CLIMATE CHANGE ADAPTATION STRATEGIES BY SMALLHOLDER FARMERS IN THABA NCHU RURAL COMMUNITIES, SOUTH AFRICA

By

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DECLARATION

I, Dikeledi Gloria Mohlakoana, declare that the mini-dissertation hereby submitted for the Masters in Disaster Management at the Disaster Management Training and Education Centre for Africa, Faculty of Natural and Agricultural Sciences, University of the Free State, is my own independent work and that I have not previously submitted this work for a qualification at/in another university/faculty. I hereby concede copyright to the University of the Free State.

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DEDICATION

“I dedicate this mini dissertation to the Almighty God for the grace and strength provided, to my family and last but not least to my parents, it would not have come without their inspiration”

ABSTRACT

The climate is changing, the earth is growing warmer, and the effects of these phenomena are increasing. Climate change effects have a huge potential for leading to disasters. The world has been experiencing major disaster events (floods, drought, tropical cyclones etc.) resulting from the changing climate. It is also apparent that these effects mostly affect the agriculture sector due to their dependency on weather and climate. Reductions in rainfall and the amount of rainfall days as well as increase in inter-annual rainfall variability has led to droughts becoming more intense and widespread in Thaba Nchu a semi-arid environment region. Increasing temperatures and varying precipitation have a significant impact on a variety of crops, mostly on the rain-fed crops. The extreme weather events overall impact on health issues and the loss of livelihoods among the smallholder farmers.

It is worth noting, however, that while literature is available on frameworks and policies guiding the reduction and mitigating of disaster through climate change adaptation strategies. There is a gap between the policy and the actual implementation of the climate change adaptation techniques by the targeted group (smallholder farmers). This study provides better understanding of the smallholder farmers coping and adapting mechanisms relating to the effects of climate change and identifies the gaps in the implementation of the climate change adaptation measures. As a final outcome, improved ways of adapting to the effects of climate change are recommended.

A mixed approach (Quantitative and Qualitative design) was used to collect data for this study, through the administration of questionnaires to the smallholder farmers and through the interview of the key informants (extension officers). Results revealed that climate change undeniably has a negative impact on the smallholder's farms and their livelihood. Scarcity of rainfall and extreme temperatures affect both their livestock and crops negatively. Although they are using climate change adaptation techniques such as in-field rainwater harvesting (IRWH), conservation agriculture, and crop and livestock variations, they still need intensive support from government to sustain them. Drawing on the results and conclusions, the study recommends interventions from government and related institutions to ensure survival of farmers through the continuous subsidising of feed and fodder. In terms of infrastructure, it is suggested that government should assist with irrigation infrastructure, as well as fencing for the protection and control of overgrazing; furthermore, that agro-climatic information be communicated in an appropriate format. It was observed that while most of the farmers are older adults, they are illiterate. It is essential to find a way to disseminate relevant knowledge on climate change and to promote

adaptation. Another recommendation is continuous investment in climate change education and awareness programmes in rural areas. In collaboration with agricultural extension officers, these outreach activities could enable smallholder farmers to better understand, respond to, and adapt to the effects of climate change.

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ACRONYMYS

AR4	Assessment Report 4
CBNRM	Community-Based Natural Resource Management
CCA	Climate Change Adaptation
CO2	Carbon Dioxide
COAG	Committee on Agriculture
CSA	Climate Smart Agriculture
DAFF	Department of Agriculture Fish and Forestry
DEA	Department of Agriculture
DFID	Department for International Development
DMTP	Disaster Management Training Programme
DRR	Disaster Risk Reduction
EWS	Early Warning System
FAO	Food and Agriculture Organization
GHG	Green House Gas
HFA	Hyogo Framework of Action
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IPCC	Inter Panel Climate Change
IRWH	In-Field Rain Water Harvesting
ISDR	International Strategy for Disaster Reduction
KPA	Key Performance Areas
LDC	Less Developed Countries
MMM	Mangaung Metropolitan Municipality
NDMF	National Disaster Management Framework
NGO	Non-Governmental Organization
PAR	Pressure and Release
RSA	Republic of South Africa
SACN	South African Cities Network
SADC	South African Development Corporation
SDG	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SLF	Sustainable Livelihood Framework
SPSS	Statistical Package for Social Sciences
StatSA	Statistics South Africa
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
WGII	Working Group II

DEFINITION OF TERMS

Climate Change: Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC, n.d.). Climate change affects not only average surface temperature, but it also involves other physical modifications, such as changes in precipitations, intensity and frequency of storms, and the occurrence of droughts and floods

Climate Change Adaptation: is any adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli, and their effects or impacts. This term refers to changes in processes, practices or structures to moderate or offset potential damages or to take advantages of opportunities associated with changes in climate (IPCC, 2007).

Climate Smart Agriculture: is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible. CSA is an approach for developing agricultural strategies to secure sustainable food security under climate change. CSA provides the means to help stakeholders from local to national and international levels identify agricultural strategies suitable to their local conditions (FAO, 2017).

Conservation Agriculture: is a farming system that promotes maintenance of a permanent soil cover, minimum soil disturbance (i.e. no tillage), and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production (FAO, 2017).

Disaster Management: as a continuous and integrated multi-sectoral, multi-disciplinary process of planning and implementation of measures aimed at preventing or reducing the risk of disasters; mitigating the severity or consequences of disasters; Emergency preparedness; rapid and effective response to disasters; and post-disaster recovery and rehabilitation. A process of managing disaster, using all disaster techniques prevention, mitigation, preparedness, response, recovery and rehabilitation (Republic of South Africa, 2002).

Disaster Mitigation: refers to structural and non-structural measures that are undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards on vulnerable areas, communities and households. These efforts can target the hazard or threat itself (for example, the positioning of firebreaks on the urban/wildland interface). This is often referred to as 'structural mitigation', since it requires infrastructure or engineering measures to keep the hazard away from those at risk. Disaster mitigation efforts can also target people who are at risk, by reducing their vulnerability to a specific threat (for instance, promoting community responsibility for controlling fire risk in an informal settlement). This is often called 'non-structural mitigation', as it promotes risk-avoidance behaviours and attitudes (DRR Platform, 2016).

Disaster Risk Reduction: is the systematic development and application of policies, strategies and practices to minimize vulnerabilities and disaster risks throughout a society to prevent and limit negative impacts of hazards, within the broad context of sustainable development. In South Africa, disaster risk reduction is an integral and important part of disaster management (Republic of South Africa, 2002).

Environmental Degradation: is the exhaustion of the world's natural resources: land, air, water, soil, etc (Tyagi, et al., 2014).

Global Warming: refers to the long-term warming of the planet. Global temperature shows a well-documented rise since the early 20th century and most notably since the late 1970s. Worldwide, since 1880 the average surface temperature has risen about 1 °C (about 2 °F), relative to the mid-20th-century baseline (of 1951-1980) (IPCC, n.d.).

Sustainable Livelihood: is based on capabilities, assets (both material and social resources) and activities required for living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and

in the future, while not undermining natural resource bases. Livelihoods can therefore be affected by external factors which increase their resilience and consequently reduce their vulnerability (FAO, 2009).

Resilience: The ability to prevent disasters and crises as well as to anticipate, absorb, accommodate or recover from them in a timely, efficient and sustainable manner. This includes protecting, restoring and improving livelihoods systems in the face of threats that impact agriculture, nutrition, food security and food safety

Smallholder Farmer: is an agricultural holding run by a family using mostly (or only) their own labour and deriving from that work a large but variable share of its income, in kind or in cash. The family relies on its agricultural activities for at least part of the food consumed – be it through self-provision, non-monetary exchanges or market exchanges. The family members also engage in activities other than farming, locally or through migration. The holding relies on family labour with limited reliance on temporary hired labour but may be engaged in labour exchanges within the neighbourhood or a wider kinship framework (FAO, 2009).

Vulnerability: is a multidimensional concept which varies across temporal and spatial scales and depends on economic, social, geographic, demographic, cultural, institutional, governance, and environmental factors. Despite the various definitions of vulnerability, most comprehensive and accepted is the definition by the Intergovernmental Panel on Climate Change (IPCC, 2000): “The degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.” Thus, vulnerability of any system is frequently considered as a function of three elements: exposure to a hazard, sensitivity to that hazard, and the capacity of the system to cope with and adapt to or recover from the effects of those conditions mostly referred to as adaptive capacity. Vulnerability is also a degree of risk and inability to resist to climate deviations (Harvey, et al., 2011).

CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 BACKGROUND TO THE STUDY

Mangaung Metropolitan Municipality (MMM) is an urban area, but it includes a large section surrounded by rural communities where both subsistent and commercial agricultural activities prevail on a varying scale (StatsSA, 2011). The Thaba Nchu semi-urban and rural villages are part of the MMM. According to the Mangaung Metropolitan Municipality report (2016) the recent episodes of drought have put an immense pressure on people's means of livelihood especially those depending on rain fed agriculture, thereby putting pressure on government for support and interventions. In Thaba Nchu rural areas, shortage of rainfall and low soil moisture have a negative impact on agriculture, veld ecological status and livestock. The changes in climate and global warming affects the farmers' management practices, for example changing the sowing and harvesting dates (Nhemachena & Hassan, 2007). A good understanding of the climate change adaptation measures used by the smallholder farmers is needed in order to effectively mitigate the effects of climate change on crops and livestock production and thereby improve the livelihood of the people depending on agriculture for both subsistence and commercial purposes (De Waal, 2016). Therefore, this case study attempts to assess the climate change adaptation measures practiced by smallholders in Thaba-Nchu rural areas to improve the resilience to climate change and identify possible disaster management interventions.

1.2 DESCRIPTION OF STUDY AREA

Thaba-Nchu meaning “Black Mountain”, is a town, in the Free State Province of South Africa. Thaba-Nchu forms part of the Mangaung Metropolitan Municipality and the town, is about 75 kilometers east of Bloemfontein on the N8 highway It was established in 1893 and named after the deep shadow of nearby mountains (Figure 1-1a). Thaba-Nchu consists of 35 rural villages scattered within a radius of about 20 kms (Figure 1-1b). Some areas of Thaba Nchu and the villages are still mainly dominated by the chieftaincy of the Barolong tribe led by Chief Moroka (StatsSA, 2011). The current research covers 33 out of the 35 villages of Thaba Nchu.

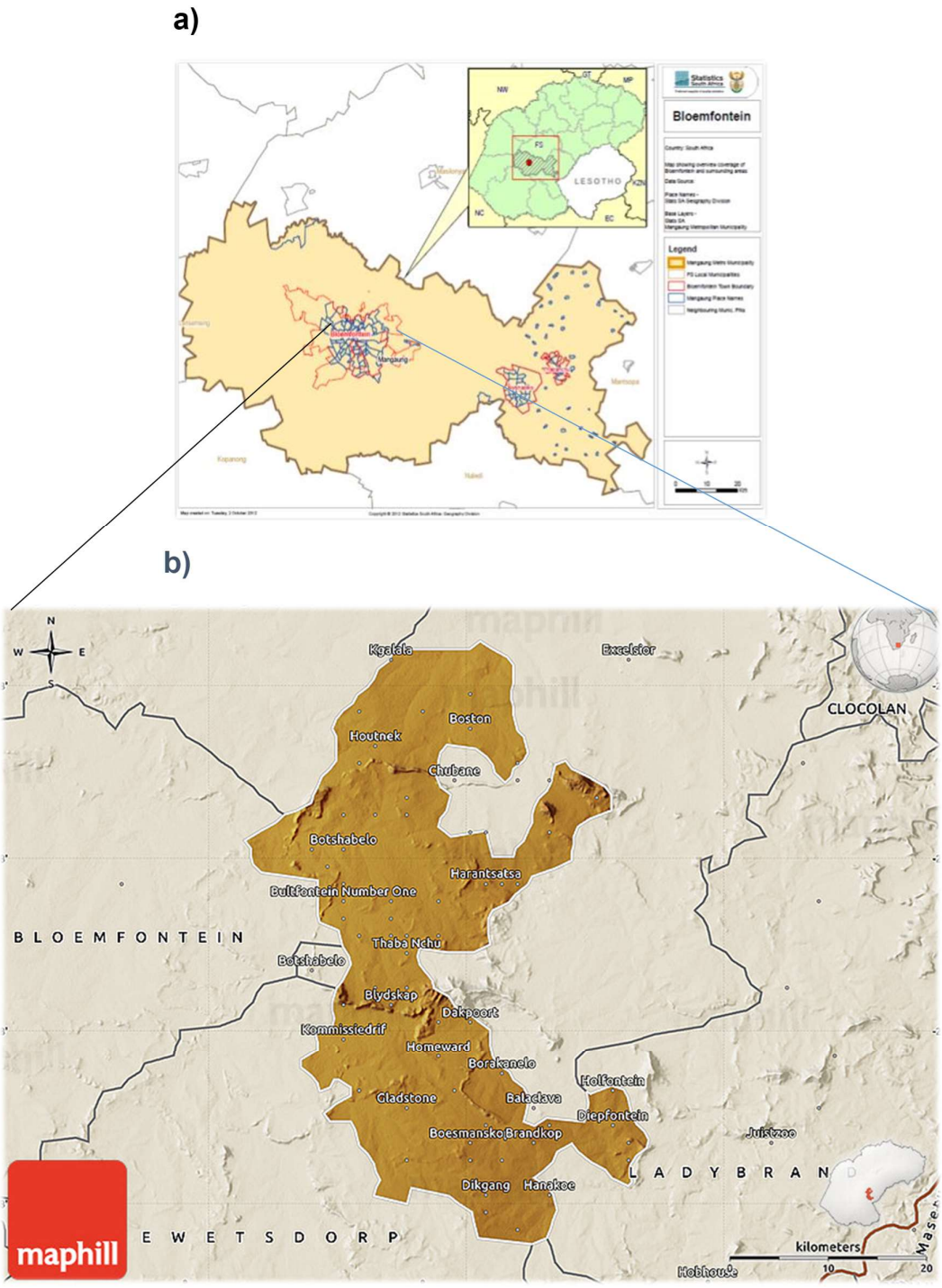

Figure 1-1 Map of the study area, a) Mangaung Metropolitan Municipality in the Free State Province in South Africa; b) Thaba-Nchu and the surrounding rural villages.

Source: Maphill,2011

1.2.1 Demography

The villages of Thaba Nchu have a population of 10 774, and 3739 households with an average household size of 3 people per household (StatsSA, 2011). The population of the the villages of Thaba- Nchu is dominantly female with an average percentage of about 52%. The dominant race(98%) is Black Africans who mostly speak Setswana. The other races; White, Coloured, Asian and Indian constitute 2% (StatsSA, 2011).

1.2.2 Socio Economic Status

According to StatsSA (2011), 12, 9% of people in Thaba-Nchu have no income while about 22,4% earn an income between R19, 601 and R38, 200 per annum. The dependency ratio is 52.2%. Only 30% of households have access to piped water inside their dwellings and 95.2% have access to electricity (StatsSA, 2011). The settlement is about 56.3% farm and 43.7% urban, which indicates that the major economic activity is agricultural (StatsSA, 2011).

1.2.3 Climate

Thaba Nchu experiences a semi-arid climate with hot summer days between October and February. During this summer season, the maximum temperature is 32 °C and the minimum 19 °C. Frequent afternoon thunderstorms are customary. Winters are cooler and dry often with frosts in July with a maximum temperature of 14 °C and minimum temperature of −3 °C. Snow is uncommon but occasionally as in August 2006 it does snow in the area (Mangaung Metropolitan Municipality, 2010). Table 1.1 below shows the climate of Thaba Nchu based on a 30 years period from 1961 to 1990. The table shows average monthly temperature, precipitation and sunshine for the area of Thaba Nchu during this period. The climate data in Table 1.2 indicates hot summers, high precipitation days during the period of September until March which result in high growing season, and cold, weather with low precipitation during April to August which results in low agricultural activities. The increased annual temperature and the decreased annual precipitation as a result of climate change could affect the growing seasons. This may result in changes in farming practices. Variations could be observed between the previous climate data and the recent climate data due to climate change (YU, et al., 2014).

Table 1-1: Climate data for Thaba Nchu (1961-1990,)

Climate data for Thaba Nchu (1961−1990)													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Average high °C	30.8	28.8	26.9	23.1	20	16.8	17.4	20	24	26.1	28.1	30.1)	**24.4**
Average low °C	15.3	14.7	12.4	7.7	2.5	−1.5	−1.9	0.5	5.2	9.1	11.7	13.8	**7.5**
Average precipitation mm	83	111	72	56	17	12	8	15	24	43	58	60	**559**

Source: Meteoblue, 2014)

1.2.4 Topography, Soil and Vegetation

Mangaung Metropolitan Municipality including Thaba Nchu is located in the center of South Africa, in the Free State and on the southern edge of the Highveld at an elevation of 1400 meters, adjoining the semi-arid region of the Karoo. The area is generally flat with occasional hills and characterized by Highveld grassland vegetation (Meteoblue, 2014).

Poor rainfall distribution leads to low levels of vegetation for most of the year, in such a way that the soil surface is bare from the starting of the rainy season in arid and semi-arid environments. Resulting in soil crusting after the initial rainfall due to the compacting effect of raindrops. These hardened surfaces reduce infiltration rates, generating runoff that causes the topographic variability of the surrounding areas, enhancing erosion and causes loss of organic matter and nutrients. This soil sealing and crusting, a common phenomenon in soils of semiarid and arid regions like the study area (Thaba Nchu), poses serious challenges for crop production (Tekle, 2004).

1.2.5 Agriculture

The majority of the households are dependent on agricultural activities to survive. The main agricultural activities are vegetable and crop production, poultry and livestock. Vegetable and crop production are very popular and the main source of water is from boreholes. (StatsSA, 2011).

1.3 RESEARCH PROBLEM

According to Van Staden (2014), the earth's climate is indisputably changing resulting from global warming. Climate Change is the significant continuous change in climate for an extended period of decades or longer. Global Warming is a steady increase in the earth's atmosphere temperature generally associated with the greenhouse gases effect caused by increased levels of carbon dioxide, and other pollutants gases. The intentional and fugitive emission of these gases are principally the as a result of human and industrial activities, as observed in the last 100 years (DoA, 2007). The changes in climate are seen in all geographical regions; the atmosphere and oceans are warming, the snow volume and extent of ice are lessening, sea levels are rising and weather patterns are changing, and extreme weather is experienced (IPCC, 2015).

Climate related disasters are on the rise. The 2004 Indian Ocean tsunami was a tidal wave that changed the world with about 250 thousand people dying, and some years later the world experienced the Haiti earthquakes and lost about the same number of people (Renaud, et al., 2013). The recent weather extremes occurring in South Africa, such as the Tropical cyclone Dineo in the area of Mozambique, Mpumalanga, and Limpopo in February 2017, storms and floods in Durban in October 2017, and the drought which hit the Free State and other provinces between 2014 and 2016 as well as more recently, are evidence of the extreme changes in weather patterns in South Africa and the world at large. These weather extremes are strongly related to climate change (Weathersa, n.d.). A state of disaster due to drought was declared in 2015 in Free State, by the Premier of Free State Hon Ace Magashule, and among the areas that were affected was Mangaung (Coleman, 2015).

The impacts of climate change on South African cities are increasing. The rise in temperatures, heat stress, water scarcity, pollution, sea-level rise, extreme weather events, heavy rainfall and strong winds, inland flooding and food insecurity are all adverse effects of the climate change (Van Staden, 2014). Climate change is a serious environmental, security, and socio-political challenge and it is projected to increase the frequency and intensity of extreme weather events which will have a negative environment, infrastructure, socio-economic impacts. At the level of human experience, heat waves will likely be more severe while storms and floods will likely be more intense and frequent (Van Staden, 2014).

The common sector facing high risk particularly in the study area of Thaba Nchu is water. The highest climatic risk faced by MMM in this regard is the fact that increasing temperatures will have an impact on water availability, capacity and its usage within the city (South African Cities Network, 2014).

Sustainable water provision is already a major issue for MMM and the projections regarding rainfall shows that the municipality will have a decrease in rainfall (South African Cities Network, 2014). Climate change is progressively, but undeniably, changing the environmental, social and economic conditions affecting agriculture (smallholder farmers). Agriculture in Thaba-Nchu, with specific reference to the smallholder farmers faces various risks associated with climate change, such as changes in rainfall patterns, increased evaporation, high temperatures, increased pests and diseases as well as diseases and pest distribution, reduced yields and spatial shift in prime growing regions (Zwane, 2016).

In the Free State and in Mangaung specifically, recurring drought is a major challenge due to the lack of rainfall and the high temperatures resulting sometimes in heat waves (Udmale, et al., 2014). About 20% of the households in MMM depends on agriculture for their livelihood, for instance rain fed cropping and livestock are the major income activities for the farmers in Thaba Nchu (StatsSA, 2011). Prolonged droughts exceeding two years in duration and/or uninterrupted years of reduced rainfall can severely threaten the livelihoods of the farmers in Thaba-Nchu as such conditions result in crop failure, leading to decreases in the yield of food grains which weakens the income of agrarian households and farmers (Udmale, et al., 2014).

Economic impacts have a negative impact on the social, health, and psychological wellbeing of the affected smallholder farmer. Some farmers die due to psychological effects as people lose their jobs (EWN, n.d.). People living in rural areas and resource-poor farmers are often referred to as vulnerable and therefore will be more affected by the adverse effects of climate change.

Adaptation to climate change involves changes in agricultural management practices in response to changes in climate conditions, long-term temperature and precipitation. Access to credit as well as awareness of climate change are some of the important determinants of farm-level adaptation (Nhemachena & Hassan, 2007). Due to all these adverse effects of climate change on Thaba Nchu smallholder farmers, a study on how these smallholder farmers are coping and adapting to all these challenges resulting from the extreme changes

in climate is timely. It is essential to find out whether their adaption and coping measures are adequate.

1.4 RESEARCH QUESTIONS

A research question is a clear, focused, brief, complex and arguable question around which the research will be centered. Research questions helps with focusing the research by providing a path through the research and writing process (George University Writing Center, n.d.).

The research question differs from the research problem in that the research problem is a broader, more general statement of a theoretical or empirical uncertainty which involves the narrowing down of the general interest in research. This process leads to the setting of the research questions which aims to solve the problem by breaking it down into a set of related research questions and finding the answers to them. In other words, specifying one's research questions is one step in the direction of actually solving the research problem (Welman, et al., 2005).

1.4.1 Main Research Question:

What are the climate change adaptation strategies adopted by smallholder farmers in Thaba Nchu rural areas and are these strategies sustainable for their livelihoods?

1.4.2 Sub Research Questions:

1. What are the climate changes experienced by smallholder farmers in Thaba Nchu?
2. What are the impacts of climate change on smallholder farmers in Thaba Nchu?
3. What are the adaptation measures of the smallholder farmers to the effect climate change?
4. Are these adaptation measures sufficient and suitable to sustain their livelihoods?

1.5 RESEARCH OBJECTIVES

1.5.1 Main objective

The main objective of the study is to assess the climate change adaptation strategies practiced by small holder farmers in Thaba Nchu rural areas, and to find out if these measures sustain their livelihoods, and subsequently to propose measures where gaps are identified.

1.5.2 Sub Objectives;

1. To determine the impacts of climate change on smallholders' farmers.
2. To assess the adaptation capacity and strategies of smallholder farmers to climate change.
3. To assess if the adopted measures help the smallholder farmers to sustain their livelihoods.
4. To identify gaps and propose measures to improve the livelihood of smallholder farmers.

1.6 SIGNIFICANCE OF STUDY

This study is unique, since no similar study has been undertaken on the topic of Climate Change Adaptation strategies relative to the smallholder farmers in Thaba Nchu in the Free State. The study will add to the body of knowledge on the climate change adaptation strategies employed by smallholder farmers in the study area, assess their effectiveness, and recommend solutions where gaps have been identified. Furthermore, the study will assist the smallholder farmers and the community at large to mitigate the adverse effects of climate change and adapt to its impacts more effectively.

1.7 RESEARCH METHODOLOGY

1.7.1 Research Design

A mixed approach was used, in that both Qualitative and Quantitative Research methods were used. Both designs have characteristics that can contribute to collecting data in the best possible way (Leedy & Ormrod, 2016).

i. Qualitative research is concerned with human behaviour in the reasons people behave and act the way they do (Leedy & Ormrod, 2016). Qualitative research was chosen because of the following reasons:

- It provides a description of people experience to a research subject
- It provides evidence about human (often contradictory) behaviours, beliefs, opinions, and relationships of individuals and it is effective in identifying elusive factors, such as social norms, socioeconomic status, gender roles, ethnicity, and religion (Leedy & Ormrod, 2016).

ii. Quantitative research collects numerical data and assists the researcher in obtaining a view from many people. Reasons why Quantitative research was chosen are that it uses rigid instruments, and it uses highly structured methods to quantify variables, predict causal relationships, and describe the characteristics of a population (Leedy & Ormrod, 2016).

1.7.2 Population and Sampling Methods

i. Population

The population is the object under study which could either be individuals, groups, organizations, human products, or conditions to which they are exposed. The population contains the total collection of all units of analysis about which the researcher desires to make certain deductions (Welman, et al., 2005).

The study targeted the smallholder farmers in the rural villages of Thaba-Nchu. Kirsten and van Zyl (1998) defined a smallholder farmer as the farmer in which the scale of operation is too small to attract the provision of goods and services. The population of smallholder farmers in 33 Thaba-Nchu villages seems uncertain and may be changing from time to time. The Department of Agriculture in the Free State has a database of 1135 smallholder farmers registered under DAFF. These smallholder farmers operate in the 33 villages. Therefore, this study focused on the total population of 1135 registered smallholder farmers.

ii. Sampling Process

Sampling was done in stages. Firstly, purposeful sampling was used to select participants with a particular purpose based on the study objectives. Non Probability sampling was used to identify the final group of participants. In purposive sampling the sample is approached according to the purpose of the research. The criteria for who are to be included in the study

are predefined. Not everyone was included, only those who met the defined criteria (Leedy & Ormrod, 2016). Only smallholder farmers in the Thaba Nchu region were therefore sampled.

Secondly, a probability sampling process was applied in further sampling the population from the clusters, Cluster random sampling was used which divides the population into clusters, clusters were randomly selected, and all members of the selected clusters were included in the sample. Smallholder farmers registered in the database of the Provincial Department of Agriculture in the 33 villages were chosen, and each one of the 33 villages had a chance of being included in the population to be studied (Alvi, 2016). The sample size set at 99 smallholder farmers.

1.7.3 Data Collection Methods

i. Qualitative Methods

- Participant observation: this procedure assists in collecting data on natural occurring behaviours in their natural context. The behaviour patterns of the smallholder farmers and the agricultural activities were observed to see practical adaptation strategies employed by these smallholder farmers in agricultural activities. Indicators such as the growing seasons, the types of agricultural activities such as type of crops were monitored for different seasons.
- Questionnaires: surveys using questionnaires with open ended questions were administered to obtain more comprehensive views.
- Interviews: individual conversations are useful for collecting data on people's personal viewpoints, histories, and experiences. The key informants and specialist in the fields related to climate change and agriculture were interviewed.

1. Quantitative Methods

- Questionnaires: were administered to a large number of people, including those who live far away. For illiterate the questionnaires were administered by the researcher in person.

1.7.4 Data Analysis

Data analysis transform data into findings through analytic procedures, into a clear, understandable, insightful, trustworthy original information. Data were organised and analysed to deduce logical information from the data collected, to make induction possible (Leedy & Ormrod, 2016).

1.7.5 Validation and Reliability

Validity of a measurement instrument or a tool is the extent to which the instrument measures what it is supposed to measure (Alvi, 2016). The measuring tools were checked for validity by ensuring that the instruments measures what they are supposed to measure. This was done through checking the instruments for both quantitative and qualitative methods for content validity, ensuring that the contents of the instruments are representative of the targeted phenomenon or objectives. The appropriateness of the content of the instrument was checked using face validity to check whether the measuring tool appears to serve its purpose with the type of questions being asked. The instruments were also checked for construct validity on whether they actually measure the construct each instrument purports to measure (Alvi, 2016).

Reliability is the consistency with which a measuring tool yields a certain result when the entity being measured has not changed (Welman, et al., 2005). Test-retest reliability was used to check the reliability of the instruments. A pilot study was employed, where instruments were administered the first time for pilot purposes and the second time to test the reliability of the measuring tools (Alvi, 2016).
Besides the measures listed above, the data collection tools were also scrutinised by the supervisor of the study for both validity and reliability.

1.8 LIMITATIONS AND DELIMITATIONS OF THE STUDY

1.8.1 Limitations

The area to be studied is vast, scattered and rural. Due to the poor infrastructure access to these areas posed a potential challenge. The assistance of relevant stakeholders such as the Provincial Department of Agriculture, Tribal Authority and Ward Councillor's in Thaba Nchu was solicited for ease of coordination. South Africa was facing possible political

change at the time of the study, t and the elections that were to be held in 2019 might influence the willingness of the participants to engage and answer questions honestly. For this reason anonymity and confidentiality were emphasised. The climate data used in the study were obtained from Bloemfontein airport, but as Thaba Nchu is within 100km radius of Bloemfontein airport the difference in climate and temperature between the two areas is insignificant.

1.8.2 Delimitations

Mangaung Metropolitan Municipality is comprised of areas such as Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Van Stadensrus and Wepener, but the research study was conducted only in Thaba Nchu due to resource constraints.

There are different scales of farming in the area. This study concentrated on smallholder farmers, which meant that large scale commercial farmers were not be included despite the fact that both groups may be facing climate change impacts. The focus of the study was on more vulnerable smallholder farmers who may lack adaptive capacities when compared to their commercial counterparts.

1.9 ETHICAL CONSIDERATIONS

Research ethics involve the protection of the dignity of both the subjects and the researcher and the publication of the information in the research. In all aspects of academic writing researchers must adhere to ethical behaviour in conducting and disseminating their research findings. This study was conducted in a sound and moral way based on ethical principles (Akaranga & Makau, 2016). This research observed appropriate values at all the stages of research, from obtaining approval for the research proposal, to obtaining ethical clearance prior to the actual data collections, the actual data collection, the analysis and interpretation of result and the dissemination of findings. Relevant ways to collect the data and appropriate methodology which guarantees fairness should be implemented (Akaranga & Makau, 2016).

1.10 CHAPTER OUTLINE AND CHAPTER SUMMARY

Chapter 1: Introduction and Background to the study.

This chapter introduce the topic of the study, giving the background of the study as well as a description of the study area, the research problem, and research question along with

research objectives and the significance of this study. The methodology of the research and finally the limitation and delimitations to the study were addressed.

Chapter 2: Theoretical and Legislative Framework

The chapter explains the theoretical and legislation frameworks governing the subjects of the study, and its relevancy to the study.

Chapter 3: Literature review of the variables to be studied.

This chapter gives an overview of the literature related to the study and links it to the research study.

Chapter 4: Methodology the research followed

The chapter describes in detail the methodology the research followed.

Chapter 5: Present the Data analysis and interpretation of the data

The chapter presents the results, the data analysis as well as the interpretation of the data linking it to the study aim and objectives.

Chapter 6: Conclusions and recommendations

This chapter wraps up the research document by presenting conclusions and recommendations resulting from the research study, answering the research questions and attempting to solve the research problem.

2 CHAPTER 2: THEORETICAL AND LEGISLATIVE FRAMEWORK

2.1 INTRODUCTION

Due to the interdisciplinary nature of the study no one current model could totally capture the scope of the study. Theoretical frameworks were then picked to deal with the theoretical background of the three disciplines contained in this study.

The theories discussed are related to disaster management with a focus on disaster risk reduction; climate change science with emphasis on climate change adaptation; and agriculture with specific reference to smallholder farming. Other relevant frameworks such as those relating to risk and vulnerability are cross-cutting and are therefore discussed under the applicable sections in different sections. The way in which every one of these frameworks relates to this study is deliberated in the relevant sections. All these frameworks are used as sets of guides and building blocks toward the attainment of the aim of this study which was to formulate a holistic and integrated framework for climate change adaptation in smallholder farming (Belle, 2017).

Legislative framework which govern the study phenomenon was also explored. These include legislative frameworks governing disaster management, the agriculture sector with specific reference to smallholder farmers, climate change and the associated adaptations. These legislations will be explained with regard to how they relate to the study and what bearing they have on the study phenomenon.

2.2 GLOBAL AND SOUTH AFRICAN LEGISLATIVE FRAMEWORKS

2.2.1 The International Context

1. Disaster Management

The South African government through the different sector departments plays an active role in the United Nations Disaster Assessment and Coordination (UNDAC) system and the International Strategy for Disaster Reduction (ISDR). Since 1994, South Africa has consistently made a strong commitment to supporting international humanitarian policy and good practice, starting from its support for UN General Assembly Resolution 46/182 of 1991 and succeeding humanitarian policies. In 1991, the UN General Assembly adopted resolution 46/182, which created the humanitarian system.

This resolution formulated the plan for the international humanitarian system, which attempts to provide life-saving assistance. The resolution pushed for the creation of humanitarian mechanisms for a well-coordinated system to assist bodies in their pursuit of aiding people affected by disaster (UNOCHA, 2016). South Africa also regularly participates in several world's conferences on disaster management. For the purpose of this study. The Sendai Framework will be discussed as a point of departure to understand the nature of Global legislative intervention around the issues of Disaster Risk Management.

The third UN World Conference on Disaster Risk Reduction (WCDRR) took place in March 2015 in Sendai, Japan. Participants from the global community discussed and adopted an internationally agreed strategy to make the world safer from natural hazards. South Africa was among the countries which pledged support for the adoption of the Sendai Framework for Disaster Risk Reduction for 2015-2030 (SFDRR 2015-2030).

a. The Sendai Framework for Disaster Risk Reduction (SFDRR) for 2015-2030

The SFDRR is a 15-year, voluntary, non-binding agreement that acknowledges that the State in this case South Africa, has an important role in reducing disaster risk. It aims for the following outcome: *The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.* The Sendai Framework follows the Hyogo Framework for Action (HFA) 2005-2015, whose focus was "*Building the Resilience of Nations and Communities to Disasters"*. The SFDRR was the result of stakeholder consultations introduced in March 2012 and inter-governmental negotiations held from July 2014 to March 2015.

The SFDRR call onto stakeholders to recognize that the carrying out of the new framework rest on the constant and continuous, collective determinations to make the world more save from the risk of disasters in the years to come for the benefit of the present and the future generations (Sendai Framework, 2015).

The SFDRR sketch out seven (7) well-defined goals and four (4) priorities for action to prevent new and to reduce existing disaster risks. The SFDRR (2015) recapitulated the commitment to addressing disaster risk reduction and the building of resilience to disasters from a perspective of sustainable development and poverty eradication, and to integrating, both disaster risk reduction and the building of resilience into policies, plans, programmes and budgets at all levels. Achievement of the expected outcome and goal of the Sendai

Framework, will require intensive action within sectors by states at local, regional, national and global levels in the following four (4) priority areas:

Figure 2-1: Sendai Framework Disaster Risk Reduction priority areas (Source: SFDRR: 2015-2030)

It was in the context of the commitment to the Hyogo Framework for Action (HFA) 2005-2015 which was succeeded by the SFDRR that the government of South Africa produced the National Disaster Management Framework (NDMF 2005) which will be discussed later in the chapter. The NDMF provides guidance in disaster management reduction.

All legislative frameworks for disaster management in South African follows the guidance of the Sendai Framework. It assists in planning, and coordination of disaster management risk reductions, as well as building of resilience to disasters. These factors also affect Climate Change Adaptation as part of the suite of disaster risk reduction and capacity building tools, which is the focus of this study. This study seeks to understand the adaptation techniques used by smallholder farmers as part of reducing their risk and exposure to disaster. To this end it is vital to understand the global principles guiding disaster reduction and mitigation.

2. Climate Change Adaptation

a. The Paris Agreement

The focus of this study is also on Climate Change Adaptation for smallholder farmers and as such the Paris Agreement is relevant for the study in terms of understanding the rules guiding climate change adaptation from a global perspective.

The main aim of the Paris Agreement is to reinforce the global response to the danger of climate change by restricting the increasing global temperature to below 2 degrees Celsius above pre-industrial levels and to engage in efforts to further limit the increase in temperature to 1.5 degrees Celsius. Moreover, the agreement intends to increase the capacity of countries to deal with the adverse effects of climate change. To achieve these goals, suitable financial flows, a new technology framework and an enhanced capacity building framework to be in place, therefore supporting activities by developing countries and the most vulnerable countries, in line with their own national goals.

On 12 December 2015, at COP 21 in Paris, a group of countries including both developed and developing countries adopted an international agreement to address climate change which required greater commitment to emissions reduction. South Africa was part of those countries. The agreement includes requirements to hold countries accountable to their commitment and source greater investments to help developing countries in building low-carbon, climate-resilient economies.

3. Agriculture and Smallholder Farming

a. Food and Agriculture Organization (FAO) Strategy Framework

It is critical for agriculture sector to receive necessary support particularly with reference to smallholder farmers, if SDGs 1 (No poverty) and 13 (Climate Action) were to be achieved during changing climate, because the food and agricultural sectors represent huge potential to create a concerted effort between both the climate and development agenda.
The Strategic Framework is therefore a document for Governing Bodies, which is an important source of vital information and reference in order to meet the needs of broader audiences, including partners of FAO and constituents world-wide to ensure the necessary support is given to the agriculture sector (FAO, 2009). A description of the framework is

relevant for the current study and will provide information on the vision of the FAO and the global goals of members; the challenges facing food, agriculture and rural development more so the smallholder farmers; the results-based regime in the Organization Strategic and Functional Objectives and the Core Functions and how the Framework intends to give guidance regarding objectives of the study.

b. FAO Strategy on Climate Change

The FAO places sustainability at the centre of all their activities, to make sure that the earth's mountains, oceans, forests, waters and soils can carry on providing for the 10 billion population projected for the years to come, and their generations (FAO, 2017). The Strategy is built in seven (7) principles in relation to social inclusion, environmental sustainability and results-oriented action. Three outcomes support the FAO's Climate Change Strategy and Plan of Action:

1. Improved capabilities of Member Nations on climate change through FAO guidance as a provider of technical knowledge and expertise.
2. Enhanced incorporation of food security, agriculture, forestry and fisheries within the international agenda on climate change through strengthened FAO engagement.
3. Intensified coordination and delivery of FAO work on climate change (FAO, 2017).

The Strategy sets the FAO on a path to deliver on the SDGs, an important part of the FAO's Strategic Framework. The Strategy was implemented through a Plan of Action, which will strengthen the FAO's existing capacities (FAO, 2017). The FAO can support this development with a wealth of knowledge and proper instruments and encourages for large-scale climate finance to be directed into the sectors where investment can lay the groundwork for the change needed to accomplish the future required. (FAO, 2015). The strategy is important for the study objectives because the study was looking at the impacts of climate change with reference to the smallholder farmers (in the Agriculture sector), and this document is a guiding document with relation to the coordination and governance of the relations between agriculture and climate change and the available support.

2.2.2 The South African Context

1. Disaster Management

    a. The Constitution of the Republic of South Africa (Act No. 108 of 1996)

The primary responsibility for disaster management in South Africa resides with the government. Section 41(1) (b) of the Constitution of the Republic of South Africa, Act 108 of 1996, states that all spheres (local, provincial and national) of government are obligated to keep the people of South Africa safe. Disaster risk management is a functional area of both the national and provincial legislative competence as well as of a municipality specifically for the administration of any matter which relates to local government (Republic of South Africa, 1996).

The Constitution also requires local government (municipality) to provide for functions which are linked to disaster risk management as well as to 'promote a safe and healthy environment' (Republic of South Africa, 1996). This act is relevant to the study as it shows what the country's law says about the need to address the challenges faced by the smallholder farmers as a result of climate change, and to ensure an environment that is not harmful to the health or well-being of those who live in it.

    b. Disaster Management Act (Act 57 of 2002) as amended Disaster Amendment Act 16 of 2015

As a result of the disasters occurring decades ago, South Africa under the guidance of the United Nations established the disaster management act to govern disaster management activities and structures. The Act aims to provide for: an integrated and co-ordinated disaster management strategy which centres around, preventing and/or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery (Republic of South Africa, 2015).

The Disaster Management Amendment Act on the other hand maintains that the municipality should establish capacity and institutional arrangement for the development and coordination of a disaster management plan and the implementation of a disaster management function. Acknowledgement and understanding of the act are relevant to the current study, in understanding which governing structures, legislations and laws exist to administrate disaster management in South Africa. The Acts serves as a bible for the

coordination of disaster management in South Africa. The ultimate objective of the current study is to contribute towards preparing for, preventing, reducing/mitigating the risk of disasters which could affects the smallholder farmers.

c. Intergovernmental Relations Framework Act (Act 13 of 2005)

Disaster Management is a collective effort by all spheres of government, and as such requires the constitution to guide its relations. The purpose of the act is to institute a framework for the national government, provincial governments and local governments to encourage and assist intergovernmental relations; to make available for mechanisms and procedures to aid the settlement of intergovernmental disputes; and to afford for matters connected therewith (Republic of South Africa, 2005).

The act stipulates that Disaster Management is a collective effort by different sectors, spheres and organizations. The process needs to be well coordinated, each stakeholder knowing their roles, responsibilities, and powers to ensure smooth integration as well as implementation of activities. The study will touch on three sectors, namely disaster management, climate change, and agriculture, and all three are governed by different government departments of South Africa. As a result it is important to understand the intergovernmental relation framework act governing these structures and bodies relevant to the study.

2. Climate Change Adaptation

a. Climate Change Bill

The study focuses on attempting to understand the climate change impacts on and adaptation techniques of the smallholder farmers. It is pivotal to understand the country's (South Africa) position regarding mitigating and adapting to climate change impacts. The purpose of the bill is to develop the Republic's effective climate change response and the long term, transition to a climate resilient and lower carbon economy and society in the context of an environmentally sustainable development framework; and to provide for matters connected therewith (Republic of South Africa, 2018). There are many guiding legal documents for climate change. We will however only quote the following which are closest to the objectives of the study.

i. National Climate Change Response White Paper

This White Paper depicts the South African Government's vision for an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society. South Africa's response to climate change has two objectives:

- Effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity.
- Make a fair contribution to the global effort to stabilise greenhouse gas (GHG) concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner (DEA, 2018).

The policy summarized in this White Paper represents South Africa's dedication to a fair contribution to stabilising global GHG concentrations in the atmosphere and to protecting the country and its people from the impacts of unavoidable climate change. It a vision premised on Government's commitment to sustainable development and a better life for all (DEA, 2018).

ii. National Commitment to Green House Gas (GHG) Reductions/National Response Strategy

The Department of Environmental Affairs and Tourism the custodian of the Climate Change utilized information from the IPCC Assessment Report III to develop a national climate change response strategy (DEA, 2004). The aim of this strategy is to aid the policies and principles laid out in the Government White Paper on Integrated Pollution and Waste Management, as well as other national policies including those relating to energy, agriculture and water.

The strategies outlined in this document are created to tackle issues that have been identified as priorities for addressing climate change in South Africa. The point of departure reflected in this strategy is achievement of national and sustainable development objectives, whilst simultaneously responding to climate change (DEA, 2004).

3. Agriculture and Smallholder Farming

The smallholder farmers were the main target population group for the study. Their activities were central to the research as well as the implication of their usage of natural resources. The adaptation techniques they use were measured against the directives provided by the following Acts which consider conserving the agricultural resources, protecting the environment while they go about their farming activities, and the usage of strapped water resources.

a. The Conservation of Agricultural Resource Act

The aim of the Act is to offer required support for the conservation of the natural agricultural resources of South Africa by upholding the production potential of land, fighting against and prevention of erosion and weakening or destruction of the water sources, and protection of the vegetation and the combating of weeds and invasive plants (Republic of South Africa, 1993).

b. The Environment Conservation Act

The purpose of the act is to provide for the effective protection and controlled utilization of the environment and for matters relating to caring for the environment. (Republic of South Africa, 1989).

c. Water Services Act, Act 108 of 1997

The objective of the Water Services Act is to provide access to basic water supplies, and basic sanitation, and to set national standards, norms and tariffs for South Africa. The Act also provides water services development plans, a regulatory framework for water services institutions and water services intermediaries, and gives for the establishment and disestablishment of water boards and water services committees. The Act further gives for the monitoring of water services and intervention by the Minister or by the relevant province, provides financial assistance to water services institutions, defines certain general powers of the Minister, gathers and maintains a national information system and may repeal certain laws. The Water Services Act also covers wetlands as part of the water supply system (Republic of South Africa, 1997).

d. Black Authorities Act 68 OF 1951

This act aims to provide for the establishment of certain Black authorities and to define their functions, to abolish the Black Representative Council, to amend the Black Affairs Act, 1920, and the Representation of Blacks Act, 1936, and to provide for other incidental matters. The smallholder farmers and the phenomena under study fall under the jurisdiction of the Tribal authority which is governed and guided by the black authorities act, which explains the roles and responsibilities of the tribal authority, the chief, the headman and the councillor (Republic of South Africa, 1951).

e. Communal Land Rights Act 11 Of 2004

The Act provides for legal security of occupancy by transferring communal land, to communities, or by awarding comparable amends. It also aims to provide for the democratic administration of communal land by communities; to provide for Land Rights Boards; to provide for the co-operative performance of municipal functions on communal land; to change or revoke certain laws related to communal land; and to provide for matters incidental thereto (Communal Land Rights Act, 2004). The study area in located in the rural areas of Thaba Nchu in the jurisdiction of the Municipal Planning Tribunal authorities. The study population (smallholder farmers) occupy communal land. It is crucial to understand how they are legislated to determine if this is in one way or another impacting on their vulnerabilities as well as to recognize the communal property associations act discussed under (f) below, see also Transformation of Certain Rural Areas Act regulations in section (g) below.

f. Communal Property Associations Act 28 of 1996

The purpose of the Act is to enable communities to form juristic persons, to be known as communal property associations in order to gain, hold and manage property on a basis agreed to by members of a community in terms of a written constitution; and to afford for matters connected therewith (Communal Property Associations Act, 1996).

g. Transformation of Certain Rural Areas

The Act stipulates the regulations for the transfer of certain land to municipalities and certain other legal entities; the removal of restrictions on the alienation of land; matters with regard to minerals; the repeal of the Rural Areas Act, 1987, and related laws; and other matters related therewith (Transformation of Certain Rural Areas Acts, 1998).

2.3 GLOBAL AND SOUTH AFRICAN THEORETICAL FRAMEWORKS

2.3.1 Disaster Management

1. The Progression of Vulnerability

The Pressure and Release model (PAR model) is an instrument for exposing the occurrence of disasters in the event whereby natural hazards affect vulnerable people. Studies shown that their vulnerabilities are usually as a result of some underlying causes such as social processes which may in the end be isolated from the disaster event itself. The model tries to explain the disaster occurrence considering the progression of vulnerability by establishing the link between the impact of a hazard and the social factors affecting people. The foundation for the PAR concept is that a disaster is the coming together of two conflicting forces; the processes (social factors) generating vulnerability on the one side, and the natural hazard event on the other. Figure 2.2 is like a nutcracker which depicts the increasing pressure on people arising from both sides, from their vulnerability (caused by social factors) and from the impact and severity of the hazard exposed to those people. The 'release' idea is incorporated to conceptualize the reduction of disaster. In order to relieve the pressure, vulnerability must be reduced, implying that the social factors must be addressed (Wisner, et al., 2003).

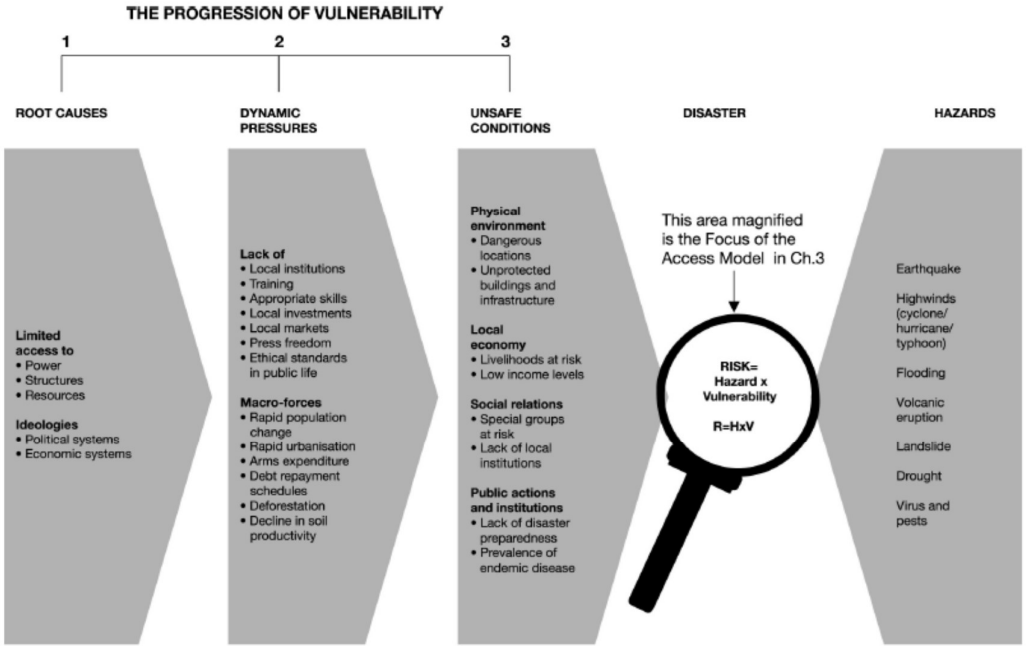

Figure 2-2Progression of Vulnerability (Source: Wisner, et al., 2003)

Wisner and colleagues (2003) are of the opinion that the explanation of vulnerability has three sets of links, the most aloof of these being the *root causes* which are an interconnected set of common and general practices within a society and the economy. The most important root causes that escalate vulnerability are economic, demographic and political processes, such as limited access to power, structures and resources. These affect the allocation and distribution of resources, among different groups of people. This will also help to explain the causes of vulnerabilities among the smallholder farmers, and how vulnerability progresses. Root causes are also connected with the function or dysfunction of the state, political and economic systems. Root causes shows the use and distribution of power in a society. People who are financially constrained such as rural dwellers (smallholder farmers) or who resides in places which are isolated, arid or semi-arid, flood prone they tend to be of less important to those who hold economic and political power. This aggravates vulnerability, as often people who have no money and political power are more likely to stop trusting their own methods for self-protection and lose confidence in their own local knowledge. Even if they still have confidence in their own abilities, that may serve useless due to lack of resources needed or required to activate their use of local knowledge and methods (Wisner, et al., 2003).

The other social factors influencing the vulnerability are *dynamic pressures* which are processes and activities that also turn the effects of root causes into unsafe conditions. Dynamic pressures are general underlying economic, social and political patterns such as lack of local institutions, lack of training, lack of appropriate skills, lack of local investments, lack of markets etc. They also include pressure such as rapid population growth, urbanization, deforestation (destroys the farming systems), decline in soil productivity (affects agriculture and undermine food security), climate change etc. Migration from rural to urban comes as a result of the loss of land used by poor farmers and pastoralists, discriminatory pricing of crops produced in small quantities by poor farmers and proletarianization of the peasantry, this may also lead to the diminishing of local knowledge that might serve to prevent disasters and a loss of the skills required for coping in the aftermath of a disaster (Wisner, et al., 2003).

These dynamic pressures mostly will operate to direct root cause to U*nsafe conditions*, these could either the unsafe physical environment, unsafe local economy (lack of cash, shelter, resources), social relations (network of support, sources of assistance) at risk and lack of public actions and institutions. Examples include people living in hazardous locations, having minimal food privileges (Wisner, et al., 2003). To understand the level of

vulnerability experienced by the smallholder farmers, they need to be assessed against these processes.

2. The National Disaster Management Framework (Notice 654 of 2005)

The National Disaster Management Framework (NDMF) (2005) provides guiding principles for the development of the provincial and municipal disaster management frameworks. The NDMF categorises disaster management into four Key Performance Area (KPA) and three Enablers.

- KPA 1: Integrated institutional capacity
- KPA 2: Risk assessment
- KPA 3: Disaster risk reduction
- KPA 4: Disaster response and recovery

→ Enabler 1: Information and communication management
→ Enabler 2: Education, training, public awareness and research
→ Enabler 3: Funding arrangement for disaster management

This framework is important to this study as it sets the legal and institutional foundation for integrating Disaster Risk Reduction (DRR) into Climate Change Adaptation (CCA) in Mangaung Metropolitan Municipality. The four key performance areas which are supported by three enablers of the NDMF (Figure 2.3), are used to develop disaster management plans in South Africa for risks such as drought, fires and floods which are common in MMM and also affect, and are affected, by Climate Change (National Disaster Management Framework, 2005). In the Mangaung Metropolitan area of the Free State, there are institutional arrangements such Disaster Management Advisory Forum, National Joint Drought Coordinating Committee, National Capacity Building Coordinating Forum, National Fire Services Advisory Committee, Heads of Provincial Disaster Management Forum, etc to which they are participant. Various stakeholders, from different sectors of national, and provincial department and local municipalities together with the South African Local Government Association are part of the forums. All of these forums play a critical role in ensuring multi-sphere and multisectoral institutional collaboration and coordination which is fundamental for effective disaster risk management and reduction. Continuous information and communication, education, training, public awareness and research as well as funding are necessary to keep the forums running and effective. The forums use the GIS to enable

them to do risk assessment pointing out where the major risk is, as well as the severity and intensity of each risk, to be able to allocate resources and interventions accordingly. Various stakeholders incorporate disaster risk reduction into their plans and policies.

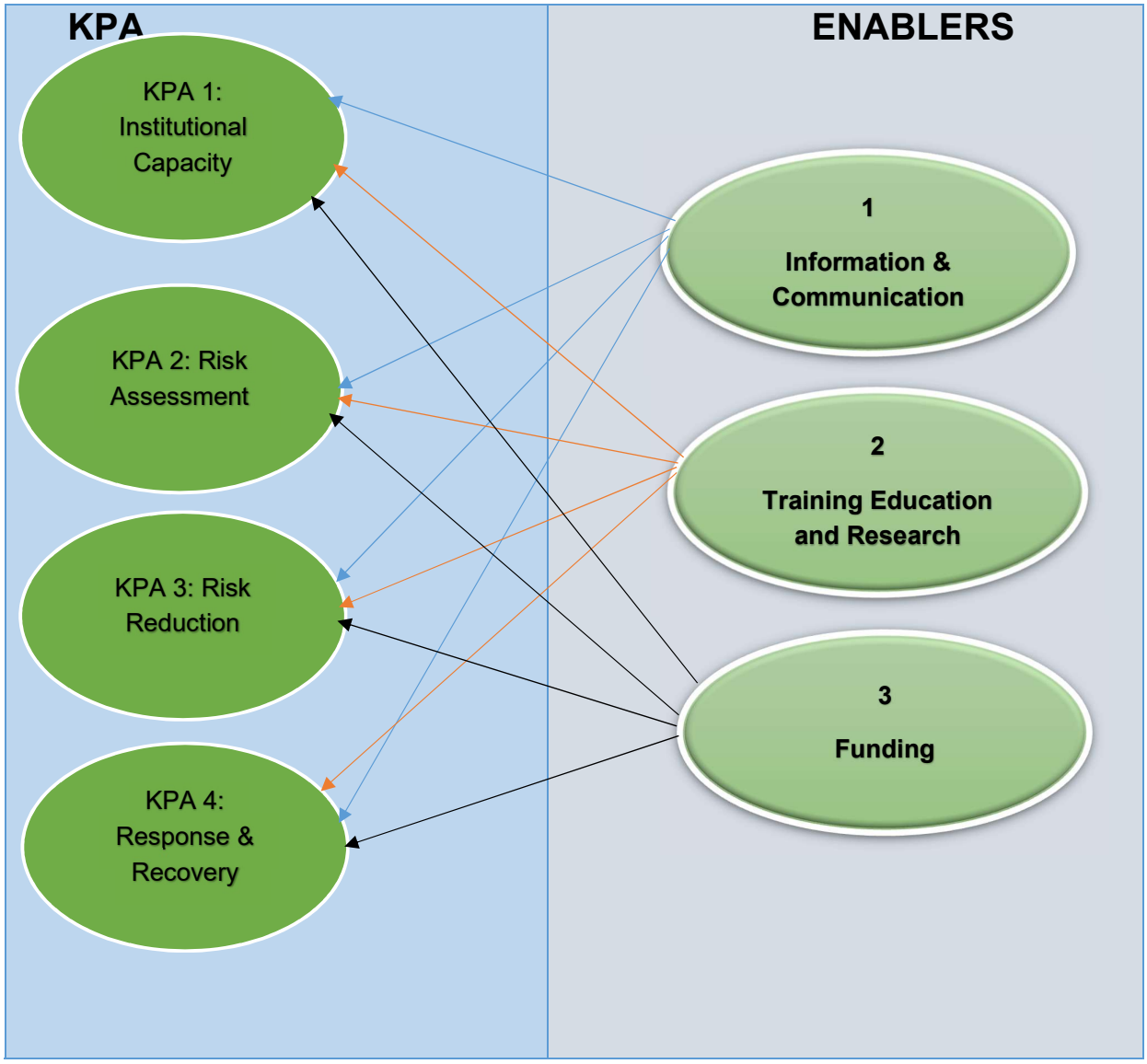

Figure 2-3The National Disaster Management Framework Four Key Performance Areas supported by three enablers (Source: NDMF, 2005)

2.3.2 Climate Change Adaptation with reference to Smallholder Farmers

i. Sustainable Livelihood (SL) Model

The SL approach is a universal method that attempts to understand and give explanation, to the critical triggers and aspects of poverty without limiting the attention onto just a few factors, for example economic issues, food security, etc. In addition, it tries to explain how the different aspects such as causes and manifestations of poverty relate, so that the necessary actions can be prioritized effectively at an operational level. The objective of the SL model is to assist the poor people to acquire sustainable livelihood improvements determined using poverty indicators that they, themselves, label (DFID, 2000).

The SL of DFID (2000) framework sets out to conceptualise:

- How people function in a vulnerable environment that is shaped by different factors including shifting seasonal constraints (changing climate) and opportunities (available natural resources), economic shocks and longer-term trends
- How they draw on different types of livelihood assets or capitals in different combinations which are influenced by their vulnerable environment context, as well as a range of institutions and processes
- How they use their asset base to develop a range of livelihoods strategies to achieve desired livelihood outcomes

Furthermore, livelihoods analysis serves as an important factor to regulate transformation. This is supported by many researchers who confirm that the SL framework gives a valuable conceptual foundation for grasping poverty and the situation of people living in poverty and that it is an effective tool for analyzing the impact of regulations on their livelihoods. It can also be utilized to analyze the coping and adaptive strategies practised by individuals and communities (smallholder farmers) in responding to shocks and stressors such as drought, civil strife and failed policies and anti-poor regulatory frameworks and climate change impacts (DFID, 2000).

The SL framework combines different actors, such as local government (municipal) and local communities in decision making and formulating policies and its implementation. It strives to integrate macro policies and micro realities (and vice versa) which impacts on these livelihoods (UNDP, 1999).

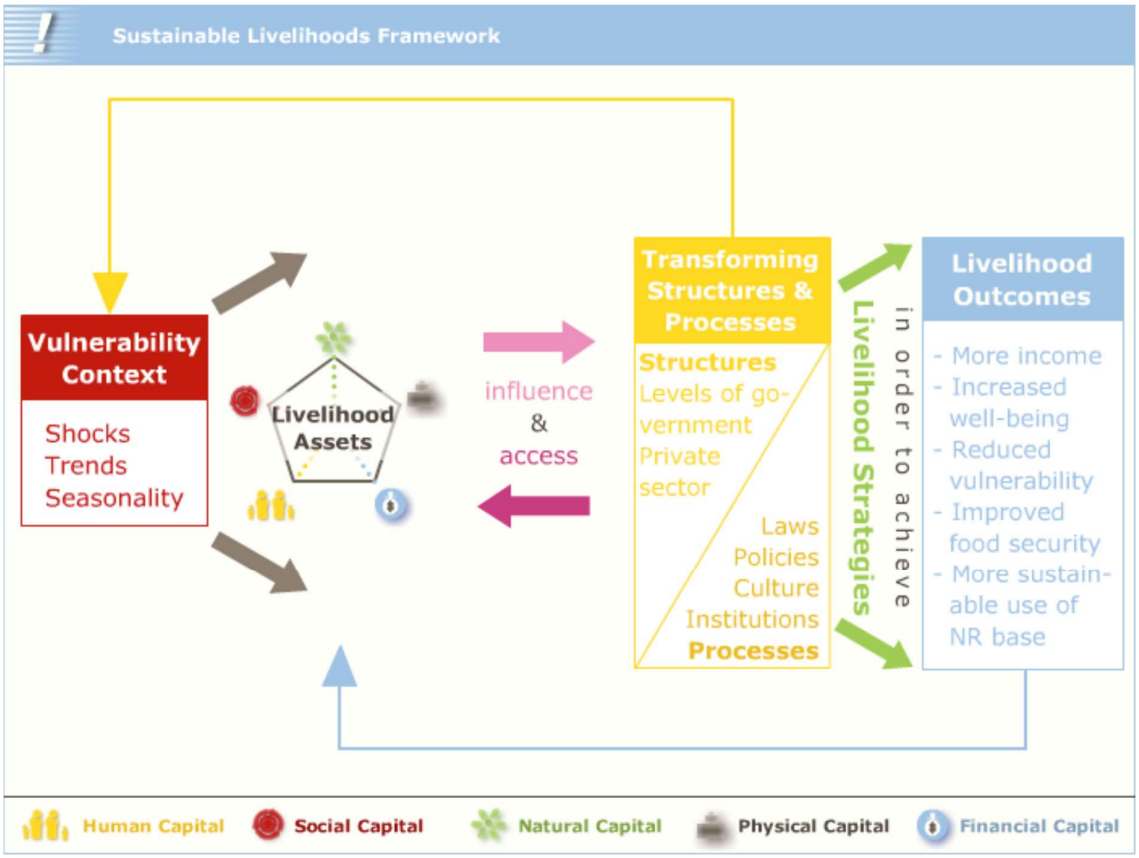

Figure 2-4Sustainable Livelihoods Framework (Source DFID, 2000)

The framework depicts stakeholders (smallholder farmers) operating in a vulnerable environment, within which they have available certain assets. Human Capital (their health, their knowledge, their skills, available information, and ability to work), Social Capital such as social resources (relationships of trust, membership in a group, available social networks, and access to wider institutions), Natural Capital or commonly known as natural resources (land, water, biodiversity, environmental resources), Physical Capital such as basic infrastructure (water, sanitation, energy, transport, communications network, housing and the means and equipment of production), and Financial Capital which are financial resources available (regular remittances or pensions, savings, supplies of credit). A number of amendments to the assets categories are proposed by McLeod (2001), the addition of two new assets: institutional knowledge and institutional or political capital which do not receive the attention they deserve although they are as important (DFID, 2000).

Assets increase in weight and value through the existing social, institutional and organizational environment (such as policies, institutions and processes). This context

decisively controls the livelihood strategies that are open to people in search of their self-defined beneficial livelihood outcomes (DFID, 2000).

Broadly speaking, the SL intention is to encourage sustainable livelihoods through the usage of assets (providing smallholder farmers with better access to the assets as a foundation for their livelihoods, support the more effective functioning of the structures and processes (e.g. policies, public- and private-sector organisations, markets and social relations) that influence not only access to assets but also which livelihoods are open to smallholder farmers. If smallholder farmers have better access to assets, they will have more ability to influence structures and processes so that these become more responsive to their needs (DFID, 2000).

The SL approach provides both a theoretical and programming framework for sustainable poverty reduction and livelihood for the affected (smallholder farmers). Unlike more traditional approaches that have sought to tackle poverty by identifying and addressing needs of poor people, the SL methodology plans to advance their lives by building on what they already have, their assets (land, dams, traditional ways etc) to assist the smallholder farmers to adapt to the effects of climate change and become resilient in order to sustain their livelihoods (farming activities) (UNDP, 1999).

2.4 CHAPTER SUMMARY

The legislative and the theoretical framework providing guiding principles to the three disciplines that are the focus of the current study (Disaster Management, Climate Change and Agriculture) were discussed in this chapter. The chapter started off discussing the global and South African legislative frameworks, touched on the legislative frameworks regulating the disciplines and their relevance to the study. In the global context, the SFDRR's relevance was explained as the legislation governing disaster management on a global level, while The Constitution of the Republic of South Africa (Act No. 108 of 1996), Disaster Management Act (Act 57 of 2002) as amended Disaster Amendment Act 16 of 2015 and Intergovernmental Relations Framework Act (Act 13 of 2005) were also explained on a local level (South African Context). The Paris agreement was discussed as a guiding legislative globally for Climate Change, whereas the Climate Change Bill, National Climate Change Response White Paper and National Commitment to Green House Gas (GHG) Reductions/National Response Strategy were described as legislative frameworks guiding the climate change locally (South Africa). Finally, the Food and Agriculture Organization (FAO) Strategy Framework and FAO Strategy on Climate Change were discussed as the

guiding legislative framework for the Agriculture and Smallholder farming community globally. In South Africa The Conservation of Agricultural Resource Act, The Environment Conservation Act, Water Services Act, Act 108 of 1997, Black Authorities Act 68 OF 1951, Communal Land Rights Act 11 Of 2004, Communal Property Associations Act 28 of 1996, Transformation of Certain Rural Areas are all relevant, since the current research focuses on the smallholder farmers based in the rural villages of Thaba Nchu where the communal land approach and tribal authority are still dominant.

The second part of the chapter touched on the theoretical frameworks guiding the study phenomenon. As one of the objectives of the study was to observe the smallholders' vulnerabilities, the Progression of Vulnerability was discussed and the National Disaster Management Framework (Notice 654 of 2005) which has guiding principles to reduce and mitigate the disasters. The theoretical framework relevant to the study vis-à-vis the climate change adaptation of smallholder farmers is the Sustainable Livelihood Model which is seen to give direction regarding adaption to the effects of climate change and to ensure the sustainability and livelihood of the smallholder farmers using the available assets.

3 CHAPTER 3: LITERATURE REVIEW

3.1 INTRODUCTION

This chapter will be looking at the literature relating to Disaster Management, how disasters occur and how they affect the world at large, with specific reference to climate change and agriculture particularly the small holder farmer's adaptation to climate change.

Major disasters caused by natural hazards affect the lives and livelihoods of millions of people around the world. Although the devastating earthquake in Haiti in 2010 and the floods in Pakistan showed the danger of countries affected by natural disasters, the 2011 flood and recent forest fires in Australia, along with the New Zealand earthquake, accompanied Japan, earthquakes and tsunamis also showed that people in the rich country are not immune to the dangers of disaster. Globally, the financial losses and the damage caused by these events are increasing exponentially with the frequency and severity of major natural disasters. One of the reasons for this is due to the combination of rapid simultaneous development of the global economy and population. According to the World Economic Forum, from 1950 to 2010, the world's population increased from 2.5 to 6.9 billion, a high percentage of this growth occurs in hazardous areas such as coastal areas and riverbanks.

The rapidly changing global climate resulting from global warming, also influences disasters. It leads to, among other things, the polar and the ice melting, rising sea levels, acidic oceans, rainfall and snow patterns changing, frequent floods and droughts, increase in frequency and intensity of extreme weather events, such as tornadoes, hurricanes and cyclones. With the rapid pace of climate change, the earth's biophysical system cannot adapt to these changes naturally. There is no peace without improving food security and ending hunger. There is no food without fighting climate change.

Agriculture sector and food production are somewhat guilty of the increased temperatures but are also an important part of the solution to mitigate greenhouse gas emissions and promote adaptation to a changing climate, especially for rural family farmers in developing countries. It is mostly the poorest people who are more prone to climate change adverse effects. For millions of people, the actions of their fellow human being can make a difference between poverty and prosperity, between hunger and food security, smallholder farmers hold the key to food system transformation their adaptation to the negative effects of climate

change is therefore vital. As the impacts of climate change increase and become more intense, an immediate global transformation to sustainable agriculture becomes more urgent, policies and developmental approaches needs to support and assist the smallholder farmers to achieve the food system transformation.

3.2 DISASTER MANAGEMENT

The Disaster Management Act of South Africa defines Disaster Management as a continuous and integrated process involving multiple sectors, multiple disciplines planning and implementating of measures designed to prevent, reduce the risk of disasters; mitigate the severity or consequences of disasters; be prepared for emergencies; be responsive rapidly and effectively to disasters; and recover and rehabilitate post the disaster. Disaster Management is a process of managing disaster, using all disaster techniques for prevention, mitigation, preparedness, response, recovery and rehabilitation.

3.2.1 Phases of the Slow Onset Disaster Management Continuum

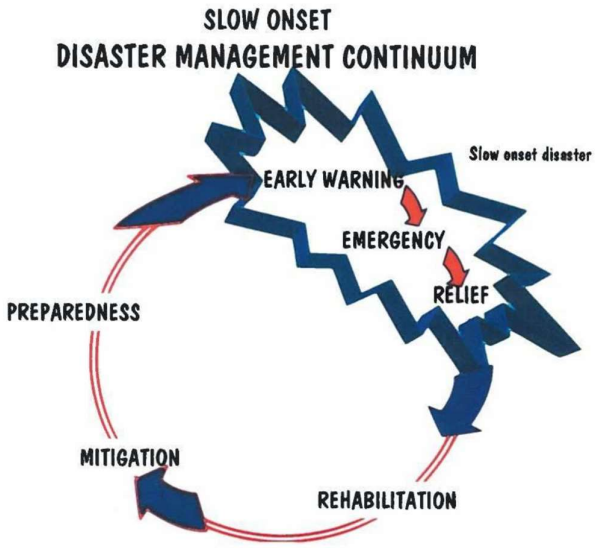

Figure 3-1: Slow Onset Disaster Management Continuum (Source: Tekle, 2004)

According to an almost three decades old initial publication of “An overview of Disaster Management” UNDP-DMTP (1992), disasters can be seen as a continuous series of stages. At one end of the continuum are activities focused on reducing vulnerability and building resilience to slow onset events (drought) and processes. These actions are primarily related

to sustainable development, such as efforts to reduce poverty. At the other end of the continuum are activities that address the risks of specific slow onset impacts of climate change. The UNFCCC identifies “sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity and desertification” as all related to climate change as slow-onset events.

Certain activities focus on risks that are outside of climate variability (UNFCCC, 2012). Recognising and understanding these stages will assist in knowing and describing the needs related to the disaster and to conceptualize the necessary activities accompanying the stages, which are summarised as follows.

- Early Warning

Early warning refers to the process of observing conditions and vulnerability indicators in communities prone to the onset of hazards. Staupe-Delgado (2019) indicated that early warning technologies do not automatically guarantee pre-emptive response to slow-onset disasters due to political and practical limitations with regard to the response turnaround time. It is evident that discussions around early warning and timely response is associated with technological challenges rather than the time actions following warnings. Most studies on early warning presumes that better projections and more reliable forms of warning will result in more timely response. Yet, researchers working on slow-onset disasters such as droughts, famines and environmental change observe instead a tendency of “early warning, late response” to creeping disasters. Hence, the relationship between early warning and response is not an automatic one. The research in hand seeks to fill this gap.

- Emergency Phase

This refers to the time where certain extraordinary and extensive measures must be applied. It involves implementing emergency procedures with emergency authorities to assist with human needs, and to maintain livelihoods. Staupe-Delgado (2019) is of the opionion that slow-onset disasters can potentially be managed and terminated at their early stages, and their impacts would then be largely avoided.

- Relief Phase

The relief phase is the time immediately after the occurrence of a disaster when special measures must be taken to aid the community by providing them with the basic needs. Staupe-Delgado (2019) suggests this that this stage could be avoided by rather being proactive with the response instead of being reactive and not waiting until the destructive impacts are seen.

- Rehabilitation

This is the phase in which corrective measures are taken after a slow onset disaster such as drought and famine to restore the society livelihoods.

- Mitigation

It is the stage where pre-disaster measures are taken to reduce the risk and impacts of a potential disaster by reducing the hazard or vulnerability of the affected community using tool, powers and budget of the government, which is what is this study seeking to achieve with the smallholder farmers.

- Preparedness

Preparedness is a phase where activities associated with readiness are effected in preparation of disaster occurrence by minimising loss or damage in the affected society, and enabling timely and effective rescue, relief and rehabilitation processes (UNDP-DMTP, 1992). Although Staupe-Delgado (2019) argues that instead of viewing preparedness as a function whereby you are waiting to react wanting to secure effective response once adverse impacts are a fact, as in the disaster phase model it should rather be seen as preparedness for effective response (ex-post) more in terms of 'preparedness for proactive response (ex-ante).

Disasters differ significantly in the way they occur as well as the speed in which they occur, which greatly affects how authorities interpret and respond to them. Some disasters are more gradual or creeping in their occurrence, such as droughts or El Niño and climate change. Disaster assessments show that indescribable and slow-onset disasters affect most people on average than sudden-onset disasters. Not only do slow-onset disasters provide enough time of warning, but also a large potential for proactive response, which in turn provides plenty of time to act. However, the unfortunate reality is that hazards (drought) with a slow-onset are often ignored, left fuming in the background, while their impacts gradually building up and strengthened over time - sometimes irreversibly so – until eventually they become critical emergencies (livestock dying). This proved to be the case with the climate change and global warming, authorities waited until it is too late to manage the adverse effects of climate change.

3.2.2 Causal Factors of Disasters

- Poverty

The greatest significant specific effect on the impact of a disaster is poverty. Poverty increases the vulnerability of the people. It is the most often quoted reason why people move to urban areas or cities to seek refuge and dwell in the dangerous places in an attempt at survival. If poverty was not rife most people who are currently affected in Africa, would not be affected as intensively by disasters, as disasters mostly have an adverse impact on the poor people rather than the wealthy (The Conversation, 2017).

- Population Growth

Population growth is the increase of population numbers. Population in most Less Developed Countries (LDC) continues to rise and a high percentage of growth in the coming decades is predicted in African countries, most of which are exposed to recurrent dangerous natural events. Population growth is believed to be a major world-wide force adding to rising vulnerability. Due to increased numbers, people are obliged to dwell in threatened dwellings. Even worse is the fact that more children appear to live in risky locations. The pressure also amplifies the number of landless families. The degree of rural-urban migration has led to increased numbers of people looking for dwelling place and survival on disaster-prone land within and alongside major rivers of African countries (Donner & Rodriguez, 2011).

- Rapid urbanisation

Urbanisation occurs when a large section of a population moves from rural to urban areas, Rapid urbanisation is when the move from rural to urban areas is happening quickly and there is a fast increase of population in towns and cities (Business dictionary, n.d.).

Urbanisation influence the progression of vulnerability, mainly of low earnings families staying in squatter camps. The urbanisation development causes land pressure as migrants from outside move into already congested towns, which results in new arrivals having few other options but to dwell in hazardous place, build insecure structures or work in unsafe environments. It also creates malnutrition and poor health which leads to vulnerability. Shantytown dwellers suffer huge risks from natural hazards (flood, landslide and mudslide) as a result of having to live in densely -built structures which can disrupt natural and land drainage designs and water course. The rate at which the African population is becoming urban is starting and a potential for increased vulnerability to hazards (Seduski, 2016).

- Transition and cultural practices

Many of the unavoidable transformations lead to an escalation in the societies' vulnerability to disasters, due to the move from non-industrialized to industrializing societies, and the introduction of new construction materials and building designs in a society that is used to conventional materials and way of doing things, which results in supplies being used wrongly. These transitions are tremendously disruptive and uneven, making it difficult to cope. People do not have support systems as in most cases they find themselves in new dwelling places without familiar faces. Conflicting as well as transitional cultural practices also lead to conflicts, for example, communal violence triggered by religious dissimilarities or cultures (Kulatunga, 2010)

- Environmental degradation

Environmental degradation is the breakdown of the earth or deterioration of the environment through depletion of resources (Conserve energy future, n.d.). Damage to land, soil, wetland, forests, and water sources are important forces which results in hazards that causes disasters. South Africa is experiencing droughts, floods, cyclones, and fires as a result of environment deterioration. Coastal areas are stressed by human activity such as pollution, and coastal ecosystems are being eroded. Forests are drained and cut in order to provide lodgings for tourists and other undertakings that advance profits. The forests have been devastated by the timber industry over many decades (Tyagi, et al., 2014).

Decrease in farming has been seen over the years even in rural areas, Land degradation resulting in empty lands has been caused by ranching or commercial cropping. The increasing demand for wood and charcoal in certain African cities leads to fuels being produced at ever-increasing distances, causing loss of vegetation. With population growth and decrease in farming which is commonly known as a form of survival for the low earning, the consequence could be famine (UNEP, 2012).

Unfavourable environmental change, universal climate change, and changes in the interacting systems of the atmosphere, hydrosphere, and biosphere have caused the accumulation of greenhouse gases. The risks are that changes will expand the concentration and occurrence of climatic hazards and broaden those areas affected by them. Rising sea level due to global warming is another negative force (UNEP, 2012).

- Lack of information

Lack of information make matters worse in the presence of hazard, when the community is not well prepared. The society might not be well informed about the hazard or what to do in a disaster, or how to prepare for the occurrence of a disaster, or after the occurrence of a

disaster or act after the occurrence of a disaster. This poses a challenge and increases the impact of the disaster (The New Humanitarian, 2012).

- War and civil strife

In recent times many violent conflicts have broken out and countless citizens have been affected. Conflicts worsen natural life-threatening events such as droughts (Eastin, 2017).

According to Wisner et al.(2003:27), Violent conflict affects natural hazards in various ways; It is one of the causes of social vulnerability; people being displaced due to war and other violent conflicts can result in new risks (exposure to disease, unfamiliar hazards in new rural or urban environments; participatory methods meant to empower and engage socially vulnerable groups may be difficult or impossible during violent conflicts. There is huge risk and a possibility of damages to infrastructure, which may then intensify natural hazards (e.g. irrigation systems, dams, levees) or compromises warnings and evacuations (e.g. land mines on roads). Lack of sustainable development will also lead in conflict over resources and that often wreak havoc on vegetation, land and water, and this undermines sustainable development" (Eastin, 2017).

3.2.3 Overview of Risks, Hazards and Vulnerabilities in Disaster Reduction

To achieve better understanding of disaster management the specific aspects risk, hazards, vulnerabilities and how they contribute to the disaster risks are examined. Disasters that seem to be caused by natural hazards, are not the biggest threat to humanity. Despite the deadly nature of earthquakes, epidemics and famine, most of the world's population lives are shortened by events that sometimes go unnoticed such as violent conflict, illnesses, and hunger. Sometimes earthquakes kill many people, and sometimes floods, famines or epidemics also kills millions of lives at a time. But to focus on these is to ignore the millions who are not killed in such events, but who nevertheless face grave risks (Wisner, et al., 2003).

According to Wisner, et al (2003), the disconnection among people at risk from natural hazards and the many dangers found in normal life is not real. Analysing disasters allows us to show why they should not be disconnected from everyday living, and to show how the risks involved in disasters should relate to the vulnerability created for many people through their normal existence. Analysing disasters should find the relation between the risks people are facing and the reasons they are vulnerable to these hazards. It should therefore show how analysing them in this way may provide a much more beneficial way of building policies, that can help to reduce disasters and mitigate hazards, while at the same time improving

living standards and opportunities more generally by minimising their vulnerability, increasing their capacity thereby mitigating risks.

The importance about understanding the causes of disasters is that it is not only natural events that cause them, but they are also the product of social, political and economic environments, because of the way these structures affect the lives of different groups of people in this case the smallholder farmers. It is dangerous to treat disasters as something unique as events that deserve their own special attention. It is to risk separating 'natural' disasters from the social frameworks that influence how hazards affect people, thereby putting too much emphasis on the natural hazards themselves, and not nearly enough on the surrounding social environment which plays a major role. In this case it is important to understand the vulnerabilities of those affected (smallholder farmers). Vulnerability involves a combination of factors which determine the degree to which someone's life, livelihood, property and other assets are put at risk by a discrete and identifiable event (or series or 'cascade' of such events) in nature and in society.

Because this study focuses on smallholder farmers, it is critical to understand what their vulnerabilities are, and what risks and hazards they are faced with when exposes to a disaster. Key variables explaining various impacts include differences in wealth, occupation, class, ethnicity, gender, disability, health status, age and immigration status (whether 'legal' or 'illegal'); and the nature and extent of social networks.

Vulnerability is in this instance explained with the notion of capacity (disaster management), the ability of a group or household to resist a hazard's harmful effects and to recover easily which is the goal and aim of the study to identify ways for the smallholder farmers to cope with observed harmful effects, adapt and recover easily. The word 'livelihood' is important in the definition. It refers to command an individual, family or other social group has over an income and/or bundles of resources that can be used or exchanged to satisfy their needs and sustain them. This may involve information, cultural knowledge, social networks and legal rights as well as tools, land or other physical resources (Wisner, et al., 2003).

The study seeks to balance and/or manage the factors leading to a disaster for the smallholder famers in understanding the risk, hazard and vulnerabilities they face each day, with the agriculture sector being the sector most affected by the effects of climate change. The effects of climate change increase the impact of disasters on the most vulnerable.

Agricultural and food systems are specifically sensitive to the impacts of climate change. The increase in temperature together with changing rainfall patterns, is likely to shift optimum growing areas for key crops, generate an increase in the frequency and severity of extreme and moderate weather events, and result in pests and diseases finding new ranges and potentially trigger an onset disaster such as drought. This translates into increased vulnerability in agriculture over the medium to long term and poses new risks to farming and food system unless measures are put in place to strengthen the resilience of agriculture systems and to enable farmers to adapt to cope with climate change, a recognition that has led to the concept of “climate smart agriculture” (Schulze & Taylor, 2016). The smallholder famers are the most vulnerable when it comes to the effects of climate change, and they are most at risk for the hazard of extreme weather variability and events. More smallholder farmers vulnerabilities to climate change will be discussed in point 3.4.2.

3.3 CLIMATE CHANGE

Understanding Climate Change and all its facets is pivotal to the purpose of the study. Prior to determining how the smallholder farmers adapt to climate change impacts, it is necessary to recognize how climate change occurs, and to appreciate its impacts and the necessity for adaptation. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as any change in climate over time, due to natural changeability or as a result of human activity (IPCC, 2007), whereas the United Nations Framework Convention on Climate Change (UNFCCC) (2015) defines climate change as a change of climate that is attributed directly or indirectly to human actions, in addition to natural climate variability. The IPCC is the United Nations body for assessing the science related to climate change. It was established to give policy makers regular scientific assessments reports on climate change, its implications and future risks, as well as to put forward adaptation and mitigation alternatives. The UNFCCC was formed in 1992 by 196 parties and set the ultimate objective which is to “stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system” (IPCC, 2015).

Tyagi et al.(2014) explain climate change as the change in climate and weather patterns which comes as the result of the excess gas emission by human interventions or accumulation of greenhouse gases and the presence of carbon dioxide in the atmosphere which bring imbalance in the atmosphere. Although climate change is defined in different ways, the definitions share common attributes: changes in climate over time resulting from human interventions which lead to changes in the atmosphere and weather patterns. Of the

three definitions the one formulated by Tyagi et al., (2014) seems to combine all significant attributes. Important elements of the climate that are often observed and recorded over a long period (at least 30 years) include the following:

- Precipitation, which commonly refer to rainfall and snowfall.
- Temperature, where minimum and maximum temperatures are observed to get the daily, monthly and annual average temperature over a long period.
- Wind direction, speed, content and intensity.
- The atmospheric humidity and pressure.
- The amount of sunshine is also important in observing the weather and subsequently the climate (IPCC, 2014).

3.3.1 Observed Changes and their Causes

✓ Past and recent drivers of climate change

The is an experience of the warming of the atmosphere and the ocean, the snow and ice diminishing, and sea level rising. Human activities have been seen to be the main cause of climate change (IPCC, 2007) as a result of their actions which generate gas emissions. Anthropogenic emissions of greenhouse gases are currently at the highest level in recorded history to date. Much of the observed increase in global average surface temperatures was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic drivers of global warming (IPCC, 2014). The three main greenhouse gases related to climate change are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) (IPCC, 2007).

- Observed Changes

The following are the observed changes over decades as a result of the variations in climate.

  - Atmosphere

The last thirty years (30) have been consecutively warmer at the Earth's surface than any previous years since 1850. The period from 1983 to 2012 was possibly the warmest thirty (30) year period of the last 1400 years in the Northern Hemisphere. The global average

temperature data over the land and ocean surface as calculated by a linear trend indicates a warming of 0.85°C over the period 1880 to 2012 (IPCC, 2014).

- Ocean

The warming of the ocean exceeds the increase in energy stored in the climate system, which more than 90% of the energy and about only 1% stored in the atmosphere. On a global scale, ocean warming is most intense near the surface. In average precipitation has increased since 1901 over the mid-latitude land areas of the Northern Hemisphere. Observations of changes in ocean surface salinity also provide indirect evidence for changes in the global water cycle over the ocean. It is very likely that regions of high salinity, where evaporation dominates, have become more saline, while regions of low salinity, where precipitation dominates, have become fresher since the 1950s. Since the beginning of the industrial era, oceanic uptake of CO2 has resulted in acidification of the ocean; the pH of ocean surface water has decreased by 0.1, corresponding to a 26% increase in acidity, measured as hydrogen ion concentration (IPCC, 2014).

- Cryosphere

The Greenland and Antarctic ice sheets have also been losing mass, likely at a higher rate as time goes by. Glaciers continue to shrink almost worldwide. Northern Hemisphere spring snow cover has continued to decrease in extent. There is high confidence that permafrost temperatures have increased in most regions since the early 1980s in response to increased surface temperature and changing snow cover (IPCC, 2014).

- Sea Level

The earth's average sea level has risen, the rate of sea level rise since the mid-19th century has been larger than the average rate during the previous two millennia (IPCC, 2014).

The record of observed climate change has thus allowed characterization of the basic properties of the climate system which have implications for future warming, including the equilibrium climate sensitivity and the transient climate response (IPCC, 2014). The causes and observed impacts attributed to the observed changes which have impact on agriculture and the smallholder farmers (the subject of the study) and how these observed changes have impacted smallholder farmers negatively will be discussed below.

3.3.2 Causes and Observed impacts attributed to climate change

Recently, changes in climate have caused impacts on natural and human systems globally and across the land and oceans, indicating the immense sensitivity of natural and human systems to changing climate. Results from studies attributing climate change to specific causes provide estimates of the magnitude of warming in response to changes in radiative forcing and hence support projections of future climate change (Niang, et al., 2014).

Changes in many extreme weather and climate events have been observed since about 1950, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions these changes unfortunately affect the agriculture sector negatively especially the smallholder farmers who are more vulnerable to the weather and climate conditions due to their dependency on climate for their farming productions (Niang, et al., 2014).

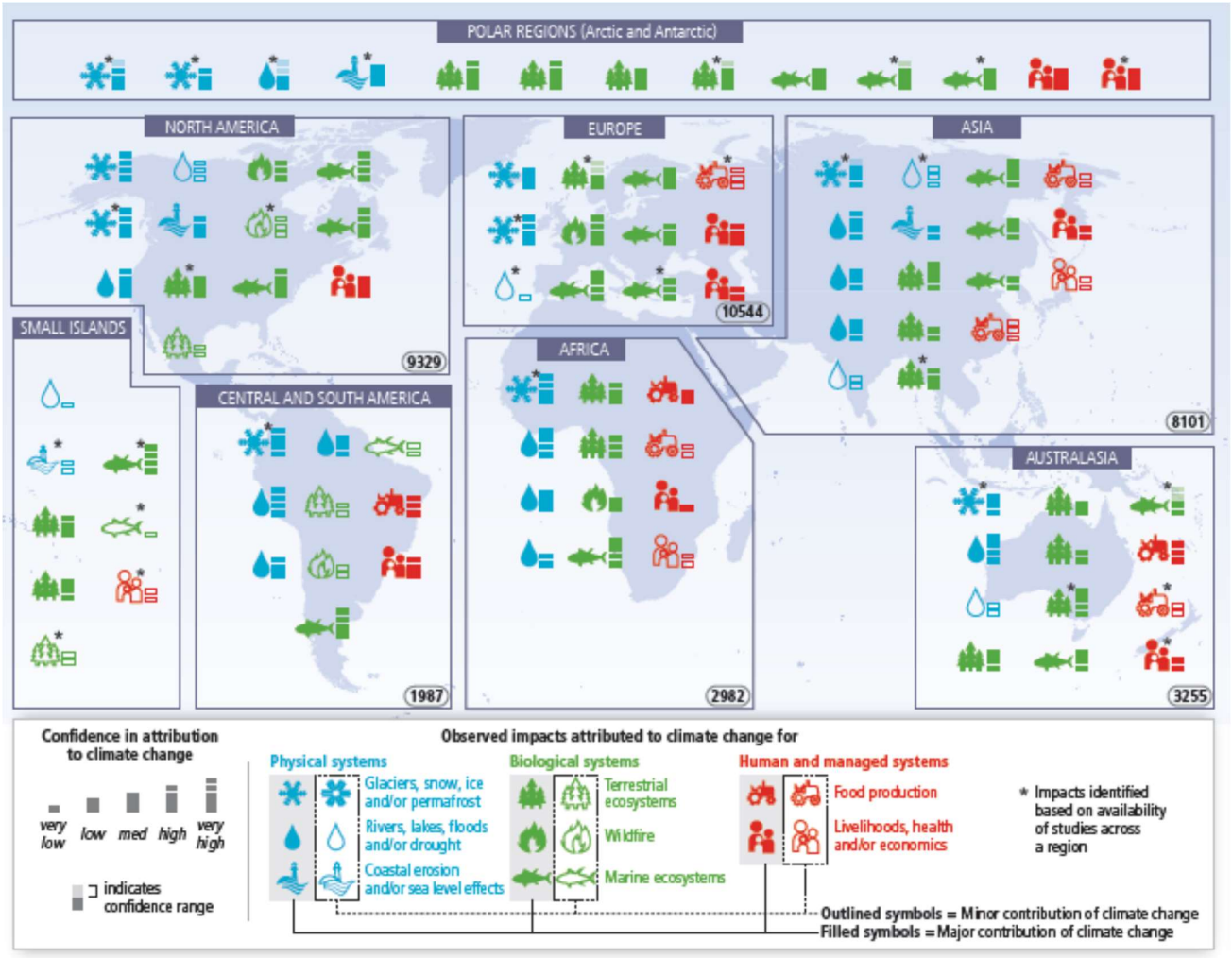

Figure 3-2 Widespread impacts attributed to climate change based on the available scientific literature since the AR4 (Source: WGII, 2014)

Figure 3.2 displays symbols indicating categories of impacts attributed to climate change, the relative contribution of climate change (the major contribution indicated by means of filled symbols and minor contribution indicated by outlined symbols) to the observed impact, and confidence in attribution. Each symbol refers to one or more entries in Working Group II (WGII) Table SPM.A1, grouping related regional-scale impacts. Numbers in ovals indicate regional totals of climate change publications from 2001 to 2010, based on the Scopus bibliographic database for publications in English with individual countries mentioned in title, abstract or key words (as of July 2011). These figures give an overall evaluation of the available scientific data on climate change across continents. They do not indicate the number of publications supporting attribution of climate change impacts in each continent. Studies for polar regions and small islands are grouped with neighbouring continental regions. This, then, indicates that more research needs to be done and published regarding the impacts of climate change in Africa and consequently South Africa. The major contributions attributed to climate change in all natural and human systems for Africa, as depicted in Figure 3.2, will be discussed next.

- Climate change impacts in Africa

Figure 3.2 shows that climate change will significantly affect the risk profile of Africa. Africa is believed to be the continent most vulnerable to the impacts of climate change (IPCC, 2014). Most African countries with a population of more than one million are in low-lying coastal areas, and face high risk of sea level rise, coastal storms, coastal erosion, flooding and saline sea water intrusion (UNISDR, 2015). Most parts of Africa are also estimated to see less precipitation, except the east central regions of Africa. By 2020, between 75 and 250 million Africans will be water stressed due to climate change and this will have serious after-effects mostly for agricultural production and access to food. A 50% drop in yield from rain-fed agriculture is projected for some African countries. Changes in rainfall will also lead to increase in the risk of diarrheal infection due to floods and droughts, and temperature increases will also lead to increased risk and spread of malaria as the mosquito band increases (IPCC, 2014).

- Climate change in Southern Africa

A universal trend of warming has been observed in southern Africa over the last few decades. Temperatures have been rising by over 0.5 ºC over the past 100 years. The Indian Ocean has warmed by over 1 ºC since 1950. There has also been a decrease in rainfall in southern Africa with below normal rainfall periods becoming more frequent (SADC, 2010).

The region encompasses the following countries: Angola, Botswana, the Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

During the past decade droughts have become recurrent in Southern Africa, while it experienced the increase in frequency and intensity of the El Niño episodes. Southern Africa is projected to be hotter and drier in the future, and like the rest of Africa, southern Africa is very vulnerable to the impacts of climate change (SADC, 2010). Climate change is affecting climate susceptible sectors such as agriculture, water, infrastructure and transport, coastal zones, health, energy, urban planning and management, tourism, biodiversity and ecosystems, forests, fisheries and the general environment. These effects will require adaptation and mitigation measures for sustainability (SADC, 2010).

- Climate change in South Africa

South Africa is very vulnerable to the impacts of climate change and at the same time South Africa is one of the highest emitters of greenhouse gases per capita of GDP in the world. Climate change predictions show that in the next 50 years, the western part of South Africa will become drier, while the eastern part will become wetter. According to research conducted by IPCC (2007), temperatures will increase in the interior of South Africa and extreme weather and climate events will also be more frequent and intensive, while the highest rise in temperature will occur in the most arid regions (IPCC, 2007).

An IPCC assessment report (2012) indicated that reduction of rainfall of between 5% and 10% in the summer rainfall regions like the FS will be prevalent, while an increase in early winter rainfall for the winter rainfall regions like the Western Cape will be experienced. It is expected that increased incidents of both drought and floods as well as prolonged dry spells will be prevalent, at times accompanied by poor land use management which will be followed by intense storms. All in all, South Africa might witness a drier north and west, and marginally wetter south and east regions, but rainfall will become more erratic accompanied by intense storms (IPCC, 2007). Other impacts which might be experienced according to Renaud et al. (2013) are change in the base flow, increased heat stress on wildlife, extended activity of pest and disease vectors, increased flooding, increased soil erosion and sediment load, decreased recharge of floodplain aquifers, decrease in water quantity and quality, and increased risk of fires.

- Mangaung Metropolitan Municipality (MMM)

The highest climatic risk the municipality area is facing is the fact that increasing temperatures will have an impact on water availability and its usage. Water and sustainable water provision are major issues for the municipality. The future predictions regarding rainfall shows that Mangaung will experience a major decrease in rainfall. This prediction is very important in terms of any future planning within the city. The area normally experiences a warm, dry climate with annual average temperatures of 32ºC (summer) and 19ºC (winter). Presently the area receives on average between 200 and 600mm of rainfall annually. By 2040 it is expected to have an overall 2.5ºC increase in temperature. Equally, the seasonal average temperatures will increase by 2ºC. By 2040 there will be a decrease in rainfall of between 5 and 10%, which will add to the current water stress which the city experiences. Furthermore, major occurrences of drought periods are expected for 2040 (South Africa Cities Network, 2017).

According to the SACN (2017) it was observed that reference is made to climate change in a very isolated manner in the municipality's documents and that the concept is not sufficiently incorporated into the overall strategic planning of the city. Additionally, there is no supporting data management system in place to provide for the proactive resilience planning. Coupled with this, external partnership does not provide enough support to effectively incorporate climate change planning and strategies. It is with this understanding that it can be concluded that no climate change resilience system has been developed for Mangaung (South Africa Cities Network, 2017). SACN (2017) further indicated that Mangaung has not yet adopted a climate change adaptation strategy. There is also observation of very little evidence of a link between climate change and planning within the city. Although, between 2008 and 2012 the Department of Water Affairs, Bloemwater, the municipality and all other relevant stakeholders developed a Bloemwater Reconciliation Strategy, which serves to develop a sustainable balance between future water availability and recent water requirements in the municipality. The plan also focuses on water usage and availability and take into consideration the impact climate change has on water availability. The overview of the city's risk rating for food security is moderate and the risk rating for water provision is very high. Climate change in mangaung is managed by a disaster management team and its climate change resilience system has not yet been developed (South Africa Cities Network, 2017).

3.4 AGRICULTURE AND SMALLHOLDER FARMERS

Agriculture is commonly believed to be one of the most high-performance motors of growth in national and global economies, and there has been reflection that in developing countries such as South Africa, agricultural growth contributes more than most other sectors to overall growth of revenue especially in the rural environment where the most part of the vulnerable population lives and works. It also stimulates growth in the other sectors of the economy by increasing further the demand for goods and services produced within the agricultural sector, and it also reduces levels of poverty, famine and malnutrition by increasing the supply of food and improving access to a better diet and increase food security (Schulze & Taylor, 2016). The food and agricultural sectors are essential for human development and are also at the centre of the international response to climate change. They are at risk because of climate change and at the same time, they are significant sources of GHG emissions (COAG, 2018). The consequences of climate change on agriculture must therefore be viewed in terms of both productivity of farming operations and the risk of interruption of production, with implications for food security and income for millions of households in South Africa (Schulze & Taylor, 2016).

The most affected group would be the smallholder farmers considering the vulnerability they are already faced with. The framework for the development of smallholder farmers through cooperatives development of the Department of Agriculture, Forestry, Fisheries (2012), defines smallholder farmers in various ways depending on the context, country and even ecological zone. But commonly, the term ‘smallholder’ is often interchangeably used with ‘small-scale’, ‘resource poor’ and sometimes ‘peasant farmer’. Smallholder only refers to their limited resource capability in relation to other farmers in the sector. Smallholder farmers are also defined as those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost entirely on family labour.

The production systems of smallholder farmers are characterized by outdated, simple technologies which brings low returns, with family acting as labour in production. Smallholder farmers differ in individual characteristics, farm size, resource distribution between food and cash crops, livestock and off-farm activities, their use of external inputs, the proportion of food crops sold, and household expenditure patterns (DAFF, 2012). Smallholder farmers are the generators of many economies in Africa even though their potential is often ignored, and efforts needs to be made to change this perception. Smallholder farmers can play a vital role in sustaining the livelihoods for the rural poor. Although smallholder production is critical for food security, their productivity is quite low.

Poor yields may be one of the reasons why urban and rural households either abandon or are uninterested in agricultural production (DAFF, 2012).

3.4.1 Climate Change Impacts on Agriculture and Farming

The extreme weather events resulting from climate change will see changes in agricultural production with impacts on income and on the well-being of rural people. Many studies to evaluate the impacts on the agricultural sector and its implications for communities have been done at various levels, ranging from micro-level farm models to large-scale regional and country level (Dasgupta & Morton, 2014).

As it has been earlier indicated that Africa's food production systems are among the world's most vulnerable due to the large dependence on rain-fed crop production, high intra- and inter-seasonal climate variability, recurrent droughts and floods that affect both crops and livestock, and continuing poverty that interferes with the capacity to adapt. Agriculture is predicted to face major challenges in adapting to climate changes in the mid-century, as negative effects of high temperatures become increasingly evident, therefore increasing the chance of reduced yield potential of major crops in Africa. The arrangement of farming systems from mixed crop livestock to having more livestock dominated food production may happen resulting from decreased growing season length for annual crops and increases in the frequency and prevalence of failed seasons. Livestock keeping is predicted to substitute mixed crop-livestock systems by 2050 (Niang, et al., 2014).

Livestock systems are faced many unfavourable pressures that react from the climate change and variability to increase the vulnerability of livestock keeping farmers. These pressures consist of rangeland degradation; unpredictable access to water; reduction of grazing areas; changes in land occupancy from communal toward private ownership; moving in of non-pastoralists into grazing areas; lack of opportunities to diversify livelihoods; conflict and political crisis; weak social safety nets; and insecure access to land, closed markets, and other limited resources. Loss of livestock under extended drought conditions is a critical risk considering the widespread rangeland that is susceptible to drought (Niang, et al., 2014).

3.4.2 Smallholder Farmers Vulnerabilities

The decline in farming activities, is the main cause of increasing poverty amongst small-holder farmers, and its recovery presents huge potential for rural communities to escape poverty. Food insecurity amongst the vulnerable poor rural farming communities forces a

risk-minimising careful attitude towards farming and livelihoods systems. The potential role smallholder famers play in agriculture is normally either ignored or taken as just another small adjusting sector of the market economy which is most often viewed as insignificant (Wreford, et al., 2010).

Smallholder farmers in South Africa are faced with many challenges that prevents their growth, development and ability to successfully add to food security compared to the commercial farmers. Some of the limitations they come across relates mainly to lack of access to land, poor physical and institutional infrastructure, and the fact that markets for agricultural inputs and outputs are often non-existent and often unreliable for smallholder farmers. Lack of access to proper roads limit the ability of a farmer to transport inputs and produce and as well as to access information. This means that the acquisition of agricultural resources becomes difficult and the supply of market services also becomes limited. Lack of assets, information and access to services prevents smallholder participation in potentially lucrative markets (DAFF, 2012).

High transaction cost is also one of the major factors limiting growth of smallholder farmers and this is largely attributed to poor infrastructure, and the fact that rural areas are mostly so scattered which makes transportation challenging. A poor road network, for instance, and undependable distribution will compel farmers to grow their own food to a larger extent and less of perishable commodities causing a lower productivity (DAFF, 2012).

Lack of reliable markets is also believed to be one of the main limitations facing smallholder farmers, many of them get low prices for their products in selling the products on the streets, homes and/or local markets. They could however, receive better prices for their products if they were provided with the know how on marketing and selling skills as well as information regarding opportunities for product diversification or the links between market research and product development (DAFF, 2012).

Lack of human capital is yet another serious challenge for smallholder farmers. Majority of them are illiterate with inadequate technological skills, which can be serious hindrances in getting into beneficial formal institutions that communicate technological knowledge. Most smallholder farmers are not capacitated with financial and marketing skills and are not able to qualify to the quality standards set by fresh produce markets and food processors. Lack of production knowledge leads to lower quality in production (DAFF, 2012).

As a result of low capacity in production factors as indicated earlier, such as land, water and capital assets, most smallholder farmers harvest small quantities of products with poor quality leading to their products being rejected by output markets. The consumers are increasingly becoming demanding and raise issues of food safety as a result this makes it

difficult for the smallholder farmers with small quantities and poor quality to enter the high value market (DAFF, 2012).

Inconsistent production also poses challenges for the smallholder farmers, that together with not having bargaining power due to the poor quality of products, as well as inadequate access to market information and limited access to financial markets, which prevents them from selling their products at the most profitable time and value. As a result of all these factors the smallholder farmers become extremely vulnerable and even more so in the presence of the negative impact of climate change (Schulze & Taylor, 2016). There is therefore a need to significantly increase the productivity of smallholder farmers to ensure long term food security and production. One of the methods by which this can be achieved is encouraging smallholder farmers to pursue sustainable intensification of production through improved inputs (DAFF, 2012).

3.5 CLIMATE CHANGE ADAPTATION FOR SMALL HOLDER FARMERS (SA, FS, MANGAUNG-THABA NCHU)

The following figures and models attempt to explain and/or increase an understanding of the concept of Climate Change Adaptation and Disaster Risk Reduction as well as building resilience and capacity.

3.5.1 Convergence between Climate Change Adaptation and Disaster Risk Reduction

It is projected that climate change impacts and disasters could drive over 100 million people into poverty in the next 15 years. Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) can protect the livelihoods of people with the goal of strengthening the resilience of communities in ensuring they are able to expect, absorb, and bounce back from shocks, stressors and hazardous and unwanted events (DRR Platform, 2016).

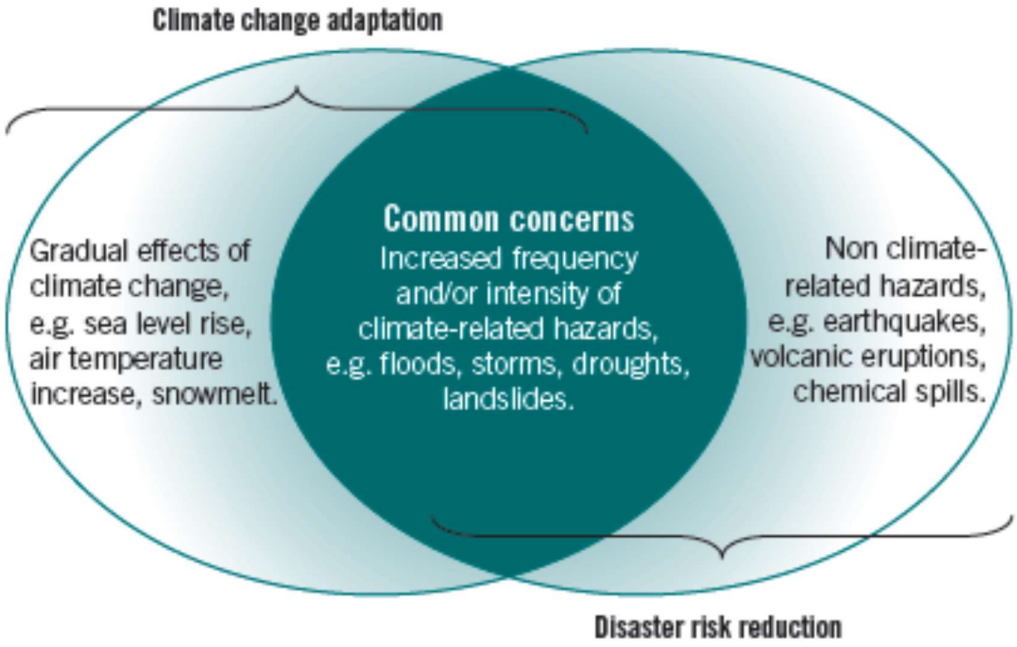

Figure 3-3 Convergence between CCA and DRR (DRR Platform, 2016)

Climate Change Adaptation (CCA) is a technique, methodology or rather the process of change, alter, modify and adapt to actual or expected climate change and its effects. Its aim is to reduce the impacts of climate change. CCA seeks to balance the harmful impacts and to exploit available beneficial opportunities where possible and facilitate adjustment to expected climate and its effects.

There is significant convergence between the problems that DRR and CCA wants to solve (Figure 3.3). The two conceptual frameworks agree on components of risk and ideas on how to reduce the risk: minimizing the exposure, reducing vulnerability, and building capacity in ways that solve disaster and climate change risk hence they are overlapping. DRR and CCA are conceptual frameworks aiming to systematically circumvent or avert, and control, prepare and mitigate disaster risks and adapt to changes which are challenging to project regarding loss of lives(DRR Platform, 2016).

3.5.2 Climate Change Adaptation Classification

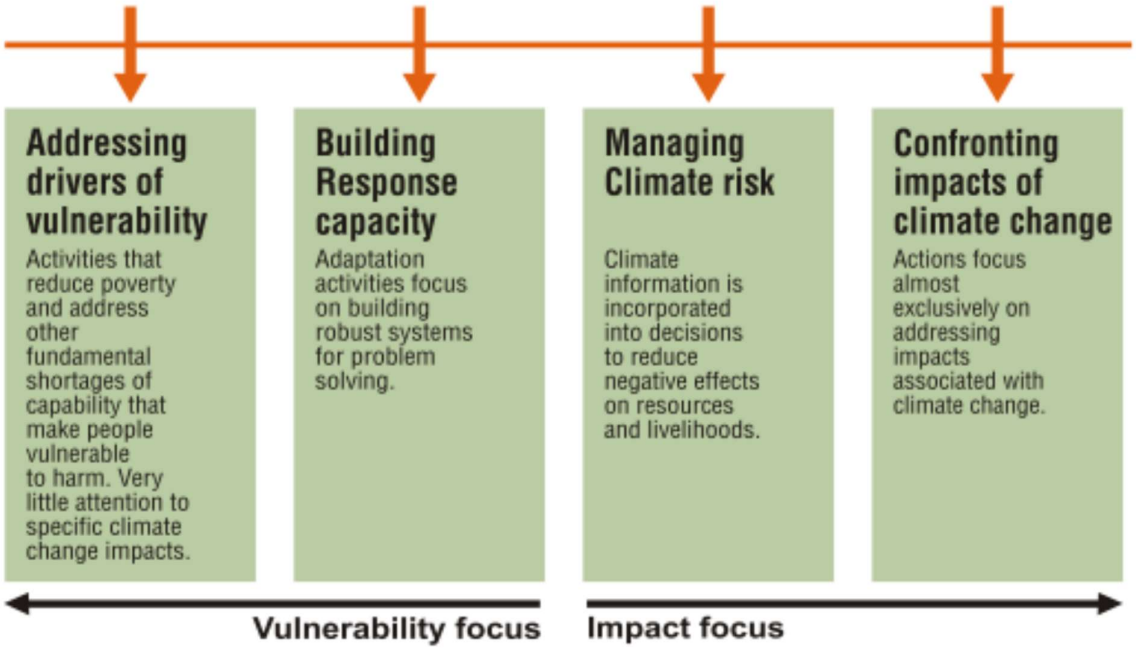

Figure 3-4 Adaptation Classification (DRR Platform, 2016)

To structure and classify approaches for CCA, one can identify a similar flow of methods. A useful point of reference is provided in Figure 3.4. The four intervention fields show a continuum of techniques stretching from efforts targeted at addressing the drivers of vulnerability and those targeted at the direct impacts of climate change. The first are measures that can be built in to development solutions, alleviating poverty and inequality and thereby strengthening important capacities. The latter are more climate-specific solutions across sectors, making sure that livelihoods and resource base are preserved and the impacts of climate change, such as droughts, extreme temperatures or shifted precipitation patterns do not cause harm for the people affected (DRR Platform, 2016).

3.5.3 Resilience and Building Capacity as a form of Adaptation

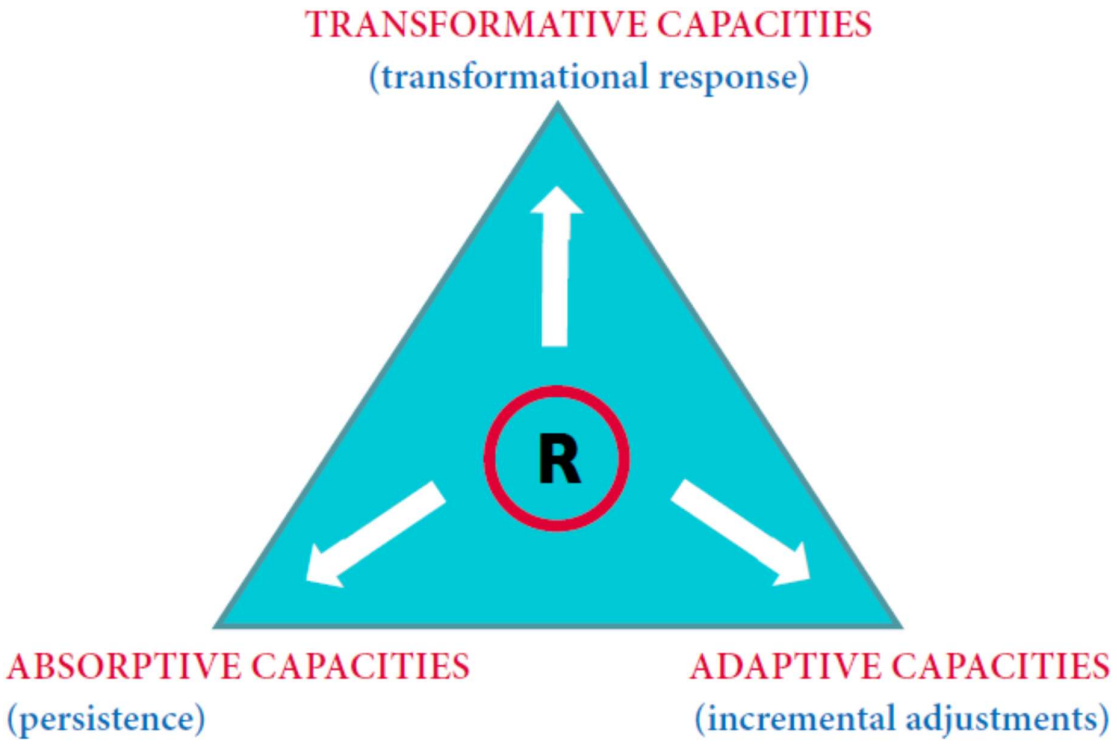

Figure 3-5 The Three Elements of Resilience (Source: DRR Platform, 2016)

What characterize the definitions of resilience is the statement that "resilience is not just the ability to maintain or return to a previous state, but about adapting and learning to live with changes and uncertainty". (DRR Platform, 2016). The authors of the DRR briefing note explain further that "Resilient systems which are individuals, households, communities or even countries, have a specific set of capabilities that allows them to foresee the impact from a hazard, and to be to withstand, absorb, and recover from shocks and stressors and to reorganise and transform accordingly. In absence of these capacities, a system is weak to can absorb the shocks, it is less flexible and diverse and thus suffers greater losses and damages as a result. There are three types of capacities related to resilience: Absorptive capacity, it is in the term absorb, that is, the ability to cope with, and absorb the effects of shocks and stressors (for instance when a household temporarily reduces its expenses following a drop in its income); the other is adaptive capacity which is also in the term adapt, that is, the ability of individuals or societies to adjust and adapt to shocks and stressors, but keep the overall system functioning in broadly the same way (example is when a household decides to change and diversify its crops in order to respond and allow to changing weather

conditions) what it is precisely envisioned for the smallholder farmers; the third leg on the triangle is transformative capacity also inherent in the term transform, that is, the ability to change the system fundamentally when the way it works is no longer viable (when a farmer decides to stop farming, and migrates to a city to become a taxi driver for example) (DRR Platform, 2016).

3.5.4 Adaptation Measures

i. Greenhouse Reduction Measures

Substantial and sustained reductions in greenhouse gas emissions together with adaptation, can mitigate climate change risks. South Africa is taking measures to reduce greenhouse gases, and green the economy under the direction of the South African Department of Environmental Affairs with key role players like the Energy Research Centre (Wreford, et al., 2010). Targeted sectors for greenhouse gas reduction in South Africa include the energy sector with emphasis on the use of renewable energy sources like wind energy, the agricultural sector, the transport sector, and manufacturing industries such as the cement industry (SADC, 2010) that will reduce the greenhouse gas emissions to the level required by the UN and thereby reduce the impacts of climate change.

ii. Adjusting Farming Practices

Smallholder farmers have a history of responding to the impacts of climate change by embarking on various adjustment measures in relation to their farming practices such as planting, harvesting, watering/fertilizing existing crops; diversifying crops; implementing management practices such as shading and conservation agriculture. Water management for agriculture is also critical in rural areas, for example, the use of rainwater harvesting and more efficient irrigation, particularly in rural dry lands. Adaptations are also evident among small-scale livestock farmers who use many different strategies, including changing herd size and composition, grazing and feeding patterns, or diversifying their livelihoods; they may also use new varieties of fodder crops suited to the changing conditions. Diversified farms are more resilient than specialized ones (Dasgupta & Morton, 2014).

iii. Political and Institutional Adjustments

The challenges associated with current risk reduction strategies include political and institutional challenges in translating early warning into early action. Mitigation of climate risk and adaptation requires political and institutional support to ensure proactive response

and ensuring that the smallholder farmers receives the necessary support for an effective and productive farming system.

iv. Adaptation as a Participatory Learning Process

Since the Assessment Report 4 (AR4) (IPCC,2007), the importance of flexible and iterative learning methodologies for effective adaptation and its benefits have been emphasized. Implementing adaptation as a participatory learning process allows smallholder farmers to adopt a proactive or preventive attitude to avoid “learning by shock” Iterative and experiential learning allows for flexible adaptation planning, which is suitable taking into account the uncertainty inherent in climate. Research have highlighted the use of participatory action research, social and experiential learning, and creating enabling spaces for multi-stakeholder dialog for managing uncertainty and unlocking the social and behavioural change required for adaptation. Learning approaches for adaptation may involve co-production of knowledge—such as combining local and traditional knowledge with scientific knowledge in a way in which it makes simpler for the illiterate smallholder farmers to comprehend (Dasgupta & Morton, 2014).

v. Knowledge Development and Sharing

Recent research study has shown the positive and important role of local and traditional knowledge in building resilience and adaptive capacity and shaping responses to climatic variability and change. This applies mostly at the community level, where there may be limited access to, quality of, or ability to use scientific information. Choosing specific adaptation actions that are informed by users’ perceptions and supported by accurate climate information, relevant to the level where decisions are made, would be supportive of the largely independent adaptation taking place in the country South Africa currently. There is agreement that culture, or the shaping social norms, values, and rules including those related to ethnicity, class, gender, health, age, social status, cast, and hierarchy is of crucial importance for adaptive capacity as a positive attribute but also, on the other hand, as a barrier to successful local adaptation a case which should be avoided (Dasgupta & Morton, 2014).

vi. Communication, Education, and Capacity Development

Regional and national research institutions, both national and international programmes as well as NGO's have undertaken to develop capacity and create awareness in order raise understanding of climate change impacts, adaptation expertise and to encourage behavioural change through civil society-driven approaches. Examples of such approaches include youth ambassadors in Lesotho and civil society organizations in Tanzania, whereby children have been rallied as effective communicators and advocates for adaptation-related behavioural and policy change. In addition, the inclusion of climate change studies into formal education as well as environmental education although the progress is very slow. The creative methods being used to communicate climate change for instance are; participatory video, photo stories, oral history videos, vernacular drama, radio, television, and festivals, with an emphasis on the important role of the media. Better evidence-based communication processes will enhance awareness raising of the diverse range of stakeholders at all levels on the different aspects of climate change (Dasgupta & Morton, 2014).

vii. Ecosystem Services, Biodiversity and Natural Resource Management

The harnessing of the longstanding local experiences to develop efficient and ecologically sustainable local adaptation strategies for natural resource management and community based natural resource management (CBNRM), and the use of ecosystem-based responses such as rangeland regeneration, afforestation, catchment rehabilitation, and biodiversity use. The local experience referred to also include among other things using mobile grazing to deal with both spatial and temporal rainfall variability and reducing the negative impacts of drought and floods on agricultural and livestock-based livelihoods through forest goods and services (Dasgupta & Morton, 2014).

viii. Technological and Infrastructural Adaptation Responses

The use of technological and infrastructural adaptation in agricultural and water management responses have proven to be useful, experience obtained from other countries, farmers changing their farming practices through technical and behavioural means. The application of climate proofing infrastructure, technologies such as improved food storage and management to reduce post-harvest losses, constructing embankments to more effectively capture rainwater and reduce soil erosion, reduced tillage practices and

crop residue management to more effectively bridge dry spells, and adjusting planting dates to match shifts in the timing of rainfall in addition to the carrying out of conservation agriculture (Dasgupta & Morton, 2014).

3.5.5 Barriers and Limits to Adaptation for Small Holder Farmers

The institutional, political, social, cultural, biophysical, cognitive, behavioural all have potential to act as barriers and limitations to the local level adaptation for smallholder farmers (Niang, et al., 2014).

According to Niang, et al. (2014), institutional barriers at the local level hinder adaptation through elite capture and corruption, institutions lacking grounded social roots and lack of attention to the institutional requirements of new technological interventions. Unclear ownership security over land and vital assets often prevent people from making longer-term and forward-looking decisions in the face of uncertainty, such as the change of farming practices, farming systems, or even transforming livelihoods altogether. In addition to unclear land ownership, laws prohibiting ecosystem use is also one of the issues strengthening underlying conflicts over resources. Resolving this would enable ecosystems to contribute to adaptation beyond short-term coping.

There is also evidence that innovation may be hindered if the dominant culture does not agree with the changes. Attributes such as wealth, gender, ethnicity, religion, class, or profession can act as social barriers for some to adapt successfully or gain the required adaptive capacities. Only small number of small-scale farmers can adapt to climatic changes, while others are restricted by a suite of overlapping barriers. Limitations identified includes poverty and a lack of cash or credit which are financial barriers; limited access to water and land, poor soil quality, land fragmentation, poor roads, and pests and diseases which are categorised under biophysical and infrastructural barriers; lack of access to inputs, shortage of labour, poor quality of seed and inputs attached to a lack of quality controls by government and corrupt business practices by traders, insecure occupancy, and poor market access, which are collectively considered institutional, technological, and political barriers; and finally a lack of information on agroforestry and afforestation, different crop varieties, climate change predictions and weather, and adaptation strategies characterised as informational barriers (Niang, et al., 2014).

Dasgupta & Morton (2014) further noted an increasing recognition that it is important to understand psychological factors such as mind-sets and risk perceptions for supporting adaptation. Cognitive barriers to adaptation include different rationalizations of extreme

events and weather such as religion ‘God’s will’, the ancestors, and witchcraft, or seeing these changes as out of people’s own control. Climate uncertainty, high levels of variability, lack of access to appropriate real-time and future climate information, and poor predictive capacity at a local scale are commonly cited barriers to adaptation from the individual to the national level. Despite the cultural and psychological barriers noted earlier, several studies have shown that farmers with access to climate information are more predisposed to adjust their behaviour in response to perceived climate changes. At a policy level, studies have detected political, institutional, and discursive barriers to adaptation. Adaptation options in southern Africa have been blocked by political and institutional inefficiencies, lack of prioritization of climate change, and the dominance of other discourses, such as the mitigation discourse in South Africa and short-term disaster focused views of climate variability. Lack of local participation in policy formulation, the neglect of social and cultural context, and the involuntary undermining of local coping and adaptive strategies have also been identified by several commentators as barriers to appropriate national policies and frameworks that would support local-level adaptation. Many of these constraints to adaptation are embedded and they will be difficult to overcome. Biophysical barriers to adaptation in the arid areas could present as limits for more vulnerable groups if current climate change trends continue. Traditional and autonomous adaptation strategies, particularly in the dry lands have been constrained by social-ecological change and drivers such as population growth, land privatization, land degradation, widespread poverty, poorly conceived policies and modernization, obstacles to mobility and use of indigenous knowledge, as well as erosion of traditional knowledge, to the extent that it is challenging or almost impossible to respond to climate variability and risk in ways that people did in the past. As a result of these multiple stresses working together, the number of response options has reduced, and traditional coping strategies are no longer enough. There are simply too many barriers to implementing substantial changes that require investment such as irrigation. Such adaptation strategies would be improved through government and private sector/NGO support, without which smallholder farmers and many poor communities may face real limits to adaptation (Niang, et al., 2014).

3.6 CHAPTER SUMMARY

The research study focuses on multidisciplinary fields which include disaster management, climate change and agriculture. This chapter, therefore, discussed the literature from a wide range of viewpoints, drawing together and linking these three disciplines. Firstly, the Concept of Disaster Management was deliberated with its disaster prevention techniques, mitigation, preparedness, response, recovery and rehabilitation. Because disaster is

understood as a continuous series of stages, recognising and understanding these stages would assist in understanding the needs related to any disaster and to conceptualize the necessary activities accompanying the stages. Causal factors of disasters were summarized because the social characteristics of communities are extremely important for hazard managers as these characteristics may increase peoples' vulnerability to hazards as well as their inability to reduce disaster. Social root causes of disaster must be addressed, otherwise realisation of the Sendai Framework will remain elusive. To achieve an encompassing view of disaster management, with a specific emphasis on risk, the issues of hazards and vulnerabilities and how they contribute to the disaster risks were also examined.

Understanding climate change and all its facets is also vital for the purpose of the study, with a view to understanding how the smallholder farmers adapt to climate change impacts. Initially it needs to be recognized how climate change occurs, what its impacts involve, and the necessity for adaptation. For this reason the observed climatic and weather changes, their causes, and observed impacts attributed to climate change were discussed. Finally, climate change impacts on agriculture and farming. The considerable changes in agricultural production with impacts on incomes and on the well-being of rural people were explored, the vulnerabilities of smallholder farmers and climate change adaptation measures were investigated, and barriers and limitations to adaptation experienced by smallholder farmers were discussed, all in order to understand the obstacles to achieving sustainable livelihood for the smallholder farmers.

4 CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter outlines in detail the research methodology employed, the type of research design applied, how data was collected and analysed. The chapter goes on to describe the target population, sampling strategy, data collection methods and tools, data analysis tools, validity and reliability of the research instruments, and ethical issues that the researcher took into consideration while conducting the research and finally the research limitations.

4.2 RESEARCH METHODOLOGY

4.2.1 Research Design

Both Qualitative and Quantitative research methods were used. Both designs have characteristics which contributed to collecting data the best way possible and to ensuring an optimal volume of data (Leedy & Ormrod, 2016). The following are the reasons why the mixed approach was chosen.

Qualitative research is concerned with human behaviour and why people behave and act the way they do (Leedy & Ormrod, 2016). Qualitative research reveals how people experience a research subject provided, and provides information about human contradictory behaviours, beliefs, opinions, emotions, and relationships between individuals. It is useful in identifying intangible factors, such as social norms, socioeconomic status, gender roles, ethnicity, and religion (Leedy & Ormrod, 2016). Qualitative design enabled the researcher to acquire knowledge through observing the qualitative indicators such as the behaviour of smallholder farmers, their views, beliefs, opinions, emotions, status, norms and standards relating to climate change and its impacts, as well as patterns and models of behaviour they use to adapt to climate change. The design assisted also in developing new concepts and theoretical perspectives about climate change adaptation from discussing the issue in depth with the smallholder farmers. The method further provided a way to explore new insights into the phenomenon, revealing the complex and multi-layered nature of certain situations, settings, processes, relationships and systems relating to climate change, agriculture and smallholder farmers. It allowed the researcher to test the assumptions, theories or generalization which are already available regarding the phenomenon being investigated.

The approach uncovered key problems which exists within the phenomenon and provided a means of assessing the effectiveness of policies, practices and innovations of climate change adaptation (Leedy & Ormrod, 2016).

Quantitative research: collected information, which could be obtained from many people and could be converted to numerical data for better statistical analysis of issues relating to the phenomenon. Quantitative research uses rigid instruments and highly structured methods to quantify variables, predict causal relationships, and describe characteristics of a population as well as to better understand the relationship between various factors relating to the phenomenon (Leedy & Ormrod, 2016).

The design was also used for obtaining primary data with structured closed ended questionnaires targeted at large groups of smallholder farmers (Alvi, 2016).

4.2.2 Population and Sampling Methods

4.2.2.1 Population

The population is the study object and consists of individuals, groups, organisations, human products and events, or conditions to which they are exposed. The population encompasses the total collection of all units of analysis about which the researcher wishes to make specific conclusions (Welman, et al., 2005).

Singh (2006) defines population as the entire mass of observations, which is the parent group from which a sample is to be formed. The sample observations provide only an estimate of the population characteristics. The researcher proceeds from specificity to generality. The sample observation involves the specific situation, the subset group that is seen to reflect specified characteristics exemplified in a target population. Sampling is fundamental to all statistical techniques and statistical analysis. The measures of a sample are known as statistics and measures of a population are termed parameters. Generally, parameters are estimated based on sample statistics. The accuracy of the parameters depends on sample representativeness or statistics. In research work generalization is made by estimating parameters based on sample statistics. This study was targeted at the smallholder farmers in the rural villages of Thaba-Nchu, therefore the population for the study was the smallholder farmers. Kirsten and van Zyl (1998) define a smallholder farmer as one whose scale of operation is too small to attract the provision of the services, he/she needs to be able to significantly increase his/her productivity. According to the framework for the development of

smallholder farmers through cooperatives development of Department of Agriculture, Forestry, Fisheries (2012), a smallholder farmer is defined in various ways depending on the context, country and even ecological zone. The term '**smallholder**' is often interchangeably used with '**small-scale'**, 'resource poor' and sometimes 'peasant farmer'. In general, terms smallholder only refers to their limited resource endowment relative to other farmers in the sector.

Smallholder farmers are also defined as those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour. Smallholder farmers are different in their characteristics, farm size, resource distribution between food and cash crops, livestock and off-farm activities, their use of external inputs and hired labour, the proportion of food crops sold and household expenditure patterns (DAFF, 2012). It should be noted that the population of smallholder farmers in 33 Thaba-Nchu villages seemed uncertain and could be changing from time to time, although the Department of Agriculture in the Free State has a database of 1135 smallholder farmers registered under DAFF (Table 4.1). These smallholder farmers operate in the 33 villages of Thaba Nchu. Therefore, this study focused on the total population of 1135 registered smallholder farmers. Table 4.1 depicts the number of all the smallholder farmers in the 33 villages registered on the database of the Department of Agriculture Free State Province.

4.2.2.2 Sampling Process

A non probability sampling process was used to identify the participants for qualitative study because no random selection was done. A specific group was targeted according to the purpose of the research which was to interview the key informants of the Agriculture sector, namely those supporting small holder farmers in Thaba Nchu. These informants are called extension officers (Alvi, 2016). A purposeful sampling technique was used to select participants with a purpose based on the study objectives (Leedy & Ormrod, 2016). The total population of key informants was 8, therefore the whole population was selected to be interviewed.

Table 4-1 List Villages & Number of Smallholder Farmers Registered of the DAFF Data Base

No.	**Number of Small Holder farmers**	**Village**
1	35	Ratabane
2	46	Rooibult
3	54	Woodbridge
4	49	Thubisi
5	21	Tigerriver
6	9	Spitskop
7	23	Potsane
8	25	Yolksfort
9	15	Mariasdal
10	62	Kgalala
11	47	Modutung
12	26	Bofulo
13	33	Rietfontein
14	28	Tabale
15	33	Moroto
16	16	Springfontein
17	25	Kommisiedrift
18	35	Tweefontein
19	38	Merino
20	48	Feloane
21	70	Paradys
22	51	Talla
23	41	Rakhoi
24	44	Morago
25	5	Nogaspos
26	48	Gladstone
27	2	Grootdam
28	24	Houtnek
29	10	Longridge
30	85	Sediba
31	13	Klipfontein
32	23	Balaclava
33	51	Middeldeel
Total	**1135**	

A probability sampling process was used in sampling the population of smallholder farmers. Cluster random sampling was used, which divided the population into clusters (villages). Clusters (villages) were randomly selected and all members of the cluster (village) selected were sampled (Leedy & Ormrod, 2016). Smallholder farmers registered in the database of the Provincial Department of Agriculture in the 33 villages were selected. The 33 villages of Thaba Nchu will be representative of all the smallholder farmers in the villages of Thaba Nchu. A sample of smallholder farmers per village were randomly selected, so that each smallholder of the 33 villages on the database list had a chance of being included in the

population studied. A total of 99 smallholder farmers were sampled, but not all were able to participate.

Table 4.2 depicts the number of smallholders in each village and the number of respondents who managed to participate and respond to the questionnaires.

Table 4-2 Smallholder Farmers & Villages who participated in the Research Study

No.	No.of farmers	Village	Respondents
1	21	Tigerriver	**4**
2	9	Spitskop	**2**
3	62	Kgalala	**4**
4	47	Modutung	**2**
5	26	Bofulo	**3**
6	70	Paradys	**3**
7	44	Morago	**3**
8	24	Houtnek	**4**
9	38	Merino	**4**
10	54	Woodbridge 1	**3**
11	16	Springfontein	**16**
12	25	Kommisiedrift	**5**
13	5	Nogaspos	**7**
Total	**441**	-	**60**

4.2.3 Data Collection Methods

As both Qualitative and Quantitative research approaches were used the following methods of data collection and instruments were applied.

i. Qualitative Methods

- Observation was used to assist in collecting data on natural occurring behaviours in their natural setting. Indicators such as the growing seasons, weather and climate, the types of agricultural activities such as type of crops, vegetation, and type of soil were observed.
- Interviews were conducted to collect data on the 'panel of experts' extension officers giving support and assistance to the smallholder farmers, regarding their expertise, responsibilities, challenges, personal viewpoints, histories, and experiences. The key informants and specialist in the fields related to climate change and agriculture were interviewed. Out of 8 potential

(sampled) participants only 6 could be interviewed. One was not always available and in one case the appointment could not be secured.

ii. Quantitative Methods

Questionnaires were administered to the 99 research participants to collect quantitative data. Face to face administration of questionnaires was done for the illiterate participants. The questionnaires were physically administered due to the nature of the participants, most of them were illiterate and old, and questions needed to be explained. The people residing in the villages are still very conservative and less trusting due to the failed promises by the people always approaching them. As a result they are wary of meeting anybody unless the interviewer is brought by someone trusted to them. This would typically be the headman who is the leader in the community as they are still using the tribal authority rules. Introduction via the contact person in the Department of Agriculture had to be channelled through the tribal committee as well as the headmen, who then were able to make introductions to the smallholder. Out of the 99 smallholder farmers targeted from the sampled 33 villages, only 60 smallholder famers from 13 villages managed to respond.

4.2.4 Data Analysis

Data was organised and evaluated through analytical processes and logical reasoning. Analysing the qualitative data involved interpretations of the collected data using key themes and trends emerging from the data. Context, consistency, contradiction of views, frequency and intensity of participants' comments were carefully measured. Two approaches were applied in analysing the qualitative data: framework analysis and thematic network analysis. The framework analysis assisted in examining the findings by setting a pre-defined framework which reflected the aim, objectives and the interest of the research. Only specific answers were considered, namely those that were relevant to the objectives, aims and interest of the research. The thematic approach assisted in considering and coding all the data to allow new impressions to shape the interpretation. This approach further assisted in ensuring that information that is valuable to the research was not lost. The following steps were followed: getting acquainted with the data, making notes of thoughts which spring into mind and writing a summary, developing a coding framework for the material, merging the codes when the list became too long, abstracting themes from codes, and finally grouping them together to represent common, salient and significant themes (The Open University, n.d.).

For the quantitative data, Microsoft Access was used to input the numeric data after coding and data entry, cleaning, and analysis had been completed using the SPSS. In analysing quantitative data, the descriptive statistics were presented using graphs and tables, to help with summarising the data. Both categorical variables and numerical variables were applied. Groups of variables were categorised and analysed using percentages and the weather data was analysed using measures of central tendency (Leedy & Ormrod, 2016).

4.2.5 Validation and Reliability

The measuring tools were checked for validity to ensure that the instruments measured what they were supposed to measure. Instruments used in both the quantitative and qualitative sectors were checked for content validity by ensuring that the contents of the instruments were representative of the targeted phenomenon or objectives, and the contents of the instruments were indeed found to be representative. The appropriateness of the content of the instrument was also checked using face validity to check whether the measuring tool appears to serve its purpose with the type of questions being asked. The instruments were also checked for construct validity, that is, whether they actually measured the construct they purported to measure (Alvi, 2016).

Test-retest reliability was investigated to check the reliability of the instruments. Questionnaires have a history of being regarded as a reliable instrument for both qualitative and quantitative studies, and this also holds true for interviews and the observation method.

4.2.6 Limitations and Delimitations of the Study

4.2.6.1 Limitations

The geographical study area is vast, scattered and rural. Due to the poor infrastructure for access to some of these areas, getting there was a challenge. Meeting the participants at some central point was a possible option, but due to the cost of travel and the fact that most of them are struggling financially, it was too much to ask of them. As a result most of the potential participants could not be interviewed.

South Africa is currently facing possible political change, and the elections in 2019 influenced the willingness of the participants to engage and answer questions honestly. Most seemed reluctant to answer certain questions although anonymity and confidentiality

were emphasised. Some expressed bitter emotions towards government which may have influenced the objectivity of the answers even though the objective of the research was explained. The failed delivery of promises from stakeholders in the past also influenced their willingness to participate. Some were more reluctant to participate due to their trust having been abused previously, although the benefits of the research were emphasized.

Dealing with climate change is dependent on weather and climate recordings which are highly variable and unpredictable. The data documented for years may take a sharp turn and bring out different results and as a result it is not easy to predict, but the information will still be useful to predict and prepare for the major changes in climate.

Of the sample of 99 smallholder farmers who had been identified as participants, only 60 were available for the study due to the scattered nature of their villages as well as their unavailability during the time of research. Most participants are illiterate as the research area is in the rural villages, and the sample consists mostly of older participants who could not understand the questionnaires. Consequently, a trusted literate member of the community had to be involved for interpreting of the questionnaires into native language, and this became a time consuming excise. In the course of translation, some meaning might have been lost. The researcher attempted to do a reversed translation to minimise this loophole.

The climate data used in the study was obtained from Bloemfontein airport, but since Thaba Nchu is within a 100km radius of Bloemfontein airport the difference in climate and temperature between the two areas is insignificant.

4.2.6.2 Delimitations

Mangaung Metropolitan Municipality is comprised of areas such as Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Van Stadensrus and Wepener, but the research study was conducted only in Thaba Nchu villages due to resource constraints.

There are different scales of farming in the area. Since this study focused on smallholder farmers, large scale commercial farmers were not included even though they, too, may be facing climate change impacts. The focus of the study is more on vulnerable smallholder farmers who may lack adaptive capacities when compared to their commercial counterparts.

4.2.7 Ethical Consideration

Research ethics involve the protection of the dignity of both the subjects and the researcher and the publication of the information in the research. In all aspects of academic writing

researchers must adhere to ethical behaviour in conducting and disseminating their research findings. This study was conducted in a sound and moral way based on specific ethical code and principles (Akaranga & Makau, 2016). During the research, appropriate values and ethical principles were observed at all stages, from obtaining approval for the research proposal to obtaining ethical clearance prior to the actual data collections, the actual data collection, the analysis and interpretation of results and the dissemination of findings. Appropriate data collection methods were adopted and the data collection was conducted in ways which guarantee fairness (Akaranga & Makau, 2016).

A code of conduct which ensures the protection of the dignity of the research participants was adhered to. The correct ethical procedure was followed. Firstly, written approval for conducting the research was sought from all the stakeholders involved (Department of Agriculture Free State Province); the academic institution where the study is conducted (University of the Free State) and the local authorities where the area of study is located (Tribal Authority: Thaba Nchu). Voluntary and informed consent was requested from the research participants after explaining clearly to the participants the name and contact details of the researcher, the purpose of the research, and the fact that the participants have a right to either accept or decline to participate in the research. The research participants' safety was advocated regarding them being exposed to intimidation especially by the politicians as a result of their participation in the research. The participants were assured of confidentiality regarding their identity, and codes were used to identify the participants to ensure anonymity. The participants' privacy was respected through avoiding questions that could cause embarrassment and uneasiness. The sincere benefit of the research was explained, the participants were not deceived into believing and expecting that they would benefit more than what the study could provide. A summary of the ethical promise is provided in the questionnaire as a declaration. The participants had freedom in their responses and were not intimated and manipulated to answer in a certain way. While conducting research, the researcher did not misuse power for personal gain from the participants (Akaranga & Makau, 2016).

The researched information and findings were interpreted, presented and published in accordance with the signed declaration stating that the research shall not falsify, manipulate or fabricate the findings and or data collected. Throughout the research process fraudulent activities as well as plagiarism were avoided through use of the "turnitin" software suite.

4.3 CHAPTER SUMMARY

This chapter discussed the research methodology in detail. The research design which was selected, namely a mixed approached research, was also explained. The population was identified, and sampling methods were described as well as observation, interviews, and questionnaires as methods of data collection. The data analysis process was explained, along with issues of validity and reliability. Ethical considerations were highlighted, and limitations and delimitations to the study were underlined.

5 CHAPTER 5: DATA ANALYSIS AND INTERPRETATION OF RESULTS

5.1 INTRODUCTION

Data analysis was conducted in accordance with the research objectives and the interpretation of the results of this study is presented in this chapter. The chapter is divided into five sections, with the first section presenting a description of socio-economic characteristics and demographics of the smallholder farmers. The second section deals with the smallholder farmers' awareness of climate change, followed by the third section, a discussion on smallholder farmers' perceptions and attitudes to climate change. The fourth section considers the strategies employed by farmers to build resilience and adapt to climate change as well as factors that affect the adoption of these strategies. The last section will discuss the interpretation of interviews with the key informants also referred to as extension officers.

The findings are presented in both tabular and graphical form and results are summarized based on the objectives of the study. The objectives of the study were to assess the climate change adaptation strategies practiced by small-holder farmers in the Thaba Nchu rural areas of Mangaung Metropolitan Municipality in the Free State province of South Africa; to assess if these adaptation strategies sustain their livelihoods; and to propose measures where gaps are identified.

5.2 FARMERS' RESPONSE

A total of 60 out of the target sample of 99 smallholder farmers participated. This means that 60 questionnaires (60%) were administered (Table 5.1). Out of the total 33 rural villages in Thaba Nchu only 13 villages (40%) participated in the study. Springfontein village had the most respondents (26,7%) with a number which exceeded the intended sample size of the villages and the significant observation here was that the whole population of registered smallholder farmers participated and responded. Modutung and Spitzkop had the lowest response rate (both at 3,3%). Paradys had the highest population of registered farmers with 70 smallholder farmers and Nogaspos the lowest with 5 smallholder farmers.

Table 5-1 List of villages used for data collection and number of questionnaires administered

No.	Villages	Registered Population	No. of Questionnaires Administered	%
1	Morago	44	3	5,0
2	Merino	38	4	6,7
3	Paradys	70	3	5,0
4	Kgalala	62	4	6,7
5	Modutung	47	2	3,3
6	Bofulo	26	3	5,0
7	Houtnek	24	4	6,7
8	Spitskop	9	2	3,3
9	Springfontein	16	16	26,7
10	Woodbridge	54	3	5,0
11	Nogaspos	5	7	11,7
12	Kommisdrift	25	5	8,3
13	Tigerriver	21	4	6,7
	Total	441	60	100

5.3 DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

The respondents' demographic characteristics data are presented in Table 5.2. Respondents were mostly (about 72%) in the late adult stage with ages above 40 years, followed by respondents between the ages of 36 and 40 (about 8%). This showed that majority of the smallholder farmers are late adults or rather older people. There are various factors which could possibly be influencing the occurrence and the nature of farming activities among adults aged above 40 years of age. Firstly, the years of experience in farming could be a determining factor, another factor could be the need to care for their households, a further factor is that they could be engaging in farming activities to keep themselves busy to overcome boredom, and finally it could be that they are farming as a result of an inheritance left to them.

A total of 13 females and 47 males participated, male being the dominant gender in smallholder farming. This supports the notion that men are still the dominating gender with regard to farming activities today. In the past men often had full primary access rights to land and women often had partial or conditional secondary access rights to land, and this greater control over land was strongly determined by control over land being ascribed to men by lineage or clan heads. Their dominance in decision-making processes as well as in leadership positions within the communities and households, the benefits accorded to them by local tradition, custom and the patrilineal inheritance system, men's greater opportunities to acquire land, their relatively better financial position and the greater status ascribed to

men by society placed them in a more opportune position for farming than women (Kushagra , et al., 2016). Almost all of the respondents at (93%) own the land while only 7% were renting. This supports the notion that in South African rural areas almost all the land is communally owned and administered by a Traditional Authority, and it is used mainly for subsistence purposes. The communal ownership of land in these areas tends to diminish its commercial value, especially within a neo-liberal orientation that underlies commercial farming in South Africa, which promotes competition and individuality. This could be one of the restrictions limiting smallholder farmers' operation in the open market (Thamaga-Chitja & Morojele, 2014).

Table 5-2 Demographic and socio-economic characteristics of respondents

Household participant characteristics		**Frequency**	**Percentage**
Sex	Male	47	78.3%
	Female	13	21.7%
Land ownership	Own	56	93%
	Rent	4	7%
Age groups	20-25	3	5%
	26-30	4	7%
	31-35	5	8%
	36-40	5	8%
	41 & above	43	72%
Household members	Live alone	4	6.6%
	1 to 2 people	15	25.0%
	2 to 4 people	19	31.7%
	4 to 6 people	8	13.3%
	6 & above	14	23.7%
Educational level	Primary & others	41	68%%
	Higher/ Matric	15	25%
	Graduate	2	3.3%
	Any technical	2	3.3%
Level of skill	Semi-skilled	30	50.0%
	Skilled	12	22.1%
	Unskilled	17	27.9%

The highest number of respondents - 41 (68%) - selected "other" on the level of education which could mean anything, and most did not specify the level or mature of their education. However, based on observations during data collection, most of them functioned at a low level of literary, from which it may be deduced that they had had very little or no education.

This supports the research results reported by Thamaga-Chitja and Morojele (2014), who reflected that most smallholder farmers in South Africa are poor, less educated, and reside in rural communities with less developed infrastructure, which locates them in the so called second economy. About 15 respondents (25%) indicated that they have South African senior certificate and four (6.6%) are either graduates or have technical qualifications. When comparing qualification with gender, 0 female smallholder farmers respondents held a graduate qualification while 2 out of 60 males report having a graduate qualification, and 9 male respondents have a South African senior certificate. The greatest number of the respondents, namely 30 (50%), are semi-skilled, followed by 17 (28,3%) smallholders being unskilled and only 12 are skilled. Further in-depth analysis of the demographics depicted in Table 5-2 would reveal that 16,7% of the smallholder farmers have about 2 dependents and a further 16,7 % take care of 3 dependents. About 11% have no dependents and another 11% take care of 7 and more dependents. With regard to farming experience, 78,3% of the respondents had 9 years or more experience in farming. It is obvious, therefore, that the majority of the smallholder farmers have been farming for a very long time (Table 5-3).

Table 5-3 Farming experience in years of the respondents

Farming Experience	Frequency	Percent	Valid Percent	Cumulative Percent
• 3 years	2	3,3	3,4	3,4
• 4 years	2	3,3	3,4	6,9
• 5 years	1	1,7	1,7	8,6
• 6 years	1	1,7	1,7	10,3
• 8 years	2	3,3	3,4	13,8
• 9 years and more	47	78,3	81,0	94,8
• Less than 2 years	3	5,0	5,2	100%
Sub-total	**58**	**96,7**	**100%**	**-**
Missing	**2**	**3,3**	**-**	**-**
Total	**60**	**100%**	**-**	**-**

5.4 FARMING SYSTEM

The greatest number of the respondents (36,7%) are engaged in mixed farming with crops, livestock and chicken, followed by 28,3 % farming crops and livestock, and the lowest sectors are crops and chicken and chicken only farming at 1,7% each. Chicken farming is not so popular among the respondents (Fig. 5.4).

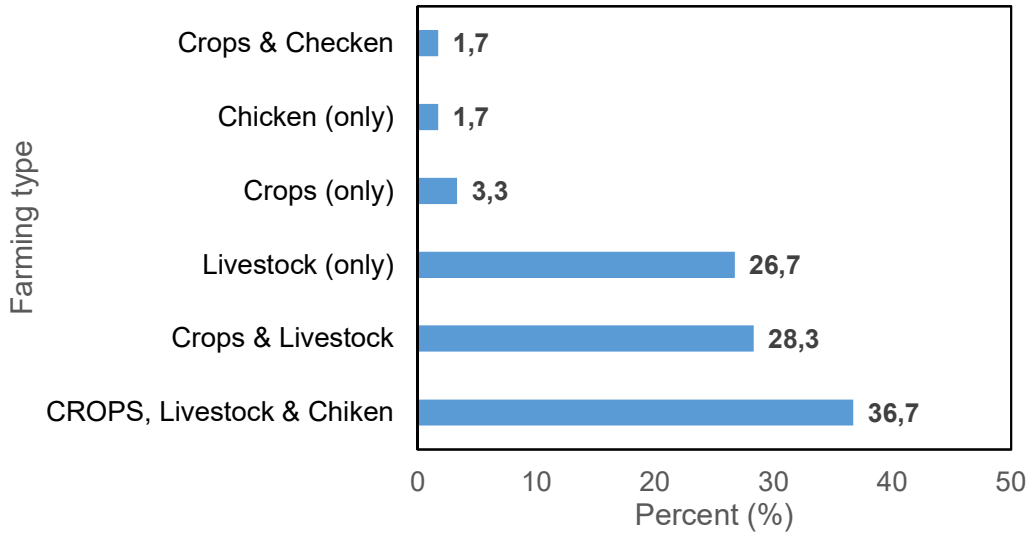

Figure 5-1 Respondents farming system categories in percentage

With regard to the specific nature of the livestock, a large number of smallholder farmers (40%) keep sheep and cattle, followed by 33,3% only farming with cattle, and 15% farming with sheep livestock. A small percentage (1,7%) farm with goats. Goats are not popular among the smallholder farmers in Thaba Nchu (Table 5-4).

Table 5-4 The percentages of the type of livestock owned by the respondents

Livestock Ownership		Frequency	Percent	Valid Percent	Cumulative Percent
Livestock	Cattle	20	33,3	35,7	35,7
	Goats	1	1,7	1,8	37,5
	Sheep	9	15,0	16,1	53,6
	Sheep & Cattle	24	40,0	42,9	96,4
	Sheep, Cattle & Goats	2	3,3	3,6	100%
	Total	56	93,3	100%	-
	Missing	4	6,7	-	-
Total		60	100%	-	-

5.5 CLIMATE CHANGE AWARENESS

The majority of the respondents (n= 37, 62.7%) indicated that they understand what climate change is. Harvey et al. (2011) also indicated that farmers appear to be relatively aware of the causes of climate change.

It should be noted, though, that 22 (37,3%) of them do not know what climate change is (Table 5-5). Most of the respondents (n=32, 54.2%) indicated that they know what causes climate change, and 27 (45,8%) do not know the causes of climate change. There is a small margin between those who said they know the causes and those who said they do not know the causes, only 8,5%. Most of the farmers (n=44, 74,6%) said they know the impacts of climate change and 15 (25,4%) said they do not know the impacts of climate change. Similarly, 43 (72,9%) reported that they know the climate of their region and 16 (27,1) replied that they do not know the climate of their region. Almost all of the respondents (n=59, 98,3%) agreed that climate change has an impact on farming, which is in accordance with the literature in 3.4.1.

Table 5-5: Number of respondents according to their villages' level of understanding of Climate Change

Variables (Understanding of climate change)		Villages													
		Morago	Merino	Paradys	Kgalala	Modutung	Bofulo	Houtnek	Spitskop	Springfontein	Woodbridg	Nogaspos	Kommisdrif	Tigerriver	Total
Do you know what climate change is?	No	0	0	2	1	0	0	2	0	6	2	4	3	2	22
	Yes	2	4	1	3	2	3	2	2	10	1	3	2	2	37
Total		2	4	3	4	2	3	4	2	16	3	7	5	4	59
Do you know what causes Climate Change?	No	1	0	3	1	0	1	2	0	8	2	4	3	2	27
	Yes	1	4	0	3	2	2	2	2	8	1	3	2	2	32
Total		2	4	3	4	2	3	4	2	16	3	7	5	4	59
Do you know the impacts of Climate Change?	No	0	1	2	0	0	1	1	0	2	1	4	3	0	15
	Yes	2	3	1	4	2	2	3	2	14	2	3	2	4	44
Total		2	4	3	4	2	3	4	2	16	3	7	5	4	59
Do you know the climate of your region/area?	No	0	0	3	0	0	0	1	0	3	2	5	2	0	16
	Yes	2	4	0	4	2	3	3	2	13	1	2	3	4	43
Total		2	4	3	4	2	3	4	2	16	3	7	5	4	59

5.6 ATTITUDE TOWARDS CLIMATE CHANGE

Almost all of the respondents (n=59, 98,3%) indicated that they do believe climate change is occurring, and while 3 (5%) inexplicably believe that climate change has positive impacts, 55 (91,7%) believe climate change has negative impacts (Table 5-6). The considerable number who believe climate change has a negative impact seem to be in agreement with the literature discussed in earlier chapters.

Table 5-6 Respondent views in climate change and their attitude

Respondents views in climate change	percent
• Does climate change have impact on farming?	98%
• Do you believe climate change is here?	98%
• Do you believe that Climate Change has positive impacts?	5%
• Do you believe that Climate Change has negative impacts?	92%

The reasons stated by the respondents on why they believe that climate change has negative impacts on their livelihood can be summarized as follows:

Changing seasons, irregular rainfall, and rain delays cause smallholder farmers to plant late, leading to lack of income from not being able to sell crops. Research has found that smallholder farmers engage in subsistence agriculture to obtain extra food, both for consumption and for selling as an additional survival strategy to meet their daily needs (Thamaga-Chitja & Morojele, 2014). There is a scarcity of rainfall when they are supposed to cultivate. Crops die due to cold weather in springtime and livestock weakens as a result of poor grazing. Temperatures cause great concern - the winter season is very cold, and it is very hot in summer. According to Thamaga-Chitja and Morojele (2014), iincrease in temperature and reduction in water availability will have a direct effect on agriculture through changes in soil characteristics, water availability, and crop productivity as well as indirect effects relating to changes in farm management systems, pest and disease life cycles, and competition for land and water resources. Climate change negatively impacts the health of both farmers and animals as well as the environment. Losing large portions of livestock and crops causes sickness and stress for both farmers and the animals. Because there is no food for livestock, animals also lose their value. The intense and prolonged heat leads to sickness from pests. Literature supports these reports, indicating that heat stress relates to the animal's inability to dissipate environmental heat and is affected by temperature, humidity and wind speed. An increase in air temperature, as associated with climate change, will have a direct effect on animal performance through alterations in the heat balance (Thamaga-Chitja & Morojele, 2014)

5.7 EXPERIENCE OF CLIMATE CHANGE AS A SMALLHOLDER FARMER

A large percentage of the villages had smallholder farmers who believe Climate Change has impacted them as farmers, and few villages had smallholder farmers who disagreed that climate has impacted them as farmers (Table 5.7). The latter response raises the question whether they understood the questions properly or whether they understood what climate change is.

Table 5-7 The experience of the respondents towards the Climate Change impacts on their livelihood

Has Climate Change impacted you as a farmer in some way?	Frequency	Percent
• Morago	3	75%
• Merino	3	75%
• Paradys	3	100%
• Kgalala	3	75%
• Modutung	2	100%
• Bofulo	3	100%
• Houtnek	3	75%
• Spitskop	2	100%
• Springfontein	15	94%
• Woodbridge	1	33%
• Nogaspos	7	100%
• Kommisdrift	5	100%
• Tigerriver	4	100%

A considerable number (n=41, 68,3%) of the respondents believe that climate change can be managed, and 16 (26,7%) do not believe that it can be managed. A comparably large number (n=40, 66,67%) of the respondents believe that government is not doing enough towards climate change. The rest are either neutral, believe that government is doing enough, or did not respond. Table 5-8a shows the frequency of the respondents who believe climate change can be managed. Table 5-8b shows how many respondents believe Government is doing enough and how many believe government is not doing enough.

Table 5-8 Mitigation of Climate Change for the respondents. a) believing Climate Change can be managed and b) believe Government is doing enough for climate change

a) Do you believe that Climate Change can be managed or dealt with?				
Response	Frequency	Percent	Valid Percent	Cumulative Percent
• Yes	41	68,3	68,3	68,3
• No	16	26,7	26,7	95,0
b) Do you believe the government is doing enough towards Climate Change?				
Response	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	7	11,7	11,7	16,7
Disagree	24	40,0	40,0	56,7
Neutral	7	11,7	11,7	68,3
Strongly Agree	3	5,0	5,0	73,3
Strongly Disagree	16	26,7	26,7	100,0

A good number (78,3%) responded that they receive information regarding climate change from the media, mostly radio, and 3,3% reported receiving information from social media. Only 1,7% said they receive information from the government.

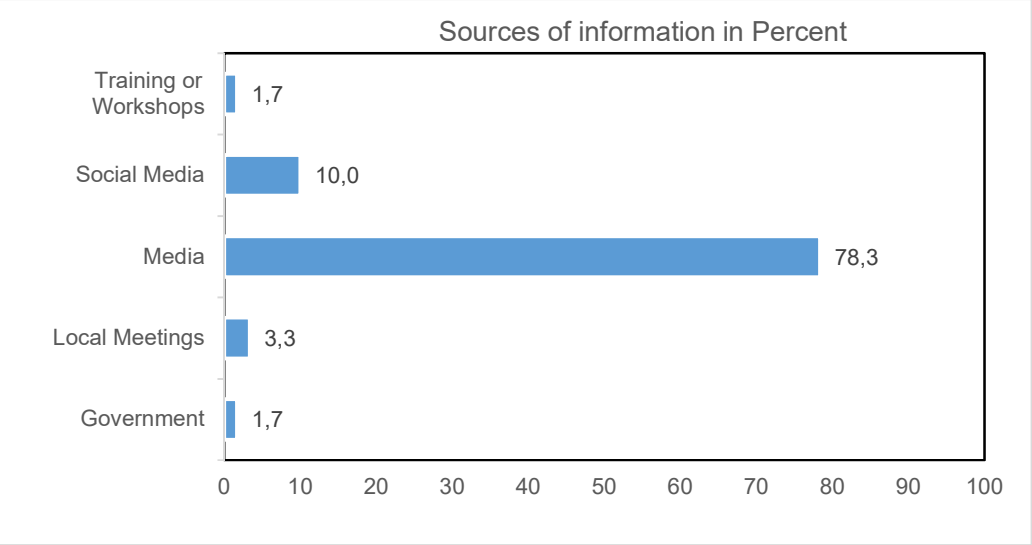

Figure 5-2 Source of information for climate change awareness

5.8 ADAPTATION TO CLIMATE CHANGE

5.8.1 Surviving the shocks of climate change

A noteworthy number of respondents (n=42, 70%) indicated that they are adapting to climate change impacts, and only 16 (26,7%) seem not to be adapting. A sizeable number (n=40 66,7%) said they can mitigate the impacts of climate change while 16 (26,7%) are

barely coping with the effects. In terms of village comparison, 6 of the 13 villages are completely adapting to the impacts of Climate Change, 2 of the 13 villages indicated that they are completely not adapting to the impacts of climate change, and 5 villages had a combination of the smallholder farmers adapting to the impacts of climate change and those that are not adapting to the impacts. In these latter villages, the majority of the smallholders said they are adapting except for Kommisdrift which had the most (3out of 5, 60%) smallholder farmers not adapting to the impacts of climate change. It would be interesting to see the factors which contribute to the differing viewpoints of the smallholder farmers in different villages regarding the adaptation to climate change, whether attitude change and/or support received contributed in some way to the farmers views.

Table 5-9 Percentages of the respondent's adaptation and survival against the effects of Climate Change

a) Are you adapting to the climate change impacts				
Response	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	42	70,0	70,0	70,0
No	16	26,7	26,7	96,7
b) Are you surviving the climate change impact?				
Response	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	40	66,7	69,0	69,0
No	16	26,7	27,6	96,6

5.8.2 Adaptation Strategies applied by the smallholder farmers to the Climate change

The smallholder farmers indicated the following adaptation strategies which they are applying to mitigate the impacts of climate change. Only a summary will be listed as most of their answers were similar:

- They reported that building manmade (artificial) dam, repairing windmills which provide water for livestock, buying fodder for livestock, obtaining water from the water sources when water is available, and reduction of livestock are some strategies they put in place to mitigate and adapt to the effects of climate change, which is similar to what the literature suggests in 3.5.4 "Adjusting farming practices".
- Farmers cope by studying climate variability during the season when it occurs and observing the change of temperature or weather forecast, selling crops and livestock, using greenhouses and changing grazing areas. Their farming practices

are an indication that some if not most smallholder farmers understand the concept of climate change and the required adaptation techniques.

- Other measures involve obtaining help from corporations with “food for cattle”, as well as using municipal water to aid in drought relief.
- Planting more green plants and planting earlier than usual, as well as timely preparation regarding livestock through storage of food for livestock as early as March, are some of the measures farmers put in place to help them adapt.
- Some farmers indicated that they make use of the available research, and study climate in the area each year to help them to plan more effectively for the seasons to come. They also experiment with the use of crops which use less water.

Table 5-10 Adaptation rate by respondents according to the villages

Are you adapting to the climate change impacts?	Response = Yes		Response = No	
	Frequency	Percent	Frequency	Percent
Morago	2	67%	1	33%
Merino	1	25%	3	75%
Paradys	0	-	3	100%
Kgalala	2	100%	-	-
Modutung	3	100%	-	-
Bofulo	3	75%	1	25%
Houtnek	12	75%	4	25%
Spitskop	2	100%	2	100%
Springfontein	12	75%	15	94%
Woodbridge	3	100%	-	-
Nogaspos	6	86%	1	14%
Kommisdrift	2	40%	3	60%
Tigerriver	4	100%	-	-

5.8.3 Sustainable Farming Practices

The following are the sustainable farming practices suggested by the smallholder farmers:

- A great number of farmers suggested that building farrows to channel storm water towards the crops or towards man-made dams is one technique which could be used to retain the water from the rain. Water harvesting with the assistance of Jojo tanks from the Government is a popular technique suggested by the smallholder farmers.
- Changing crops seasonally to aid in fertilizing the soil, as well as the use of cow dung to nourish the soil and to retain nutrients for the longest time.
- In some areas vegetation is not removed in order to retain the soil moisture for the next planting, and farmers also make use of mulching.

5.9 RELATIONSHIPS AND CORRELATION BETWEEN VARIABLES

Smallholder farmers were asked about level of satisfaction on adaptation measures to cope with changing climate and its impact. The result shows that, farmers in Thaba Nchu use diverse adaptation strategies at household level to minimize the risk of climate change impacts on agriculture. The study includes three main topics: adoption of improved practices, smallholder's awareness and the farmer's attitude to climate change. Table 5.12 shows that the correlation values of these three main topics of climate change, from the results found in the study on adaptation strategies and about the level of farmers attitude and awareness in Thaba Nchu rural communities. The smallholder farmers awareness showed a significant positive correlation (r = 0.61) with their attitude towards to climate change impact. Similarly, the adoption level revealed a strong positive correlation (r = 0.71) with farmers attitude or behavioral changes in believing the impact of climate change effects on their livelihood. However, the awareness of the farming community even though positively related (at sig. level $P<0.05$) with their ability of the adoption of improved practices but it indicated at lower correlation values (r = 0.32). This shows the effort needed to alleviate the smallholder's awareness in climate change impacts and coping mechanisms on their livelihoods.

Table 5-11 Major correlation variables with significance level for awareness, attitude and adoption

Major correlation variables		Awareness	Attitude	Adoption
Awareness	R^2 value	-	0.61^{**}	0.32^{*}
	Sig. level	-	0.001	0.012
	N	60	60	60
Attitude	R^2 value	0.61^{**}	-	0.71^{**}
	Sig. level	0.000	-	0.000
	N	60	60	60
Adoption	R^2 value	0.32^{*}	0.71^{**}	-
	Sig. level	0.012	0.000	-
	N	60	60	60

*NB:** P value at 0.01 sig. level & * P value sig level at 0.05 sig level*

In order to achieve this goal the study asked respondents and tested accruing to age variation, gender, education level, skills, farming type, experience and source of information (Table 5.13). As shown in Table 5.13, there is no significant correlation between smallholder's variables (such as age / gender / qualification) with either the adoption level or awareness or even with their attitudes to climate change impacts. The farming type has also shown no correlation with all three main topics of the of climate change impacts in this current study (Adoption, awareness, attitude). However, the level of skill and the farmers experience showed a strong positive correlation with the awareness. From the study, it is clear that the importance

of the communication capacity or source of information in promoting adaptation strategies and changing attitude in identifying the effect of climate change to improve smallholders livelihood. Thus, there was strong correlation (r = 0.75) between the source of information and farmers adoption level.

Therefore, the main question tends to answer in this study: Firstly, are the smallholder farmers in Thaba Nchu aware of climate change and associated risks? Secondly, what are the factors that influence these awareness and farmers perception and how they will adopt? Thirdly, is the government aware of climate risk faced to smallholder farmers in rural communities? These questions impose that climate change adaption and mitigation measures are in line with the terms of responsibility of the farming community and thereof inform policy makers. Understanding of future disaster risk in the environment and increase of awareness with positive attitude has contribution as a tool in the struggle future global warming. According to this study, the farming community and support from the government play big role to practice improved adaptation measures in order to be resilient at local level and to put pressure to policy makers to reduce climate risk on agriculture.

Table 5-12 Independent variables test with major variables of adoption, awareness and attitude

Independent variable		Adoption	Awareness	Attitude
Age	R^2 value	0,068	0,155	0,154
	Sig. level	0,604	0,236	0,241
	N	60	60	60
Gender	R^2 value	0,156	0,104	0,041
	Sig. level	0,233	0,428	0,756
	N	60	60	60
Educational Qualification	R^2 value	0,135	0,013	0,133
	Sig. level	0,305	0,923	0,311
	N	60	60	60
Level of skills	R^2 value	-0,050	0.802**	-0,031
	Sig. level	0,703	0,000	0,812
	N	60	60	60
Farming sector / type	R^2 value	-0,021	-0,136	-0,001
	Sig. level	0,873	0,303	0,992
	N	59	59	59
Farming Experience	R^2 value	0,008	0.536**	-0,048
	Sig. level	0,951	0,000	0,718
	N	60	60	60
Source of Information	R^2 value	0.749**	0,051	0.671**
	Sig. level	0,000	0,699	0,000
	N	60	60	60

*NB:** P value at 0.01 sig. level & * P value sig level at 0.5 sig level*

5.10 THE KEY INFORMANTS INTERVIEWS AND KEY FINDINGS

In analysing and interpreting qualitative data researchers typically look for key themes emerging from the data in the context of the aim of the research. The Framework and Thematic network analysis approaches were applied. The Framework analysis guided the researcher in examining the findings against the aims and objectives of the research, which were: to determine the impacts of climate change on smallholders farmers; to assess the adaptation capacity and strategies of smallholder farmers to climate change; to assess whether the adopted measures help the smallholder farmers to sustain their livelihoods; to identify gaps and propose measures for improved livelihood of smallholder farmers. The Thematic approach assisted in considering and coding all the data to represent common relevant and significant themes.

5.10.1 Background of the Key Informants (Extension Officers)

The key informants interviewed are eferred to as the “extension officers” whose focus region is Thaba Nchu. There are 8 extension officers in total, although only 6 managed to participate in the research study. Their focus and responsibility towards the smallholder farmers can be described as providing technical support and advice to “communal” (smallholder) farmers, linking the smallholder farmers with other relevant stakeholders, organizing them into commodity organizations, managing their daily activities through monitoring and evaluation of the work they do, and implementing projects. They also arrange information sessions for the farmers, and support them with resources such as seeds, training and coordination of disaster relief. Overall, they support smallholder farmers with agricultural projects and programmes. The extension officers’ village accountability ranges from 4 to 7 villages per extension officer so that on average they serve about 5 villages per extension officer, some maybe more and some less. In average there are about 1200 small holder farmers supported by each extension officer. In terms of the number of smallholders each extension officers supports, it ranges from 500 to 2100. The extension officer managing the highest number (2100) is provided with an assistant.

5.10.2 Discussion with extension officers and stakeholders

Out of the six (6) respondents two (2) extension officers have the highest number of smallholder farmers which they are supporting and of the two, one has an assistant. It would be interesting to see if this has an impact on the performance and challenges experienced by the farmers regarding the type of support the farmers are receiving. In terms of

understanding climate change, the extension officers' explanation of the meaning of climate change indicates that they generally understand climate change and how it impacts agriculture, farming, and the smallholder farmers. Two (2) extension officers out of the six (6) respondents seemed to have a limited understanding about climate change whereas the rest have a thorough understanding of what climate change is.

Theme 1: Smallholder's Vulnerabilities

IPCC 's definition of vulnerability is "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2007).

Farmers are frequently exposed to pest and disease outbreaks and extreme weather events which cause significant crop and income losses and exacerbate food insecurity. Although farmers use a variety of risk-coping strategies, these are insufficient to prevent them from remaining food insecure (Harvey, et al., 2011). in terms of understanding the adaptation of small scale farmers to climate change, considering their vulnerability towards climate change is vital to understanding the factors contributing to vulnerability. According to four (4) of the respondents, lack of resources (working capital, funding and infrastructure); lack of knowledge, information, education, skill and experience; lack of market as well as limited land are the results of vulnerabilities among small holder farmers, while one (1) other respondent indicated that livelihood dependency on farming is the main vulnerability. The other respondent indicated that attitudes, resistance and denial of the required adaptation to climate change is the main vulnerability concern for the farmers. Moreover, they all agree that the vulnerabilities of the smallholder farmers specific to climate change are crop failures, animal condition which is too poor to sell them, crop season change which is unpredictable, animals dying as well as poor crop production. Resistance to innovation and lack of understanding of the dynamics of climate change is another major cause of their susceptibility. Furthermore all the respondents believe the vulnerabilities are very intense and they affect the farmers immensely. In addition to this they also all agree on how the vulnerabilities are impacting farming activities in that farmers are forced to produce inferior products and sell lean animals at low prices. They also produce poor quality vegetables with low nutritional value for their own consumption, level of operation and production is limited, and one extension officer even said there could be "… no progress, no profit, no growth and no sustainability".

Could vulnerability be reduced? In answer to this question, two extension officers stated that they believe it is possible, although their reasons differ. One said that it would be possible if they could cultivate fodder crops during good rainfall and build up fodder banks, practice conservative agriculture, cultivate vegetables and implement infield rainwater harvesting techniques. Two other respondents' reasoning was that farmers need funding to build infrastructure such as kraals and tunnel system for intensive farming. The other two indicated that the farmers would have to listen to advice and cooperate on the adaptation techniques of farming practices.

Theme 2: Impacts of Climate Change on Smallholder Farmers

The extension officers had different views regarding the impacts of climate change on smallholder farmers. Two (2) indicated that smallholder farmers experience low production and income levels which drive the farmers to severe poverty and also result in reduction in quality of life, while the other three (3) mentioned that the market is too open, to the extent that the smallholder farmers are competing with commercial farmers in which process they lose the market to them and don't stand a chance. They are not able to negotiate for high rates, the more so because their products are poor, their animals are lean, and the vegetables have little nutritional value. The last respondent added that in recent times there have been more invasive species due to drought, which is not favourable for farming as the invasive species destroy the grassroots and that negatively affects the grazing of the animals. According to the extension officers, the main reason why climate change impacts so heavily on the smallholder farmers is that their agricultural activities are weather and climate dependent. In addition, the majority of them pointed out that the farmers' limited adoption of resilient methods and their low education levels affect understanding and acceptance of new changes and adaptation strategies. These findings correspond with the research reports that poor crop yields and soil degradation are characteristic of South African smallholder farms. Soil degradation including decreased soil fertility has been described as one of the key constraints that contribute to poor productivity especially in communal areas of South Africa, and areas where smallholders and subsistence farmers farm are less productive particularly due to insufficient resources (water) because of erratic and unreliable rainfall in these areas (Thamaga-Chitja & Morojele, 2014).

Theme 3: Adaptation Capacity and Adaptation Techniques to Climate Change Impacts

The responses from the extension officers on how they observe the smallholder farmers' adaptation to climate change were varying. One indicated that they adapt by keeping large numbers of livestock and some have begun to use the IRWH technique. In-field rainwater harvesting (IRWH) is a technique whereby rainfall runoff is promoted on a 2m furrow between alternate crop rows and stored in basins. Water collected in the basins penetrates deep into the soil past the surface evaporation zone. The stored rainwater is used productively to grow a variety of crops (Anon., 2011).

Two respondents said the farmers change the type of crops and livestock. They choose those breeds that adapt to drought and are able to travel some distance for water. Because market changes, however, they don't cope with commercial competition and as a result they only conduct business locally.

The observation of one respondent was that the farmers rely on the support they get from the extension officers and on research with new technology to counteract the impacts of climate change. Only one respondent indicated that the farmers are not adapting to climate change impacts.

The different views of the extension officers on how different farmers cope to the climate change impacts can be summarised in a few sentences. They pointed out that the smallholder farmers sell a large number of animals (although in poor condition) and they are also able to cultivate small amounts of crops and vegetables in their backyard. They change crop and livestock and use traditional knowledge to survive. Farmers use conservation agriculture to minimise usage of resources like water and to conserve water. Some smallholder farmers were found to be resilient because they grew up in the villages.

Theme 4: Gaps and Measures for improved livelihood for Smallholder Farmers

A number of the respondents believe that farmers need support and assistance from government, which concurs with the statement that more specific support for smallholder farmers is included in the strategic plan of the national department of agriculture and the agricultural research council. Sadly, however, the strategic plan does not appear to have been operationalized (Thamaga-Chitja & Morojele, 2014).

Others believe that farmers need to change their attitudes in order to adapt to the effects of climate change. Most extension officers are of the opinion that, if the support and assistance from government and other stakeholders can be intensified and converged comprehensively to address the needs of the farmers directly when they are seasonally challenged, for instance when there is drought, the future may be brighter. Support should be instant during the dry season, however, not thereafter. *"A lot more people could have lost a reasonable number of livestock and experienced crop failure but when support and assistance arrive the situation have already changed, e.g. cattle already died, and government bring cattle feeds and water. And/or government bring drought resistant seeds for the past season while people will be looking for the next season crops"* (according to an extension officer).

The others indicated that attitude change of the farmers is important to help them adapt. What could help the farmers to change their attitude is exposing them to best practices from those farmers who are at an advanced stage of adaptation. This would allow the successful farmers to advise and demonstrate, so that other farmers can follow their example. One respondent cautioned that although their attitudes might change, the farmers would still need support with resources such as new research studies, fencing to control the movement of animals to avoid over grazing, drilling of boreholes, windmills, etc. One indicated that the experts should from time to time give and offer the small holders workshops and training to change their mindset and attitude, as they are too comfortable with the current extension officers and therefore, they do not listen to them anymore.

The extension officers suggested that the following be provided to ensure the sustainability of the smallholder farmers:

- Continued training and technical support as well as coordinating drought resilience methods such as IRWH, veld management, drought resistant seed technology.
- Information days with external stakeholders and specialists in the field to do demonstrations.
- Benchmarking sessions which would entail visiting other districts which are doing better in order to obtain advice from experienced farmers.

5.11 CHAPTER SUMMARY

This chapter discussed the analysis, interpretation and presentation of the research results. The process of data analysis and interpretation was explained. The first section focused on the analysis and interpretation of qualitative data followed by the second section where the qualitative analysis of data was discussed.

The first section made use of the rate and percentage of the farmers' responses. Points of discussion were the demographic and socio-economic characteristics of the smallholder farmers, the farming system, the level of climate change awareness of the farmers, their attitudes towards climate change, and their experience regarding the climate change. The level of adaption of the smallholder farmers was also presented, as well as the perceived impact of climate change along with adaptation strategies applied by the smallholder farmers and sustainable farming practices and finally the section ended with discussing the relationship and correlation between these variables (awareness, attitude and adaptation). The discussion was presented using tables and graphs with figures and percentages.

The second section presented the qualitative analysis findings from the interviews with the key informants. Their background and role were highlighted. Four themes were discussed and presented: smallholder's vulnerabilities according to the key informants, the impacts of climate change on smallholder farmers, adaptation capacity and adaptation techniques to climate change impacts, and finally gaps and measures for improved livelihood for smallholder farmers.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

Climate Variability have caused impacts on natural and human systems globally and across the oceans. Changing precipitation altered the hydrological systems, affecting availability of water in quantity and quality. The geographical ranges of terrestrial and freshwater species have shifted, seasonal activities, migration patterns, abundances and species interactions in response to ongoing climate change have also changed. Studies have shown negative impacts of climate change on agriculture.

Agriculture being the most high-performance motors of growth in national and global economies, is mostly affected and most vulnerable due to its nature of climatic and weather dependency. Because it is this sector which reduces levels of poverty, famine and malnutrition by increasing the supply of food and improving access to a better diet. Smallholder farmers in South Africa face many problems which stop them from growing and effectively contributing to food security. The various challenges they face puts more pressure on the already strained smallholder farmers.

The risk associated with disaster occurrence is a result of the hazard coupled with vulnerabilities. In most case there is nothing we can do about the hazard, but we can manage the vulnerabilities. In this case the vulnerabilities are those experienced by the small holder farmers, and in order to reduce the risk of a disaster occurrence the capacity of the small holder farmers to combat climate change impacts must be managed by means of adaptation to climate change effects. Reducing their vulnerabilities is important, as was seen in sub- section number 1 of section 2.3.1 (The Progression of Vulnerability), where it was explained how vulnerability occurs. In order to reduce the vulnerability, “progression of safety” the opposite of progression of vulnerability will have to be employed which is to address the root causes, reduce the dynamic pressures and achieve sustainable livelihoods.

The use of both DRR and CCA approaches can save lives and livelihoods with their intentions of strengthening the resilience of communities enabling them to anticipate, absorb, and bounce back from shocks, stresses and hazardous event, It was against this background that this research was conducted with the aim of assessing the adaptation strategies the smallholder farmers employ to adapt to the effects of climate change, and these techniques were indeed found to be potentially sufficient.

6.2 CONCLUSION OF THE STUDY OBJECTIVES

It should be noted that many studies have been conducted on the impacts of climate change on smallholder farmers, and how they are coping with the pressures. However, this study will add to the body of knowledge regarding the current adaptation techniques used by the smallholder farmers specific to the local villages of Thaba Nchu, Mangaung Metropolitan Municipality, and whether these strategies are working for the smallholder farmers. This section summarises the main conclusions that have been drawn from the findings in Chapter Five.

6.2.1 Objective 1: To determine the impacts of climate change on smallholders' farmers.

All the farming respondents believe that climate change has a negative impact on the farming and the livelihood of the smallholder farmers. The indication was that there is scarcity of rainfall when they are supposed to cultivate, climate and weather variability negatively affects them with very cold winter seasons and very hot summer seasons, in addition to the strong winds which causes soil to dry out, causing conditions unsuitable for their crops. Furthermore, unpredictable changing of seasons, rain delays causing delay in planting, and irregular rainfall destroy crops. Livestock weakens due to unpredictable cold weather in spring, crops die and as a result there is no harvest at the end of the season. All these delays in harvesting and planting lead to lack of income from selling crops. The drought and poor grazing cause financial strain, as the smallholder farmers are compelled to buy fodder in spite of their already financially strapped condition. Due to cold conditions crops and/or vegetables weaken, and grass becomes poor which makes animals to suffer. This essentially means that farmers cannot sell their produce or have to sell the produce for less, due to the poor quality of vegetables lacking nutritional value and lean livestock. The other impact which became evident is health issues for both the smallholder farmers and their livestock. Sickness from pests result from heat and the environment (poor vegetation). All these negative impacts cause stress (physical, mental and psychological ill-health) for the farmers, and the climate variability increases sickness in animals. These impacts are further exacerbated by price increases, as everything becomes more expensive. As a result of all these factors farmers are forced to produce inferior products and sell lean animals at low prices. They also produce poor quality vegetables with low nutritional value for their own consumption. A further pressure which makes the smallholder farmers vulnerable is the fact that they live in a rural village where they are distant from most resources, as a result their livelihood is dependent on farming activities. That is the main reason why climate change impacts hit them so hard. It became evident that should their vulnerabilities be reduced they

will be able to cope better and adapt. Although the smallholder farmers reflected that climate change is impacting them negatively, a considerable number still believe that it can be managed. It also became clear that the contribution of government support is vital, as they indicated that government is not doing enough and if they can put in an effort to support them all will not be lost.

There was strong evidence of the role of vulnerability in the impacts of climate change on farmers. Farmers' lack of resources (working capital, funding and infrastructure); lack of knowledge, information, education, skill and experience; lack of market as well as limited land are the results of vulnerabilities among small holder farmers, and the fact that their livelihood depends on farming activities makes matters worse. The attitudes, resistance to and denial of the need to adapt to climate change are the main vulnerability concerns for the farmers which lead them to experience the impact. Resistance and lack of understanding of the dynamics of climate change is another major cause of their susceptibility.

6.2.2 Objective 2: To assess the adaptation capacity and strategies of smallholder farmers to climate change.

A significant number (about 70%) of the smallholder farmers indicated that they are adapting to the climate change impacts and about the same number are just surviving the effects. Several adaptation capacities and strategies of smallholder farmers were identified. Although windmills are still very popular for water provision for livestock, the challenge is that most windmills are not working. Maintenance of equipment needs to become a priority. The most popular strategies are buying fodder for the animals, storing food for livestock, and obtaining water from water sources (mostly municipal water) when water becomes available. Some farmers decide to let the animals die and sell their crops to avoid further strain on themselves and their animals. A further strategy seen to be working is studying climate variability during the season when it comes and observing the change of temperature or weather forecast to help them plan better for the next planting season, for instance by planting more green plants and planting earlier than usual. The use of greenhouses and the strategy of changing grazing areas are prevalent. Farmers change the type of crops and livestock, they choose those breeds that adapt to drought and are able to travel some distance for water. Using tap water for planting irrigation seems to be working. Keeping a large number of livestock and the use of in-field rainwater harvesting (IRWH) techniques, among others, serve as coping mechanisms. The farmers keep their business local to avoid commercial competition. The indication was also that some smallholder farmers sell a large number of animals (although the animals are in poor

condition). They are also able to cultivate small amounts of crops and vegetables in their backyards and use traditional knowledge to preserve food. Most use conservation agriculture to minimise usage of resources like water and also conserve water. Some smallholder farmers were found to be resilient because they grew up in the villages.

The following are the different activities the farmers engage in to ensure survival.

- Livestock sales and vegetable vending
- Reduction of livestock to sustain them for reproduction and crop planting for household consumption
- Harvesting and mulching techniques
- Add types of livestock which can sustain them through the dry spell such as pigs, chickens, etc.
- Water saving techniques (water harvesting, Jojo tanks), irrigation techniques, building man-made dams, burst pipes to water certain areas, mulching for crops (reduces weeds and retains moisture), shading for livestock, boreholes and windmills are some of the activities smallholder farmers employ to ensure survival. The majority of the respondents believe these techniques are working and assisting farmers in sustaining their livelihood.

6.2.3 Objective 3: To assess if the adopted measures help the smallholder farmers to sustain their livelihoods.

The findings shown that the adopted adaptation measures assist the smallholder farmers to sustain their livelihoods, although in most cases it is for survival only. Smallholder farmers barely sustain their farming activities. The available adaptation the smallholder farmers apply are not used optimally due to the following reasons. Farmers limited adoption of resilient methods and the low education levels affect understanding and acceptance of new methods and adaptation strategies. There is a limitation in the way the smallholder farmers implement the adaptation techniques mainly due to the limited resources required for adaptation techniques. For instance, the use of water & soil conservation techniques, irrigation techniques & harvesting techniques, greenhouse farming requires capital resources which the smallholder farmers are struggling with. Secondly because of the limited understand of the techniques themselves and how to execute them. The lack of market also discourages the smallholder farmers to go through the trouble of carrying out the adaptation techniques

6.2.4 Objective 4: To identify gaps and propose measures to improved livelihood of smallholder farmers.

Smallholder farmers receive information regarding climate change through the media and to a lesser extent from the government which should be their main and reliable source. It became noticeable that the major support required is from government, which essentially implies that the farmers feel they have not been receiving enough of the required support. It also became evident that farmers need to change their attitudes in order to adapt to the effects of climate change. The techniques might be available but if the attitude and mindset is one of not being willing to adapt, it will be almost impossible to adapt. Delay in response by the government affects the adaptation measures farmers are trying to put in place. Early warning systems are almost non-existent in the community and among farmers and calls for help are delayed until it is too late. Even then the response (drought relief) turnaround is not favourable.

6.3 RECOMMENDATION

This section gives an outline of recommendations derived from the results and analysis of the study. Acknowledgement is given to the vast information and literature that has been gathered by other researchers over the years on climate change adaptation for smallholder farmers.

What became outstanding in the key finding was that the smallholder farmers have a certain level of knowledge about climate change, its effects and relevant adaptation measures, and most are attempting to adapt. There are, however, still some measures which need to be considered and emphasised.

Firstly, the support and assistance from government and other stakeholders need to be intensified and converged comprehensively to address the needs of the farmers directly. Early warning systems and forecast measures should be put in place to sensitise the farmers on time and to mitigate the effects of climate change. The packaging of early warning information also needs to be improved, including translation into local languages.

Secondly, building and maintaining of infrastructure (dams, windmill, farrows, greenhouses, fencing for livestock to control the movement of animals to avoid over-grazing) will allow a greater measure of adaptation. Development of irrigation infrastructure may allow the region to grow crops all year round and not only depend on climatic conditions for cultivation.

Thirdly, conservation and greening (planting more green plants) as well as continued provision of technical support regarding harvesting techniques, conservation agriculture and IRWH are indispensable. Land degradation, water scarcity and pest control are the most significant environmental issues facing agriculture in south Africa. By following an environmentally sustainable approach to soil, water and natural veld management, the agriculture sector will be able to sustain the natural resource base while ensuring greater productivity and food security. Specific measures include more efficient use of irrigation water, minimum disturbance of the soil, crop rotation, crop diversification, crop residue management and incorporation of organic matter, and best grazing systems. All of these measures are inherent to the principles of initiatives such as conservation agriculture, climate-smart agriculture and agroecology.

Fourth, training and workshops are essential in ensuring that the smallholder farmers change their attitudes and mindset, and that they understand the climate change adaptation mechanism. Iterative and experiential learning can unlock the social and behavioural change required for adaptation. This is particularly the case on the community scale, where there may be limited access to, quality of, or ability to use scientific information. Inclusion of climate change into formal education should be a part of environmental education in most institutions and schools to ensure they are well equipped before taking on farming for future generations. Innovative methods that can be used to communicate climate change include participatory video, photo stories, oral history videos, vernacular drama, radio, television, and festivals, with an emphasis on the important role of the media. The media can be encouraged to assist with presenting complicated scientific information in a simple way, especially for those who are illiterate. Better evidence-based communication processes will enhance awareness of the diverse range of stakeholders at all levels on the different aspects of climate change. Continuous research needs to be conducted and shared with smallholder farmers using local forums for dissemination of information.

Communicating agro-climatic information in an appropriate format to government, extension services and smallholder farmers is essential to enhance decision support. Communication and trust should be increased between authorities and all farming sectors to disseminate relevant knowledge on climate change and to promote adaptation. Such communication should be augmented with processes that support vulnerable communities to interpret and respond to such messages

Finally, the capacitating of the Extension Officers in terms of giving them knowledge and skill to be able to support the smallholder farmers, as well as increasing their human capacity to ensure their outreach to the farmers is adequate.

7 REFERENCES

Akaranga, S. I. & Makau, B. K., 2016. Ethical Considerations and their Applications to Research: a Case of the University of Nairobi. *Journal of Educational Policy and Entrepreneurial Research,* 3(12), pp. 1-9.

Alvi, M., 2016. A Manual for Selecting Sampling Techniques in Research. *Munich Personal RePEc Archive,* Volume 70213.

Anon., 2011. *IWMI.* [Online]
Available at: http://www.iwmi.cgiar.org/wp-content/uploads/2011/11/infield.pdf

Belle, J. A., 2017. *The integration of disaster risk reduction and climate change adaptation strategies into wetlands management in the Eastern Free State, South Africa.* Bloemfontein: The University of Free State.

Bryan, E. & Behrman, J., 2013. Community-based adaptation to climate change: A theoretical framework, overview of key issues and discussion of gender differentiated priorities and participation. *CAPRi,* Volume 109.

Center for Water Resources Redsearch: University of Kwazulu-Natal, 2016. *Handbook on Adaptation to climate change for farmers, officials and others in the Agricultural Sector of South Africa,* Durban: University of Kwazulu-Natal.

COAG, 2018. *Committee on Agriculture Twenty Sixth Session.* Rome: FAO.

COAG, 2018. *FAO's Programme of Work in Food and Agriculture under the FAO Strategic Framework.* Rome: FAO.

Coleman, A., 2015. *Free State drought officially declared a disaster.* [Online]
Available at: https://www.farmersweekly.co.za/agri-news/south-africa/free-state-drought-officially-declared-a-disaster/
[Accessed 17 November 2017].

Communal Land Rights Act, 2004. *COMMUNAL LAND RIGHTS ACT.* Cape Town: Government of South Africa.

Communal Property Associations Act, 1996. *COMMUNAL PROPERTY ASSOCIATIONS ACT.* Cape Town: Government of South Africa.

DAFF, 2012. *A framework for the development of small holder farmers through cooperatives development.* Pretoria: Department of Agriculture, Forestry, Fisheries.

DAFF, 2012. *A Framework for the development of smallholder farmers through cooperative development.* Pretoria: DAFF.

Dasgupta, P. & Morton, J., 2014. *Working Group II Assessment Report 5: Rural Areas Ch9.* Geneva: IPCC.

Davis-Reddy, C. L. & Vincent, K., 2017. *Climate Risk and Vulnerability: A Handbook for Southern Africa.* 2nd ed. Pretoria: CSIR.

De Waal, H. O., 2016. *Livestock production during drought.* [Online]
Available at: https://www.farmingportal.co.za
[Accessed 20 November 2017].

DEA, 2004. *South African National Climate Change Response Strategy.* Pretoria: South African Department of Environmental Affairs.

DEA, 2018. *National Climate Change Response White Paper.* Pretoria: Government of South Africa.

Department of Humanitarian Affairs/UNDR, 1992. *An Overview of Disaster Management.* [Online]
Available at: http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0aedl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0--4----0-0-11-10-0utfZz-8-00&cl=CL1.3&d=HASH68c99b49db2847ff4206b4.4.2.3.5&gt=1
[Accessed 16 February 2017].

DFID, 2000. *Sustainable Livelihoods Approach and its Framework.* London: DFID.

DoA, 2007. *Climate Change and The Agricultural Sector in South Africa.* Pretoria: Department of Agriculture.

Donner, W. & Rodriguez, H., 2011. *Disaster Risk and Vulnerability: The Role and Impact of Population and Society.* [Online]
Available at: https://www.prb.org/disaster-risk/
[Accessed 25 November 2019].

DRR Platform, 2016. *Disaster Risk Reduction, Climate Change Adaptation and Resilience,* Geneva: Swiss NGO DRR Platform.

Eastin, J., 2017. *Do Natural Disaster Prolong Civil Conflict?.* [Online]
Available at: https://www.oxfordresearchgroup.org.uk/blog/do-natural-disaster-prolong-civil-conflict
[Accessed 25 December 2019].

EWN, n.d. *Free State Drought.* [Online] Available at: ewn.co.za [Accessed 23 November 2017].

FAO, 2009. *FAO Strategic Framework.* Rome: FAO.

FAO, 2015. *Paris Agreement.* Rome: FAO.

FAO, 2017. *FAO Strategy on Climate Change.* Rome: FAO.

George University Writing Center, n.d. *How to write a Research Question.* [Online]
Available at: http://writingcenter.gmu.edu/resources-template.php?id=59
[Accessed 27 July 2018].

Harvey, C. A. et al., 2011. *Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar.* [Online]
Available at: https://www.ncbi.nlm.nih.gov/pubmed/24535397

IPCC, 2007. *Mitigation of Climate Change.* Geneva: IPCC.

IPCC, 2014. *Climate Change 2014 Synthesis Report.* Geneva: IPCC.

IPCC, 2015. *Climate Change 2014 Synthesis Report,* Switzerland: Intergovernmental Panel on Climate Change.

IPCC, n.d. *IPCC.* [Online] Available at: https://www.ipcc.ch/ [Accessed 22 August 2018 2018].

ISDR, 2005. *International Strategy for Disaster Reduction.* Geneva: UNDRR.

Kirsten, J. F. & van Zyl, J., 1998. Defining Small-Scale Farmers in the South African Context. *Agrekon,* 37(4).

Kulatunga, U., 2010. *Impact of Culture towards Disaster.* [Online]
Available at:
https://usir.salford.ac.uk/id/eprint/15891/1/Impact_of_Culture_towards_Disaster_Risk_Reduction.pdf
[Accessed 25 November 2019].

Kushagra , J., Roy, M. L. & Chandra, N., 2016. Gender Roles in Dominant Farming System of Western Plain Zone of Uttar. *TECHNOFAME- A Journal of Multidisciplinary Advance Research,* pp. 40-49.

Leedy, P. D. & Ormrod, J. E., 2001. *Practical Research: Planning and Design.* 9th ed. New York: Pearson.

Leedy, P. D. & Ormrod, J. E., 2016. *Practical Research: Planning and Design.* 11th ed. New York: Pearson.

Mangaung Metropolitan Municipality, 2010. *Mangaung.* [Online]
Available at: https://www.mangaung.co.za
[Accessed 17 November 2017].

Mangaung Metropolitan Municipality, 2016. *Update on water status in Mangaung.* [Online]
Available at: http://www.mangaung.co.za/2016/10/20/update-on-water-status-in-mangaung/
[Accessed 20 November 2017].

Mangaung Metropolitan Municipality, n.d. *Mangaung.* [Online]
Available at: https://www.mangaung.co.za
[Accessed 17 November 2017].

Meteoblue, 2014. *Climate Mangaung Pass.* [Online]
Available at: https://www.meteoblue.com/en/weather/forecast/modelclimate/mangaung-pass_south-africa_979448
[Accessed 16 November 2017].

Meteoblue, n.d. *Climate Mangaung Pass.* [Online]
Available at: https://www.meteoblue.com/en/weather/forecast/modelclimate/mangaung-pass_south-africa_979448
[Accessed 16 November 2017].

National Disaster Management Framework, 2005. *South African National Disaster Management Framework.* Cape Town: Government of South Africa.

Ngaka, M. J., 2012. Drought preparedness, impact and response: A case of the Eastern and Free State provinces of South Africa. *Journal of Disaster Risk Studies,* 4(1), p. 47.

Nhemachena, C. & Hassan, R., 2007. *Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa,* Washington DC: International Food Policy Research Institute.

Niang, I. et al., 2014. *Working GroupII Assessment Report 5: Chapter 22 Africa,* Geneva: IPCC.

Renaud, F. G., Sudmeier-Rieux, K. & Estrella, M., 2013. *The Role of Ecosystems in Disaster Risk Reduction.* New York: United Nations University Press.

Republic of South Africa, 1951. *BLACK AUTHORITIES ACT.* Cape Town: Government of South Africa.

Republic of South Africa, 1989. *Environment Conservation Act.* Cape Town: Government of South Africa.

Republic of South Africa, 1993. *THE CONSERVATION OF AGRICULTURAL RESOURCES ACT.* Cape Town: Government of South Africa.

Republic of South Africa, 1996. *The Constitution of the Republic of South Africa.* Cape Town: Government of South Africa.

Republic of South Africa, 1997. *Water Services Act.* Cape Town: Government of South Africa.

Republic of South Africa, 2002. *Disaster Management Act.* Cape Town: Government of South Africa.

Republic of South Africa, 2005. *Intergovernmental Relations Framework Act.* Cape Town: Government of South Africa.

Republic of South Africa, 2015. *Disaster Management Amendment Act.* Cape Town: Government of South Africa.

Republic of South Africa, 2018. *Climate Change Bill.* Cape Town: DEA.

Researchgate, 2014. *Environmental Degradation: Causes and Consequences.* [Online]
Available at: http://www.researchgate.net/publication/284395582
[Accessed 26 February 2018].

SADC, 2010. *Southern Africa Sub-Regional Framework of Climate Change Programmes.* Gaborone: SADC.

Seduski, D., 2016. *How Urbanization is Affecting Natural Disaster Risk Assessment.* [Online]
Available at: https://www.hsdl.org/c/how-urbanization-is-affecting-natural-disaster-risk-assessment/
[Accessed 25 November 2019].

Sendai Framework, 2015. *Sendai Framework for Disaster Risk Reduction.* Japan: UNDRR.

Singh, Y. K., 2006. *Fundamental of Research Methodology and Statistics.* New Delhi: New Age International Publishers.

South Africa Cities Network, 2017. *Synthesis Report: Analyzing Climate Change Cities Resilience, Food Security, Transport and Water,* Johannesburg: SACN.

South African Cities Network, 2014. *Cities Resilience to Climate Change Synthesis Report.* [Online]
Available at: http://sacitiesnetwork.co.za/wp-content/uploads/2014/07/Cities-Resilience-to-climate-change-Synthesis-Report.pdf
[Accessed 10 May 2018].

StatsSA, 2011. *Mangaung.* [Online]
Available at: http://www.statssa.gov.za/?page_id=993&id=mangaung-municipality
[Accessed 16 November 2017].

StatsSA, n.d. *Mangaung.* [Online]
Available at: http://www.statssa.gov.za/?page_id=993&id=mangaung-municipality
[Accessed 16 November 2017].

Staupe-Delgado, R., 2019. *Overcoming barriers to proactive response in slow-onset disasters.* Norway: UNDRR.

Sweet, J., 1998. *Livestock-Coping With Drought,* Namibia: Northern Regions Livestock Development Project Tsumeb.

Tekle, S. A., 2004. *A Soilscape Survey to Evaluate Land for In-Field Rainwater Harvesting in the Free State Province, South Africa.* Bloemfontein: University of the Free State.

Thamaga-Chitja, J. M. & Morojele, P., 2014. The Context of Smallholder Farming in South Africa: Towards a Livelihood Asset Building Framework. *J Hum Ecol,* 45(2), pp. 147-155.

The Conversation, 2017. *Understanding the root causes of natural disasters.* [Online]
Available at: http://theconversation.com/understanding-the-root-causes-of-natural-disasters-80017
[Accessed 25 November 2019].

The New Humanitarian, 2012. *Analysis: When lack of early warning becomes manslaughter.* [Online]
Available at: https://www.preventionweb.net/news/view/29936
[Accessed 5 December 2019].

The Open University, n.d. *6 Methods of Data Collection and Analysis.* [Online]
Available at: www.open.edu/openlearncreate/mod/resource/view.php?id=52658
[Accessed 21 June 2018].

Transformation of Certain Rural Areas Acts, 1998. *TRANSFORMATION OF CERTAIN RURAL AREAS ACT.* Cape Town: Government of Sout Africa.

Udmale, P. et al., 2014. Farmer's perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra State, India. *International Journal of Disaster Risk Reduction,* Volume 10, pp. 250-269.

UN, 2006. *UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE.* Geneva: UNFCCC.

UNDP-DMTP, 1992. *An Overview of Disaster Management.* s.l.:UNDRO.

UNEP, 2012. *Annual Report 2012.* Geneva: UNEP.

UNFCCC, 2012. *Slow onset events.* Geneva: UNFCCC.

UNFCCC, 2015. *Conference of the Parties (CoP21): Paris Agreement.* Paris: UNFCCC.

UNISDR, 2015. *Global assessment report on disaster risk reduction.* Geneva: UNISDR.

UNOCHA, 2016. *Resolution 46/182, which created the humanitarian system.* [Online]
Available at: https://www.unocha.org/story/resolution-46182-which-created-humanitarian-system-turns-twenty-five
[Accessed 06 November 2019].

Van Staden, R., 2014. *Climate Change: Implications for Cities,* Cambridge: University of Cambridge.

Weathersa, n.d. *Weather Extremes in South Africa.* [Online]
Available at: http://www.weathersa.co.za
[Accessed 20 March 2018].

Welman, C., Kruger, F. & Mitchell, B., 2005. *Research Methodology.* 3rd ed. Cape Town: Oxford University Press Southern Africa.

Wisner, B., Blaikie, P., Cannon, T. & Davis, I., 2003. *At Risk.* Second Edition ed. Wiltshire: Cromwell Press.

Wreford, A., Moran, D. & Adger, N., 2010. *Climate and Agriculture: Impacts, Adaptation and Mitigation.* Paris: OECD Publications.

YU, Q.-y.et al., 2014. Interpretation of Climate Change and Agricultural Adaptations by Local Household Farmers: a Case Study at Bin County, Northeast China. *Journal of Integrative Agriculture,* 13(7), pp. 1599-1608.

Zwane, M., 2016. *Policy Assessment: Climate Change Adaptation and Agriculture in South Africa.* Pretoria: Gaylor Montmasson-Clair.

Zwane, M. & Montmasson-Clair, G., 2016. *Policy Assessment: Climate Change Adaptation and Agriculture in South Africa.* Pretoria: WWF SA.

ANNEXURE A: QUESTIONNAIRE

UNIVERSITY OF FREE STATE

DiMTEC

Evaluation of Climate Change Adaptation Strategies by small scale village Farmers in Thaba Nchu, Free State Province; South Africa

QUESTIONNAIRE

INTRODUCTION

Interview Reference Number: **DIMTEC/09/2018** Date of the survey:

Interviewer: **1996739114** Respondent:

2018/DIMTEC/01

Place of Interview: **Thaba Nchu, South Africa** Duration: **15min-30min**

The questionnaire aims to survey Climate Change Adaptation Strategies by small scale village Farmers in Thaba Nchu, Free State Province; South Africa. The following themes will be surveyed: awareness of the climate change; attitudes towards climate change impacts, adaptation strategies to climate change

The respondents identity and responses will be kept strictly confidential and findings will be used only for the purpose it is intended which is for research and academic purposes and to assist the famres to adapt better to climate change.

PART A: SOCIO-ECONOMIC AND DEMOGRAPHICS

Question 1: Age

1	20-25	
2	26-30	
3	31-35	
4	36-40	
5	40 and above	

Question 2: Gender

1	Male	
2	Female	

Question 3: Race

1	African	
2	White	
3	Coloured	
4	Asian	
5	Other, specify	

Question 4: Educational Qualification

1	Matric	
2	Graduate	
3	Post Graduate	
4	Any Technical Qualifications	
5	Other, specify	

Question 5: Skills Category

1	Skilled	
2	Semiskilled	
3	Unskilled	
4	Other, specify	

E

Question 6: Farming Sector (choose which applies to you)

1	Crops	
2	Livestock	
3	Chicken	
4	Crops & Livestock	
5	Crops & Chicken	
6	Crops, Livestock and Chicken	

Question 7: Livestock (choose which applies to you)

1	Sheep	
2	Cattle	
3	Goats	
4	Sheep & Cattle	
5	Sheep, Cattle and Goats	

Question 8: Land Ownership, (choose which applies to you)

1	Own	
2	Rent	

Please specify hectares**……**

Question 9: Farming Duration (choose which applies to you)

1	Less than 2 years	
2	3 years	
3	4 years	
4	5 years	
5	6 years	
6	7 years	
7	8 years	
8	9 years and more	

Question 10: Duration of stay (choose which applies to you)

1	Less than 2 years	
2	3 years	
3	4 years	
4	5 years	
5	6 years	
6	7 years	
7	8 years	
8	9 years and more	

Question 11: Dependecy (choose which applies to you)

1	No dependant	
2	1 dependant	
3	2 dependants	
4	3 dependants	
5	4 dependants	
6	5 dependants	
7	6 dependants	
8	7 and more dependants	

Question 12: Monthly Income

1	R5 000- R15 000	
2	R16 000- R25 000	
3	R26 000-R30 000	
4	R31 000-R45 000	
5	R46 000-R55 000	
6	R56 000-R65 000	
7	R66 000-R75 000	
8	R76 000 and above	

8 PART B: AWARENESS

Question 13: Do you know what is Climate Change?

1	Yes	
2	No	

Question 14: Do you know what causes Climate Change

1	Yes	
2	No	

Question 15: Do you know the impacts of Climate Change?

1	Yes	
2	No	

Question 16: Do you know the climate of your region/area?

1	Yes	
2	No	

Question 17: What is the climate of your area in Summer: (only select the best one that applies)

1	Hot	
2	Humid	
3	Rainy	
4	Dry	
5	Cool	
6	Warm	

Question 18: What is the climate of your area in Winter?: (only select the best one that applies)

1	Cold	
2	Humid	
3	Rainy	
4	Dry	
5	Hot	
6	Warm	

Question 19: Which Month's do you experience Summer? (only select the best one that applies)

1	January	
2	February	
3	March	
4	April	
5	May	
6	June	
7	July	
8	August	
9	September	
10	October	
11	November	
12	December	

Question 20: Which Month's do you experience Winter? (only select the best one that applies)

1	January	
2	February	
3	March	
4	April	
5	May	
6	June	
7	July	
8	August	
9	September	
10	October	
11	November	
12	December	

Question 21: What is your typical average temperature in Summer? (only select one answer)

1	Below 20˚C	
2	Between 21˚C and 34˚C	
3	35˚C and above	

Question 22: What is your typical average temperature in Winter? (only select one answer)

1	Below -1˚C	
2	Between 2˚C and 11˚C	
3	12˚C and above	

Question 23: Does climate change have impact on farming?

1	Yes	
2	No	

9 PART C: ATTITUDES

Question 24: Do you believe climate change is here?

1	Yes	
2	No	

Question 25: Do you believe that Climate Change has negative impacts or Positive Impacts

1	Negative	
2	Positive	

Question 26: State the reasons for your answer on Question 21?

Question 27: Has Climate Change impacted you as a farmer in some way?

1	Yes	
2	No	

Question 28: How has Climate Change impacted you?

Question 29: Do you believe that Climate Change can be managed or dealt with?

1	Yes	
2	No	

Question 30: Do you believe the government is doing enough towards Climate Change?

1	Strongly Agree	
2	Agree	
3	Neutral	
4	Disagree	
5	Strongly disagree	

Question 31: Where have you heard about Climate Change?

1	Media	
2	Social Media	
3	Government	
4	Local Meetings	
5	Training or Workshops	

Question 32: Do you believe we as humans contribute to climate change?

1	Strongly Agree	
2	Agree	
3	Neutral	
4	Disagree	
5	Strongly disagree	

Question 33: How do We as humans contribute to Climate Change?

Question 34: Are you aware about the campaign Reduce, Reuse, Recycle

1	Yes	
2	No	

Question 35: Are you aware about the munipaliry water restriction by law?

1	Yes	
2	No	

10 PART D: ADAPTATION

Question 36: Do you agree with the municipality's water restriction by-law"

1	Strongly Agree	
2	Agree	
3	Neutral	
4	Disagree	
5	Strongly disagree	

Question 37: State the reasons for your answer on Question 32?

Question 38: Are you surviving the climate change impacts?

1	Yes	
2	No	

Question 39: How are you surviving the climate change impacts

Question 40: Are you adapting to the climate change impacts

1	Yes	
2	No	

Question 41: How are you adapting to the climate change impacts

Question 42: Which activities are you doing to ensure you adapt to climate change?

Question 43: What are the sustainable farming practices?

Question 44: Are you practicing them? (sustainable farming practices)?

1	Yes	
2	No	

Question 45: Is there anything that the government can do to assist farmers to adapt better to climate change?

1	Yes	
2	No	

Question 46: State the things the government can do to assist you to adapt better to climate change

Question 47 Which measures do you put in place to ensure your farming is sustainable against all weather and climate effects?

Thank you very much for your time!

END OF QUESTIONNAIRE

ANNEXURE B: INTERVIEW QUESTIONS

KEY INFORMANTS INTERVIEW QUESTIONS

Assessment of Climate Change Adaptation Strategies by small scale village Farmers in Thaba Nchu, Free State Province; South Africa

The main objective of the study is to determine and assess the climate change adaptation strategies by small scale farmers in Thaba Nchu, Mangaung Metropolitan Municipality, Free State of South Africa to see if they sustain their livelihoods and propose measures where gaps are identified.

Sub Objectives;

5. To determine the impacts of climate change on smallholders farmers.
6. To assess the adaptation capacity and strategies of smallholder farmers to climate change.
7. To assess if the adopted measures help the smallholder farmers to sustain their livelihoods.
8. To identify gaps and propose measures for improved livelihood of smallholder farmers.

Interview Reference Number:_____/_____/2018

Date of Interview:_____/_____/2018

Place of Interview:_____

Interview time: Start:_____/_____End /_____

11 PREPARATION

Below is the list of equipment and or documents to be required

- An office with table and two chairs
- Information Sheet
- Consent form
- Stationary for the participant
- A pen and a note pad for the interviewer
- Audio recorder

12 THE INTERVIEWER SESSION

12.1 INTRODUCTION TO THE PARTICIPANT

Time Duration: ± 5 Minutes

- The researcher welcome the participant & introduces herself to the participant
- The researcher hand over the Information Sheet to the participant.
- The purpose of the study is explained to the participant by the researcher.
- The participant rights in relation to taking part in the study are explained.
- The Researcher hand over an informed consent form to the participant for
    - Endorsement.

12.2 KEY INFORMANTS BACKGROUND

Duration: ± 10 Minutes

12.2.1 Please explain your role and responsibilities?

12.2.2 Which type of support are you providing to the small holder farmer?

12.2.3 How many small holder farmer are you supporting?

12.2.4 What do you understand about Climate Change

12.3 GENERAL INFORMATION ON THE VULNERABILITIES

Duration: ± 10 Minutes

Question 1: Based on your own experience, what are small holder farmer's vulnerabilities?

Question 2: In your own opinion and experience what are the vulnerabilities experienced related to climate change

Question 3: Please explain the intensity of the vulnerabilties?

Question 4: How are the vulnerabilities impacting on the farming?

Question 5: In your own opinion, is there a possibility to reduce the vulnerabilities and how

12.4 GENERAL INFORMATION REGARDING IMPACTS

Duration: ± 15 Minutes

Question 6: What are the impacts of climate change on the small holder farmers?

Question 7: Based on your experience, what do you think is the main cause of climate change impacts?

Question 8: In your opinion, what do you think lead to climate change impacting farmers?

12.5 GENERAL INFORMATION REGARDING ADAPTATION

Duration: ± 20 Minutes

Question 11: With the vulnerabilities and impacts of climate change experienced, how are the small holder farmers adapting to climate change impacts?

Question 12: What are their coping strategies to climate change impacts?

Question 13: Which activities do they engage in to ensure survival in farming?

Question 14: Are these strategies working for them?

Question 15: Do any of the adopted strategies assist them in sustaining their livelihoods?

Question 16: What do you believe they need in order for them to be resilient against the climate change impacts?

Question 16: How are you assisting them to adapt to climate and to sustain their livelihoods?

12.6 CLOSING

12.6.1 Thank the participant for his/her time

12.6.2 Reassure the participant that anonymity and confidentiality will be guaranteed

Total duration of the interview: approximately 60 minutes (1Hour)

END OF INTERVIEW