)

Race of farmers in the area		
	Number	**Percentage**
Asian	**1**	**2%**
Black/African	**3**	**6%**
European/white	**46**	**92%**
Coloured	**0**	**0%**

5.2.1.3 Age of farmers

Most of the farmers in the area are between 35-54 years old (Table 4). There was only one farmer who was between the ages 18-24, and six farmers between the ages 25-34, while 11 farmers were between 55-74 years old.

Table 4: Age distribution of farmers in the Fezile Dabi District Municipality (Source: Mhlomi)

Age of farmers in the area		
	Number	**Percentage**
18- 24 years	**1**	**2%**
25-34 years	**6**	**12%**
35-54 years	**32**	**64%**
55-74 years	**11**	**22%**

5.2.1.4 Education of farmers

Based on the received questionnaires, the following results were also evident. Out of the 50 respondents, 56 % of farmers had tertiary education, 26% of farmers had secondary education while 18% of farmers had only primary education (see Table 5).

Table 5: Distribution of farmers in terms of education in the Fezile Dabi District Municipality (Source: Mhlomi)

Education of farmers in the area		
	Number	**Percentage**
Primary	**9**	**18%**
Secondary	**13**	**26%**
Tertiary	**28**	**56%**

5.2.1.5 Discussion on gender, race, age and education

The data reflected in the study shows that in the Fezile Dabi District Municipality, young men in the area are more likely to participate in farming as compared to young women. Through the semi-formal interviews, some older farmers in the area said they preferred their sons to take over their farming activities rather than their daughters. This shows that the stereotype behaviour of “farming is a career for males” is still dominant amongst the farmers in the area. One reason that was discovered during the study, is that the majority of young females in the area moved out to urban areas where there are few agricultural activities happening. This reduces their interest in farming or agricultural activities.

Based on the questionnaires, most of the farmers in the area are middle-aged, and they have tertiary level education. The majority of farmers with primary education are old-aged farmers. The level of education can be positively associated with youth participation in farming, as well as the rise in interest of agriculture as an occupation across different races, such as Asian and Black. The area was previously dominated by white older farmers; however, the influx of younger farmers of different races positively increased the level of education amongst farmers

in the area. Data supports the importance of education in the sector, as stated in the literature review that illiteracy rates in the District Municipality seriously hamper the involvement and participation of farmers during meetings; however, most farmers in the area are mostly educated with tertiary qualifications (Swatuk, 2009). This means that understanding of key concepts in the Act is not a major problem amongst the farmers in the area.

5.2.1.6 Years of Farming, Part-time versus full-time farmers

The study shows that out of the 50 respondents, 32 (64 %) farmers have been farming for over 30 years in the area. Most of the current farmers inherited the farms from one generation to the other. The created inter-generational wealth has kept the farm in the hands of the same family over the years. The other 18 (36%) farmers have been farming for not more than 30 years. This can result in different farming practices regarding the farmers with more experience and farmers with less experience. This supports Botha's and Walker's (2013) observation that most farmers in South Africa rely on farm knowledge and experience when dealing with water scarcity resulting from climate change, and this is based on exposure to climate variability and meteorological observations they made over time, and one farmer in the area said "you cant teach an old dog new tricks".

Many factors affect the years spent on farming in the area; one that stood out most was the rural-urban migration. Also, the number of livestock and size of the farm affect migration levels in the area. Most farms in the area are sold to the Government as a result of farmers participating in the Land Reform Programme. After selling, most farmers in the area migrate to urban areas, seeking urban salaried employment. The study also noted that all the farmers in the area are full-time farmers residing on the farms.

5.2.1.7 Core Problems Experienced by Farmers

There are a number of core problems experienced by farmers in the area:

Drought: This has been the biggest problem experienced by farmers in the Fezile Dabi District Municipality. Drought has had a devastating effect on farmers, which resulted in a depletion of natural grazing areas across most farms in the area of study. Most of the farmers have resorted to forced slaughtering in order to reduce the number of their livestock to a more manageable number during a drought season. High temperatures in the area have affected pollination and this has resulted in the reduction of crop production.

Floods: Due to climate change and the drought season in the area, less rainfall has been experienced. However, not only does rainfall patterns affect farming. Also most of the rain falls late in the season and high volumes of rain are experienced by farmers. This results in flooding of the areas and a complete wipeout of the crops, thus reducing crop production drastically.

Diseases and Pests: As a result of the current climatic conditions in the area, there has been a gradual rise in pest and pathogen in the area. Although it has not been an epidemic yet, the rise in "Rift Valley Fever" had largely affected the animals in Fezile Dabi. Also, with high temperatures in the area there has been emerging pests in the area such as *Fall Armyworm*, *Maize Lethal Necroisis* and *Tuta absoluta*. These pests affect the crop production in the area resulting in a reduced capital gain for farmers.

These are amongst the core problems highlighted in the literature review section of the study. Due to the disrupted ecological balance as a result of climate change, pests and diseases are tolerated but controlled in the area. Colonisation of insects in the area is one the main problems (Nayamuth *et al*., 2002). Periods of rapid warming with excessive mean annual temperatures, were cited to be larger than the previous mean annual temperature with drier

subtropical regions. This as has resulted in drought conditions and flash floods as being some of the core problems experienced by farmers in the area (Niang *et al*., 2014).

5.2.2 Adaptive Strategies used by Farmers

5.2.2.1 Diversification

Reliance on a single type of crop and on a single farming technique has become a non-option over the years. This is due to the continued impact of climate and external stressors, and it is important that farmers, particularly small-scale growers, seek alternative sources of income to supplement the income from the sugarcane crop. A number of farmers in the research area use the livestock as an income source, to build houses with or assist their other businesses (basic supply stores and other small business generally run by the community).

Crop production in the area is the extra income source used by farmers to make up for shortages. Other farmers have opened eco-tourism businesses or have opened adventure trails on their farms. Some have begun to run their own consultancies (engineering and farm practices) or work for other businesses in nearby urban areas to supplement the farm income. Zwane and Montmasson-Clair (2016) stated that perception and knowledge of farmers towards climate change is very important as it allows farmers to develop strategies to adapt to climatic changes. This strategy has been the most effective strategy amongst the farmers in the area as it acts as a means of “one sector supports the other” type of relationship (Zwane & Montmasson-Clair, 2016).

5.2.2.2 The use of crop-modelling

Crop-modelling access is largely through research departments such as ARC, facilitated by extension officers and scientific departments within the agricultural sector. The Department of Agriculture working together with SAWS through the land care programme, offers forecasts, crop and climate modelling systems, yield and RV estimates, as well as early warning systems. Information is available through websites, the Department of Agriculture’s extension officers

and the SAWS website. A number of farmers who have access to the internet and cellular phones, have regular updates through newsletters and visits from officials of the Department of Agriculture (extension officers); hence, they are able to obtain yield and pricing estimates, climate and crop prediction data, and information on crop varieties. This assists the farmers in their financial and farm planning.

5.2.2.3 Seasonal forecast

Seasonal forecast is available to the farmers but are limited in their scope and not often used by due to issues of accessibility and easy understanding of the forecasts. Some farmers have access to these forecasts but did not indicate that they were of particular use to their day-to-day activities.

This strategy, though somewhat limited in its current use, has assisted farmers (at every level) with preparedness and early action to prevent further vulnerabilities. It has assisted with financial and farm management plans, reducing risk of total crop damage and crop failure and increasing yields (both in quantity and quality of the crop). It has also resulted in outcomes such as improved resource management and sustainable resource use (particularly of natural resources). This section also links to the fact that most farmers in South Africa rely on farm knowledge and experience when dealing with water scarcity resulting from climate change (Botha and Walker, 2013).

5.2.3 Farming Activities in Fezile Dabi District Municipality

Based on the information gleaned from completed questionnaires, the following results were evident: out of the 50 respondents 32 % were livestock farmers, 24% were crop farmers while 21% practised mixed-farming (Table 6). The farmers in the area of study practise large-scale commercial farming. This means that most of their production requires a lot of water.

Table 6: Farming activities in the Fezile Dabi District Municipality (Source: Mhlomi, 2016)

Type of farming activity		
	Number of Farmers	**Percentage (%) of farmers**
Livestock farming	**16**	**32 %**
Crop farming	**12**	**24%**
Mixed farming	**22**	**44%**
Total	**50**	**100%**

The majority of farmers in the area practise mixed-farming (44%). The most practised agricultural activity in the area is livestock farming (24%), which is mainly driven by the availability of grazing land. The grazing capacity of Fezile Dabi District Municipality is estimated at 91 332 hectares with most of the grazing capacity located around the Vaal River north of Fezile Dabi District Municipality. The lowest practised agricultural activity is crop farming, which became reduced significantly due to drought conditions in the area.

5.2.4 Main Water Sources for Farmers

As indicated previously, the main source of water for commercial farmers in the area is got from 8 catchments. Results in table 6 show that farmers rely on different water sources in the catchments. Most of the farmers in the area get their water from boreholes (72%), which show that most of them are registered with the Department of Water Affairs. Some of these boreholes are old and near to drying up. Eight percent (8%) of the farmers in the area draw their water from the nearby rivers. The biggest problem facing these farmers who draw their water from the rivers is the compliance with the legislated Act. Most of these farmers get fines from the local water resource authority and this can affect them financially. About 20% of the farmers in the area have constructed their own dams (Table 7).

Table 7: Main sources of water for farmers in the Fezile Dabi District Municipality (Source: Mhlomi)

Main Source of Water		
	Number of Farmers	**Percentage (%) of farmers**
Borehole	**36**	**72%**
River	**4**	**8%**
Ponds	**0**	**0%**
Reservoir/Dam	**10**	**20%**
Municipality	**0**	**0%**
Total	**50**	**100%**

5.2.5 Farmers' Perceptions

5.2.5.1 Climate change

The importance of understanding farmers' perceptions about drought is because it provides an insight into the previous drought experiences, as well as a level of understanding and awareness about climatic changes (Botha & Walker, 2013). Most farmers had at some point experienced a climate change event. They classified drought and flooding as one of the worst climate change events that at least one farmer has experienced in the area. Only a few of the farmers claimed they have never experienced drought; this can be attributed to the fact that they are new farmers.

The prolonged drought conditions in the area had been the key observation by farmers. They perceive drought as a result of climate change (Botha & Walker, 2013). One of the farmers in the area mentioned that over the 30 years he has been farming in the area, he has never experienced a drought season that is as severe as the recent one. Farmers in the area are aware that climatic conditions in the area are changing, and they also need to adapt to this ongoing phenomenon (Botha & Walker, 2013). There are attempts made by farmers (who have experienced adverse climatic conditions) such as crop rotation, diversification and use of Early Warning Systems, to reduce the climate change effects on their farms. This shows that there

are adaptive mechanisms used by farmers to ensure sustainability during periods of water and grass shortages (Botha & Walker, 2013). Out of the livestock or mixed-farming farmers interviewed, 40 % provided supplementary feeds for their livestock during normal times; 60 % did not supply their animals with supplements. Although these farmers have no understanding or never experienced drought before, they had put measures in place to combat this phenomenon.

5.2.5.2 National Water Act and climate change adaptation strategies

The perception of and response to climate change is mainly based on experience and knowledge of farmers which they have, and much of this knowledge is based on firsthand experiences of how climate impacts farming practices. During the research, farmers were interviewed individually and some together in a focus group. A group of emerging farmers who are mostly young, understood and had knowledge of the National Water Act. However, the older farmers showed little understanding of the National Water Act. Perception and knowledge of farmers towards climate change has been displayed as being very important as it allows farmers to develop strategies to adapt to climatic changes (Zwane & Montmasson-Clair, 2016). Based on the farmers' narratives, the burden of challenges experienced by the farmers are mainly exacerbated by the constantly changing and amending of the Act. Furthermore, the farmers explained that adaptive strategies adopted in response to climate change challenges are mostly "contradictory" to the Act - rather than being helpful, the Act ironically affects potential future strategies.

The section is broken down further into some of the experience's farmers have regarding the National Water Act and climate change adaptation. Some of the farmers highlighted that some of them located upriver have increased river water abstraction (for irrigation), resulting in less water for farmers living downstream. The farmers also raised the point that although the Act makes provision for the volume of water to be abstracted, the location of abstraction in not considered in the Act.

Some of the farmers in the area aim to expand their farms, however this will require increased irrigation. Due the ongoing climate change, this option is said to be restricted due to limited river water supply as a result of the water restrictions detailed in the Act. Authorisations for increased storage capacity is also said to be difficult to acquire. They suggested that the only option available after increasing storage capacity would be to implement additional water conservation methods and different irrigation techniques, which at the moment is difficult as a result of the restrictions placed by the National Water Act.

The farmers in the area found that the water extracted from boreholes is very salty and therefore unusable in some areas. Dryland farming is practised on their farms and therefore droughts are said to have a significant impact on production than they do on irrigated farms. The lack of water has resulted in the need for higher input costs and additional dam building for increased rainwater storage, although this is restricted by the local government department. The farmers also experienced issues with limited availability of adequate labour in the area, which they suggest is because of increased urbanisation (e.g. fewer people in rural areas willing to become farmworkers, as well as decreased opportunities due to there being a decreasing number of labour-intensive jobs).

5.3 LIVELIHOOD ASSET MANAGEMENT

When assessing adaptive capacity and understanding its dimensions outlined in the previous chapters, we must examine the livelihood assets available to, and used by, the farmers and the role of the National Water Act - its policies and strategies. These assets are investigated under the Sustainable Livelihood Framework (also outlined in the previous chapters) which informs the research framework of this study. This section also examines stressors acting upon some of the livelihoods of these farmers which constrains the use of these assets, in relation to the role of the National Water Act pertaining to each asset available to the farmers.

5.3.1 Physical Assets

In the study area the assets available to farmers include transport systems and infrastructure such as tractors, trucks and trailers, cars, and access to public transport (for employees). It also includes buildings and water management systems such as dams (Figure 10). A lack of basic production capital (mentioned under financial assets) makes the purchase of equipment and machinery difficult and this is compounded by the purchase tax on various items which restricts buying (Getibouo *et al*., 2010). Furthermore, there are several basic infrastructural concerns such as poor road maintenance in a number of areas which makes transport of agricultural products difficult, issues of poverty and food security, and access to basic services (water, electricity and sanitation) which continue to be of concern to farmers.

Figure 10: Showing one of the dams used by farmers in the Fezile Dabi District Municipality (Source: Mhlomi)

One of the main concerns is the rise in fuel prices over the years due to a number of political and economic factors acting out in the global markets. The increase in the fuel price has meant

an increase in the cost of products. However, the increased cost of delivering the harvested agricultural products to the mill often outweighs the return.

The lack of capital and physical assets that these farmers experience force them to rely on the services of contractors to provide them with ways of increasing production with the little water available, due to them avoiding building dams. Some of the contractors charge high prices because they know the farmers have little experience concerning the going rate for their services. Some of the older farmers in the areas also rely on contractors to drill boreholes - some use the same contractors to interpret the Act for them. However, most of the contractor's job is to drill the boreholes. Also these contractors often misinterpret the Act which results in the farm owners transgressing by-laws unknowingly.

It is sometimes necessary to build dams for water provision; however, there are regulations in place by the National Waters Act concerning this. This becomes a problem especially for the older farmers due to their lack of understanding of the National Water Act. This tends to affect them after building the dams on their properties. Another problem that is faced by farmers in the area is the issuing of water-use licences. In some cases, less water is allocated than was previously used as a result of water restrictions. The main reason for this is usually a shortage of water in the area arising from the impact of droughts. This eventually has a huge impact on the farm's value and in turn this has serious negative financial consequences for the farmers. Section 21 of the National Water Act makes provision for 11 categories of water use, of which some of the water uses are directly applicable to the farmer. One of the water use categories that mainly pertains to farmers in the area is taking water from the source. The Act highlights the actual water capacity in cubic metres per annum that the farmer can draw from the river source and for storage. Due to climate change in the area farmers find themselves storing more than the regulated amount of water, as a result of water restrictions in the areas. Nutrient deficiencies in the soil and grazing land following a drought tend to increase the need for

fertilizers and other supplementary livestock feed (Figure 11) particularly for the farmers who are engaged in mixed-farming.

Figure 11: Showing one of the supplementary feed areas used by farmers in the Fezile Dabi District Municipality (Source: Mhlomi)

5.3.2 Social Assets

Social assets are the social resources that the farmers use to sustain their livelihoods and include the informal social networks formed within communities, farmers groups and associations, as well as agricultural associations. Farmers in the area organise farm visits and networking sessions. These farm visits happen monthly and give neighbouring farmers a chance to see some of the activities happening on each other's farm. These are learning, as well as problem-solving opportunities for the group. These visits are also used as a support system for farmers in the area and as an opportunity for social gatherings. Family members and neighbours are also valuable social assets available to the farm, particularly to the small-scale farmers who live within close proximity of each other and within extended households. Community policing forums and farm-watch programmes have been run in the past and some

still operate within this area to assist in mitigating threats of crime and violence. Because of past political divisions and the scarce natural resources in some areas, there is mistrust in some farming communities. Farmers are seen to be less interested in getting involved in cooperatives and formal farm groups. This has led to weakened formal organisations, difficulties with internal politics, and a breakdown in collective social and economic activities. This breakdown in unity has also weakened social assets and weakened the adaptive capacity of commercial farmers in the area.

5.3.3 Financial Assets

The financial assets available to farmers include loans from banks and agricultural organisations, grants from the Department of Agriculture, money earned from other economic activities such as small consultancy businesses or profits from product sales and interest from investments or saving schemes. However, the financial impact on commercial farmers is particularly a problem for the emerging farmers, simply because experienced farmers are generally financially stable. Once emerging farmers have acquired the land and it is paid for, the farmer still needs working capital to run operations on the farm. Financial institutions insist on security and financial statements. Many emerging farmers do not have these and are denied access to loans and overdrafts due their scale and experience in the commercial farming sector. Off-farm economic and political threats such as land reform threats affect profits, input costs and the ability of farmers to sustain their livelihoods and agricultural production, thereby reducing their resilience and increasing vulnerability (Free State Legislature, 2013).

Political policies and legislation also play a huge role. Land reform threats can affect profits, input costs and the ability of farmers to sustain their livelihoods and agricultural production. Therefore, this reduces their adaptive capacity resulting in increasing vulnerability to the effects of climate change. A number of the aforementioned factors may not directly impact on the day-to-day lives of the farmers but they do affect their financial bottom line, their profits, and their means of production. They have an impact but cannot be directly managed. These types of

impacts are detached from the context physically but have a cascading effect on the farmers. They have a severe impact and are controlled by external forces making it difficult to manage.
The withdrawal of most government subsidies also added to the huge financial burden on the emerging farmers as they now had to face all the financial stress without subsidies. Another stress on the financial assets of farmers is the paying of fines as a result of transgressing the law. Most of the farmers do not understand legislation therefore they find themselves having to pay fines, which also adds stress regarding their financial assets.

5.3.4 Natural Assets

This refers to the natural resources that are useful for sustaining the livelihoods of the farmers and is closely linked to the ecological dimensions of vulnerability. Types of natural assets include land, water and the natural fauna and flora of the area, which can be negatively affected by natural devastations such as flooding and droughts. The farmers in this area undertake dry and wet land agricultural activity with irrigation mainly done during times of dryness and heat-stressed periods (Moetetsi & Walker, 2012). The most important natural assets in this area are crops and livestock (Figure 12).

Figure 12: Showing one of the natural assets (crops) used by farmers in the Fezile Dabi District Municipality (Source: Mhlomi)

The main biophysical stress that acts on the system, increasing vulnerability and affecting natural assets, is that of climate change and climate variability with its concomitant risks. Climate change and variability affect all aspects of farmers' livelihood systems - political, social, economic, and biophysical - (Morse & McNamara, 2013).

The element of risk associated with climate change and climate variability was identified as a perceived threat by the farmers and was placed at the top of the list of threats. Climate variability affects a number of elements of the farming system in this area. This effect is not only felt through a decrease in yield but also through a number of related and cascading impacts (Moeletsi, 2010). Periods of climate variability such as drought, flooding, frost episodes and periods of high temperatures, affect inputs and operational costs, livelihoods assets and farm management practices. Soil and crop nutrition have been seen to suffer during periods of climate stress and, in some cases, require technology and information transfers on climate

predictions, yield predictions, varieties, harvesting times, and best practice operations on the farms (Moeletsi, 2010).

The farmers pointed out that drought has the biggest negative impact on them. Drought conditions contribute to difficult economic conditions that caused the abandonment of cultivating some of the crops (e.g. sugar cane) due to the deterioration of cane quality and stalk mortality. Farmers who lost their crops as a result of drought could not plant new crops for the new season. This was exacerbated by debts that had accumulated with the need for more inputs to manage the drought situation. The expense of replanting, higher input costs and a drop in crop quality resulted in debt levels rising even further.

Another major concern that influences the soil crop nutrition is that of access to water. The National Water Act has made it difficult for some large- and medium-scale farmers to store water and register their water usage (water licence) on their farms. Some of the farmers started to break down dams and reservoirs in order to avoid having to pay the tariffs for the storage of the water on their farms. Most of the crops produced in the area require a lot of water for production; however, some farmers in the area have switched to dryland farming due to these restrictions (Vos, 2006). The National Water Act aims at ensuring compliance with registered water use via licensing. However, the process of issuing licences to water users is seen a serious challenge. The study found that the Government aimed specifically at removing the backlog in water use licences, as some licence applications had been with the Department for up to eight years without being finalised. Furthermore, the system of registering water use across the country is not up-to-date and reflects incorrect water use figures. Resulting in significant billing and revenue collection challenges and difficulties in ensuring compliance with registered water use.

5.3.5 Human Assets

Human assets include available and skilled labour. Human assets were investigated at farm level and this revealed that there are a number of human assets available to the farmers in the

research area. Within households themselves, there are a number of people who are able to help with the farm operations (Smalley, 2013). However, farmers are aware of the health of the employees, including gender issues around work allocation. Farmers do employ a number of skilled (Figure 13) and unskilled laborers on a part- and fulltime basis who receive advice from advisors, sales representatives, extension officers, and technicians.

Farm labourers are an important asset for the farmers, but numerous stressors may lead to challenging circumstances. Labour shortage is a prime risk and the main challenge to farmers in the area. Those with a higher level of education are leaving rural areas for work in the urban areas. Concerns were raised during interviews by farmers in the area regarding the shortage of workers who are willing to work on the farm. New labour legislation based on minimum wage standards has been another challenge for farmers and has complicated the employment of labourers. It has resulted in reducing the number of people employed and thus finding ways of mechanising processes are being looked at. The traditional system that was in place for payment to farm workers is now not compatible with minimum wage standards.

Figure 13: An example of one of the skilled workers working on a water storage system in one of the farms in the Fezile Dabi District Municipality (Source: Mhlomi)

5.4 DATA COLLECTED FROM THE RELEVANT AUTHORITY

The focus now will be shifted to the relevant authorities in the Fezile Dabi District Municipality. The Free State Department of Agriculture and Rural Development, the Free State Agricultural Research Council, as well as the Department of Water and Sanitation, were chosen to be included in the focus group discussions for this study. The relevant authority plays a critical role concerning the adaptation to climate change by farmers because it provides institutional arrangements (Swatuk, 2008), which formalise and determine the access to water resources that will allow the farmers to improve the adaptive capacity to climate change. This section will look into these institutional arrangements.

5.4.1 Climate Change Plan/Strategy

There is evidence of localised and national climatic changes over the recent years, reported by the Intergovernmental Panel on Climate Change (IPCC). Through the analysis done by IPCC, SAWS and ARC, these climatic changes have been generally based on the key vulnerability in

the biophysical, economic and social sectors (Table 8). Based on the observations, the Government has responded to climate change by developing the National Climate Change Adaptation Strategy. This strategy is a critical tool in adaptation planning and implementation in the country.

Adapted from the National Climate Change Strategy, the Free State Provincial Government has undertaken a proactive approach to respond to and adapt to the challenges posed by climate change (DRDLR, 2016). The impacts of and vulnerabilities to climate change vary across regions, economic sectors, social groups and types of systems; therefore, there is need for case-specific vulnerability assessments. Based on this, the Free State Provincial Government responded to the adaptation of the Climate Change Vulnerability Assessment which resulted in the development of the Free State Province Adaptation Response Strategy.

The strategy is very important because it serves as a reference point for all adaptation efforts, thus helping to guide the Fezile Dabi District Municipality to develop its own climate change strategy (DRDLR, 2016). It also guides the development activities in all sectors at all levels to reflect on adaptation processes in all their strategies or plans. It also produces a stage at which all adaptation objectives can be sourced to provide guidance to all sectors. This means that all sectors can be cohesive and collaborative when planning, reporting and implementing climate change adaptation in the country. The strategy makes provisions for the water resource to be centre stage when dealing with development and trade-offs (DRDLR, 2016). It highlights the water resource as a critical constraint when coming to economic development, with most of the restrictions seen in the agricultural sector.

Table 8: Key vulnerability factors in the biophysical, economic and social sectors (adapted from Vos, 2016)

Key Vulnerability	Biophysical	Economic	Social
Unreliable and uncertain access to water	X	X	X
Risk to agricultural productivity and livestock		X	X
Human safety from climate-related extreme events	X		X
Vulnerable energy system and infrastructure		X	X
Diminished labour force productivity through exposure and ill-health		X	X
Supply and demand volatility of the market		X	X
Carbon intensity and dependence on economy		X	
Ecosystems and conservation	X	X	X

5.4.2 Measures in place for farmers assistance

The commercial farmers in the study struggle to see the role that the Government plays. However, officials have indicated that the Government plays a critical role in improving resilience to climatic changes, as well as decreasing vulnerability in areas (Swatuk, 2008). There are measures in place to bring about links between the markets and farmers (Merrey *et al.*, 2009). One of these measures is the Agri-Park initiative, which is one of the Government's key initiatives aimed at poverty alleviation by stimulating the agricultural economy in the country. This concept provided an integrated approach to collective farming efforts such as the agri-clusters, agri-villages, and eco-villages (Free State Legislature, 2013).

The Agri-park Model Initiative aims to support all farmers by strengthening the partnership between Government, civil society, commercial and small-scale farmers, as well as the private sector. These institutions interact at a number of different levels: internationally, nationally and locally. Their influence over the distribution of capital and access to strategies is very significant, especially how they respond and adapt to changes in the contextual setting,

whether devastating such as the drought and food security crisis, or more measured such as the demographic transition. In terms of the institutional interplay, the effectiveness of these institutions depends not only on the instructional features, but also on how they interact with other institutions. This includes interactions with institutions at the same or on different societal levels.

A key finding in this study is that Government institutions do help in the development of adaptation strategies in this context. However, the implementation of these strategies is difficult and leads to mediocrity (Woodhouse, 2012). Furthermore, Government institutions are key in shaping vulnerability and adaptation practices in the agricultural sectors. The influence of Government on the distribution of capital and access to strategies is very significant as this assists farmers on how they can respond and adapt to climatic changes such as droughts which affects food security.

5.4.3 Water Resource Policy and its Implications

The main objective of the water resource policy is to manage quantity, quality and reliability of the nation's water resources; this implies long-term environmental sustainability, and social and economic benefits for society. The biggest challenge which cuts across all sectors is policy-implementation resulting from the lack of capacity in Government. The practical implementation of the water resource policy is a top-down approach (Swatuk, 2008; Woodhouse, 2012) which gives power to those in charge of implementing the legislation; hence, this becomes a challenge because as stated above, Government is faced with a lack of capacity, therefore water resource policy implementation takes a back seat until a water resource related problem arises. However, policy implementation must not exclude the community; farmers and the private sector should together open networks for all stakeholders involved (DRDLR, 2016). A positive outlook on the policies is that the National Water and Sanitation Master Plan developed by the Department of Water and Sanitation, makes provision for affordable water for the agriculture sector (DRDLR, 2016). The National Water and Sanitation

Master Plan should also make provision for the promotion of more efficient irrigation processes and technological developments. This will help farmers to rely less on borehole and surface water; thus reducing costs to service-providers while complying with the National Water Act concerning efficiency and sustainable water use (DRDLR, 2016). In addition, the Department of Water and Sanitation must improve the water use licensing process, with the aim to assist more farmers regarding compliance to the National Water Act. The Department must introduce the Raw Water Pricing Strategy (DRDLR, 2016) as required by the National Water Act to charge reasonable rates. This strategy will seek to find cost-achievable ways of maintaining the water resource at minimal cost to the consumer (DRDLR, 2016). This means that high water pricing for farmers who consume more water through irrigation, will be placed under review and this will possibly help reduce the stress on the financial assets of the farmers**.**

CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

This chapter gives an overview of the thesis, beginning with global and local climate changes, vulnerability and adaptation as main topics. The main findings will then be discussed followed by the conclusions made from this study. Thereafter, suggestions and recommendations are provided for further research.

6.2 CLIMATE CHANGE AND ADAPTIVE CAPACITY

Climate change is one of the most significant elements of global environmental discussions. This stems from the fact that climate change is expected to bring fluctuations in rainfall patterns, temperatures, including social, biophysical and economic systems - both globally and locally. Even if we undertake immediate and drastic mitigation strategies, the earth is still going to undergo some degree of climate change (IPCC, 2014).

Farmers' adaptive capacity is viewed as a focal point in this study and is seen as a reaction to three elements: vulnerability, sensitivity and exposure. One of the ways to deal with the impact of climate change is by finding ways to adapt to it. Adaptation is one of the most widely used strategies in dealing with the impact of climate change in South Africa (e.g. policies and legislation). In the past, the study area received a low amount of rainfall that had a great negative impact on the farmers; in particular, the farmers who reside in agricultural villages. Not only is a decline in annual rainfall disastrous, but an increase in mean annual temperatures is also a sign of future climatic catastrophes.

6.3 METHODOLOGY AND FINDINGS

Based on previous studies, the approach to this study assumed that there was a direct relationship between catastrophic climate events and farmer-adaptive-capacity linked to the National Water Act (REF). Climate change studies have evolved from a research paradigm

focused primarily on the 'impacts' and mitigation, to adaptation to climate change. The methodology recognised the close relationship regarding legislation changes towards enhancing adaptive capacity.

The following hypothesis was tested: "The farmers' ability to adapt to climate changes is either constrained or enhanced by the National Water Act". The influence of climate as a risk factor was considered in conjunction with stressors related to farmers' livelihoods. A key element was improving the understanding of the livelihood of farmers. This involved the undertaking of an assessment under the Sustainable Livelihood Framework.

This study also explored perceptions of climate risk and variability and what internal and external, past and future risks and shocks farmers face in this case study area. It also examined coping and adaptive strategies used in response to shocks such as climate events (e.g. droughts). Assets and access to these assets as well as the ability to put these assets into productive use was explored. The role that various institutions, policies and organizations have in determining this access and in shaping agricultural strategies was also investigated.

6.4 SUMMARY OF THE FINDINGS

There are several assets that farmers have access to and use in their livelihood strategies. These assist in increasing the adaptive capacity of the farmers. Other threats and stressors include a lack of access to start-up and production capital, and high levels of debt (off-farm and on-farm). Land issues such as land tenure, land reform and land claims, the quantity and quality of the land (off-farm and on-farm) and a lack of access to tools that will equip them to understand Government legislation and policy decisions, all add up to complicate and stifle the adaptive capacity of farmers.

Farmers have applied a number of response strategies including some emerging adaptation strategies in response to stressors affecting their livelihood assets and the environment in which they operate (Morse & McNamara, 2013). Within this study area, these strategies include

diversification (in the type of farming and the activities undertaken besides farming in order to supplement income), changing land use and farm practices, the use of social networks and support systems, combined farming practices, and the use of crop modelling and climate forecasts. These strategies make use of the livelihood assets that farmers have access to (Morse & McNamara, 2013). It is argued that the more strategies that are available to the farmers, the more accessible they become to farmers as this will increase the farmers' potential to adapt to those threats acting on and within the system which drive risk and social vulnerability. However, strategies adopted in response to climate change challenges are explained by farmers as being mostly opposed by the National Water Act rather than being helpful; therefore affecting potential future strategies.

The Government plays a critical role in improving the adaptive capacity of commercial farmers in the Fezile Dabi District Municipality through initiatives such as the Agri-parks. However, one of the critical findings is that there is a lack of support by the Government with regards to the issue of the water resource. Government encourages the development of water related strategies; however, there is no effective implementation being done. There is also a shift in water policy as climate change is regarded as being critical; however, little is done in terms of effective legislation. The main objective of the National Water Act is to ensure environmentally sustainable water use with hands-on management for long term social and economic benefits. However, this has a huge impact on the farmers in the area especially with climate change events affecting livelihood assets. When looking at the adaptive capacity of farmers with reference to the Sustainable Livelihood Framework (SLF), three assets are mostly affected by the National Water Act:

1. **Natural Assets:** Although the National Water Act aims at ensuring compliance with the principle of registered water use, the biggest stress to farmers' natural assets is the process of issuing of Water Use licences to farmers. This results in water use restrictions particularly affecting the way famers irrigate their crops. Climate change resulted in the need for more water for crops; this means large volumes of water

will be required for irrigation purposes particularly since the area is affected by drought due to climate change. The study found that the Government aimed specifically at removing the backlog regarding the issuing of water use licences, as some licence applications had been with the Department for up to eight years without being finalised. This put more stress on the farmers' natural assets because without amended water used licences, famers could not increase volumes of water used for irrigation.

2. **Physical Assets:** Climate change has resulted in water scarcity and drought in the area; therefore, farmers must find ways of increasing productions with the little water available. This increases the need to build dams to store water. Without the water-use licences in some cases, farmers could not build dams on their farms as the National Water Act strictly requires the possession of a water use licence for the building of dams. This eventually had a huge impact on a farm's value leading to serious negative financial consequences for the farmers. Section 21 of the National Water Act makes provision for 11 categories of water use, of which some of the water uses are directly applicable to the farmer. Alternatively, farmers take water directly from the rivers. The Act stipulates the actual water capacity in cubic metres per annum that the farmers can draw from the river sources for storage purposes. Due to Climate Change in the area, farmers found themselves storing more than the regulated amount of water, as a result of water restrictions emanating out of drought situations.
3. **Financial Assets:** The National Water and Sanitation Master Plan makes provision for the introduction of more efficient technologies to facilitate irrigation processes. This will help farmers to utilise less borehole water and less surface water, thus reducing costs incurred by engaging service-providers. This will also facilitate compliance to the National Water Act with regards to efficient and sustainable water use while providing relief for some of the farmers' financial assets as less capital will be required for production. However, during the research, it was also brought to the

attention of the researcher that the Department aims to introduce the Raw Water Pricing Strategy (DRDLR, 2016). As required by the National Water Act, water usage must be charged for within the governmental framework rate. This will help reduce the stress on the financial assets of farmers. This is one of the positives that emanated out of the study.

The Government angle of trying to enhance adaptive capacity by developing water-related strategies, does no justice to the fact that the National Water Act restricts the adaptive capacity of farmers concerning critical assets. Not all is lost however - one of critical challenges raised by a Government representative during the semi-formal interviews was the lack of capacity particularly in implementing these strategies; Government is in the process of improving capacity to deal with climate change phenomena.

6.5 RECOMMENDATIONS

There are a number of recommendations that emerged from the study. These recommendations concerning adjustments for farmers in the Fezile Dabi District, and for the Government (relevant local authority).

6.5.1 Recommendations for Farmers

The following recommendations were made for farmers in the Fezile Dabi District Municipality:

Changing Land Use and Farm Practice: As with diversification strategies, changes in land use and farm practices are strategies that can be adopted in response to issues of access to livelihood assets and threats and stressors from climate change.

Correct varieties of crops to cope with soil, pests, disease and weather conditions is one of the most important decisions a farmer can make. Environmental sustainability and management of natural resources are also important for increasing resilience to adverse conditions. A change adopted by the large-scale farmers is the move away from the burning of crop waste to the removal of the leaves by hand which is known as trashing.

Crop rotation: Another well-used response strategy, particularly in larger operations of medium-scale (emerging) and large-scale farming, is crop rotation. It is also an effective method in reducing harmful pests and disease thus improving yields. One farmer in the area, for example, has adopted the approach of planting a maize every ten to fourteen years immediately after ploughing an old ratoon cane field. It also assists in spreading production risk between crops, and breaks the monoculture cycle while enabling chemicals to be used more efficiently which reduces the potential of herbicide resistance crop-farming.

The Use of Social Networks: The use of social networks and support systems are benefits to combat main threats and stressors identified when investigating the livelihood assets and adaptive capacity of the farmers in this area. The strategies are undertaken in response to a range of current and potential stressors such as: climate change and climate variability, the low domestic and world sugar price, the variable rand, high input and operational costs, the lack of access to start-up capital and high levels of debt, lack of access to skills and planning tools, inaccessibility to networks, and little support and knowledge - all of which threaten the livelihood of the farmers and contributes to increased social vulnerability.

Combined Farming Practices: Combined farming is directly linked to the use of social networks. A few combined farming schemes have been initiated in this area. A public meeting was attended, and an informal discussion and farm visits were undertaken in a farming community within the study area.

Equipping themselves with knowledge of the Act: Many old farmers in the area are not aware of the amendment made to the National Water Act. They also miss the opportunity to comment on the amendments to the Act. Most of the details of the amendment to the Act are published in the *Government Gazette*, but farmers need to know where they can access the

Gazette so that they can have the opportunity to comment on any amendments as well as all the water-related strategies published.

6.5.2 Recommendations for the Relevant Authority (Free State Government)

The following recommendations were made for the relevant authority, in this case the Free State Provincial Government as well as the National Department of Water and Sanitation:

Review the National Water Act: A review of the National Water Act in relation to the recent developments concerning climate change is required. The aim of the National Water Act is clear; however, it needs to harmonise with the challenges faced by all South Africans across the spectrum, particularly the farmers. The Act needs to enable farmers to adapt to rapid climate changes in the country.

Implement the National Water Plans and Strategies: Most of the water resources plans and strategies are only present in paper; in fact, most of the local farmers argue that these strategies are a waste of paper, as they are sitting in Government offices gathering dust. These strategies and plans need to be working documents with time-frames and monitoring mechanisms in order to make it come alive to benefit all.

Capacitate local farmers and the Government sectors: Most of farmers in the area are not well capacitated with regards to understanding the National Water Act. Most of the roadshows done across the District Municipality do not capacitate and benefit farmers with regards to the National Water Act. The roadshows explain the National Water Act on a national level but little is related to farmers at District Municipality level. Also, hiring more staff to deal with water related issues could speed up the processes such as the issuing of water use licences.

6.6 AREAS FOR FURTHER RESEARCH

According to the IPCC (2014) Climate change may trigger the overproduction of those crops that cope better with climate change thus creating a surplus of one crop and a deficit of others such as wheat and fruit in some areas. This led to new drought and water-resistant variety of crops developed for the future, which are currently doing very well in the testing phase. There are several aspects highlighted in this study that could be explored further in future research and analysis.

Further investigation is needed into the understanding of these crops in a better practical manner, especially the aspect of the suitability of these crops. Also, the appropriateness of some strategies in the context of the South African Agricultural Industry is also an area which needs to be investigated. Again, further investigation is needed into the role that institutions play in shaping access to these strategies and exploring adaptation options. Also, the explanation of the role which Government and legislation play in enabling access and implementation of these strategies, as well as allowing farmers to practise cultivating these drought-resistant crops, is needed. Most of these crops are considered alien and this may trigger some reactions to specific sections of National Environmental Act [NEMA] (Fuggle & Rabie, 1992). Also, one could look at the possibility of the cohesive alignment of NEMA and the National Water Act as an enabler or a restrictor to the cultivation of the drought and water-resistant crops.

References

Ajayi, V. 2017. Primary Sources of Data and Secondary Sources of Data. Historical Social Research. Germany.

Alexandre, W. J. R. 2000. *Climate Change and its Consequences - An African Perspective*. Pretoria: University of Pretoria Press.

Arrheinius, S. 1896. *On the influence of carbonic acid in the air upon the temperature of the ground.* London: Journal of science

Becker, A., Finger, P., Meyer-Christoffer, A., Rudolf, B., Schamm, K., Schneider, U. & M. Ziese. 2013. A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre. *Earth Systematical Science Data,* 5(2): 71-99.

Bergold, J. & Thomas, S. 2012. Participatory Research Methods: A Methodological Approach in Motion. *Historical Social Research,* 37(13): 191-222.

Botha, J. J. & Walker, S. 2013. Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. *Environmental Development*, 5(1): 39–53.

Coetzee, J. & Saba, A. 2013. Eerste River runs dry in the town of Stellenbosch. *The Mail and Guardian*. 15 June 2013. Pp 5

Crétat, J. B., Pohl, Y. R. & Drobinski, P. 2012. Uncertainties in simulating regional climate of Southern Africa: sensitivity to physical parameterizations using WRF. *Climate Dynamics*, 38(3-4):613-634.

Davis, C. L. 2011. *Climate Risk and Vulnerability: A Handbook for Southern Africa. Council for Scientific and Industrial Research,* p. 92. Pretoria: European Commission.

ENCA. 2008. Western Cape farmers who misuse water warned. ENCA news online paper. 19 January 2018. Available from: https://www.enca.com/south-africa/western-cape-farmers-who-misuse-water-warned. Accessed on: 19/01/2018

European Union. 2008. *Climate Change: The Challenges for Agriculture.* Agriculture and Rural Development EU: Belgium.

Free State Provincial Legislature. RSA. 2013. *Free State legislature Annual Report vote 2.* Bloemfontein: Government Gazette

Fuggle, R. F. & Rabie, M. A. (Eds.). 1992. *Environmental Management in South Africa*. Cape Town: Juta & Company Limited.

Gbetibouo, G. A., Hassan, R. M. & Ringler, C. 2010. Modelling farmers' adaptation strategies for climate change and variability: the case of the Limpopo basin, South Africa. *Agricultural Economics Research, Policy and Practice in Southern Africa*, 49(2): 55-60

Hewitson, B., Engelbrecht, F., Tadross, M. & Jack, C. 2005. General Conclusions on Development of Plausible Climate Change Scenarios for Southern Africa. In: Schulze, R. E. (Ed.). *Climate Change and Water Resources in Southern Africa: Studies on Scenarios, Impacts, Vulnerabilities and Adaptation: Water Research Commission*. pp.75-79. Pretoria: Government Printer.

Intergovernmental Panel on Climate Change (IPCC). 2007. Historical Overview of Climate Change. In: *Climate Change 2007*: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Core Writing Team: Le Treut, H. R., Somerville, U., Cubasch, Y., Ding, C., Mauritzen, A., Mokssit, T., Peterson, M. & Prather, M.). (Eds.). Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate Change 2013: The Physical Science Basis*. (Editors: Stocker, T. F., Qin, M., Plattner, T., Tignor, M. M. B., Simon, K. A., Boschung, J., Nauels, A. & Xia, Y.). Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Core Writing Team: R. K. Pachauri & L. A. Meyer, (Eds.). Geneva: IPCC. pp. 151-155

Ishaya, S. & Abaje, I. B. 2008. Indigenous people's perception on climate change and adaptation strategies in Jema'a local government area of Kaduna state. *Nigeria Journal of Geography Regional Perspective*, 1(8): 138-1473.

JPC Mostert SNR and others v The State of South Africa. 2009. Supreme Court of Appeal, Bloemfontein.

Kruger, A. C. & Sekele, S. S. 2013. Trends in extreme temperature indices in South Africa: 1962–2009. *International Journal of Climatology*, 33(7): 661-676.

MacKellar N., New, M. & Jack C. 2014. Observed and modelled trends in rainfall and temperature for South Africa: 1960–2010. *South African Journal of Science*, 110(16.): 7-8.

Mathers, N., Fox, N. & Hunn, A. 2007. Surveys and Questionnaires. *Bulletin of the American Meteorological Society*, 91(2): 157-166.

McSweeney, C., New, M. & Lizanco, G. 2007. *Climate Change Country Profiles*. Oxford: UNDP.

Moeletsi, E. 2010. *Agroclimatological risk assessment of rainfed maize production for the Free State Province of South Africa*. Unpublished Doctoral Thesis. University of the Free State, Bloemfontein.

Moeletsi, M. E. & Walker, S. 2012. Rainy season characteristics of the Free State Province of South Africa with reference to rain-fed maize production. Pretoria: Water Research Council.

Morse, S. & McNamara, N. 2013. *Sustainable Livelihood Approach.* Dordrecht: Springer.

Muller, C., Cramer, W., Hare, L. W. & Lotze-Campen, H. 2011. Climate change risks for African agriculture. *Proceedings of the National Academy of Sciences of the United States of America*, 108 (11): 4313–4315.

Myhre, G., Shindell, D. F. M., Bréon, W., Collins, J., Fuglestvedt, J., Huang, D., Koch, J. F., Lamarque, D., Lee, B., Mendoza, T., Nakajima, A., Robock, G., Stephens, T., Takemura, T. & Zhang, H. 2013. Anthropogenic and Natural Radiative Forcing. In: Stocker, T. F. D., Qin, G. K.,

Plattner, M., Tignor, S. K., Allen, J., Boschung, A., Nauels, Y., Xia, V., Bex, P. & Midgley, M. (Eds.). *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

National Oceanic and Atmospheric Administration (NOAA). 2007. *Climate Change: NOAA National Weather Service*. New York: Department of Commerce, United States.

National Research Council. 2012. *Climate Change Evidence Impacts and choices: answers to common questions about the science of climate change*. Washington: National Academy of Sciences.

Nayamuth, A. R., Koonjah, S. & Cheeroo-Nayamuth, F. C. 2002. Addressing Climate Change Impacts on the Mauritian Sugarcane Industry. In: Schmidt, E. & Purchase, B. (Eds.). *Climate Change: Implications for the South African Sugar Industry.* Summary of Discussions at a SASTA Workshop held at Mount Edgecombe on 28 November 2002. Durban: SASTA.

Neftel, A., Oescheger, H., Staffelbach & Stauffer, B. 1988. *CO_2 record in the Bryd ice core 50,000-5,000 years BP*. Zurich: Springer Publishers

New, M., Hewitson, B., Stephenson, D., Tsiga, A., Kruger, A., Manhique, A., Gomez, B., Coelho, C., Masisi, N., Kululanga, E., Mbambalala, E., Adesina, F., Saleh, H., Kanyanga, E., Adosi, J., Bulane, L., Fortnata, L., Mdoka, M. & Lajoie, R. 2006: Evidence of Trends in Daily Climate Extremes over Southern and West Africa, *Journal of Geophysical Research*, 111(2):22-50

Niang, I. Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J. & Urquhart, P. 2014. Climate Change in Africa. In: Barros, V. R., Field, C. B., Dokken, D. J., Mastrandrea, M. D., Mach, K. J., Bilir, T. E., Chatterjee, M., Ebi, K. l., Estrada, Y. O., Genova, R. C., Girma, B., Kissel, E. S., Levy, A. N., MacCracken, S., Mastrandrea, P. R. & White, L. L. (Eds.). *Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. pp. 1199-1265. Cambridge: Cambridge University Press.

Peters, P. E. 2009. Challenges in land tenure and land reform in Africa: anthropological contributions. *World Development*, 37 (8): 1317-1325.

Petit, J. R., Jouzel, J., Raynaud, D., Barkov, I., Barnola, M., Basile, I., Bender, M., Chapellaz, J., Davis, M., Delaygue, G., Delmotte, M., Kotlykov, M., Legrand, M., Lipenkov, V., Lorius, C., Pepin, L., Ritz, E., Saltzman, T. & Stievenard, M. 1999. Climate and atmospheric history of the past 420, 000 years from the Vostok Ice core, Antartica. *Nature* 399(10): 429-436.

Rosenzweig, C. W. D., Solecki, S. A., Hammer, S. & Mehrotra, S. 2011. Urban Climate Change in Context. In: C. Rosenzweig, W. D. Solecki, S. A. Hammer, & S. Mehrotra (Eds.). *Climate Change and Cities: First Assessment Report of the Urban Climate Change Research Network.* pp. 3-11. Cambridge: Cambridge University Press.

RSA. 1998. *National Water Act, No. 39 of 1998*. Pretoria: Government Printer.

RSA. 2007. *Department of Foreign Affairs. South Africa Year book 2007/08.* Pretoria: Government Printer.

RSA. Department of Rural Development and Land Reform. 2016. *Fezile Dabi District Municipality: Rural Development Plan*. Pretoria: Government Printer.

Smalley, R. 2013. Plantations, Contract Farming and Commercial Farming Areas in Africa: A Comparative Review. *Institute for Poverty, Land and Agrarian Studies (PLAAS)*. Land and Agricultural Commercialization in Africa LACA working paper.

Smit, B. & Pilifosova, O. 2003. *From adaptation to adaptive capacity and vulnerability reduction*: Climate change, adaptive capacity and development. pp. 9-28. World Scientific Publishing

Statistics South Africa. 2016. Community Survey - 2016. Report number .03-01. 05 July. Pretoria: Government Printer.

Swatuk, L. A. 2008. A political economy of water in Southern Africa. *Water Alternatives*, 1(1):24-47.

Tandwa, L. 2018. Drought Crisis: 3 provinces declared national disasters. News24 South Africa. 2018-02-13 @ 21:28.

Thiam, D. R., Muchampondwa, E., Kirsten, J. & Bourblac, M. 2014. Implications of water policy reforms for agricultural productivity in South Africa: Scenario analysis based on the Olifants River basin. *Journal for Water Resource and Economics,* 9 (2):60-79.

Trenberth, K. E. 2011. Changes in precipitation with climate change. *Climate Research*, 47(9):123-138.

Trenberth, K. E., Jones, P. D., Ambenje, P. & Bojariu, R. 2007. Observations: surface and atmospheric climate change. In: Solomon, S., Qin, D., Manning, M. & Chen, Z. (Eds.). *Climate change 2007: The Physical Science Basis.* Intergovernmental Panel on Climate Change 4th Assessment Report. Cambridge: Cambridge University Press.

UNICEF. 2011. *Exploring the Impact of Climate Change on Children in South Africa*. Pretoria: UNICEF South Africa.

United Nations Environment Program (UNEP). 2013. *Mid-Term Evaluation of UNEP's Medium-term Strategy*. New York: UNON Publishing Services Section.

United Nations Framework Convention on Climate Change (UNFCC). 2002. *Poverty and Climate Variability*. Reducing the Vulnerability of the Poor: A Contribution to the Eighth Conference of the Parties to the United Nations Framework Convention on Climate Variability, Consultation Draft. Bonn, Germany

Van Lanen, H. A. J., Wanders, N., Tallaksen, L. M. & Van Loon, A. F. 2013. Hydrological drought across the world: impact of climate and physical catchment structure. *Hydrology and Earth System Sciences*, 17(33):1715-1732.

Vogel, C. 2005. "Seven Fat Years and Seven Lean Years"? Climate Change and Agriculture in Africa, *IDS Bulletin*, 36(2): 10-23

Vos, J. 2016. *Quantitative Analysis of Agricultural Resources of the Fezile Dabi Region*. Johannesburg: Agriwiz.

Walton, N. & Webster, L. 2010. *Fezile Dabi District Air Quality Management Plan*. Johannesburg: Gondwana Environmental Solutions.

Warburton, M. & Schulze, R. 2006. *Climate Change and the South African Commercial Forestry Sector*. University Of KwaZulu-Natal, Pietermaritzburg.

Wiid, N. & Ziervogel, G. 2012. Adapting to climate change in South Africa: commercial farmers' perception of and response to changing climate. *South African Geographical Journal*, 94(2): 152-173.

Woodhouse, P. 2012. Reforming land and water rights in South Africa. *Development and Change*, 43(4): 847-868.

World Meteorological Organization. 2013. *The Climate in Africa: 2013*. The Global climate in 2011-2015. Zurich: Switzerland WMO Publications.

Ziervogel, G., Cartwright, A., Tas, A., Adejuwon, J., Zermoglio, F., Shale, M. & Smith, B. 2010. *Climate change and adaptation in African Agriculture*. Stockholm: Stockholm Environmental Institute.

Zwane, M. & Montmasson-Clair, G. 2016. *Climate change adaptation and agriculture in South Africa: a policy assessment*. Report compiled for WWF-SA. Pretoria: Government Printer.

Appendix: A

Questionnaire

Role of the National Water Act on the adaptive capacity of commercial farmers

Instructions

Thank you for participating in the questionnaire. Your input will be valued and the results from the questionnaire will be used as part of the research project. You are not required to provide your name.

a) Please insert a cross (X) in the appropriate space(s), or write your answer in the space provided.

b) If you feel you would like to elaborate on certain responses - please do, as it can only enhance the value of the research.

Individual farmers: Participants

Local Municipality: _____

Name of the farm: _____

Farm size: _____

Date: _____

1. **What is your Gender?**

   Male____ or Female: _____

2. **Which of the following best describes your race/ethnicity?**
   Asian
   Black/African
   European
   Coloured
   Other

3. **Which of the following best describes your age?**
   18- 24 years
   25-34 years

35-54 years
55-74 years
75 or more

4. What is your current education level?

Primary
Secondary
Tertiary

5. What are your main farming activities?

Livestock farming
Crop farming
Mixed farming
Other- Please specify

6. How long have you been farming in this area?

_____
_____
_____
_____
_____

7. Are you a full-time farmer or part-time farmer?

_____
_____
_____
_____
_____

8. What are the core problems you experience with farming now?

_____
_____
_____
_____
_____

9.

What is/are your main sources of water?

Borehole
River
Ponds
Reservoir /dam/Municipality

Borehole ☐
River
Ponds
Reservoir /dam/Municipality

River ☐
Ponds
Reservoir /dam/Municipality

Ponds ☐
Reservoir /dam/Municipality

Reservoir /dam/Municipality ☐
/Municipality
Other _____

10. Has the National Water Act and the actions of the Department of Water and Sanitation affected the use of the water resource?

Yes ☐
No

No ☐

11. If yes, how?

_____
_____
_____
_____
_____

12. What do you find particularly helpful about the National Water Act and the actions of the Department of Water and Sanitation?

_____
_____
_____

_____
_____

13. What do you find restrictive about the National Water Act and the actions of the Department of Water and Sanitation?

_____
_____
_____
_____
_____

14. Has the effect of climate change and drought made the National Water Act and the actions of the Department of Water and Sanitation more or less helpful?

_____
_____
_____
_____
_____

15. How has the National Water Act affected your:

Social assets:

_____
_____
_____
_____
_____

Physical assets:

_____
_____
_____
_____
_____

Financial assets:

_____
_____
_____
_____

Natural assets:

_____
_____
_____
_____

Human assets:

_____
_____
_____
_____
_____

16. **How do you deal with the effects of the National Water Act and the actions of the Department of Water and Sanitation on these assets (strategies used)?**

_____
_____
_____
_____
_____

Additional Information

Appendix B

Instructions

Thank you for participating in the questionnaire. Your input will be valued and the results from the questionnaire will be used as part of the research project. You are not required to provide your name or any other personal information.
If you feel you would like to elaborate on certain questions- please do, as it can only enhance the value of the research.

Questions

Local Municipality: _____

Name the farm: _____

Farm size: _____

1. Does your department has a change plan or response strategy with regards to the agriculture sector? **Yes/No**
2. Does it speak to water use and water management in the agricultural sector?
3. Is there a government body that has been tasked with coordinating climate change planning and actions in farming areas? **Yes/No**
4. Does planning involve farmers' awareness of climate change? **Yes/No**
5. Are there measures in place to help farmers deal with the impact of drought and climate change? **Yes/No**
6. What are these measures?
7. Are there water restriction policies implemented by the Government to deal with the impact of drought and climate change? **Yes/No**
8. What are the implications of these restrictions on commercial farmers?
9. What measures has the government put in place to address these impacts/implications?
10. What other measures has the Government put in place to address the impact of climate change on farmers in the area?

Appendix C

Farmer (1)

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YUNIVESITHI YA FREISTATA

NRF RISA

Questionnaire

Role of the National Water Act on adaptive capacity of commercial farmers

Instructions

Thank you for participating in the questionnaire. Your input will be valued and the results from the questionnaire will be used as part of the research project. You are not required to provide your name or any other personal information.

a) Please insert a cross (X) in the appropriate space(s), or write your answer in the space provided.

b) If you feel you would like to elaborate on certain questions- please do, as it can only enhance the value of the research.

Section A

Individual farmers: Participants

1. What are your main farming activities?

   Livestock farming
   Crop farming
   Mixed farming X
   Other- Please specify

   ☐
   ☒ +
   ☐
   ☐

2. How long have you been farming in this area?
   40 years

3. What are the core problems you experience with farming at the moment?
   DROUGHT / RAIN TOO LATE IN SPRING AND HAVING TO BUY EXPENSIVE FOOD FOR THE LIVESTOCK DUE TO GRASS NOT GROWING BECAUSE THERE IS NO RAIN

4. What is/are your main source of water?
   Borehole X
   River
   Ponds
   Reservoir /dam X
   Municipality
   Other _____

   ☐
   ☒
   ☐
   ☒
   ☐

1

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NRF RISA

5. Has the National Water Act and the actions of the Department of Water and Sanitation affected the use of the water resource?
   Yes
   No ☒

6. If yes, How?

7. What do you find particularly helpful about the National Water Act and the actions of the Department of Water and Sanitation?
   N/A Focus Group Answer

8. What do you find restrictive about the National Water Act and the actions of the Department of Water and Sanitation?
   N/A Focus Group Answer

9. Has the effect of climate change and drought made the National Water Act and the actions of the Department of Water and Sanitation more or less helpful?
   N/A Focus Group Answer

10. How has the National Water Act affected your:
    Social assets
    Physical assets
    Financial assets
    Natural assets
    Human assets
    Recording ①

11. How do you deal with the effect of the National Water Act and the actions of the Department of Water and Sanitation on these assets (strategies used)?

Additional Information
THE DROUGHT HAS LEFT OUR DAMS EMPTY FOR YEARS AND LATE RAIN HAS SERIOUSLY CRIPPLED ALL FARMING ACTIVITIES AND CROP PLANTING. FARMS DO NOT BENEFIT FROM THE NATIONAL WATER ACT.

2

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NRF RISA

Farmer 16

Questionnaire

Role of the National Water Act on adaptive capacity of commercial farmers

Instructions

Thank you for participating in the questionnaire. Your input will be valued and the results from the questionnaire will be used as part of the research project. You are not required to provide your name or any other personal information.

a) Please insert a cross (X) in the appropriate space(s), or write your answer in the space provided.

b) If you feel you would like to elaborate on certain questions- please do, as it can only enhance the value of the research.

Section A

Individual farmers: Participants

1. What are your main farming activities?

   Livestock farming
   Crop farming
   Mixed farming
   Other- Please specify

   [ ]
   [ ]
   [X]
   [ ]

2. How long have you been farming in this area?

   16 years

   * Safety General supply

3. What are the core problems you experience with farming at the moment?

   * Drought
   * Unreliability ground policy uncertainty
   * Finance Red tape

4. What is/are your main source of water?

   Borehole
   River
   Ponds
   Reservoir /dam
   Municipality
   Other _____

   [X]
   [ ]
   [ ]
   [ ]
   [ ]

   * Stagnant economy → sustainability ↓ Production Down
   * Lots of Pollution
   * Human Resources → lack skill Labour
   * Lack of Health care →
   * No Sanitation in the area

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NRF | RISA

5. Has the National Water Act and the actions of the Department of Water and Sanitation affected the use of the water resource?
   Yes ☐
   No ☒

6. If yes, How?

   N/A Focus Group

7. What do you find particularly helpful about the National Water Act and the actions of the Department of Water and Sanitation?

8. What do you find restrictive about the National Water Act and the actions of the Department of Water and Sanitation?

   N/A → Because they Dont show up in the areas

9. Has the effect of climate change and drought made the National Water Act and the actions of the Department of Water and Sanitation more or less helpful?

   N/A Focus Group

10. How has the National Water Act affected your:
    Social assets
    Physical assets
    Financial assets
    Natural assets
    Human assets

    N/A Recovery (16)

11. How do you deal with the effect of the National Water Act and the actions of the Department of Water and Sanitation on these assets (strategies used)?

    * No government officials visit area
    * Farmers does not know their farms posi[illegible]
    * Registration of Borehole

Additional Information

* Government must come help people use water sparingly
* help with managing the human resource better
* So they will be profitable for every sector
* Management of human Resource Is Important to boost economy