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Adapting to Climate Change to achieve Household Food Security: A Case Study of Small-Scale Farmers at Dzindi Smallholder Irrigation Scheme in the Limpopo Province of South Africa)

By

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Abbreviations

AF	Adaptation Fund
AAP	Africa Adaptation Programme
CDM	Clean Development Mechanism
COP	Conferences of the Parties
DFID	Department for International Development
DAFF	Department of Agriculture, Forestry and Fisheries
FAO	Food and Agriculture Organisation
GDR	Greenhouse Development Rights framework
GECAFS	Global Environmental Change and Food Systems
GEF	Global Environment Facility
GHS	General Household Survey
HEA	Household Economy Approach
HFS	Household Food Security
IES	Income and Expenditure Survey
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
LDCF	Least Developed Countries Fund

LDCs	Least Developed Countries
NAPA	National Adaptation Programmes of Action
SAWS	South Africa Weather Service
SCCF	Special Climate Change Fund
SLA	Sustainable Livelihoods Approach
SSA	Statistics South Africa
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VDM	Vhembe District Municipality
WFP	World Food Programme

Abstract

This dissertation explored adaptation mechanisms and adaptation options employed by rural small-scale farmers at Dzindi Irrigation Scheme to achieve food security in the midst of climate change as well as reflecting on the role of the state in building capacity of rural small-scale farmers to adapt to climate change. The study employed qualitative research techniques and data was obtained through semi-structured interviews with 40 small-scale farmers at Dzindi smallholder irrigation scheme.Irrigation control, high yielding crop varieties (HYVs), drought resistant crop varieties, drip irrigation are among a host of adaptation strategies successfully employed by farmers at Dzindi. These strategies have been effective in giving the farmers a lifeline in terms of household food supply and income.However, lack of funding, modern infrastructure and equipment has hampered adaptation efforts at the scheme. This has been compounded by lack of support from the Government. Government seemingly has not done enough to capacitate and assist famers to adapt to climate change.

Keywords: Climate Change, Adaptation Strategies, Food Security, Household Food Security, Vulnerability

Declaration

I, **Blessing Munyaradzi Chigavazira**student number **201013866**, sincerely declare that this dissertation titled;

Adapting to Climate Change to achieve Household Food Security: A Case Study of Small-Scale Farmers at Dzindi Smallholder Irrigation Scheme in the Limpopo Province of South Africa:

is my own work. All the relevant sources consulted, used, and quoted have been acknowledged and listed in the bibliographical reference page. I hereby declare that, this work has never been previously submitted for a degree at another university.

Signed ..... Date 23/11/2012

I **Blessing Munyaradzi Chigavazira** student number **201013866** hereby declare that I am fully aware of the University of Fort Hare's policy on plagiarism and I have taken every precaution to comply with the regulations.

Signed: ..... Date: 23/11/2012

I**Blessing Munyaradzi Chigavazira** student number **201013866** hereby declare that I am fully aware of the University of Fort Hare's policy on research ethics and I have taken every precaution to comply with the regulations. I have obtained an ethical clearance certificate from the University of Fort Hare's Research Ethics Committee and my reference number is the following:.....

Signed: ..... Date: 23/11/2012

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Dedication

To my mother and late father

Chapter One

Introduction to the Study

1.1 Introduction and Background

Food security in the sub-Saharan region faces the risk of a changing climate. With potentially devastating effects on food production capacity, agriculture is extremely vulnerable to climate change. Higher temperatures and more erratic rainfall patterns have reduced yields, encouraged weed and pest proliferation and increased the likelihood of short run crop failures and long run production declines (Nelson *et al*., 2009) *cited in (*World Bank, 2010). With a rapidly growing population, demand for food has increased, calling for efforts to step up food security globally. According to the World Bank (2008), "In Africa, demand for food is expected to reach $100 billion by 2015, double its level of 2000" (World Bank, 2008:1). Further to that, Sub-Saharan Africa is the only region where yields of food crops have declined, and farmers get only one-third of the yields achieved by Asian farmers (World Bank, 2008:1).The capacity to produce food has come under severe challenge due to changing climatic conditions therefore calling for responses to curb the effects of climate change.

Developing countries are more susceptible to climate change due to their low adaptive capacity and growing dependence on resources sensitive to changes in climate. Climate change will weaken development efforts in Africa and the rest of the developing world; will hit the poorest and most vulnerable sections of society hard (Madzwamuse, 2010). Madzwamuse argues that climate change will further deepen

the development crisis faced by developing countries. According to Madzwamuse, (2010) climate changes “threaten to reverse the gains of sustainable development and put additional pressure on already overstretched human and financial resources in developing countries” (Madzwamuse, 2010:1).

The perennial challenges faced by the Sub-Saharan countries being, poverty, burden of diseases, conflict, environmental degradation, malnutrition among others, risk gettingaggravated by climate change (O’Brien, 2010). In short, the implications of climate change are serious. According to O’Brien (2010:1), “Climate change can be considered as the biggest environmental threat in human history, and as the defining human development challenge for the 21st century” (O’Brien, 2010: IPCC, 2007b; UNDP, 2007; Stern, 2007). Thus, the magnitude of the effects of climate change is far reaching and this has seen a number of climate change related disasters taking place.

The majority of Sub-Saharan Africa’s population (96%) is dependent on rain-fed agriculture and in some countries; predictions forecast a 50% yield deficit by 2050while arable land will decline by 6% (Madzwamuse, 2011). Climate change has already compromised food security and access to food in poor rural communities. This has condemned poor countries with the least financial, institutional and technological capacity to adapt to climate change to being the worst affected and most vulnerable.

The implication is that, with agriculture facing harsh climate vulnerability, food production in countries and even at the household level has to keep up with internal demand (World Bank, 2007). Therefore, small-scale farmers face the task of either

adapting or falling casualty to the effects of climate change, taking into account that small-scale subsistence agriculture is essential to growth and to reducing mass poverty and food insecurity (World Bank, 2007).

The capacity of small-scale farmers to adapt to climate change is enabled by some form of state intervention. Government has an increasing role to build capacity of small-scale farmers so that they manage to adapt to climate change. This is based on the understanding that in South Africa an estimated 2.2 million households are food insecure, 14 million people are vulnerable to food insecurity and cannot adapt with some form of state assistance (HSRC, 2004; DAFF, 2006).

Global climate conditions and patterns have recently been changing. This has seen countries mostly in the Sub-Saharan region and beyond suffering perpetual droughts. Increasing temperatures have taken their toll on crops, water bodies and in some instances led to perpetual rains that have resulted in floods. This has compounded the fate of a continent suffering from a myriad of development challenges where for example,malnutrition is responsible for several deaths every year. Therefore,against this background an in-depth qualitative study was conducted to establish adaptation mechanisms employed by small-scale farmers to achieve household food security.

Adaptation can greatly reduce vulnerability to climate change by making rural communities better able to adjust to climate change and variability, moderating potential damages, and helping them cope with adverse consequences (IPCC, 2001). The purpose of this study is to establish or identify adaptation strategies

employed by rural small-scale farmers to achieve household food security in the midst of the effects of climate change.

The case for such a study was stimulated by the realisation that approximately over 1,2 million households particularly in the former Bantustan[1] areas derive some part of their income from farming (HSRC, 2004). According to the HSRC,about 50 % of the labour time of resident adult, able-bodied individualsis spent on farming but generates no more than about 5% of income, usually mostly in kind (HSRC, 2004). Despite small-scale agriculture not being the highest source of income, the role it plays in alleviating food shocks and household income is imperative considering that other sources of income in welfare grants and other remittances are by far lower than the average basic needs basket (HSRC, 2004).

Further to the argument above, the case for dwelling on household food security is motivated by the fact by results of the 2009 General Household Survey report [GHS] (Stats SA, 2010), which estimated that at least 20% of South African households had inadequate or severely inadequate access to food (DAFF, 2010). The report states that food access problems are the most serious in Free State province where 33,5% of households have inadequate or severely inadequate food access; followed by

[1]*Wikipedia. 2012.* A Bantustan (also known as black African homeland or simply homeland) was a territory set aside for black inhabitants of South Africaas part of the policy of apartheid for the purpose of concentrating the members of designated ethnic groups, thus making each of those territories ethnically homogeneous as the basis for creating "autonomous" nation states for South Africa's different black ethnic groups,

KwaZulu-Natal (23,1%), Eastern Cape (21,4%) and Mpumalanga (21,5%), with Limpopo (11,9%) and Western Cape (14,5%) having the least problems with food access (DAFF, 2010). This places the situation of food insecurity into perspective, revealing the importance of household food security and criticallythe role of small-scale agriculture is an inevitable aspect of the household livelihoods.

Past research has come up with a number of adaptation options for communities experiencing extreme weather variability. In a study by Lobell *et al* (2008), communities can cope with climate change, for example, by switching from producing corn to producing sorghum, whose lower water requirements and higher temperature tolerances are better suited to a warmer and drier climate.

Thomas, Twyman, Osbahr and Hewitson (2007) conducted a study on adaptation to climate change and variability. Among the coping strategies, respondents indicated that during dry spells, the immediate farming response was to reduce investment or even to halt cropping and focus on livestock management (Thomas*et al*, 2007). Half of the 80% of households with livestock in their farming portfolio chose to invest in animals during the last five years. In an extract from the fieldwork conducted by Thomas *et al*, (2007) one of the respondents indicated that, "It has been some years since I farmed [grew crops] and I think the rains are too unpredictable to farm here. I think that livestock farming is more important and I will increase my goats if I can" (Respondent M04.011–13)… "It is very risky investing in ploughing only to lose your money" (Thomas *et al*, 2007:315).

A study by the International Food Policy Research Institute examined farmers' perceptions of climate change. The study further examined how these perceptions

corresponded with climate data, and how farmers adapted. Analysis was based on data collected from 794 farm households in the Limpopo River Basin during the farming season 2004–2005. Overall, farmers' perceptions that the climate is changing correspond with the climate data. In light with the findings of these studies, the uniqueness of this study lays in that it will further probe the relationship that exists between adapting to climate change and achieving food security, focusing on the role of state in capacitating households to adapt to climate change.

Bryant, Smit, Brklacich, Johnston, Smithers, Chiotti, and Singh(2000) examined adaptation behaviour by Canadian farmers. Findings indicated that farmers' responses varied when faced with the same climate stimuli, even within the same geographic area. Different agricultural systems and markets systems in which farmers operate as well as different individual characteristics influenced farmer responses as well as contexts such as personal managerial style and entrepreneurial capacity and family circumstances (*cited in* Bryan *et al*, 2009).

Supporting the impression that personal characteristics and conditions influence adaptation, several studies find that farming experience, socioeconomic position, and access to resources, credit, and agricultural extension services increase the probability of uptake of adaptation measures to climate change (Maddison, 2007; Nhemachena and Hassan, 2007). Likewise, the nature of farmers' response to climate change and variability also depends on the socioeconomic position of the household poor farmers are likely to take measures to ensure their survival while wealthier farmers make decisions to maximise profits (Ziervogel *et al*, 2006).

Over the past 250 years, deforestation, incineration of fossil fuels, and production of agricultural commodities such as rice and livestock have instigated atmospheric concentrations of carbon dioxide (CO^2) and other greenhouse gases to rise significantly. “Greenhouse” gases absorb energy radiated from Earth to space and warm the atmosphere(IPCC, 2007). According to the Intergovernmental Panel on Climate Change (IPCC), escalations in greenhouse gas emissions have been concomitant with an upsurge in the average global temperature of 0.3°C–0.6°C since the late 19th century.By the end of the 21st century, the IPCC advances, greenhouse gas emissions could cause the mean global temperature to rise by another 1.4°C–5.8°C (IPCC, 2007).

Growths in average global temperature will have several effects on agricultural production, principal being variations in growing seasons, the length of time that soil temperature and soil moisture conditions appropriate for crop evolution (Darwin, 2001). The Earth’s oceans will expand, raising sea levels and reducing the amount of land available for agriculture. Extreme weather events, such as storms and floods, may also increase in frequency (Darwin, 2001).

Africa has unfairly been affected by negative effects of climate change though being the least contributor towards the advent of global warming (Darwin, 2001). Reports by the IPCC have highlighted the unavoidable impacts of climate change, and particularly the negative economic consequences for Africa (Darwin, 2001; Thompson *et al*, 2010; Africa Partnership Forum, 2007 and Greenpeace, 2007). Such is the case in South Africa, which has high inequality as well as poverty levels. Therefore, the poorest levels in societies are the hardest hit by climate change.

Despite South Africa, being relatively wealthier compared with most African countries, more than half of the country's population lives in poverty (Landman, 2003). Thus, half the population is highly vulnerable to climate change. The capacity to adapt is concomitant to household income too, where employment is a major contributor. However the Food and Agricultural Organisation (FAO),approximates that one third of the labour force is unemployed (FAO, 2003; World Bank 2003).The United Nations Development Programme (UNDP) warns that the progress in human development achieved over the last decade may be slowed down or even reversed by climate change, as new threats emerge to water and food security, agricultural production and access, and nutrition and public health. The impacts of climate change – sea level rise, droughts, heat waves, floods and rainfall variation – could, by 2080, push another 600 million people into malnutrition and increase the number of people facing water scarcity by 1.8 billion (UNDP, 2008)*cited in* (Ludi, 2009).

1.2Dzindi Irrigation Scheme

This study was conducted at Dzindi, a smallholder irrigation scheme in the former Venda homeland of South Africa. Dzindi was established shortly after World War II and is located in the Limpopo Province of South Africa (Van Averbeke, 2007; Mohamed, 2006). Dzindi is located about 6 km southwest of the town of Thohoyandou, in the Thulamela Local Municipality of the Vhembe District Municipality (VDM). It forms part of the settlement called Itsani, which had a total 1 080 households in 2001 (Statistics South Africa, 2001). The VDM is located in the North of Limpopo Province of South Africa. The area lies within a former Bantustan area, characterised by higher levels of poverty, lack of adequate infrastructure, lower

literacy rates among other indicators of underdevelopment. Limpopo province is the second poorest province in the country where an estimated 89% of its population lives in rural areas, compared to the national average of 46 % (DAFF, 2006).

The research site was selected largely because it accommodates more than 100 small-scale farmers, which suit the target sample of the study. The area is a semi-arid region without significant rainfall. Rainfall is traditionally variable from year to year, but 2005-2008 were very dry years. There is a noticeable decrease in rainfall during winter, and temperatures have increased in recent years (Gbetibouo, 2009).

Dzindi is located within the self-organising mapping (SOM) Region 1, in northern Limpopo Province which has a long term mean annual rainfall of 400–500 mm (Thomas *et al*, 2007). The climate data show evidence of a growing length to the dry season, resulting in a later start to the wet season, in late October to early November (Thomas *et al*, 2007). Within the wet season, there has been a trend towards fewer rain days in November and December and an increase in the overall occurrence of dry spells, in effect representing potentially damaging rainless spells within the growing season (Thomas *et al*, 2007). Droughts have been frequent in the last two decades (1982–3, 1987, 1990, and 1994 in particular) (Thomas *et al*, 2007).

These climate changes are affecting food security in the basin. The International Food Policy Research Institute, (2009) *cited in* Gbetibouo, (2009) predicts that maize yields in Zimbabwe and South Africa's Limpopo Province will decrease by approximately 9 % between now and 2045 due to climate change. A critical factor that influenced selection of Dzindi scheme in the Vhembe district is that most black farmers are located within district municipalities, which encompass territories

belonging to former homelands, meaning that most black farmers are located within former homelands themselves (Altman, Hart, and Jacobs, 2009). For example, approximately one quarter of all black small farmers in South Africa are in Vhembe, OR Tambo and Amatole municipalities (Altman*et al*, 2009). Aliber (2009) reveals that in four district municipalities, 57% to 72% of black households are engaged in farming at some level: Vhembe in Limpopo, UMkhanyakude in KwaZulu- Natal, and both Alfred Nzo and OR Tambo in Eastern Cape Aliber (2009) *cited in* (Altman*et. al*, 2009).

Although the 2.5 million black households who practice at least some agriculture represent a fifth of the 11million black households in the country, in a number of predominantly rural municipalities especially those incorporating former homeland areas the share is very much higher. Therefore, this activity is very important to people living in those areas (Altman*et al*, 2009).

The scheme was established in 1954 and occupies a total command area of 135.6 ha subdivided into 106 plots of 1.28 ha each, held by 102 plot holders. Of the 106 plots, one is set aside for research and demonstration. The scheme is one of 154 smallholder irrigation schemes in the Limpopo Province, where 54 % of these schemes in South Africa are located (Arcus Gibb, 2004:7; Denison and Manona, 2006:12) *cited in* (Mohamed, 2006).

Figure 2: Dzindi Smallholder Irrigation Scheme

Source: Fieldwork Research at Dzindi Smallholder Irrigation Scheme

Dzindi has a command area of 136 (ha), counts 102 farmers, and has an average plot size of 1.28 ha (Van Averbeke, 2007; Mohamed, 2006). What is unique of about Dzindi is its proximity to a large urban centre (Thohoyandou-Sibasa), which is not the case for many other schemes (Van Averbeke, 2007; Mohamed, 2006). This gives Dzindi an advantage over many other schemes in terms of access to markets. About 74 % of the smallholder canal irrigation schemes in Limpopo Province have been categorised as practicing semi-commercial farming, including Dzindi, whilst 16 % are categorised as subsistence farming schemes and 10 % as commercial farming schemes (Van Averbeke, 2007; Mohamed, 2006).

Provision of water is aided by a diversion of the Dzindi River to the scheme, a perennial river that flows south of Itsani village by means of a concrete weir. The Dzindi River is perennial, but the flow of water in the Dzindi River is subject to considerable seasonal variation (Van der Stoep and Nthai, 2005). A primary

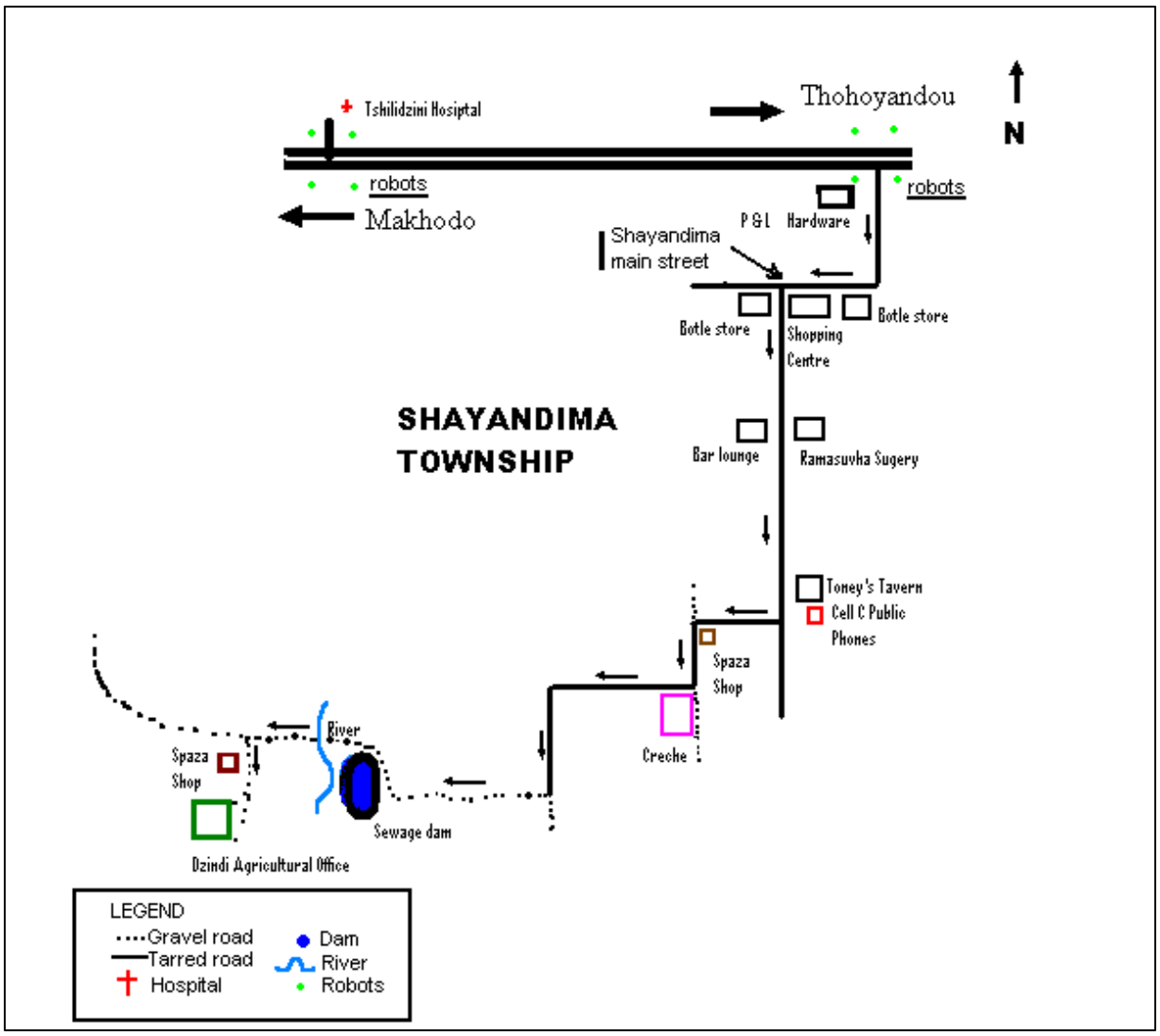
concrete canal distributes the water to the four irrigation blocks and secondary concrete canals or furrows bring it to the farmers' plots.

Figure 3: A Secondary Distribution Canal at Dzindi Scheme.

Source: Fieldwork Research at Dzindi Smallholder Irrigation Scheme

The distribution of furrows has been designed to allow water to enter the fields at regular intervals. In three of the four irrigation blocks, the main canal directly supplies the secondary distribution canals, which bring the irrigation water to plot edge. In Block 1, the canal supplies water to an earthen dam, from where it is transferred to the secondary canals and the plots. The plots are sub-divided into a variable number of strips (Van Averbeke, 2007; Mohamed, 2006)

Figure 4: Location of Dzindi Irrigation Scheme



Source: (Van Averbeke, 2007; Mohamed, 2006)

Having presented a case on the need for small-scale agriculture to adapt, the following section will problematise climate change adaptation and food security at Dzindi.

1.3Statement of the Problem

The problem haunting small-scale farmers at Dzindi Irrigation Scheme lays in a changing climate that has adversely affected crop production. There has been a noted decline in seasonal rainfall, as well as an increase in temperatures, conditions not favourable to crop production. The Dzindi River, which is the primary source of irrigation water though perennial, has had a reduction in capacity due to the erratic rainfall in the area.

Therefore low rainfall amounts, increased temperatures have drastically reduced food production capacity resulting in an increase to the incidence of household food insecurity. The question remains on whether adaptation stands as the panacea to achieving household food security. However, food security is a complex discourse, with a number of causalities and explanations being linked to the incidence of food insecurity and hunger.

Other dimensions to food insecurity in Africa have placed conflict, policy, and resource management as insinuating factors.Alternatively, Rahim (2011) argues that "hunger results, not from a decline in cumulative food accessibility, but from a lack of clear political commitment to social security provisions due to an alienation of rural land, or a loss of labour power, a loss of employment, and a fall in wages" (Rahim, 2011: 238). A vicious cycle of conflict and food insecurity makes alleviation of poverty in rural areas of the most vulnerable countries especially intractable. Having more people to feed, with less land and water, more variable climate, and greater food price volatility increases stress on livelihoods (World Bank, 2010).

Despite all contestation on the causes of food insecurity, Government in all instances has an increasing role to protect small-scale agriculture from failing. Rahim (2011) argues that small-scale agriculture is critical to redressing food insecurity and Government clearly needs to align its policy in that regard by supporting small-scale farmers. Such a scenario to some extent explains the incidence of household food insecurity at Dzindi. Small-scale farmers in the entire Vhembe district are mostly resource stricken and incapacitated to respond to any food shocks, leaving Government with an inevitable role to assist small-scale farmers. With such a picture, it is evident that food security is a complex scenario, where no single explanation can do justice in explaining its prevalence.

However, in the light of these debates, the aim of the study was to provide answers to the questions: How do small-scale farmers adapt to climate change to achieve food security? Is adaptation the key to dealing with the impacts of climate change? Is the state proactive in building capacity of households to adapt to climate change? Answers to such questions are critical towards taking steps to reduce the vulnerability of small-scale farmers to the effects of climate change. Having identified the research problem, the next section will present the objective of the study.

1.4Objective

To explore adaptation mechanisms and adaptation options employed by rural small-scale farmers at Dzindi Irrigation Scheme to achieve food security in the midst of climate change as well as analysing the role of Government in building capacity of rural small-scale farmers to adapt to climate change.

1.5Significance of the Study

Climate predictions and analyses of past and current trends indicate that small-scale farming households in tropical and sub-tropical areas have been exposed to increased climate risks (Ericksen, 2008). Research by the Global Environmental Change and Food Systems (GECAFS) has indicated that small-scale farming households will become more and more vulnerable to these risks.Unless drastic measures are implemented to increase their capacity to adapt to climate change, small-scale farmers will remain the most affected and most vulnerable to climate change (Ericksen, 2008). In the absence of measures at the local, regional, national, and international levels to better, adapt agriculture to the effects of climate change, food insecurity risks increasing. Presence of swift and appropriate measures to mitigate climate change with different agricultural practices is critical towards the attainment of food and the fulfilment of the Millennium Development Goals (Ericksen, 2008).

In light of the above, this study sought to contribute towards the practice of climate change adaptation in South Africa and sub-Saharan Africa in a bid to improve on the different mechanisms and coming up with best practices. This is considering that climate change as a discourse is relatively new in terms of research, and thus much more dynamics still need to be researched on. Government departments working on agriculture, environment, climate change and food security, civil society organisations as well as academics are likely to benefit from the findings of this study, which will open up to more informed research and debate on the climate change adaptation best practises.

Societies face fewer options towards responding to the impact and effects of a changing climate. Climate change research has since spelt out the relevance of adaptation to climate change to reduce the negative impacts of climate change. According to O'Brien (2010), climate change is not simply an environmental problem that can be addressed by regulating greenhouse gas emissions. It is about human development, social justice, equity, and human rights (O'Brien, 2010). Barnett *et al*., (2008) argue that climate change is about human security and the capacity of individuals and communities to respond to threats to their social, environmental, and human rights (Barnett *et al*., 2008 *cited in* O'Brien, 2010).

Figure 5: Proliferation of Weeds and Pests at Dzindi Scheme.

Source: Fieldwork Research at Dzindi Smallholder Irrigation Scheme

Climate change relates to how humans perceive themselves in the world and how they confront change. In fact, although it is certainly about the climate, at another level it is about how humans create and respond to change (O'Brien, 2010). It is with this understanding that climate change is a serious reality, with known and potential

devastating consequences, continuous research needs to be done so as to establish how communities, households respond to the challenges brought by nature.

1.6Delimitation of the Study

The findings of this study are not generalised to the whole Limpopo province but seek to contribute to the discourse of climate change adaptation and household food security as well as small-scale farming. The study focused on the key variables, which are climate change adaptation and household food security.

1.7Organisation of the Study

The study is organised into six chapters. Chapter 1 presents the introduction of the study, the problem statement, and objective, significance of the study, delimitations, and ethical issues. Chapter 2 presents the literature review, which includes a conceptual and theoretical framework. Chapter 3 is an extended literature review including the broad issues on climate change adaptation and food security. Chapter 4 presents the research methodology whilst Chapter 5 presents the findings and discussion of the findings. Chapter 6 sums up with the summary, conclusion and recommendations.

1.8Summary

The chapter gave an introduction and background to the issue of climate change and its impact on food security. Humankind has played a strong hand in the development of climate change. The advent of greenhouse gases, deforestation, veld fires have

played a severe role in the development of extreme temperatures, negative for agriculture and in some instances making inhabitation uncomfortable. The chapter also discussed the research problem and that; farmers at Dzindi have been affected by a changing climate, which has drastically affected their farming activities. The chapter also stated the relevance of the study, indicating that, the effects of climate change are too severe not to be recognised. All stakeholders join forces to see to the implementation of adaptation mechanisms that will safeguard especially the poor and vulnerable from being subjected to severe poverty due to the effects of climate change.

Chapter 2

Literature Review

2.1 Introduction

The following chapter is a critical review of literature on climate change adaptation and food security. For purposes of conceptual clarity, it is important to define the key concepts used in this study. Considering that, there are many interpretations and definitions relating to adaptation, climate change, food security, this section presents a discussion of these concepts and their relevance to this study. Important concepts in this study included, climate change adaptation, food security, food insecurity, climate change, household food security. A discussion on the different theoretical frameworks informing the study is also presented in this chapter.

2.2 Conceptual Framework

Key in adaptation literature is the use of coping mechanisms and adaptation strategies. Different scholars have used these two concepts somewhat differently, but in this study, they are not different in anyway. That is, the two concepts according to this study are the same and differentiated by wording. Therefore, this study used the concepts alternatingly. The same goes to the alternative use of the concepts climate change adaptation and adaptation. In some literature, some scholars have tended not to coin climate change to the word adaptation therefore just terming it adaptation, whereas some literature has coined both terms to be

climate change adaptation. However, this study used the seemingly different but similar terms alternatively.

Adaptation is termed as adjustment in practices, processes or structures to take into account changing climate conditions, to moderate potential damages or to benefit from the opportunities associated with climate change (McCarthy *et al*, 2001 *cited in* Ericksen and Naess, 2003; Smit *et al*., 2001). Adaptation has been defined in a multitude of definitions. According to the IPCC (2001), “Adaptation refers to actions that people take in response to or in anticipation of projected or actual changes in climate, either to reduce the adverse impacts or to take advantage of opportunities offered by such changes” (IPCC, 2001)*cited in*(Francisco, 2008:9).

A number of scholarly definitions on adaptation that exist in climate change literature all agree that adaptation is a mitigatory factor reducing the impacts of climate change. Burton (1992) states that “Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides” (Burton 1992)*cited in* Smit,*et al*. 2000; Olmos, 2001). Stakhiv (1993) defined adaptation as “any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change” (Stakhiv, 1993, *cited in* Smit*, et al*. 2000; Olmos, 2001).

Thus, adaptation is a response mechanism done by individuals or set activities employed by individuals to shield themselves from the effects of climate change.Watson *et al*, (1996) advance that, adaptation can be impulsive or planned,

and can be carried out in response to or in anticipation of change in conditions (Watson *et al*. 1996, *cited in* Smit *et al*. 2000; Olmos, 2001).

This study adopted the United Nations Framework Convention on Climate Change [UNFCCC] (2007) definition of adaptation which states that, "Adaptation is a process through which societies make themselves better able to cope with an uncertain future" (UNFCCC, 2007:10). Unbundling this definition, adapting to climate change entails taking proper measures to mitigate the negative effects of climate change (or exploit the positive ones) by making the necessary adjustments and changes. This indicates that adaptation is the panacea to responding to the effects of climate change and failure to adapt has crippling effects particularly relating to the incidence of food insecurity, hunger and instability.

Importantly the capacity to adapt is essential for any adaptation to materialise, this referring to adaptability. According to Watson, Zinyowera, and Moss (1996), adaptability refers to the extent to which modifications are conceivable in practices, methods, or structures of systems to anticipated or actual changes of climate. That is there is need for an enabling "environment' or conditions for adaptation to thrive. Thus, there are intricate factors that are necessary for any adaptation mechanisms to be implemented with success, thereby making adaptation a sensitive process.

Adaptation is a fundamentally dynamic process that is prejudiced by geographic, political, social and economic factors among others. There is apparently no single solution or prescription as the capacity of different areas to adapt to climate change is different and influenced by a number of factors. Francisco (2008) states that, adaptive capacities of countries, communities, and households vary and are largely

dependent on economic status. Thus “generally, developed countries have higher adaptive capacities while developing and least developed countries, which are most vulnerable to climate change, need external support to build theirs” (Francisco, 2008:9). The key question here is what adaptation options are available to deal with the impacts of climate change. According to Klein (2002), “Adaptation measures can be classified as reactive that is, those undertaken to respond to impacts of current climate variability and climate change, and anticipatory referring to those undertaken before impacts are observed” (Klein, 2002 *cited in* Francisco, 2008:9).

Having conceptualised adaptation it is essential to identify the known options or strategies for adapting to climate change. A number of factors influence the application of different adaptation strategies in different localities. Francisco (2008) argues, “depending on climate change impacts, adaptation options vary” (Francisco, 2008: 9). Some of the adaptation methods communities can adopt include simple ones like shifting planting calendars or changing crops, or more costly ones like investing in protective infrastructures such as river or sea dykes for flood control. In extreme cases, retreat may be the best strategy (Francisco, 2008).

The terms measures, options, strategies are used synonymously in adaptation literature, as is with this study. Adaptation strategies are reactions to actual or expected climatic stimuli (and their effects). Such reactions are intended to moderate harm or exploit associated beneficial opportunities (Hisalia, Birungi, Buyinza, 2011).The adjustments either can be broadly categorised as responses to current occurrences (climate variability) or planned adaptation to long-term changes (Hisalia, *et al*, 2011).

Various types of adaptation can be distinguished, including anticipatory (before impacts), autonomous (spontaneous) and planned adaptation (result of a deliberate policy decisions) and can occur at different scales – household, private sector, government institutions, local, national (IPCC, 2007). According to Berkes and Folke, (1998) Adaptive management deals with the unpredictable interactions between people and ecosystems, emphasizing the importance of feedback*s* from the environment in shaping policy and of the ability to learn, experiment and be flexible (Berkes and Folke, 1998) cited in (Balaghi, Badjeck, Bakari, Pauw, De Wit, Defourny, Donato, Gommes, Jlibene, Ravelo, Sivakumar, Telahigue and Tychon, 2010). Balaghi *et al*, (2010) further that, knowledge building whether scientific, technological or traditional as well as institutional learning and innovation, are essential for institutions to scheme adaptive management strategies (Balaghi*et al*, 2010).

The IPCC's fourth assessment report classifies adaptive responses as technological, behavioural, managerial and policy base (IPCC, 2007). According to the IPCC (2007), technological responses include building protective infrastructures like river and sea dykes whilst behavioural responses relate to changing food and recreational choices (IPCC, 2007). Managerial responses are inclined to changing cropping patterns or choice of crops; whereas policy responses relate to implementing new planning regulations (IPCC, 2007).

> "There are many options and opportunities to adapt. Adaptation options range from technological options such as increased sea defences or flood-proof houses on stilts, to behaviour change at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water

management, improved risk management, various insurance options and biodiversity conservation" (IPCC, 2007:10).

Of interest, this study sought to clarify the use of concepts of 'coping' and 'adapting'. Despite efforts to distinguish the two, this study used the terms in harmony. Thus, coping and adapting used in the context of climate change and food security are concepts used alternatively in this study. This is based on the adopted interpretation of adaptation being any mechanisms meant to ameliorate the impacts of climate change. However not all scholars agree that coping and adapting are the same. Davies (1993) makes the distinction between "coping strategies" (contingency mechanisms to deal with a short-term insufficiency of food) and "adaptive strategies" (long-term or permanent changes in the way in which households and individuals acquire sufficient food or income). Davies (1993) notes that a number of drawbacks about the use of "coping strategies" in food security research indicating that first; they are something of a catchall, although some of the clarifications just mentioned help to reduce this problem (Davies, 1993).

Second, they imply that people somehow "get by," when, in fact, coping strategies are an indication that things are getting worse; and, third, they are almost by definition nutritionally unsustainable, and are likely to be economically and environmentally unsustainable as well (Davies, 1993). Nevertheless, even though coping strategies are an indication of food insecurity, the distinction between "coping" and "failure to cope" is an important distinction to note in the famine literature (Maxwell, 1995).

The relationship between climate change adaptation and food security is inevitable. Therefore, this study sought to clarify the concept of food security and the link with

climate change. The concept of food security is broad and dissects across various dimensions. Food security is understood and used differently depending on the context, timeframe and geographical region in question (Food Security, Poverty, and Nutrition Policy Analysis, 2009). Most definitions of food security hinge on the 1986 world bank definition which defines states that "food security is attained when all people have physical and economic access to sufficient food at all times to meet their dietary needs for a productive and healthy life" (World Bank, 1986).

The 1996 World Food Summit defined food security as:

> "… a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002 *cited in* Clay, 2002).

Such definitions denote that a food-enabling environment that hinges on social, economic, political, environmental factors is critical for food security. However, the environment is an important determinant of agriculture and any paralysis of the agricultural ecosystem has negative effects on food production thereby increasing the incidence and impacts of food security. This therefore opens up the relationship between climate change and food security and the overall need to adapt.

Of interest is Ericksen (2008) who brings the multi-level delimitation of food security, stating that food security is measured at the individual, household, community, or national level and in this study food security will be focused at household level. Therefore, this study adopted the widely accepted World Food Summit (1996) definition, which reinforces the multidimensional nature of food security and includes food access, availability, food use, and stability. Ludi (2009) reiterates that food

security is not narrowly defined as whether or not food is available, but whether the monetary and non-monetary resources at the disposal of the population are sufficient to allow everyone access to adequate quantities and qualities of food (Schmidhuber and Tubiello, 2007 *cited in* Ludi, 2009).

The impact of climate change will eventually affect all dimensions of food security (Ludi, 2009). Therefore, a multi-dimensional definition that takes into account the essentials of food security is relevant to the study of food security in most sub-Saharan countries. A multi-dimensional approach to food security allows analysis to be done even at the household level in the form of household food security, which was key to this study.

In contrast food insecurity is the lack of access to an adequate diet, which can be either temporary (transitory food insecurity) or continuous (chronic food insecurity) (Devereux *et al,* 2004). “Food insecurity exists when people do not have adequate physical, social, or economic access to food” (FAO, 1996). Food insecurity is due to the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate utilisation at household level (Devereux *et al,* 2004).

Food insecurity is customarily categorised as chronic and transitory. “Chronic food insecurity is a long-term or persistent inability to meet minimum food consumption requirements” (WFP, 2009:2). Chronic denotes an individual is consistently unable to obtain sufficient quantities of nutrients. As a rule of thumb, food insecurity lasting for at least six months of the year can be considered chronic (WFP, 2009). “Transitory food insecurity is a short-term or temporary inability to meet minimum food

consumption requirements, indicating a capacity to recover" (WFP, 2009:2 *cited in* Mjonono, 2008). Transitory is a temporary reduction in sufficient nutrient intake.

As a rule of thumb, short periods of food insecurity related to sporadic crises can be considered transitory (WFP, 2009). It is important to distinguish between chronic and transitory food insecurity, as they are likely to require different types of response, in terms of both content and duration (Devereux, 2006). Typically, chronic food insecurity calls for interventions that address underlying and basic causes of food insecurity and that last for several years. Transitory food insecurity may require shorter-term interventions that address immediate and underlying causes, but interventions tackling basic causes of food insecurity may also be important to prevent repeated transitory food insecurity, which may lead to chronic food insecurity (Devereux, 2006 *cited in* Mjonono, 2008). Thus, in this case climate change stands as a critical factor in between the incidence of food security and insecurity. Therefore, interventions required in tackling food insecurity and ensuring food security be it at any level, entail some form of adaptation mechanisms and strategies.

Chronic and transitory food insecurity can be severe or moderate. Severitycan fluctuate over time, either seasonally or owing to a shock, so both chronic and transitory food insecurity can shift between severe and moderate states (WFP, 2009). According to WFP (2009) citing Devereux (2006), there are strong negative synergies between chronic and transitory food insecurity, and between moderate and severe food insecurity:

- **Transitory -** chronic: repeated shocks can provoke food insecurity ratchets, eventually forcing households into destitution and chronic poverty and food insecurity. Seasonal or cyclical food insecurity is a form of recurrent transitory food insecurity, which can eventually result in chronic food insecurity if households progressively deplete their assets (WFP, 2009).
- **Moderate** - severe: chronically food-insecure households are more vulnerable to such deterioration than the transitorily food-insecure (WFP, 2009).

Some scholars have found that failure to adapt to climate change stands as the root cause to chronic and transitory food insecurity. In as much as many factors come into play leading to food insecurity, more importantly reduced production is a direct result of climate patterns and therefore other factors need to be observed subsequently.

Climate change is an imperative concept to this study and this study sought to clarify the concept and the relevance of climate change to agriculture and food security especially in sub-Saharan Africa. Climate change is still a contested issue since there is no clear-cut definition to what climate change is. However, the South African Weather Observer (2009) defines Climate change as:

> "The natural cycle through which the earth and its atmosphere are going to accommodate the change in the amount of energy received from the sun. The climate goes through warm and cold periods, taking hundreds of years to complete one cycle. Changes in temperature also influence the rainfall, but the

biosphere is able to adapt to a changing climate if these changes take place over centuries" (South African Weather Observer, 2009:1 and SAPP, 2010:1).

Climate change has a direct and devastating impact on agricultural production, as agriculture is heavily reliant on climate conditions and is one of the most vulnerable sectors to the risks and impact of global climate change (Parry *et al*, 1999). It is no secret that global climate change insinuates reduced food production, potential leading to trigger effects associated with higher food prices, starvation among other problems. Relevance of adaptation in this case comes in that, it is widely recognised that the severest impacts are more likely to be experienced in developing countries (largely due to low capacity of populations to adapt coupled with fragile infrastructure).

It is evident that most rural and of late peri-urban communities in Africa are agro-based and that agricultural production is a key source of their livelihoods, providing employment to more than 60 percent of the population and contributing about 30% of gross domestic product (Nhemachena and Hassan, 2008). Southern Africa is expected to experience increases in temperature and declining rainfall patterns as well as increased frequency of extreme climate events (such as droughts and floods) as a results of climate change (Nhemachena, 2008).

Unfortunately, human intervention has been argued to be causing the climate to change too fast. According to Water and Energy Conservation Systems [WECS] (2011), "Climate models predict that the mean air temperature over South Africa will increase by an estimated 2°C over the next century. Plants and animals may not be able to adapt as quickly to this rapid climate change as humans can, and therefore

the whole ecosystem is in danger" (WECS, 2011). Having discussed the key concepts of the study, a discussion of theories informing the study will follow.

2.3 Conceptualising Household Food Security

The study investigated the household as a unit of analysis. The many definitions of Household Food Security (HFS), "all agree that the key defining characteristic of Household Food Security is secure access at all times to sufficient food" (Maxwell and Frankenberger, 1992:8). Other scholars like Bonti-Ankomah (2001) define Household Food Security, as access by all households at all times to adequate, safe, and nutritious food for a healthy and productive life (Bonti-Ankomah, 2001). Household Food Security is the capacity of a household to procure a stable and sustainable basket of adequate food (IFAD, 1992) and is determined by a household's current food supplies, past food supply and potential future supply (Gittelsohn *et. al*., 1998). Potential future food supply is a function of the household's available resources, such as capital (e.g., land), labour, and time (Gittelsohn *et. al*., 1998 *cited in* Msaki, 2010).

This implies that HFS is not simply a function of household food production, but is linked, often in complex ways, to the overall livelihood strategies of households (Frankenberger, 1992; Sen, 1981). Strategies include a household's ability to convert endowments into food entitlements, and even to go hungry, up to a point, to meet another objective, such as asset preservation (de Waal, 1989). Paradoxically, higher levels of household crop production may be associated with poorer food security. For example, Zambian smallholders, in their efforts to make the transition from subsistence agriculture to cash-oriented maize production enterprise, tend to have

higher levels of child malnutrition and a less varied diet than do households relying mainly on traditional subsistence crops (Mwape and Russell, 1992; Moore and Vaughan, 1987).

HFS may also be more closely related to income levels (Heisey, 1992), cash flows and the control of cash within a household than to production levels per se. In some climatic zones, greater diversification away from food-crop production alone may present the best prospects for exploiting available resources for improved food self-sufficiency. This implies that a broad perspective is required in the design of interventions to address household food-security issues, one that moves away from a specific focus on nutrition and food production towards a more embracing perspective of food systems and sustainable livelihoods (Kokwe and McEwan, 1992).

Of interest is the dynamic nature of household food security. This is based on the understanding that a household is a dynamic unit where many factors are to be considered before food security can be attained. According to Jacobs (2009), it is a complex and tricky task to formulate a one-size-fits-all set of food security targets. This is clear from the multiple determinants of the food security status of a household or its members. In an analysis of household food security, it is necessary to explain the determinants of household food security, and these are:

- Household composition: Households vary in terms of size (number of household members), age structure (adults and children), and gender (females and males). Nord and Hopwood (2007) examine the importance of household composition insofar as it aids in understanding the food security status of children in the household (cited in Jacobs, 2009).

- Wealth and livelihood strategy: This consists of various incomes (wages, social grants, etc.) and assets (land, livestock, etc.).
- Geographic location: This refers to the rural and urban locations, whether the settlement is largely formal or informal, and distance from the nearest or from frequently used food markets.
- Institutions: markets, the state, social capital/networks.
- Time: the food security condition could be transitory or chronic.
- Risk: shocks that are related to the weather, health, as well as commodity price movements.Risk has evolved into a major cross-cutter as it affects all elements of food insecurity (Webb *et al*., 2006). It includes disruptions such as climatic fluctuations, social conflicts and other crises that make households more vulnerable to food shortages (Jacobs, 2009).

An Africa regional workshop held in 1992 concluded that households will be food-secure when the conditions relating to availability and accessibility are met, noting, "Availability includes adequacy in staples, vegetable and animal protein relishes, vitamin supplements, and concentrated energy sources" (Kokwe and McEwan, 1992). These foods must meet social, cultural preferences and be safe (Kokwe and McEwan, 1992). Accessibility means that households are capableofacquiringfoodstuffs through the transformation of benefactions (land, labour, capital and other resources, etc.) into food entitlements (Kokwe and McEwan, 1992).

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Relevance of analysing food security at a household level lies in a number of factors. Incidence of food insecurity is presented in a different picture at three levels, global, national, and household levels respectively. South Africa is a somewhat food secure at national level, but high incidence of poverty points to food insecure and highly vulnerable households. For Bals *et al*, (2008) “without a detailed look at the impacts at the household level, the analysis would lack an understanding of the difficulties

and specific necessities each person faces in regard to food security" (Bals et al, 2008:44).

However, it is impossible to fully critic food security without reflecting on the national level. According to Bals *et al,* (2008) "this level of analysis is equally as important because the national level is where most agricultural policy decisions are made" (Bals *et al*, 2008:44). It is at this stage that decisions on whether food security concerns are covered by imports and how many financial resources are made available for national agricultural policies (Bals *et al*, 2008). Of interest to this study, it is at the national level where central elements of climate adaptation policies and implementation strategies are crafted and operationalised.

This knowledge is crucial in designing adequate adaptation policies that support those groups, particularly marginal producers and vulnerable consumers, which are most likely to become food insecure. Therefore, in this context, the most relevant level for explanation of the impact of climate change on food insecurity was the household level. As long as there is no global food shortage, the income of the household is the key determinant for whether or not a family becomes food insecure (Bals *et al*, 2008).

2.4 Theoretical Framework

A number of theories have since been postulated on issues to do with food security and climate change. This study critically assessed some key theories and approaches. Amartya Sen's entitlement theory of famine forms the conceptual basis of all agencies' approaches to assessing food security. The entitlement approach posits that most famine mortality results from the inability of people to acquire food

through either purchase or exchange, or transfers (Sen, 1981; Young, Jaspars, Brown, Frize and Khogali, 2001). Of course, the availability of food near to the household is a prerequisite of food security. However, despite the assertion, this study interpreted climate change being an inevitable factor that reduces the ability of people to acquire food in any way.

In justifying the relevance and importance of the entitlement approach to this study it is critical to note that increasing aggregate food availability is not enough to reduce hunger (Delgado, Townsend, Ceccacci, Hoberg, Bora ,Martin, Mitchell, Larson, Anderson and Zaman, 2010). Sens studies showed that the key to reducing hunger is to increase the "food entitlement" or command over food of individuals, which may or may not be linked to aggregate food availability in markets. Changes in food entitlements could occur through changes in a variety of factors, such as policies (domestic and foreign), environment, technologies, and individual characteristics that affect how individuals secure access to food (Sen 1981).

It is through these various factors that climate change becomes an inevitable aspect in influencing command over food for individuals. Failure to scheme and implement agricultural enabling conditions in the form of adaptation policies and strategies in this case severely affects the capacity of individuals to have command over food (Delgado *et al*, 2010).

In a way, the entitlement theory stands on the argument that food security is a complex phenomenon that is influenced by a number of factors. Young *et al,* (2001) further argue that availability is influenced by factors such as a community's proximity to centres of production and supply, or by market forces, restrictions on

trade and international policies that affect food supplies (Young *et al*, 2001). All of these are fundamental to food-security analysis. Sen's work was nonetheless a radical breakthrough; before him, the availability of food was thought to be the overriding determinant of famine. According to Sen (1981) people's 'exchange entitlements' (or their livelihood sources) reflect their ability to acquire food (Sen, 1981) *cited in*(Young*et al*, 2001).

Importantly the significance of the entitlement approach to this study lay in that, it draws analytical attention to other sources of food apart from production, and highlights the need for more empirical research and modelling on the likely effects of climate change on other components of local and national food systems (Bohle., Downing., and Watts, 1994). The distribution and reproduction of entitlements to food is determined by the livelihood system in the local economy, as well as structural factors in the local political economy that construct 'social vulnerability' [e.g. gender] (Bohle*et al*, 1994).

Taking a production based entitlement approach; entitlement analysis is more suitable at a community level. According to Vincent and Cull (2009)

> "The entitlement approach operates best at the micro-level of households or livelihood groups [e.g. farmers, landless labourers], often in combination with a livelihoods framework" (Vincent and Cull, 2009:15).

Of interest is that an entitlements-based analysis of climate change takes into account differences in dependence on food production by different groups of households.

For instance, farmers are most directly vulnerable to ‘failure of production-based entitlement’ due to climate change, because they depend most heavily on crop production for both their food and their income. Poor farmers with undiversified livelihoods and few asset buffers are most vulnerable of all, because they lack alternative sources of food when their harvests fail (Vincent and Cull, 2009). Therefore, such an analysis takes into consideration the dynamics associated with climate change and food security.

Taking a look at another critical perspective of entitlement, when crop production is inadequate, subsistence farmers look for alternative work to supplement their food and income, and the rural non-farm economy becomes an important determinant of household food security, through its capacity to generate ‘labour-based entitlement’ to food (Vincent and Cull, 2009). Apart from farmers, other groups that depend indirectly on agriculture for their living are also vulnerable to a collapse of demand for their services such as landless labourers.

One plausible consequence of climate change is that pressure on rural labour markets will increase, and if the supply of labour rises while demand for labour is constant or falling, real wages will fall, exacerbating food insecurity in poor rural communities (Vincent and Cull, 2009). Another ‘second round’ consequence of climate change could be an increase in labour migration out of areas where food production is more variable and employment opportunities are falling, with unpredictable implications for household food security that require detailed context-specific analysis and modelling (Vincent and Cull, 2009).

However, Sen's entitlement theory has its own restrictions. Of concern, it implies a straightforward sequence of entitlement failure leading to hunger and then to malnutrition, starvation and death (de Waal, 1990). But research into people's responses to famine, often referred to as 'coping strategies', has shown that their priorities in times of food stress are to preserve productive assets to protect livelihoods, rather than to meet immediate food needs (Corbett, 1988).

On the other hand, an analysis of food security requires a systems approach. The Global Environmental Change and Food Systems (GECAFS) Project have advocated this approach: a joint project of the International Geosphere-Biosphere (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme (WCRP). According to Ingram (2010) a food systems approach "…systematically connects the activities of food producers, processors, distributors, retailers and consumers involved in food systems to food security and environmental outcomes." (Ingram, 2010:3). According to Vincent and Cull (2009), a food systems methodology is also useful as it provides room for recognising the compound drivers that play a part in bringing about a situation of food security or insecurity in any given place at any given time, and also analysis of the interactions and feedbacks operating between these factors (Vincent and Cull, 2009).

Despite climate change being a major stress to food systems, particularly in southern Africa; other multiple stresses also play a role in influencing vulnerability, including conflict, HIV/AIDS, governance, the growth in interest in bio fuels, and market fluctuations, as seen in 2008 (Eide, 2008; Evans, 2008). However, the critique of food systems approaches lies in that ultimate food security is a principal outcome of

any given food system.Ingram, Ericksen and Liverman, (2010) advance that although in many cases food security is not achieved; instead, people are undernourished and face regular hungry seasons, or struggle with a host of non-communicable diet-related diseases, or spend the major portion of their income on poor or inadequate diets (Ingram *et al,* 2010).

Alternatively, analysis of food security requires a systems approach. In this case, food security analysis under these terms tends to have been based on a systems or livelihoods perspective and encompasses four main elements of food security, the availability, stability, utilisation, and access to food. Climate change is likely to impact on all four of these elements, not just on availability (Vincent and Cull, 2009). The Global Environmental Change and Food Systems (GECAFS) Project have advocated this approach: a joint project of the International Geosphere-Biosphere (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme [WCRP] (Vincent and Cull, 2009).

The GECAFS research programme investigated the vulnerability of human food systems to, and interactions with, global environmental change. The study was developed to address the growing need for integrated analyses of vulnerability and impacts of global environmental change on food systems, as well as adaptation options, and consequences of possible adaptation strategies on both socio-economic and environmental conditions (Ingram and Brklacich, 2002).

At a minimum, a food system includes the set of activities involved in producing food, processing and packaging food, distributing and retailing food, and consuming food

(i.e. linking commodity chains to consumers) (Ingram et al, 2010). To analyse the dynamic interactions among GEC processes, food systems and feedbacks from food system outcomes, the drivers of these activities and their social, environmental and food security outcomes are included (Ingram*et al*, 2010).

The drivers comprise the interactions between and within bio geophysical and human environments, which determine how food system activities are carried out. These activities lead to a number of outcomes, some contributing to food security and others contributing to environmental and social concerns. Some drivers also affect food system outcomes directly (e.g. household income levels or disease status). There are also interactions between the different categories of food system outcomes for example, between regulating ecosystem services and availability from local production, or between income levels and access to food (Ingram *et al*, 2010).

According to Ingram (2010),a food system methodologyanalytically connects the activities of food producers, processors, distributors, retailers, and consumers involved in food systems to food security and environmental outcomes (Ingram, 2010). Ingram advances that a food system approach can frame these activities as dynamic and interacting processes embedded in social, political, economic, historical, and environmental contexts (Ingram, 2010). A food system approach can help improve our understanding of the interactions between Global Environmental Change (GEC) and food security (Ingram, 2010). It can thus help identify a wider range of technical, management, and policy options available to address those interactions (Ingram, 2010:3).

A food systems approach gives room for a holistic analysis of all factors influencing food security. According to Vincent and Cull (2009), A food systems approach is also useful as it provides the space for recognising the multiple drivers play a role in bringing about a situation of food security or insecurity in any given place at any given time, and also analysis of the interactions and feedbacks operating between these factors (Ericksen, 2008). As well as climate change being a major stress to food systems, particularly in southern Africa; other multiple stresses also play a role in influencing vulnerability, including conflict, HIV/AIDS, governance systems, the growth in interest in bio fuels, and market fluctuations, as seen in 2008 (Eide, 2008; Evans, 2008).

However the criticism of food systems approaches lays in that ultimate food security is a principal outcome of any given food system, although in many cases food security is not achieved.According to Ingram *et al*, (2010) in some instances people are undernourished and face regular hungry seasons, or struggle with a host of non-communicable diet-related diseases, or spend the major portion of their income on poor or inadequate diets (Ingram *et al,* 2010).

Other approaches like The Household Economy Approach (HEA) and Sustainable Livelihoods Approaches (SLA) are extremely complementary to the Food Systems Approach, with HEA offering the opportunity of quantifying need (Save the Children, 2005). The Livelihoods Approach is valuable for understanding food insecurity as it accentuates the significance of looking at an individual's capacity for managing risks, as well as the external threats to livelihood security, such as drought (Chambers, 1989; Scoones, 1998; Carney, 1998; Moser, 1998 *cited in* Ziervogel, 2006).

The strength of the HEA lies in that it consists of a framework for analysing household economy and market information and field methods for collecting that information (Ziervogel, 2004). HEA, like many organizations' analytical tools, ordinarily examines most of the same elements as the "Sustainable Livelihoods Framework", but HEA places a greater emphasis on quantifying the outcomes of livelihood strategies pursued by different households and livelihood groups (Ziervogel, 2004). It enables the agency of individuals to be captured in their decision-making process (Ziervogel, 2004).

Among the philosophies of climate change lays the integral theory. Integral theory offers a framework that takes into account the bigger picture in which climate change is occurring, and thus it can offer insights on the types of responses and strategies that are necessary to confront the challenge responses that address all quadrants, levels, lines, states, and types (Wilber, 1996; Esbjörn-Hargens and Zimmerman, 2009; O'Brien, 2010).

Among the reasons why integral theory may be both useful and necessary for responding to climate change is that "Integral theory recognises the interior and exterior dimensions of climate change and of climate change research" (O'Brien, 2010:3). O'Brien further postulates that the problem of climate change canbe studied from both subjective and objective views, from the perspectivesof I, we, and it(s) (O'Brien, 2010). Integral theory draws attention to the role of individual cognition andconsciousness, and to the importance of collective values and beliefs as influenceson behaviour and systems (O'Brien, 2010). These subjective, interior dimensions representan important part of the picture, and they need to be considered in discussionsand debates about climate change (O'Brien, 2010).

According to integral theory, it is essential to recognise that responsesto climate change may also affect human development (O'Brien, 2010).Undeniably, one person or group's adaptation to climate change may increase the vulnerability of others; mitigation efforts can likewise influence development trajectories, either positively or negatively (O'Brien, 2010). The links between the systemic processes associated with climate change are linked to human development: the impacts of climate change can influence human development, just as human development can influence the future climate system (O'Brien, 2010).For example, it is clear that the effects of climate change may generatefurther challenges in meeting the Millennium Development Goals, particularly if climate variability and extreme events increase (Schipper and Pelling, 2006) *cited in* (O'Brien, 2010).

A key facet of the Integral theory lies in that "it recognises a diversity of needs and motivations, and hence responses" (O'Brien, 2010; 5). Climate change is anintricate phenomenon influenced by a host of factors and variables, be it political, social, economic, and geographical factors among others. There is no single cross-cutting solution to climate change, and it is unlikely that a single solution will be found (O'Brien, 2010). Overally the theory acknowledges that new technologies and innovations (e.g., efficient carbon capture and storage, harvesting solar power from space, geo-engineering) may take years to develop, and they may create new risks and problems (O'Brien, 2010).

2.5 Climate Change Adaptation Mechanisms

Globally societies have adopted various adaptation mechanisms. From traditional practices to modern practices, adaptation mechanisms have existed in many societies historically. This has seen in some instances traditional knowledge being integrated with modern knowledge to come up with more effective strategies and techniques. This section reveals a number of studies done to establish adaptation mechanisms in different parts of the world.

The extent to which communities have designed and implement adaptation mechanisms is evident across African communities at large. According to Thompson, Berrang-Ford, and Ford (2010), across Sub-Saharan Africa, communities have extensive experience in dealing with climatic uncertainties and food security implications. Subsistence livelihoods have evolved a number of coping mechanisms to manage weather variability, including drought years and low crop yield (Thompson *et al*, 2010). Dealing with the impacts of climate change requires measures that will minimise losses or take advantage of the opportunities presented referred to as adaptation (Orindi, 2009).

The Food and Agricultural Organisation (FAO) advances that adapting small-scale and rainfed agriculture to seasonal climatic variability can be ensured through effective quick-fix response strategies (autonomous adaptation) that are often the answer to short-term impacts of climatic variability (FAO, 2007). Balaghi *et al*, (2010) who postulate that autonomous adaptation may take several forms in terms of soil and land management, water management and conservation of agro-biodiversity support this. Autonomous adaptation to climate change will rely mainly on technological progress (agricultural yield improvements in arid and semi-arid conditions), irrigation (water management at the level of agricultural plot, catchment

area and region) and land use according to agricultural suitability (Gommes, El Hairech, Rosillon, Balaghi and Kanamaru, 2009) *cited in* (Balaghi *et al*, 2010).

Thompson*et al*, (2010) advance that "commonalities in coping are evident across diverse regions, involving a complex hierarchical decision-making process of sacrifice and use of support networks to endure periods of food insecurity (Thompson *et al*, 2010). These strategies initially involve responses including alterations to diet to include more famine foods, and during times of acute and, or prolonged stress borrowing from kin, selling productive assets, and eventually migration (Thompson *et al*, 2010). As famine progresses, survival strategies thus become more desperate, whereby domestic resources are increasingly committed and potential for reversing the strategies become more constrained" (Roncoli, 2001; Stock, 2004 *cited in* Thompson *et al*, 2010: 2720).

In a study by Lobell, Burke, Tebaldi, Mastrandrea, Falcon, and Naylor (2008), communities can cope with climate change, for example, by switching from producing corn to producing sorghum, whose lower water requirements and higher temperature tolerances are better suited to a warmer and drier climate (Lobell *et al*, 2008). However, this adaptation measure may be impossible to implement in many parts of the developing world (Lobell *et al*, 2008). For example, it assumes markets for millet in regions where only maize is eaten, and technology and expertise about how to process and consume sorghum in maize zones. Communities may nevertheless be forced, as they are today, to consume what they produce regardless of cultural preferences (Lobell *et al*, 2008).

Another study by Bryant, R.C., B. Smit, M. Brklacich, R.T. Johnston, J. Smithers, Q. Chiotti, and B. Singh (2000) of Canadian farmers, showed that farmers' responses vary when faced with the same climate stimuli, even within the same geographic area. Responses vary given the different agricultural systems and markets systems in which farmers operate as well as different individual characteristics and contexts such as personal managerial style and entrepreneurial capacity and family circumstances (Bryant*et al*, 2000; Gbetibouo, 2009). This reflects the broad nature of adaptation where different mechanisms are applied in different scenario. Thus indicating that there cannot be a one size fits all adaptation mechanism.

Supporting the notion that personal characteristics and conditions influence adaptation, several studies find that farming experience, socioeconomic position, and access to resources, credit, and extension services increase the probability of uptake of adaptation measures to climate change (Maddison, 2007; Nhemachena and Hassan, 2007). Furthermore, the nature of farmers' response to climate change and variability also depends on the socioeconomic position of the household— poor farmers are likely to take measures to ensure their survival while wealthier farmers make decisions to maximize profits (Ziervogel *et al*, 2006).

A study by Ringler, Bryan, Hassan, Alemu, and Marya Hillesland, (2011) found out that in Ethiopia, 73 percent and 83 percent of farmers perceived changes in temperature or rainfall, respectively, but 56 percent and 41 percent of farmers, respectively, did not undertake any adaptation measures (Ringler *et al*, 2011). Overall, 37 percent of farmers in Ethiopia did not adapt to either perceived changes in rainfall or temperature. Only adaptation responses mentioned by more than 1 percent of farmers are reported(Ringler *et al*, 2011). Among those farmers who did

adapt to climatic changes, the most common adaptation strategies include use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation (Ringler *et al*, 2011). Other responses reported less frequently, such as seeking off-farm activities, migrating to urban areas, changing farming type, using new technologies, and water conservation, are included in the ‘‘other’’ category (Ringler *et al*, 2011).

A study by Gbetibouo, (2009) for the International Food Policy Research Institute (IFPRI), examined the adaptation mechanisms employed by farmers in the Limpopo basin of South Africa (Gbetibouo, 2009). The study found out that, farmers' main adaptation strategies are switching to more drought tolerant crops, such as millet, and switching to different varieties of the same crop, such as more drought tolerant maize (Gbetibouo, 2009). They are also changing planting dates, increasing irrigation, building water harvesting schemes, changing the amount of land under cultivation, and buying livestock feed supplements (Gbetibouo, 2009).

Paul (1998) conducted a study on coping mechanisms practised by drought victims (1994/5) in North Bengal, Bangladesh. Indications were that when a drought occurs and domestic food stocks become exhausted or very low, efforts to raise cash through the sale of assets assume more importance (Paul, 1998). The survey data revealed that 88 per cent of all respondent households had sold belongings to reduce their vulnerability to the 1994/5 drought (Paul, 1998). As many as 166 (55 per cent) respondent households attempted planting dates, changing the amount of land under cultivation, and supplementing animal feeds (Paul, 1998). Other responses, such as crop diversification, which were reported by less than 1 percent of farmers, are included in the ‘‘other’’ to cope with the drought by selling their livestock, 112 (37

per cent) by selling their land and 106 (35 per cent) by mortgaging their land (Paul, 1998).

According to Paul (1998), conversations with the respondents, indicated that they sold about 5 per cent and mortgaged about 30 per cent of their land (Paul, 1998). A further twenty-six (9 per cent) respondent households sold other belongings such as poultry and housing structures (Paul, 1998). Only two respondents (1 per cent) mortgaged their livestock. No respondent spent previous savings or sold their valuable possessions such as jewellery to cope with the 1994/5 drought (Paul, 1998). It is important to note that most people in rural Bangladesh survive on a day-to-day basis. For this reason, few are able to save even part of their earnings (Paul, 1998).

However, a vast majority of the respondent households did defer the purchases of clothing and luxury items during the drought period (Paul, 1998). Contrary to expectations, members of only one respondent household migrated to another area. Migration is a typical response to drought (Paul, 1998). Drought victims migrate to other rural areas or cities in search of income-producing employment that can help them survive drought episodes (Paul, 1998).

2.6 Potential Adaptation Strategies

Ngigi (2009) identified a number of adaptation strategies employed in various places. The use of shallow wells and hand-dug wells to supplement the shortfall in water for dry-season irrigation is a potential adaptation option for rural households (Ngigi, 2009). This is coupled by the use of soil moisture improvement techniques such as

Zai, semi-moons, and mulching, which are practiced in northern Ghana, Burkina Faso, and Mali as adaptation strategies (Ngigi, 2009).

Adaptation remains a key factor in the battle against climate change. According to Thompson *et al,* (2010), adaptation responses can be in response to the three dynamics of food security, which are food availability, access, and adequacy. In relation to food availability, extensification and intensification are the major options documented to improve crop yields (Thompson *et al,* 2010).

According to Thompson *et al,* (2010), one estimate suggests that extensification could increase cereal production in Africa 47 percent by 2020. According to Thompson *et al,* (2010) extensification has future retrogressive implications, for creating further environmental dilapidation, with land coverage changes and deforestation found to contribute to CO2 emissions (Thompson *et al,* 2010). Therefore, for Thompson *et al,* (2010), intensification of agricultural land is seen as the most viable solution. This would require improving the quality of soil and maximising usage of water resources, which often require greater inputs (Thompson *et al,* 2010).

Edwards (2007) argues for the benefits of organic agriculture, whereby compost is utilised as a natural fertiliser (*cited in* Thompson *et al*, 2010). Projects in Ethiopia have shown much higher yields, both in comparison with no inputs and with chemical fertilisers. Manure is regarded as an input that could improve soil quality, and thus permit intensification. There remains debate, however, as to the potential for organic fertilisers to meet demands in soil fertility, and a more traditional approach has been the promotion of chemical fertilisers. While very common and quite heavily used in

the developed world, these are relatively absent in Sub-Saharan Africa (Thompson *et al*, 2010). While valuable for improved agricultural yields, increased use of fertiliser may also contribute to climate forcing through the introduction of increased nitrous oxide emissions from soils (Thompson *et al*, 2010).

Climate change has a serious reductionist impact on water sources creating potential agricultural challenges as well as affecting livestock. It is inevitable that climate change is already affecting water availability in most areas with the prevalence of droughts increasing. Crop irrigation has seen some success, and it is argued by some that it should be more widely implemented. Others however, highlight the limitations of subsistence farmers, and suggest that small-scale and affordable solutions would be more beneficial (Gregory, Ingram, Brklacich, 2005; Brown, 2009; Tingem, 2009) *cited in* (Thompson *et al*, 2010).

Genetic modification of seeds has become an important aspect in adaptation efforts in the light of boosting food security. According to Thompson *et al*, (2010) to better take advantage of limited water resources, certain crop varieties are also identified as important components of adaptation strategies (Thompson *et al*, 2010). Genetic modification is one possibility, in terms of the creation of drought-resistant or high-heat tolerance crop varieties. High-yielding seeds are additionally seen as a possibility to increase crop productivity. Furthermore, certain crop varieties have been identified and classified as underutilised, based on their potential value as being both highly productive in poor soil conditions and nutritionally beneficial (Thompson *et al*, 2010).

A final adaptive strategy for improving crop yield is modifying agricultural practices more directly. Thompson *et al*, (2010) argue that crop diversification is one possibility, whereby dual-land use agricultural systems may be used to grow some of the more staple crops for a specific region, along with an insurance crop in case of crop failure (Thompson *et al*, 2010). This would reduce food insecurity, whereby there is always at least one crop to fall back on. No-tillage farming is additionally seen as less disruptive to the soil, helping to maintain soil nutrients and water availability (Thompson *et al*, 2010).

According to Thompson *et al*, (2010)in terms of accessibility the primary adaptive approach to reducesusceptibility of financial capital, and thus improve market access when subsistence crops are not plentiful enough to provide food security, is livelihood diversification (Thompson *et al*, 2010). This is assumed to allow for sources of income that are not fully reliant upon the natural environment, and thus less vulnerable to climate change (Thompson *et al*, 2010). Off-farm employment is considered particularly viable for youth, who could earn money to send back to their families (Thompson *et al*, 2010). Physical market accessibility remains a challenge with respect to general improvements in urban, rural, and transportation infrastructure (Thompson *et al*, 2010).

According to Ngigi (2009), the beginning of water shortages in some areas has impelled for more efficient use of water through drip irrigation and the choice of high yielding and high-value crops (Ngigi, 2009). The use of drought-resistant crop varieties and the improvement of on-farm irrigation efficiency using better water application technologies are all methods that have been tried by smallholder farmers

as adaptation methods to climate change in Nigeria, Senegal, Burkina Faso, and Ghana (Ngigi, 2009).

Bunds, agro forestry, crop rotation, and rainwater harvesting have all been effective adaptation strategies to climate change and variability. Agricultural diversification such as the integration of livestock and crops (mixed farming) has also being practiced in some of the countries with good results (Ngigi, 2009). The alternative use of waste water for irrigation as in peri-urban irrigation schemes is another strategy for adaptation to climate change as well as migration to wetter regions (from drier to wetter regions), in pursuit of wetter and more fertile lands is another option especially for pastoralist households (Ngigi, 2009). Non-farm activities are an important strategy. According to Ngigi (2009), engagement in off-farm activities (e.g., small-scale gold mining referred to as galamsey in Ghana (Ngigi, 2009).

2.7 Climate Change and Development

Climate change will have a substantial impact on the pace of development progress in many regions. Bals, Harmeling, and Windfuhr, (2008) state that developing countries will need economic human development to overcome current shortages of basic goods and services. The Human Development Report 2007/2008 of the Development Program of the United Nations (UNDP), which analyses the connection between climate change and human development, comes to an alarming result:

> 'In the long run climate change is a massive threat to human development and in some places it is already undermining the international community's efforts to reduce extreme poverty' (UNDP 2007, v).

The report highlights the fact that the world is a heterogeneous place, where people have unequal incomes and wealth, and that climate change will affect regions very differently (Bals *et al*, 2008). Therefore, adaptation to climate change will be relatively easy in regions with lesser effects and sufficient resources, whereas poorer regions, with higher risks and vulnerability, will be disastrously affected. Existing income gaps risk being increased and deepened especially in the poorer regions of the world (Bals *et al*, 2008).

Africa's variable climate is already contributing significantly to its development problems (Hellmuth *et al*, 2007:8). According to Bals *et al*, (2008) key factors for the development of agriculture, a very important sector in African economies, such as water, energy, transportation, and health, are all particularly sensitive to climate variability and the increase of weather-related disasters (Bals *et al*, 2008). Other sectors of the economy, like industry and tourism, are at high risk due to climate change and water shortages (Bals *et al*, 2008). Vulnerability of economies to climate shocks is unequally distributed, and the risk increases dramatically as poverty increases (Bals *et al*, 2008).

It will be poorer people who will suffer most from the effects of climate change. For Bals *et al,* (2008) poorer people will be confronted with substantive changes in their livelihoods and many will be at the fringe of their coping capacities.They will have relentlesschallenges dealing with weather extremes and other shocks. The United Nations reported that, "Some 262 million people were affected by climate disasters annually from 2000 to 2004, over 98 percent of them in the developing world" (UNDP 2007: 16).

It remains unfortunate that poverty-stricken people who never contributed to climate change are most vulnerable and heavily affected by climate change. According to Bals *et al,* (2008) the right to development for the poor will be seriously threatened. The process of human development is increasingly going to be influenced or hindered by climate change. The fight against poverty and the fight against the effects of climate change must be seen as interrelated issues (Bals *et al*, 2008).

Climate change is expected to substantially affect the realisation of most Millennium Development Goals (MDGs) in Africa. In addition, investments in adaptation will require financial resources, which in turn would bind resources needed to invest in poverty reduction (Bals *et al,* 2008). The additional challenge of climate change thus requires additional resources.

The Human Development Report (HDR) 2007/2008 summarises the challenge quite well:

> "How the world deals with climate change today will have a direct bearing on the human development prospects of a large section of humanity. Failure will consign the poorest 40 percent of the world's population – some 2.6 billion people – to a future of diminished opportunities. It will exacerbate deep inequalities within countries. And it will undermine efforts to build a more including pattern of globalisation, reinforcing the vast disparities between the ‚haves ´and the ‚have nots" (UNDP, 2007:8) *cited in* (Bals *et al*, 2008).

Therefore, climate change effects will further compound to the woes of the developing nations. Where HIV/AIDS, corruption, cholera among other factors have stifled development efforts in the developing world climate change will further add to

these troubles. It is undeniable that a many of African countries will not meet the Millennium Development Goals and with the advent of climate change, this puts the continent in a dire state (Bals *et al*, 2008).

2.8 Review of Food Insecurity Coping Strategies inSouth Africa

This sub-section reviews the recent studies of food insecurity coping strategy related work in South Africa. The available literature on food insecurity coping strategies shows that food insecurity exists among households in South Africa (Majake, 2005; Hendriks, 2005; HSRC, 2004; Monde, 2003). In QwaQwa, food insecure households commonly employed food consumption coping strategies (Majake, 2005). The objective of the study conducted by Majake (2005) was to evaluate the impact of food security packages on households in QwaQwa.

A survey of 60 households, half of whom received food security packages conducted between April and June 2004 came up with a number of coping strategies employed by households. The study showed that the strategies employed by households to survive included most severe coping strategies, eating from dustbins and sending households out to beg. Relying on less preferred foods such as eating porridge with tea, jam or animal fat were identified as the least severe strategies employed by households in QwaQwa (Majake 2005).

Oldewage-Theron *et al,*(2006) observed similar strategies for coping with food security in the study conducted in the Vaal Triangle (Oldewage-Theron *et al,* 2006).The objective of this study was to determine household food security and coping strategies of an informal settlement in the Vaal Triangle. The households

employed food consumption coping strategies to cope with food insecurity. The coping strategies used were limiting the variety of foods served (practiced by 75 per cent of households); limiting portion sizes (80 per cent of households); skipping meals (60 per cent of households) and maternal buffering (76 per cent of households). The study concluded that the area is a poverty-stricken community with household food insecurity where the caregivers changed their food consumption patterns to cope, resulting in compromised nutrition (Oldewage-Theron *et al,* 2006).

A study conducted by Maliwichi, Bourne, and Mokoena (2003) in Khayelitsha also showed that households employed consumption coping strategies to alleviate food insecurity. The aim of this study was to investigate the coping strategies of households in Khayelitsha, Cape Town to ensure household food security (Maliwichi *et al,*2003). The findings showed that 70 per cent of the households in the informal settlement used short-term coping strategies. These included borrowing money (from friends or relatives) to buy food; borrowing food from neighbours or friends; purchasing food on credit; relying on help from friends/neighbours and maternal buffering (i.e. mothers limiting their food intake to ensure children get enough food to eat (Maliwichi *et al,*2003).

Ziervogel*et al,* (2006) conducted a study in Sekhukhune on household coping ad adaptation mechanisms where 597 individuals were interviewed across five municipalities. In Sekhukhune, many households have developed a wide range of coping and adaptation strategies in response to changing conditions that affect their livelihoods and well-being (Ziervogel *et al*, 2006). The objective of Ziervogel *et al,*(2006) study was to identify and assess integrated and cross-sectoral adaptive management opportunities. The study showed that household employed short-term

coping strategies that included the following: relying on piecework; eating less preferred food; reducing number of meals a day; limiting portion size of meals; borrowing food; eating elsewhere and purchasing food on credit (Ziervogel *et al,* 2006).

Therefore, a host of adaptation and coping mechanisms are available. Some which are directly in response to the climate change, whilst some are indirect thus responding to the effects and impacts of climate change. There is need for integration of mechanisms so that climate change can be dealt with at an early stage. The direct effects of climate change are critical and adaptation strategies that effective and efficiently respond to climate change are of essence.

2.9 Evidence of Climate Change

There has been significant evidence to prove that climate has been changing. Signs of a changing climate in Africa have already emerged with spreading disease and melting glaciers in the mountains, warming temperatures in drought-prone areas, and sea-level rise and coral bleaching along the coastlines becoming very much pronounced. The maximum temperature in Kericho, in Kenya's Rift Valley Province, has increased by 3.5°C during the past 20 years (Africa - Up in Smoke 2, 2007 as *cited in* Joto Afrika, 2009). Lake Chad has shrunk from 26,000 square kilometres in the 1960s to just 1,500 in 2000 (Africa - Up in Smoke 2, 2007 *cited in* Joto Afrika, 2009).

The ice caps on Africa's highest mountains are receding; Mount Kenya has lost 92 percent of its glaciers in the last 100 years (Africa - Up in Smoke 2, 2007 *cited in* Joto Afrika, 2009). A number of studies have proved that climate change is certainly

taking place and at an alarming rate. According to the South African Weather Services (SAWS), Climate models predict that the mean air temperature over South Africa will increase by an estimated 2°C over the next century. Plants and animals may not be able to adapt as quickly to this rapid climate change as humans can, and therefore the whole ecosystem is in danger (SAWS, 2011).

The Intergovernmental Panel on Climate Change released its Forth Assessment Report AR4 (IPCC, 2007). This report presents significant evidence that climate change is occurring. Global average air temperatures are rising and have risen in eleven of the last twelve years (1995-2006) ranking amongst the twelve warmest years in the instrumental record of global surface temperature. The 100 year linear trend (1906-2005) of 0.74°c is larger than the corresponding trend of 0.6°c (1901-2000) given in the Third Assessment Report (TAR), published in 2001 (IPCC, 2001). This trend for temperature increase occurs across the globe, and is slighter greater at higher northern latitudes. Warming is also occurring in Africa, with the Third Assessment Report (TAR) noting an average decadal warming of 0.05°c, over the 20th century, with the five warmest years occurring since 1996 (Desanker and Magadza, 2001 *cited in* Vincent and Cull, 2009).

2.10 Evidence of Food Insecurity in South Africa

A number of studies have been carried out and showed that rural households are the most food insecure and most vulnerable to food shocks. Where food security has been analysed using the adequacy aspect, which questions the nutritional value, expenditure for each household based on 2005/2006 Income and Expenditure Survey (IES) data gets compared to two dietary energy cost baskets (Jacobs, 2009).

The food expenditure shares of the poorest households vary between 38% and 71% according to different surveys (Jacobs, 2009). At food expenditure levels reported in the IES, one in five households met their average dietary energy cost. Deep levels of food insecurity exist in rural areas with 85% of rural households unable to afford even the 'below average dietary energy costs' (Jacobs, 2009).

2.11 The Impact of Climate Change on Food Security

There is now clear evidence about the impact of climate change on natural ecosystems and hence agriculture and the entire food system (IPCC, 2007). In as much as some individuals have questioned the presence of climate change, studies have shown that climate change affects all facets of food security. The impact of climate change is however spatially heterogeneous across a diverse range of geopolitical scales.

For instance at the international level, the risk is generally believed to be more acute in developing countries because their economy relies heavily on climate-sensitive sectors, such as agriculture and fisheries, and have a low GDP, high levels of poverty, low levels of education and limited human, institutional, economic, technical and financial capacity (IPCC, 2007; UNFCCC, 2007; WBGU, 2008).

The impact of climate change on food security has been identified as a major concern given marginal climatic conditions in many parts of Africa, subsistence livelihoods, and limited resources for adaptation (Thompson *et al*, 2010). In particular, the predominance of rain-sustained agriculture in much of Sub-Saharan African results in food systems that are highly sensitive to rainfall variability. The

Challenge Program on Climate Change, Agriculture, and Food Security (CCAFS) 2009, International Center for Tropical Agriculture (CIAT) and the International Livestock Research Institute (ILRI) have taken outputs from climate simulation models and data from various sources to simulate the growth, development and yield of maize crops over sub- Saharan Africa and Central and South America. The results showed an aggregate yield decline by 2055 for smallholder rain fed maize production of 10%, representing an annual economic loss in the order of US$2 billion (Moorhead, 2009).

A study by the International Food Policy Research Institute (IFPRI), titled 'Climate change: Impact on agriculture and costs of adaptation', highlighted some of the anticipated costs of climate change:

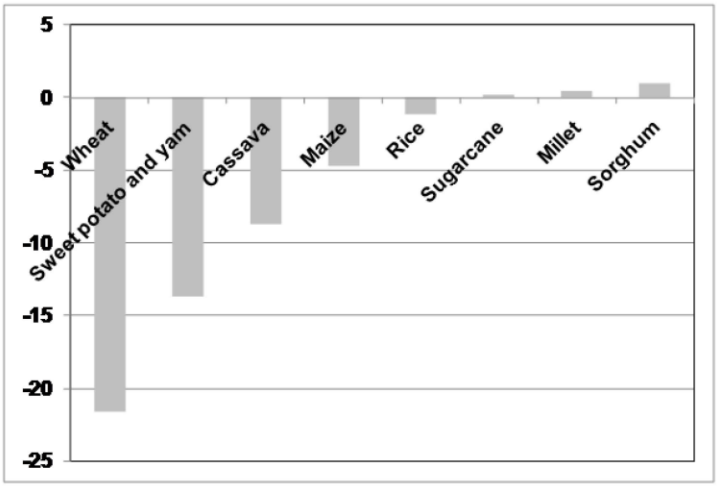
- In developing countries 25 million more children will be malnourished in 2050 due to climate change without serious mitigation efforts or adaptation expenditures
- Irrigated wheat yields in 2050 will be reduced by around 30% and irrigated rice yields by 15% in developing countries
- Climate change will increase prices in 2050 by 90% for wheat, 12% for rice, and 35% for maize, on top of already higher prices.
- At least US$7 billion a year are necessary to improve agricultural productivity to prevent adverse effects on children (Moorhead 2009:6)

2.12 Potential Impacts on Crop Yields in Sub-Saharan Africa

It is of note that, the current, short term and long term consequences of climate change to food production are devastating. According to Ringler, Zhu, Cai, Koo and

Wang, (2010), “Climate change will affect crop area, yield, and production”. Negative yield impacts are projected to be largest for wheat, followed by sweet potato, whereas overall yields for millet and sorghum are projected to be slightly higher under climate change. Although negative impacts are largest for wheat, the region grows very little of it [about 4.3 million ha in 2000] (Ringler *et al*, 2010).

Figure 6: Yield changes by crop because of climate change, 2050, Sub-Saharan Africa (percent change)



Source: (Ringler *et al*, 2010)

2.13 Impacts on Food Demand, Prices, and Trade

Due to climate change, aggregate food demand for cereals in the Sub-Saharan region is set to decline by 3.6 million metric tonnes or 1.5 percent by 2050(Ringler *et al*, 2010). Among agro ecological zones, declines are largest for Central and Southern Africa, at 2.5 and 2.1 percent, respectively, and lowest in the Gulf of Guinea, at 0.9 percent(Ringler *et al*, 2010). These differences are due to the relative impacts on cereal area and yields in the regional food baskets, as well as relative changes in global food prices of individual cereals (Ringler *et al*, 2010).

The effect of climate change is closely observed in the global agricultural market. According to Ringler *et al*, “world prices are a key indicator of the effects of climate change on agriculture and even more importantly, food affordability and security” (Ringler *et al*, 2010).The impact of climate change on prices is inevitable on key cereals. Food prices increase for all staple crops because climate change acts as an additional stressor on the already tightening price outlook (Ringler *et al*, 2010).

Ringler *et al,*(2010) further advance that under climate change, maize, rice, and wheat prices in 2050 are 4, 7, and 15 percent higher than in the historic climate scenario. Moreover, prices of other crops of importance to the region also increase: sweet potato and yams by 26 percent, cassava by 20 percent, millet by 5 percent and sorghum by 4 percent (Ringler *et al*, 2010). Impacts of higher food prices on the net food purchasers will be substantial, depressing food demand in the longer term and increasing childhood malnutrition rates (Ringler *et al*, 2010).

Research on the effects of climate change on world agricultural markets are still relatively limited (Ringler et al, 2010). Ringler *et al*argue, “Climate change alters the comparative advantage, setting up the possibility of changes in trade flows as producers respond to changing opportunities” (Ringler *et al*, 2010). More generally, agricultural trade flows depend on the interaction between the inherent comparative advantage in agriculture, which is determined by climate and the resource endowments, and a wide-ranging set of local, regional, national, and international trade policies (Ringler *et al*, 2010).

Across Sub-Saharan Africa, little change in net cereal imports is expected because of climate change because increases and declines in net cereal imports balance out (Ringler*et al*, 2010). Regarding changes in net cereal trade across agro ecological zones, Eastern Africa is projected to experience the largest increase in net cereal imports, at 15 percent, because of climate change, probably due to the large decline in maize yields. For the Sudano-Sahelian zone, a steep decline in net cereal imports (6 percent) is also projected, again driven by changes in maize yields (Ringler *et al*, 2010).

2.14 Household Food Security in South Africa

Despite South Africa being relatively wealthy compared to most other African countries, more than half of the country's population lives in poverty, and about one third of the labour force is unemployed (FAO, 2003; World Bank, 2003). Food insecurity is not an exceptional, short-term event, but is rather a continuous threat for more than a third of the population (HSRC, 2004 *cited in* Food Security Information Brief, 2006). According to Ludi (2009) the United Nations Development Programme (UNDP) warns that the progress in human development achieved over the last decade may be slowed down or even reversed by climate change, as new threats emerge to water and food security, agricultural production and access, and nutrition and public health (Ludi, 2009).

In per capita terms, South Africa is an upper middle-income country (Pauw and Mncube, 2007). Despite this relative wealth, about 43 per cent of South African households experience poverty and continuing vulnerability (Du Toit and Ziervogel, 2004). Food supplies at a national level in South Africa are adequate to feed the

entire population (de Klerk *et al,* 2004). However, a number of studies have revealed evidence of under-nutrition among certain segments of the population (Rose and Charlton, 2001). This means the country produces its main staple foods, exports its surplus food, and imports what it needs to meet its food requirements (de Klerk *et al,* 2004).

Yet, the picture at the level of households is very different. An increase in national food production does not guarantee food security. Despite South Africa being considered self-sufficient in respect to food production, food insecurity continues to remain a substantive developmental challenge (de Klerk *et al,* 2004). A substantial number of households purchase food to meet dietary requirements (de Klerk *et al,* 2004). The food insecurity situation in South Africa is likely to increase due to the impact of the HIV/AIDS pandemic and increases in food prices (Hendriks, 2005).

The Human Science Research Council [HSRC] (2004) conducted a study that focused primarily on policy issues that have to be adequately addressed by respective Departments that may be important for discussion between respective parties in developing strategies to address poverty and expenditure plans for the medium term. The study reported that approximately 1.5 million South African children suffer from malnutrition, 14 million people are vulnerable to food insecurity, and 43 per cent of households suffer from poverty (HSRC, 2004; Rose and Charlton, 2002). Therefore, it is evident that food security is a looming crisis if diligent adaptation/coping mechanisms are employed to cushion households from the devastating effects of climate change.

Measurement of household food security has come with some uncertainty in South Africa. Accordingly, different measurement tools have come up with different statistics on household food security. Nevertheless, the situation of household food security is still a challenge to most South Africans living in poverty, especially in the rural areas of the country. Altman, Hart, and Jacobs (2009) who argue that, "the General Household Survey indicates that in 2007 10.6% and 12.2% of adults and children, respectively, were sometimes or always hungry" (Altman*et al*, 2009), illustrate this.

This was in contrast, with the National Food Consumption Survey (NFCS) of 2005 which found out that 52% of households experience hunger (Labadarios *et al*, 2008, Labadarios *et al,* 2009 *cited in* Altman *et al*, 2009)". Further to that, another 33% of households are vulnerable to hunger, meaning that food inflation and the loss of income might further expose them to hunger (Altman *et al*, 2009). The GHS is a large household survey accorded official status, while the NFCS is a much smaller survey, not accorded official status. Nevertheless, the findings of the NFCS require further exploration (Altman*et al*, 2009). The GHS asks a very basic question about whether household members were hungry. The NFCS collects deeper information about nutrition, height and weight, as well as household choices made in a context of limited income" (Altman*et al*, 2009:11).

2.15 Summary

Despite being a relatively new research field, a lot of work has been done to try to explain climate change adaptation. As indicated in the discussions throughout the chapter, despite the differences in different definitions and contexts, all point out to

adaptation as a key factor in reducing the vulnerability of communities to the effects of climate change. This chapter discussed the concepts of climate change adaptation, household food security as well as the state of food security in South Africa. The face of food security has changed over years, with food security becoming a broader concept. Analysis of food security has gone beyond the production aspect, moving on to analysis of food access, adequacy, and stability.

Chapter 3

Climate Change Adaptation and Food Security in South Africa

3.1 Introduction

The following section presents an extended literature review and highlights some of the key debates and discussions informing the climate change adaptation and food security discourse. The section also discusses policy frameworks informing climate change and food security as well as the state of both food security and climate change adaptation in South Africa. This section seeks to present a holistic overview of food security, climate change in South Africa, and the historical origins of food insecurity issues affecting adaptation at a global level.

3.2 Origins of Food Insecurity in South Africa

South Africa is reckoned food secure producing enough staple foods or having the capacity to import food needed to meet the requirements of the population FAO (2008) *cited in* Du Toit (2011). However, some schools of thought have since argued that the country is only food secure at the national level. Hart *et al,*(2009) supported the argument that South Africa seems to be food secure at national level, but stated that the same cannot be said about households in rural areas (Du Toit, 2011).

In order to understand the context in which food insecurity exists in South Africa, it is critical to give a historical background of food security. One school of thought argues that food insecurity in most African countries, including South Africa, is a product of historical injustices dating back to the apartheid era (DAFF, 2002). The Department

of Agriculture, Forestry, and Fisheries (2002) in its Integrated Food Security Strategy (IFSS):

> "Poverty and food insecurity in South Africa is the result of several centuries' worth of colonial and apartheid policies, designed specifically to create general conditions unfavourable to the well-being of black people in all its aspects, especially in the former homelands" (DAFF, 2002:18).

Accordingly, contemporary South Africa evolved at the turn of the 20th century from an agrarian setting through the rapid growth of commodity markets that sprung around major industrial mining, urban population, and commercial agriculture centres (DAFF, 2002).

Initially, African farmers and entrepreneurs had successfully participated in the growing commodity markets under conditions of relative land abundance, low population size, low production, processing and distribution technologies, weak government interventions and relatively undistorted markets (DAFF, 2002).

Because of the political and economic policies of the Apartheid regime that forced blacks to become the providers of cheap wage labour for the mining, industry and large-scale agriculture, the situation of relative food security in South Africa among the majority of the population was to change. Impelled by its social and economic imperatives, successive white governments throughout the greater part of the 20th century transformed agrarian 19th century society through a two-pronged strategy that set in motion a process that would simultaneously cripple and debar African farming and entrepreneurial development (DAFF, 2002).

This strategy aimed at establishing white farmers and industrialists as the leaders and chief beneficiaries of industrial development in South Africa (DAFF, 2002). The demise of subsistence farming led to a gradual loss of agricultural and rural capital, wealth, farming and entrepreneurial skills and experience (DAFF, 2002). Farming and rural enterprise activities ceased to be a window of African entrepreneurial opportunity, management and technical development (DAFF, 2002).

The process of modern industrial development in South Africa thus became the driving force that created the contemporary poverty and food insecurity among black people in South Africa. The position of African people in the urban areas was not much better than in the reserves and former homelands. They were forced to live far from places of work and from the white population. The primary purpose of urban areas was to provide labour to the mines, industries and the white population. Most South Africans had limited access to education, health and social services. Largely these historical legacies led to the current situation, in which a majority of citizens (particularly Africans) are vulnerable to food insecurity. This occurs in spite of the good food security conditions at national level (DAFF, 2002).

3.3 Dimensions of the IFSS

In 2002, the Department of Agriculture and Fisheries (DAFF) presented the Integrated Food Security Strategy (IFSS) as a policy mechanism through which to tackle issues around food security.The contemporary food security challenge in South Africa is two pronged. The first dimension seeks to maintain and increase the ability of South Africa to meet its national food requirements whereas the second dimension seeks to eradicate the widespread inequalities and grinding poverty

among the majority of households. that is according to the IFSS poverty and inequality is manifested by inadequate and unstable food supplies, lack of purchasing power, weak institutional support networks, poor nutrition, inadequate safety nets, weak food emergency management systems and unemployment (DAFF, 2002).

3.4 Current Food Security Trends in South Africa

- **National Food Security**

According to the DAFF (2002), South Africa is food secure at the national level. It produces its main staple foods, exports its surplus food, and imports what it needs to meet its food requirements. National food security indicators reveal that South Africa has been meeting the food needs of its growing population from domestic sources in the past 20 years. Except for rice, for which the country has no domestic resource base and which it hence imports, the country has met the needs for its main staple food, such as maize by over 100% from domestic resources. The country also met its requirements for wheat, the second most important food product by up to 95%, livestock needs by 96% and its dairy products (excluding cheese) by 100% (DAFF, 2002).

- **Household and Intra-household Food Insecurity**

In the year 2000, Statistics South Africa, estimated that roughly 35% of the total population, or 14.3 million South Africans, are currently vulnerable to food insecurity. Among these, women, children and the elderly are particularly vulnerable (Stats SA, 2000). In 1996, nearly a third or 2.8 million of households spent less than R1 000 per

month, while only 18% or 1.63 million households spent more than R3 500 per month on food (DAFF, 2002). These figures disguise the bi-polar mode of income distribution that characterises South Africa; simply put, however, South Africa has many poor, food-insecure people, and a few wealthy ones (DAFF, 2002).

DAFF reported in 2002 that the distribution of poverty in the country is uneven in its spread and intensity (DAFF, 2002). Gauteng and the Western Cape are wealthier provinces with the lowest number of poor households (less than 12% each) in the country (DAFF, 2002). At the other extreme, the Free State, Eastern Cape and Northern provinces have the worst poverty in South Africa (DAFF, 2002). In the middle group are Mpumalanga, KwaZulu-Natal, Northern Cape, and North West Provinces (DAFF, 2002). The average household of Gauteng spends around R7 742 per month compared to R2 665 in the Eastern Cape. Within the provinces, there is an unequal distribution of poverty betweenurban, rural,and according to race and gender (DAFF, 2002).

Further probing the extent of food insecurity in South Africa, the 2010 General Household Survey conducted by Statistics South Africa (SSA) reported that an estimated 21,9% of South African households had inadequate or severely inadequate access to food. Food access problems were the most serious in the North West where 33,3% of households had inadequate or severely inadequate access to food (Statistics South Africa, 2011), followed by KwaZulu-Natal (26,9%), Northern Cape (26%), Free State (23,6%) and Limpopo (20,6%), Eastern Cape (20,3%), (SSA, 2011).

3.5 Measuring Food Security in South Africa

The necessity to measure food security has led to a number of debates on the most reliable measurement. Unfortunately, this has led to a situation in which the country has altogether failed to agree on and adopt a measure that defines food security. Altman, Hart and Jacobs(2009) revealed that in South Africa, there are no specific and accepted measures of food security and there are no regularised ways of monitoring it. The challenges compounding food security measurement in South Africa stem from the fact that food security is a complex and difficult topic in itself. According to Altman*et al,*(2009) food security is anexpansive concept and the meaning and the measurement thereof is not as clear as it may seem.

Food security is multidimensional considering that it has four levels of measurement (adequacy, availability, access and stability) and three levels of analysis [national, regional and household] (du-Toit, 2011). Precise measurement and policy targeting, consequently, remain a challenge due to the many dimensions involved. Different institutions to assess food security at household level falling into different contexts have used various methods (du-Toit, 2011). According to Labadarios *et al*, (2009):

> "National Food Consumption Survey (NFCS); Food Insecurity and Vulnerability information and Mapping System (FIVIMS); General Household Survey (GHS); Income and expenditure Survey (IES); Community Survey (CS); South African Social Attitudes Survey (SASAS); Labour Force Survey (LFS); are some of the national surveys conducted to assess food security status in the country" (Labadarios*et al,*2009) *cited in* (du-Toit, 2011).

These many measures of food security however complement each other, coming up with different measurements and analysis. Du-Toit (2011), states that due to the complexity of food security, these methods yield different results. The GHS, IES, LFS and Community Survey, which are implemented by Statistics South Africa, currently inform the South African government policy formulation process (du-Toit, 2011). However, this study made use of the General Household Survey (GHS), National Food Consumption Survey (NFCS) as well as the Income and Expenditure Survey (IES)(du-Toit, 2011). Although the emphasis of this paper lay on assessing the adaptation mechanisms employed by households in order to achieve household food security, it was critical to reflect on the measurement of food security (du-Toit, 2011).

3.6 South Africa's Food Security Policy Context

South Africa's food security policy is located within a broader regional and international context. According to the DAFF (2002), South Africa and the other Southern African Development Community (SADC) countries are working together on achieving regional food security. This SADC-wide strategy seeks to establish national, household, and individual food security. SADC established the Food, Agriculture, and Natural Resource Unit (FANR), based in Harare, Zimbabwe in the early 1980s, specifically to address food security issues in Southern Africa. In recent years, the public institutions that were charged with the mandate of working towards food security have increasingly come to realise the importance of 'smart partnerships' with non-public institutions.

On the international level, South Africa pledged to support the World Food Summit Plan of Action that was encapsulated in the 1996 Rome Declaration on World Food Security. The Declaration, in its broadest sense, urged the promotion of optimal allocation of natural resources and the efficient use of public and private sector resources to achieve the global food security goal (DAFF, 2002).

South Africa further committed itself to creating an enabling political, social, and economic environment and to implementing policies to eradicate poverty. It pledged to ensure that technology development, farm management, trade and growth policies, and distribution systems would improve food security. As a response to the Rome Declaration, the government appointed a Food Security Working Group to investigate options on how to achieve food security in South Africa. The IFSS builds on the proposals made in the 1997 Discussion Document on Food Security (DAFF, 2002).

3.7 Agriculture in South Africa

In the past, agriculture played a crucial role in the South African economy and to date it continues to be an important aspect contributing to the livelihoods of millions of South Africans that live in poverty (Vink and Kirsten, 1999:204; Department of Agriculture, 2000:1; Mohamed, 2006). Even though the contribution of agriculture to the total gross domestic product (GDP) of South Africa has declined in recent years, agriculture remains of crucial importance for poor rural households. With the advent of mining, industrialisation and an improved welfare system, agriculture has ceased to become a major income earner. According to Mohamed (2006), the sector continues to play a significant role in the South African economy, because it has

strong linkages with the rest of the economy and contributes significantly to employment.

At the beginning of the 21st century, primary agriculture accounted for about 5 % of South Africa's GDP (Townsend, 1997:7; Vink and Kirsten, 1999:204; Department of Agriculture, 2001:4; 2005:12; Vink and Kirsten, 2003:11; Department of Agriculture, 2006:10; Mohamed, 2006), whilst the agro-food complex accounted for 14 % (Department of Agriculture, 2001:4; 2003: Vink and Kirsten, 2003:11). The agro-food complex refers to the combination of primary production, the agricultural input sector and the agro-processing sector (Mohamed, 2006). In terms of employment, agriculture accounted for approximately 10 % of formal employment in South Africa at the end of the 20th century (Vink and Kirsten, 1999:204; Department of Agriculture, 2001:4, 2006:10).

Agriculture in South Africa is of a dualistic nature. Vink and Kirsten (2003) and Kirsten (2005) consider the dualistic structure of South African agriculture to be one of its most important defining features. The South African agricultural sector consists of a well-developed commercial and a poorly developed smallholder component (Vink and Kirsten, 2003; Kirsten, 2005). The large-scale commercial farming component consists of approximately 50 000-land holders, who are predominantly white. They hold the bulk of the agricultural land and produce more than 95 % of marketed farm output (Vink andKirsten, 2003; Kirsten, 2005).

Apart from the large-scale commercial farmers an estimated 240 000-smallholder farmersalso market at least part of their produce (Kirsten and Satorius, 2004). They are active on local and regional markets where the majority of informal traders make

their living (Kirsten and Satorius, 2004)*cited in* (Mohamed, 2006). An additional 2.76 million households engage in different forms of farming aimed mainly at producing food for home consumption (Kirsten and Satorius, 2004*) cited in* (Mohamed, 2006).

African smallholders dominate in the former homelands. These territories cover about 13 % of the total agricultural land of South Africa (Vink and Kirsten, 2003; Kirsten, 2005). According to the Department of Agriculture (2001, 2004, and 2006), Kirsten and Satorius (2004), the smallholder sector is particularly important, because it provides full or part-time employment to many people (DAFF, 2001, 2004, 2006; Kirsten and Satorius, 2004) *cited in* (Mohamed, 2006).

Agriculture everywhere in the world is subject and dependent on many factors, water being a particularly critical factor. According to Mohamed (2006), a limiting factor to agriculture in South Africa is the availability of water. The average annual rainfall in South Africa is 470 mm and 60 % of the country receives less than 500 mm, which is the lower limit for sustainable rainfed cultivation of crops in this country (Mohamed, 2006; Bruwer and Van Heerden, 1995).

In the South African context, agricultural activity is spread across different localities due to the spatial distribution of rainfall in the country. Mohamed (2006), states that rainfall is distributed unevenly across the country. Mean annual rainfall ranges from less than 10 mm in the western deserts to 1200 mm in selected parts in the east of the country (FAO *cited by* IPTRID, 2000; Backeberg, 2003; Department of Agriculture, 2006). The challenge posed by the low rainfall is further worsened by the extreme evaporation experienced throughout the country particularly during the summer periods when temperatures are very high (Lahiff, 1997; Mohamed, 2006).

Under these conditions, full or supplementary irrigation has become one crucial way of sustaining agriculture (Van Averbeke, M'Marete *et al*., 1998; Mohamed, 2006).

3.8 The Scope of Food Security Policy

According to Maxwell (1990), food security ought to focus largely on livelihood security and on the efficient and equitable operation of the food system. The concern of food security is with the production, marketing, and consumption of food, with increasing and stabilising food supply, with reducing and stabilising food prices, and with targeted food and nutrition interventions aimed at vulnerable groups (Maxwell, 1990). Food security is no longer merely concerned with food availability at the national level, but increasingly focuses on access to food at the household level (Maxwell, 1990). Again, Maxwell (1990) points to the fact that food security should be seen as an organising principle, which will produce a coherent policy stance and an overall strategy rather than a series of projects labelled food security (Maxwell, 1990).

For Monde (2003), strategies are supposed to lead to action. Food security strategies, therefore, should lead to a set of linked policies and programmes designed to improve access to food. Targeting, which most commonly refers to interventions like food subsidies or public employment programmes designed to reach specific vulnerable groups, is one way of reducing the cost of food security interventions (Monde, 2003). This study found the need for food security strategies to be specifically linked to climate change adaptation measures. This recognises the importance of a holistic approach to climate change, whose effectsaffect all facets of the food systems.

Before proceeding it is important to examine a range of food security interventions, including national food policy, regional and district projects, and community based interventions (Maxwell, 1990:7). According to Devereux (2001), good food security policies are those that make provision for transfers and safety nets for those who are in need of them. Devereux (2001) distinguishes between transfers and safety nets. He defines a transfer as any donation of cash or commodities that are given either free or subsidised (Devereux, 2001).

For Devereux (2001), justification for transfers and safety nets is that powerful interest groups can pressurise the government into introducing food subsidies and other policies that benefit poor and vulnerable groups (Devereux, 2001). The implementation of transfers and safety nets requires those involved in food security and nutrition programmes to have knowledge of the food security situation in a particular area, in terms of geographic and socio-economic characteristics, i.e. who is food insecure, how many, and how to reach them with appropriate cost effective food security interventions (Devereux, 2001).

Food security interventions require vigilant targeting. Devereux argues that, targeted interventions generally carry higher administrative costs than untargeted interventions (Devereux, 2001).Hence, most interventions in developing areas tend to be untargeted (Devereux, 2001:272). Devereux (2001) points out that identifying common characteristics of a vulnerable group tends to be simpler and cheaper than individual assessment. Group assessment allows for rapid and inexpensive identification of large numbers of beneficiaries at the cost of an acceptable degree of leakage to the non-needy. Devereux (2001) also stresses that an appropriate

intervention will depend on the objectives of the intervention and the capacity of the country to implement it(Devereux, 2001).

The capacity of a country to implement an intervention depends on several factors, such as whether there are cash and food resources available, social infrastructure such as clinics, available marketing system (strong or weak), human resources (literate and numerate personnel), as well as political and social considerations (Devereux, 2001:275). An example of a safety net programme is food aid, which is an emergency relief intervention. According to Devereux (2001), food aid usually comes in two forms. One is the emergency food aid, which is provided by the world food programme and NGOs and is distribution to the victims of natural disasters free of charge. The second one is programme food aid, which is the provision of food commodities directly to a government for sale on local markets for processes of stabilisation (Devereux, 2001).

The aim of emergency food distribution is to save lives by alleviating hunger and starvation and thereby prevent malnutrition and rising levels of mortality. Food related income transfer programmes entitle the holder to a discount on selected food items and food price subsidies, which lower the prices of selected foods below free market levels, thereby increasing the household's food supply. The target group are those people who consume less than 80% of the calories required, despite spending more than 80% of their income on food (Young, 2001:264). According to the International Food Policy Research Institute IFPRI (2002), the conditions under which a food security effort takes place are constantly changing and without a clear understanding of why these changes are made by decision makers, there is little

hope of achieving food security. Within this changing environment, certain steps will have to be taken if sustainable food security for all is to be achieved (IFPRI, 2002:5).

There is no doubt that for food security to be attained, appropriate policies and approaches need to be crafted and implemented. There is no doubt that rapid economic growth is essential for achieving food security (IFPRI, 2002).However, IFPRI (2002) notes that the challenge is to achieve this growth in a way that benefits the poor. IFPRI (2002) identified seven pro-poor action areas that will likely be high priorities for many countries, especially if food security of the poor is to be achieved (IFPRI, 2002).

3.9 The Integrated Food Security Strategy (IFSS)

Among the policies informing food security in South Africa, the Integrated Food Security Strategy (IFSS) stands out as a key strategy document. Though the IFSS does not fully centre food security efforts on agriculture, it recognises the important role of agricultural sector, whilst broadening the scope of food security to include the other facets, such as access, adequacy, and stability. Key to this study is the focus on the household. In as much as South Africa is food secure at the national level, food insecurity is prevalent at the household level, with mostly rural households being the most vulnerable (DAFF, 2002).

Putting the IFSS into perspective, South Africa's inability to meet basic needs has a variety of causes but, in contrast to most other countries, poverty and hunger are particularly shaped by the legacy of apartheid (Koch, 2011).However, in contrast to other countries, South Africa is also rich and food security should hence not be a

problem(DAFF, 2002).According to Koch (2011) “One instrument of apartheid was the deliberate dispossession of assets, such as land and livestock, from members of the black majority, while denying them opportunities to develop, access to markets, infrastructure and human capital” (Koch, 2011:4).

Because of the policy debates around agriculture and food security, the adopted IFSS is a multidimensional strategy, structured mainly around household food security in rural areas. Koch advances that the arrangements proposed in the IFSS seemare an assortment of mechanisms with clear programmes, coordinating units and multi-sectoral fora to stimulate and support programmes that can engage creatively with food insecurity (Koch, 2011). Section 27 (1) of the South African Constitution, clearly states that “Everyone has the right to have access to … sufficient food and water … The state must take reasonable legislative and other measures, within its available recourses, to achieve the progressive realisation of each of these rights” (DAFF, 2002).

According to the DAFF, the vision of the IFSS is “to attain universal physical, social and economic access to sufficient, safe and nutritious food by all South Africans at all times to meet their dietary and food preferences for an active and healthy life.” (DAFF, 2002*cited in* Koch 2011:4). This vision speaks to the definition of food security provided by the United Nations Food and Agriculture Organisation (FAO). The IFSS’s goal is linked to the Millennium Development Goals (MDGs), especially MDG 1 that seeks “to eradicate hunger, malnutrition, and food insecurity by half by 2015” (DAFF, 2002*cited in* Koch 2011:4).

The IFSS has adopted a broadly developmental rather than strictly agricultural approach to food security. It focuses mainly on household food security, without overlooking national food security, although South Africa is food-secure. Building on the vision quoted above, the IFSS develops the concept and understanding of food security along the lines of four distinct but inter-related components:

- *Food availability*: an effective or continuous supply of food at both national and household level. This is affected by input and output market conditions, as well as the production capabilities of the agricultural sector.
- *Food access or effective demand*: the ability of the nation and its households to acquire sufficient food on a sustainable basis. This addresses issues of purchasing power and consumption behaviour.
- *Reliability of food*: utilisation and consumption of safe and nutritious food.
- *Food distribution*: equitable provision of food to points of demand at the right time and place. This spatial/time aspect of food security relates to the fact that a country might be food-secure at the national level, but still have regional pockets of food insecurity at various points of the agricultural cycle (DAFF, 2002).

Key to this study is the pillar on production and trading. Any attempt to achieve food security should give specific reference to the production aspect. The primary objective of the IFSS is to overcome rural food insecurity by increasing the participation of food-insecure households in productive agriculture-sector activities and creating linkages that will bring growth and development benefits to all citizens. Hence, the goal is to *improve household food production, trade, and distribution.* The Department of Agriculture is the lead agency in this area, with the Departments of

Land Affairs, Health, Public Works, Water Affairs and Forestry, and Trade and Industry forming part of the cluster (DAFF, 2002).

The key policy actions under the programme are mainly related to increasing access to productive assets, including credit; increasing access to technologies, including food processing; supporting agriculture extension services; and improving infrastructure and trade regulations (DAFF, 2002). The policy actions seek to help certain targeted populations, such as specifically vulnerable groups (for example, female-headed households, young people, and the disabled), small-scale farmers, emerging farmers, and commercial farmers (DAFF, 2002).

The main programme in place to underpin this pillar is the Comprehensive Agriculture Support Programme (CASP 2003–2005). CASP aims to provide post-settlement support to the targeted beneficiaries of land reform, and to other producers who have acquired land through private means and are engaged in value-adding enterprises for the domestic or export markets. The programme benefits the hungry, subsistence and household-food producers, farmers and agricultural macro-systems in the consumer environment. The programme is a key area of engagement for the Department of Agriculture and makes interventions in six priority areas:

- information and technology management;
- technical and advisory assistance, and regulatory services;
- marketing and business development;
- training and capacity building;
- on/off farm infrastructure and product inputs; and
- financial support

In the current Medium Term Expenditure Review, CASP had a budget of R119 million for 2010/113 (Treasury, 2010). Surprisingly, there is no reference in the IFSS to the agriculture support programme and, in turn, CASP makes no reference to the IFSS or to any complementary role it can play probably indicating lack of coordination.

3.10 An Overview of Climate Change Adaptation in South Africa

In response to climate change, the Department of Environmental Affairs and Tourism (DEAT) drafted a National Climate Change Response Strategy (NCCRS), launched in 2004. The NCCRS outlines strategies "designed to address issues that have been identified as priorities for dealing with climate change in South Africa" (DEAT 2004, iii). A number of adaptation strategies have been proposed in the NCCRS in order to address the vulnerabilities in the agricultural, health, biodiversity, and water sectors (Madzwamuse, 2010).According to the NCCRS, "agricultural adaptation measures should include changes in agricultural management practices, such as a change in planting dates, row spacing, planting density and cultivar choice, and other measures, which would counteract the effects of limited moisture" (DEAT, 2004:20).

However, a number of factors are critical if adaptation is to become a reality. Madzwamuse (2010)argues, "the success of these strategies depends on an enabling policy environment. A lack of appropriate policies and legislative framework may present barriers to the implementation of adaptation strategies" (Madzwamuse, 2010:14). This highlights the importanceofthe state in fast tracking initiatives on the ground to help small-scale farmers and communities to respond to the impacts and effects of climate change, particularly the food production and security aspects.

3.11 South Africa and Climate Change: Impacts and Policy Responses

The Kyoto Protocol guides the focus and application of climate change interventions and policies in South Africa and beyond. Under the Kyoto Protocol, South Africa like all the other developing countries has been classified as a Non Annex I country, meaning that the country is not obliged to comply with the Protocol's targets of reducing Green House Gases [GHG] (Mokwena, 2009).

This exclusion led to considerable discontent during the climate change negotiations. According to Mokwena (2009), some critics have argued that this provision is unfair, as the global fight against climate change should be undertaken by all countries, irrespective of their economic and developmental status (Mokwena, 2009). Furthermore, this differentiated approach to addressing the challenges of climate change has been identified as a possible impediment to reducing GHG emissions, since it fails to serve as a disincentive (by penalising) for developing nations that fail to adopt more ecologically sound economic development models. This differentiation under the Protocol is justified on a number of grounds (Mokwena, 2009).

Owing to use of predominantly coal based energy production methods, South Africa "has one of the most carbon-intensive economies in the world" (Warburton *et al,*2007; DEAT, 2006). Mokwena (2009) states that South Africa is the second highest emitter of GHG in Africa, with carbon-dioxide emission levels that are higher than those of France, and tending towards those of Japan and the United Kingdom (UNEP/GRIDArendal, 2005). Such statistics have further created debate at the international stage with European countries calling on African economic

powerhouses to own up and acknowledge their role in global warming rather than attributing the problem to Europe.

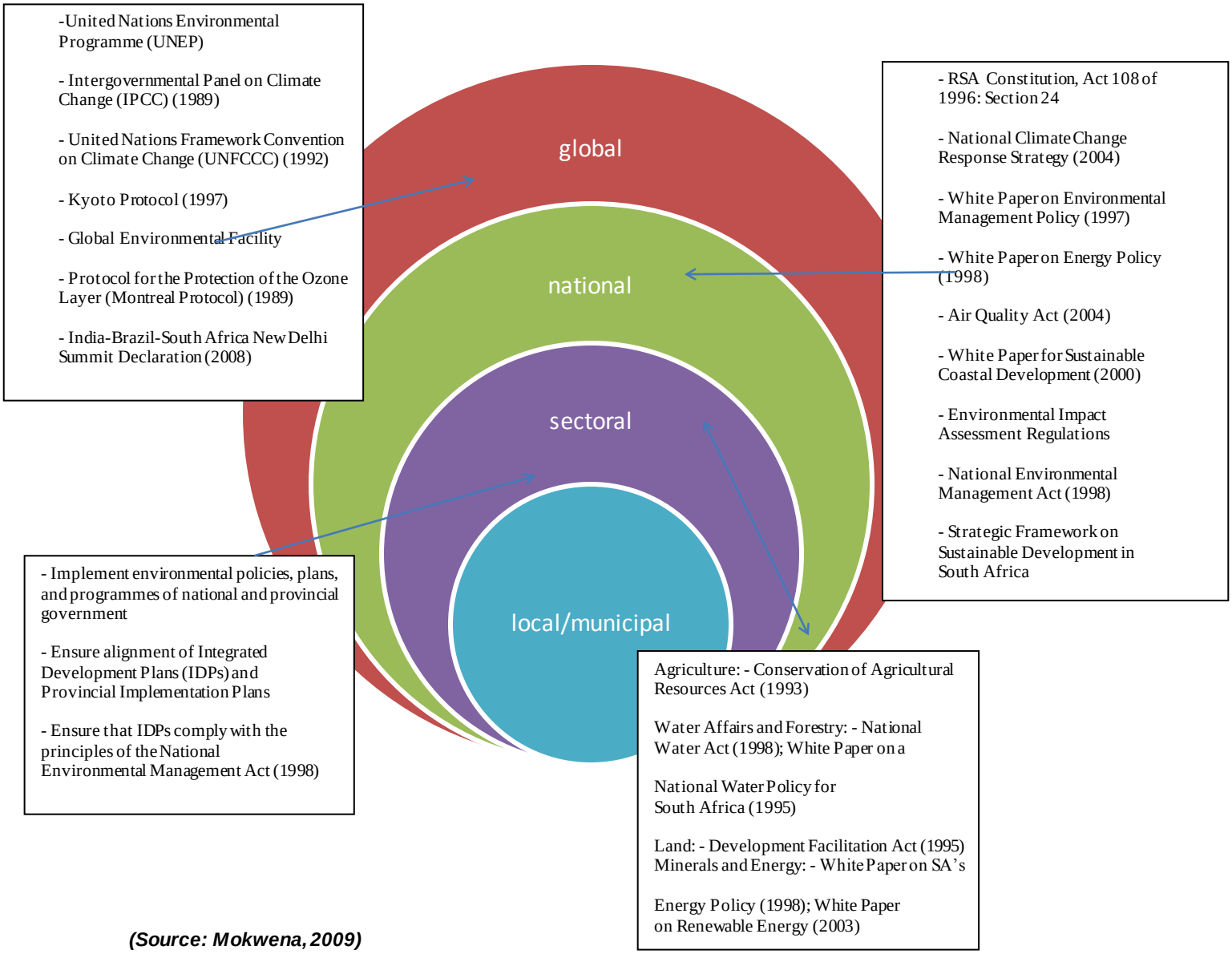
Despite this when aggregated Africa's contribution to the world's total carbon emissions is relatively small compared to Europe and Asia (Mokwena, 2009). However thus has come under severe scrutiny with the advent of emerging economies, Brazil, Russia, India, China, and recently South Africa, which have of late been major contributors to global carbon emissions (Mokwena, 2009).

3.12 Policy Frameworks and Responses to Climate Change Adaptation in South Africa

A number of policy and regulatory frameworks guiding climate change governance exist in South Africa. These include key sectoral, national, and global policy instruments and other regulatory frameworks underpinning environmental protection and climate change governance processes in South Africa.

Mokwena (2009) states that, South Africa has become decisively integrated into climate change and related environmental regimes at regional, continental and international levels by signing and/or ratifying a bewildering array of protocols, treaties, agreements and frameworks that guide its policies, programmes and strategies in this regard (Mokwena, 2009). For example, not only is South Africa a signatory to the Kyoto Protocol, but it also has a trilateral agreement with India and Brazil, one of the components of which is to strengthen the three countries' commitment to combating climate change and advancing the goal of sustainable development in these three countries (Mokwena, 2009).

Figure 7: A Review of Existing Policies and Legal Acts Related to Climate Change



(Source: Mokwena, 2009)

Mokwena (2009) states that, in terms of national policies and strategies, the South African Constitution (Act 108 0f 1996) provides an overall legal framework for government responses to the challenges of climate change and related environmental problems (Mokwena, 2009). The promotion and protection of the country's natural environment and the rights of South African citizens to access and

enjoy a healthy natural environment is one of the key provisions contained in the Bill of Rights of the country's Constitution.

Evidently, for Mokwena (2009) the elaborate legislative and regulatory framework that is currently in place in South Africa is likely to be ineffective if the institutional mechanisms and financial resources meant to ensure implementation are ineffective (Mokwena, 2009). Just as the international environmental and climate change governance regime amounts to naught in the absence of nation-state mitigation and adaptation strategies, so do national legislative provisions that have to depend on one of the chief instruments for government policy implementation that is incapable of fulfilling this function (Mokwena, 2009).

3.13 The Climate Change Debate: A Reflection on Equity, Poverty and the Right to Development

The question of equity is highly contested at the climate discussions and remains one of the main reasons behind the failure of states to reach a binding legal agreement in Copenhagen (Koketso, S. 2010. Busby, J. 2010). Where the developed north has called for all countries to be equals at the climate change discussion tables and afforded the same privileges as other, developing countries have sought for compensation and more commitment from the developed countries. Such arguments have been pointed out to historical transgressions of the industrialised countries, their economic status, as well as the vulnerability of poor developing countries.

Developing countries have always argued that they can never be equal with the industrialised north and have since called for more commitment from the industrialised north (Richards, 2003). Despite these arguments, there remains a pressing need for the international community to devise new strategies to reduce greenhouse emissions and promote low carbon pathways to economic growth and development while protecting the right of developing countries to sustainable economic development. Equity has been open to interpretation (Richards, 2003). The dominant Southern perspective regards equity as a redistributive social justice issue, considering the disproportionate human impacts and adaptation costs associated with climate change (Richards, 2003).

Developing countries argue that developed countries must pay for the cost of climate change adaptation, as they are historically responsible for the bulk of greenhouse gases causing global warming and climate change (Richards, 2003). They also argue that any effective climate change regime must preserve the right to sustainable human development, particularly in developing countries where climate change undermines the achievements of the Millennium Development Goals (MDGs) (Richards, 2003). The vulnerability of developing countries highlights their urgency to adapt to climate change and realise their right to development. Inequity has been interpreted by parties of the UNFCCC to refer to inequity between states and regions (South vs the North, developed and least developed countries) (Richards, 2003).

According to (Baer, Kartha, Athanasiou and Kemp-Benedict, 2008) the Greenhouse Development Rights framework (GDR) has been developed in order to take equitable costs and benefit sharing for climate change adaptation and mitigation into account (Baer *et al*, 2008). This paper argues that while people remain poor it is

unacceptable and unrealistic to expect them to focus their valuable resources on the climate change crises (Baer *et al*, 2008). The GDR draws the conclusion that wealthier countries that have enjoyed higher levels of development must take on their fair share of the effort to deal with the effects of climate change (Baer *et al*, 2008). The GDR calls for an expansion of the climate protection agenda to include protection of developmental equity, which can and should be specified in terms of the UNFCCC's notion of common but differentiated responsibilities and respective capabilities (Baer *et al*, 2008). Capacity is based on ability to pay, while responsibility is based on an assessment of the contribution to greenhouse gas emissions (Baer *et al*, 2008).

Baer *et al*, (2008) argue that the GDR considers intra-national income disparities, stepping beyond the usual national per capita averages that fail to capture the true depth of a country's developmental needs or the actual extent of its wealth (Baer *et al*, 2008). The framework points to inequalities within and between countries and focuses attention on class-based approaches to economic justice rather than nation-based approaches (Baer *et al*, 2008). The GDR framework specifically calls for an end to the distinction between *Annex 1* and *non-Annex 1* countries (Baer *et al*, 2008).

It implies that developing countries such as South Africa, with large emissions, should take on some emission reduction targets in effort-sharing regimes. The emission targets of developing countries must however be enabled by the North in the form of financial and technological support. For Baer *et al*, (2008) it is evident why this framework has received very little support from developing countries (Baer *et al*, 2008).

Climate change will disproportionately affect the poor due to the socio-economic circumstances they live in and the massive increases in poverty and inequality that climate change has the potential to generate (Oxfam, 2007; Richards, 2003). Adaptation governance thus also calls for a consideration of equity at a national and local level and between social groupings within a given country. According to Kelly and Adger (2000), there is need to recognise the 'architecture of entitlements', the social, economic, and institutional factors that influence levels of vulnerability within a community or nation and promote or constrain adaptation (Kelly and Adger, 2000).

For Kelly and Adger, (2000) such entitlements extend beyond income and other material measures to encompass rights, ownership, and access to resources through formal and informal institutional arrangements (Kelly and Adger, 2000). In attending to these issues climate change governance requires a closer examination of various dimensions of inequality, such as gender, poverty, access to key resources, policy formulation processes, representation, participation and institutional frameworks at national and local levels(Kelly and Adger, 2000; Agrawal, 2008; Madwamuse, 2010).

3.14Climate Change Adaptation Polices and Strategies

This study identified a comprehensive set of policies that provide an enabling environment for climate change adaptation. These policies include the National Climate Change Response Strategy (NCCRS), the Integrated Rural Development Programme (IRDP), the Agricultural Policy, and Land Redistribution for Agricultural DevelopmentPolicy on Agriculture and Sustainable Development and the National Agriculture Research and Development Strategy, among others.

More importantly is the National Climate Change Response Strategy (NCCRS), which provides an overall policy framework for climate change adaptation and mitigation at the national level (DEAT, 2004). The strategy provides broad support to the policies and principles laid out in the Government White Paper on Integrated Pollution and Waste Water Management (2000), as well as other national policies including those relating to energy, agriculture and water (DEAT, 2004).

However in as much as the NCCRS highlights the potential impact of climate change in various sectors, it failsto provide a persuasive analysis of the socio-economic implications of climate change (DEAT, 2004). Therefore, its proposed actions do not provide for strategic interventions that would adequately build the resilience of the sectors and the economy against the impacts of climate change. Climate change will have an impact on economic growth, thus making it imperative to consider socio-economic vulnerabilities and adaptation responses at a policy level (DEAT, 2004).

A number of restrictionssurface in South Africa's rural development strategies and poverty reduction policies. For instance, the South African land reform process is considered to have stalled. Some even argue that it has failed completely, mainly due to tensions between an appropriate development path at the macro-economic level and the needs at a micro-economic level. Suggestions are that the land and agrarian reform programme has failed to escape the trappings of neo-liberalism (Noyoo, and; Thwala, 2003; Greensberg, 2004; Bond 2005; Mngxitama, 2005).

Madzwamuse (2010) argues that althoughliberal policies are in place, which could enhance adaptive capacities at various levels, landlessness continues to compound

poverty. Madzwamuse (2010) advances that landlessness deters communities, especially in the rural areas, from access to a source of livelihood through farming and other land-based activities Madzwamuse, (2010). Further to that, landlessness diminishes poor peoples'capacity to use land as a reproductive asset. In addition, while a small number of women gained access to land through the Land Redistribution for Agricultural Development (LRAD) programme and other land reform programmes between 1994 and 2000, land reform did not take place at a sufficiently large scale to benefit the great majority of poor rural women (Walker, 2000).

The policy environment in South Africa is constantly shifting and adaptation strategies need to consider these changes while at the same time investing in a political drive to renew commitments towards sustainable development, equity and addressing some of the policy gaps highlighted above. Linked to the agricultural policies is the drive for economic development and poverty reduction (Madzwamuse, 2010). Macroeconomic policies such as the Growth, Employment, and Redistribution (GEAR) plan are said to have effectively denied the poor development opportunities and marginalised them from the economy.As a result, the poor were de-facto excluded from one of the fundamental pro-poor responses to climate change(Madzwamuse, 2010).

3.15The International Legal Framework

On the global level, climate change is a burning issue and numerous debates are taking place at different forums, culminating in the Congress of Parties (COP) meetings. This has set the stage for parties to agree on a specific policy framework

to guide responses to climate change. Climate change is a global problem that requires global solutions. As it is also a local phenomenon, interventions to cope with the impact of climate change require the engagement of stakeholders at the national and local level (Mace, 2003; Baer *et al*, 2008; Madzwamuse 2010).

According to Mace (2003), the basis of a climate change governance framework lies in the articles of the climate change convention (Mace, 2003). The United Nations Framework Convention on Climate Change "(UNFCCC) and the Kyoto Protocol put the onus for early action on industrialised countries citing common but differentiated responsibilities (Mace, 2003; Baer *et al*, 2008). Article 3.1 of the UNFCCC states that 'climate change protection must have an equitable basis in accordance with the parties' common but differentiated responsibilities and respective capacities'. In Article 3.4, the convention further states that 'parties have a right to, and should, promote sustainable development'(Mace, 2003).

In terms of adaptation, Articles 4.8 and 4.9 of the UNFCCC and Article 3.14 of its Kyoto Protocol, parties are required to take measures to minimise the adverse effects of climate change on developing and least developed countries (LDCs) (Mace, 2003; Baer *et al*, 2008). Both clearly state that measures to combat climate change should not limit the ability of developing countries to develop and pay special attention to the needs of the poorest countries and the most vulnerable sectors of society (Mace, 2003; Baer *et al*, 2008).

The instruments make provisions for the transfer of technical and financial resources and other assistance from developed to developing countries that are necessary for dealing with the impact of climate change(Mace, 2003; Baer *et al*, 2008). These

articles have been the subject of much debate and interpretation in the various UNFCCC Conferences of Parties. The UNFCCC stipulates that the specific developmental needs and vulnerabilities of developing countries beprotected, as economic development in such countries is essential for poverty reduction (Madzwamuse, 2010).

Based on these principles adaptation policy responses are being negotiated at the global level. Although governance structures for adaptation are not well developed, the UNFCCC adopted a Nairobi Programme of Work on Adaptation (2005-2010) aimed at helping all countries improve their understanding and assessment of the impact of climate change and to implement practical adaptation measures.

3.16 International Policy Response Options

This section will discuss the role of the (UNFCCC) as well as mechanisms for funding adaptation.

The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is an international treaty that emerged out of the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro in 1992 (UNFCCC, 2007; Wikipedia, 2012). The UNFCCC highlights what can be done to reduce global warming and cope with whatever temperature increases are inevitable (UNFCCC, 2007). There are approximately 40 Annex-1 and 150 Annex-2 Parties and Observes to the convention. Article 4 of the Convention highlights that developed country Parties shall provide

financial resources to assist developing country Parties adapt to climate change(UNFCCC, 2007).

To facilitate this, the Convention assigned to the Global Environmental Facility[2] (GEF) the responsibility of operating its financial mechanism. The GEF enables a transfer of financial resources from developed to developing countries by establishing operational programmes, providing programming documents, and allocating resources(UNFCCC, 2007). Based on guidance from the UNFCCC, the GEF operates three funds (GEF, 2009; UNFCCC, 2007). These are the GEF Trust Fund; the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). Further funding opportunities currently available for developing countries to fund adaptation projects include the future Adaptation Fund under the Kyoto Protocol, funds from other multilateral environmental agreements (MEAs), and

[2]The Global Environment Facility (GEF) unites 182 member governments — in partnership with international institutions, civil society organisations (CSOs), and the private sector — to address global environmental issues.

An independent financial organization, the GEF provides grants to developing countries and countries with economies in transition for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. These projects benefit the global environment, linking local, national, and global environmental challenges and promoting sustainable livelihoods- http://www.thegef.org/gef/whatisgef

bilateral and multilateral funding from governments, national and international organisations and agencies(UNFCCC, 2007).

The UNFCCC funding streams for adaptation have been criticised for being financially and technically inadequate for meeting the adaptation needs of developing countries. Oxfam (2008) indicates that the true monetary cost of adaptation could be in excess of US$50 billion per annum. However, commitments to date have been far from convincing. According to Huq and Ayers (2008) though by2007, the three GEF funds received pledges of approximately US $200 million these commitments still fall short of the actual figures required for adaptation.The World Bank (*cited in*Huq and Ayers, 2008) estimates that the amount of money available under the Adaptation Fund may amount to between US $100-500 million by 2012;this tremendously falls insignificantly of the estimated cost of adaptation(Huq and Ayers, 2008).

Other relevant UNFCCC policies include the Nairobi Framework on Impacts, Vulnerability, and Adaptation, which the Least Developed Countries (LDCs), and Small Island States in improving their understanding of impacts, vulnerability and adaptation actions and measures to respond to climate change (UNFCCC, 2010). The Nairobi Work Programme does not engage in implementation of concrete adaptation activities, but rather calls for a series of workshops and reports over the coming two years to share and analyse information on topics relevant to climate change adaptation (UNFCCC, 2010).

3.17 African Responses to Climate Change

There is no doubt that Africa stands as one of the most vulnerable regions to climate change (IPCC 2007) due to the continents high reliance on climate delicate sectors such as agriculture, fisheries, and livestock. According to Kumamoto and Mills, (2011)

> "Fragile ecosystems, extreme poverty, poor governance and frequent natural disasters exacerbate this vulnerability. In order to cope effectively with climate variability and change, it is recognized that countries need capacities at systemic, institutional and individual levels including policy/legal frameworks, institutional mechanisms, economic and social capital, human resources, technologies and resilient ecosystems" (Kumamoto and Mills, 2011:1).

Thus, there is need for a concerted effort to try to tackle climate change in Africa. Well-funded and strategic interventions are required, to cushion African states from the negative effects and overall devastating impact of climate change. However, besides internal support, African states need to pool the little resources they have in order to create and implement sustainable adaptation strategies.

3.17.1 Africa Adaptation Programme (AAP)

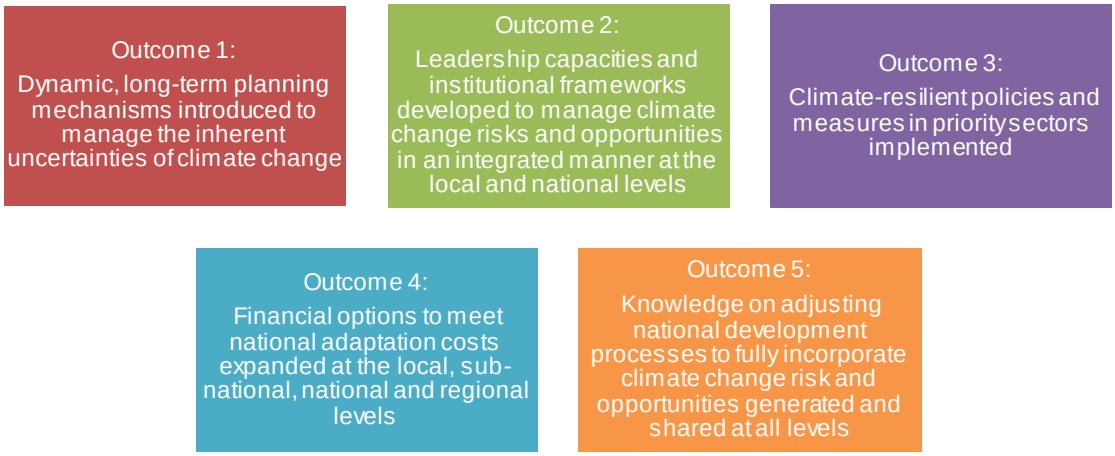
The Africa Adaptation Programme (AAP) was implemented by the United Nations Development Programme (UNDP) and launched in December 2008 to assist African countries in structural, technical responses to climate change. The programme was established under the Japan-UNDP joint framework for building partnership to address climate change in Africa. Initially the Government of Japan funded the

programme to a tune of US$ 92.1 million. To date the programme is assisting 20 countries across the African continent to incorporate climate change risks and/or opportunities into their national development processes (Kumamoto and Mills, 2011). To achieve this objective, each participating country is implementing a variety of priority activities based on the five outcomes stated in figure 7.

The 20 participating countries of AAP are spread across all the sub-regions of Africa and can be categorised into the following 4 sub-regions: 1) North Africa; 2) East Africa; 3) Southern Africa; and 4) West and Central Africa. Box 2 lists the countries in their respective categories (UNDP, 2012). Of the 20 countries, 9 countries are in West and Central Africa, 5 countries in Southern Africa, 4 countries in East Africa, and 2 countries in Northern Africa (UNDP, 2012). However, South Africa is not a beneficiary of the AAP to date.

It is worth noting that a majority of the participating countries are the Least Developed Countries (LDCs), the Landlocked Developing Countries (LLDCs) or the Small Island Developing States [SIDS] (Kumamoto and Mills, 2011). Out of the 20 participating countries, 9 countries are LDCs (i.e., Burkina Faso, Ethiopia, Malawi, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal and Tanzania); 6 countries are LLDCs (i.e., Burkina Faso, Ethiopia, Lesotho, Malawi, Niger, Rwanda); and 2 countries are SIDS (i.e., Mauritius, Sao Tome and Principe) (UNDP, 2012).

Figure 8: Outcomes for the African Adaptation Programme



The 20 AAP countries proposed 238 outputs, which we categorised into the typology originally proposed by Mcgray *et al*, (2007) and adjusted to include adaptation responses for financing. 13 types of adaptation responses were proposed and these include: 1) changing natural resource/ management practices; 2) building institutions; 3) launching planning processes; 4) raising awareness; 5) promoting technology change; 6) establishing monitoring/early warning systems; 7) changing agricultural practices; 8) empowering people; 9) promoting policy change; 10) improving infrastructure; 11) providing social protection; 12) financing options; and 13) other strategies (Mcgray *et al*, 2007 *cited in*Kumamoto and Mills, 2011); (UNDP, 2012).This indicates that the right steps are being taken to address climate change at an African stage, but it is evident that in as much as strategies have come up the disabling factor hinges on financing climate change adaptation as commitment amongst African governments is questionable.

3.18Financing Climate Change Adaptation

One of the critical questions relating to climate change adaptation is the question of funding. Funding is a potential problem for small-scale farmers and households adapting to climate change because small-scale farmers and rural households do not have the capacity to adapt to climate change without the assistance of state institutions.According to Department For International Development DFID, “The poor have mechanisms to cope with climate variability since generations, but many of these will be overwhelmed by the extent of changes or other pressures on their livelihood” (DFID, 2006) *cited in* (Bals *et al,* 2008:139).

The financing of climate change mitigation and adaptation is a complex field. Developing nations have largely held the developed countries mainly in the north accountable for the current climate changes, due to excessive industrialisation in the past. As a result, the debate around the funding of adaptation remains centred on issues of compensation and environmental justice. This in itself creates a vacuum in terms of commitment. Despite these globallevel debates, there are a host of bilateral and multilateral sources of funding.

Table 1: Current Global Options for Adaptation Funding

1) Least Developed Countries Fund (LDCF), established under the UNFCCC to help developing countries prepare and implement their National Adaptation Programmes of Action (NAPAs).

2) Special Climate Change Fund (SCCF), also established under the UNFCCC to support a number of climate change activities such mitigation and technology transfer, but place top priority on adaptation.

3) GEF Trust Fund's Strategic Priority for Adaptation (SPA), which pilots 'operational approaches' to adaptation.

4) Adaptation Fund (AF) which was established under the Kyoto Protocol and is intended to assist developing countries carry out 'concrete' adaptation activities.

Source: Huq and Ayers, (2008)

According to Huq and Ayers (2008), the LDCF, SCCF, and Trust Fund are based on voluntary pledges and contributions from donors. As of April 2007, the LDCF and SCCF amounted to around US$114 million in received allocations(Huq and Ayers, 2008). The Washington-based Global Environment Facility (GEF) under the guidance of the UNFCCC manages all three funds(Huq and Ayers, 2008). To carry out work under the funds, the GEF works with its three Implementing Agencies, the World Bank, United Nations Environment Programme (UNEP), and the United Nations Development Programme [UNDP] (Huq and Ayers, 2008).

The context of adaptation funding is based on the Kyoto protocol. The central feature of the Kyoto Protocol is its requirement that countries limit or reduce their greenhouse gas emissions (UNFCCC, 2007). By setting such targets, emission reductions took on economic value (UNFCCC, 1998). To help countries meet their emission targets, and to encourage the private sector and developing countries to contribute to emission reduction efforts, negotiators of the Protocol included three market-based mechanisms - Emissions Trading, the Clean Development Mechanism (CDM), and Joint Implementation (UNFCCC, 1998).

UNFCCC (1998) states that the CDM allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne ofCO2 (UNFCCC, 1998). These CERs can be traded and sold, and used by industrialised countries to a meet a part of their emission reduction targets under the Kyoto Protocol (UNFCCC, 1998). The mechanism stimulates sustainable development and emission reductions, while giving industrialised countries some flexibility in how they meet their emission reduction limitation targets (UNFCCC, 1998). The CDM is the main source of income for the UNFCCC Adaptation Fund, which was established to finance adaptation projects and programmes in developing countries (UNFCCC, 1998).

According to Huq and Ayers (2008), theAdaptation Fund (AF) is funded by a 2% levy on clean development mechanism (CDM) transactions. The 2% share of credits from the CDM transactions is collected directly by an international body – the CDM Executive Board – and transferred to the AF for monetisation (Huq and Ayers, 2008). As indicate earlier the World Bank has estimated that the levy could generate funding in the range of US$100-500 million by2012, which however is far from the

required totals needed for proper adaptation to take place (World Bank, 2008). The management of the Adaptation Fund was finalised at the thirteenth Conference of the Parties (COP 13) in Bali in December 2007, and was operationalised in 2008 (FAO, 2011; Bredenkamp and Pattillo, 2010; Africa Partnership Forum, 2009, Madzwamuse, 2010).

Donor countries have also come up with separate adaptation funds independent of the above stated funds. Madzwamuse (2010) states that in addition to the major UNFCCC funds, donor countries created a Copenhagen Green Climate Fund and pledged almost US$30 billion between 2010 and 2012 in short term financing for mitigation and adaptation in developing countries during the COP15 in Copenhagen (Madzwamuse, 2010; Busby, 2010; Roberts, Stadelmann and Huq, 2010). The donors further pledged to increase the funding to US$100 billion from public and private sources (Roberts *et al*, 2010; Busby, J. 2010). However, it remains unclear where these funds will come from, how they will be distributed between the countries and how they will be managed (FAO, 2011; Bredenkamp and Pattillo, 2010; Africa Partnership Forum, 2009, Madzwamuse, 2010).

Madzwamuse (2010) argues that prior to Copenhagen 2010, developing countries, including those from Africa, demanded an increase in the level of funding for climate change adaptation, as available funds were not adequate to meet the problems. Madzwamuse (2010) states prior to COP 15, only 1% of Official Development Assistance (ODA) and concessional lending was specifically directed to adaptation. US$67 billion had been raised through the adaptation fund (which has been set up with proceeds from a levy on the Clean Development Mechanism (CDM) units sold under the Kyoto Protocol) (Madzwamuse, 2010).

Significant financial commitment is required for climate change adaptation. African governments have since argued that US$67 billion will be required per year to compensate Africa alone for climate change impacts (Madzwamuse, 2010). Africa has since requested that polluting countries pay for climate change technology transfer (Madzwamuse, 2010).

Further to that,developing countries have also requested that polluting countries give support in order to improve African countries' capability to address adaptation to climate change through NAPAs and other national adaptation programmes (Madzwamuse, 2010). Developing countries have also called for support to the establishment of Climate Centres within Africa to support cooperative mechanisms (South-North and South- South). Such commitments are meant to address regional specific climate change impacts and adaptation needs (Madzwamuse, 2010).

Calls for adaptation funding have been accompanied by calls for improving the transparency, accountability and oversight regarding decisions and actions to allocate, distribute, spend and account for 'new and additional' public financing for adaptation and mitigation activities (Transparency International, 2010). Questions have been raised as to how limited global resources are allocated to particular countries and to specific locations within those countries. Questions around transparency are critical, especially in the developing world, where countries receiving aid have been lambasted for lacking prudence in terms of public finances (Africa Partnership Forum on Climate Change, 2009).

Current funding mechanisms are difficult for developing countries to access and there has been a call for funding to be made more accessible and more equitable.

For instance,developing countries with reference to the Global Environmental Facility (GEF) criteria for the UNFCCC financial mechanisms (Madzwamuse, 2010) have made two observations. Firstly, the requirement for projects to have incremental costs is said to put an additional resource mobilisation burden on vulnerable states. Secondly, the need for global benefits does not match the nature of adaptation, which is largely a local response (Madzwamuse, 2010).

Much attention has been placed on the need for mechanisms to ensure that adaptation finance contributes to poverty reduction strategies and other sustainable development frameworks, and more specifically that it reaches the most vulnerable. This issue raises the importance of identifying and highlighting capacity needs for strengthening governance structures and processes at national and local levels where adaptation interventions take place (Africa Partnership Forum on Climate Change, 2009; Madzwamuse, 2010).

It is a fact that financing adaptation is a challenge in itself and issues to do with adequacy of the available and pledged financial resources have surfaced. Furthermore, a debate is currently raging around the actual resources needed to adequately finance adaptation. The future is bleak for communities that have to adapt to climate change. The associated effects and impacts have a devastating effect on rural communities, small-scale farmers, women who are particularly vulnerable to poverty and food insecurity. The following table shows the projected figures of adaptation funding by different institutions and the current levels of commitment.

Table 2: Required Adaptation Funding and Pledges to Date

Required Adaptation Funding	Funding And Pledges To Date
Oxfam International: USD 50 billion per year.	Current allocations and pledges under the UNFCCC funds: USD 200 million.
World Bank: USD 10-40 billion per year.	Expectation of the Adaptation Fund: USD 100-500 million by 2012.
UNFCCC: USD 28-67 billion in 2030.	
Stern Review: 5% of global GDP each year, with higher losses in developing countries.	

Source: (Klein, 2007)

3.19Summary

There has been a significant shift towards the realisation of climate change with a number of policies aimed at trying to reduce the impact of climate change, as well as mitigate the factors leading to climate change. However, implementation of these policies is sadly lacking and funding continues to be a problem. Adapting to climate change requires significant resources and most sub-Saharan countries are thus not in a position to implement these policies. It serves to also highlight the fact that political will is also at times a scarce commodity. A continued delay in coming up with carbon emission targets at the climate change discussions has certainly contributed to a huge gap between policy and implantation. Commitment towards adaptation funding still remains uncertain and too little to adequately meet the adaptation needs countries severely affected by climate change

Chapter 4

Research Methodology and Methods

4.1 Introduction

This chapter presents the research methodology used in the study. Included in this chapter is the research design, research instruments, data collection strategy and data analysis techniques used to conduct the study. The study employed a qualitative methodology, where interviews were conducted using semi-structured questionnaires.

4.2 Research Methodology

The study adopted a qualitative methodology. McMillan and Schumacher (1993) define qualitative research as, “primarily an inductive process of organising data into categories and identifying patterns (relationships) among categories” (McMillan and Schumacher, 1993: 479). This definition as used in this study implies that data and meaning emerge “organically” from the research context. A key strength of qualitative methodology lies in that it is a system of inquiry that seeks to build a holistic, largely narrative, description to inform the researcher’s understanding of a social or cultural phenomenon and this system of inquiry forms the basis of this study.

Justification of adopting qualitative methodology lay in that it suited a liberal approach to research that allowed for flexibility in the process of conducting the research. Wiersma, (1995) argues for a flexible approach to research by arguing that

in qualitative research, investigators research in “nature” (Wiersma, 1995). He further advances that researchers do not impose their assumptions, limitations, and delimitations or definitions, or research designs upon emerging data, therefore indicating that the researcher’s role is to record what he or she observes and/or collects from subjects’ in their natural environment (Wiersma, 1995). Such an approach allowed participants to give a background of the research problem, which in summary were a severely changing climate and its adverse effects on crops and their livelihoods.

4.3 Justification of Qualitative Methodology

There is a more holistic understanding of complex issues and processes when using qualitative research methodology. Bamburger (2000) argues that, qualitative frameworks are often characterised as having a micro rather than macro focus, thus they seek to understand processes starting at the individual rather than aggregate level. Qualitative methods are also crucial in that they capture underlying meanings; unearth the unexpected and sensitive issues. This is advanced by Bamburger (2000) who states that the framework and analysis also tend to be interpretive, with the research relying on naturalistic observation to capture the constraints of everyday life.

However, qualitative methods have their own challenges, as observed during the study. There is a growing tendency on the respondents deviating from the objective (s) of the research and giving out historical data that was not directly relevant to the objective of the study.

4.4 Research Design

The study employed a case study design which is defined by Merriam (1998) as, "… an intensive, holistic description and analysis of a bounded phenomenon" (Merriam, 1998: xiii). The ability to come up with a holistic description and analysis of the research subject serves as justification of a case study approach being used. Yin (2003) provides more specific boundaries for case study. It is an empirical inquiry that:

- investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident;
- Copes with the technically distinctive situation in which there will be many more variables of interest than data points: and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion; and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin, 2003:13-14).

Thus, a case study examines a bounded system or a case over time in depth, employing multiple sources of data found in a setting (McMillan, 2010). Patton (1990) and Yin (2003), who argue, "a hallmark of case study research is the use of multiple data sources, a strategy which also enhances data credibility" (Patton, 1990; Yin, 2003 cited Baxter and Jack, 2008), further advance this. Potential data sources may include, but are not limited to documentation, archival records, interviews, physical artefacts, direct observations, and participant-observation (Baxter and Jack, 2008).

However, a rich narrative is dependent upon a well-organized, flexible, and careful data collection process.

4.5 Population and Sampling

The target population was all small-scale farming households at Dzindi irrigation scheme in the Vhembe district. A sampling frame of all 106 farming households was drawn where the sample size constituted 38% of the sampling frame making a total sample of 40 small-scale farming households. This sample size was justified by McMillan (2010) who states that, qualitative samples can range from 1-40 or more.

The study used purposive sampling techniques to identify the research sites for the study. According to Teddlie and Yu (2007) “Purposive sampling techniques may be defined as selecting units (e.g., individuals, groups of individuals, institutions) based on specific purposes associated with answering a research study’s questions” Teddlie and Yu, 2007:77. Maxwell (1997) further defined purposive sampling as a type of sampling in which, ‘‘particular settings, persons, or events are deliberately selected for the important information they can provide that cannot be gotten as well from other choices’’ ((Tashakkori and Teddlie, 2003a: 87; Teddlie and Yu, 2007).

Justification lied in that purposive sampling allowed the researcher to adopt areas, which suit the study’s objectives and speak to the research problem more. The strength of the method actually lies in its intentional bias. Despite its inherent bias, purposive sampling can provide reliable and robust data (Bernard, 2002, Lewis and Sheppard, 2006; Poggie, 1972; Tremblay, 1957; Tongco, 2007). Another reason for taking a non-random approach was due to the fact that, random sampling is not always feasible, and not always efficient (Alexiades, 1996). A high dispersion of

samples may induce higher costs for a researcher (Alexiades, 1996; Bernard, 2002; Snedecor, 1939).

Purposive sampling proved efficient in that easily accessible respondents were selected as well as those keen to participate in the study (Teddlie and Yu, 2007). Tongco (2007) who states, “Informants may be chosen out of convenience or from recommendations of knowledgeable people” (Lopez et al, 1997; Seidler, 1974; Smith, 1983; Zelditch, 1962; Tongco, 2007), advances this.

4.6 Research Instruments

The study utilised semi-structured questionnaires during the research as well as recording instruments. The researcher administered semi-structured or selected response questionnaires. For demographic, background information, climate change, and basic food security questions, semi-structured questions were administered to selected households. This was done in order to systematise data collection and be able to gain an insight on the type of participants interacted with.

Such insight included respondents’ age, income status, parents/guardians, and other climate change and food security questions. Semi-structured questionnaires are relatively easy to administer code and analyse statistically (McMillan, 2010). Further to that, they allow the researcher to obtain a significant depth of information, feelings, and emotions (McMillan, 2010). Secondary sources were also utilised throughout the study. Such sources included online journals, internet resources, published research studies, and books.

4.6.1 Document Review

The researcher analysed reports on climate change and food security from different sources. Meteorological data from the South African Weather Services (SAWS) was also utilised to prove long-term trends and changes in climate patterns. This was to avoid the callous task of scientifically proving the incidence of climate change as well as verifying information from the respondents, but utilising available scientific data. Food security reports from the Food Agricultural Organisation (FAO), World Food Programme (WFP) and the Department of Agriculture, Forestry and Fisheries (DAFF) were also utilised.

4.7 Data Collection

Data was collected using qualitative methods. Qualitative methods were useful in getting insight on the impact of climate change on rural households' food security. Primary data was collected by conducting interviews making use of semi-structured questionnaires, where necessary these were recorded and transcribed. Interviews were conducted in either English or Venda dialect (with the aid of an assistant). These interviews were administered to the selected respondents to determine factors such as adaptation mechanisms, access to food, production of food, perceptions on climate variability, adequacy of food among other issues relating and food security.

In this case, selected respondents included any figure in a household who held farming responsibilities as well as income andfood-earning responsibility. To get a detailed picture on prevailing weather conditions in the district, secondary data sources particularly from the South African Weather Services (SAWS) were also

utilised in the study. Such information was useful towards validating recorded trends on climate change as well as food security.

4.8 Data Analysis

Data analysis was approached using both interpretational analysis and structural analysis. According to Gall, Gall, and Borg, W.R (1996), in interpretational analysis the researcher will look for patterns (threads, constructs, commonalities, etc.) within the data to explain the phenomenon. This involvesexaminingpatterns, which may be found in conversations, text, activities, etc., with little or no explication as to pattern meaning (Gall *et al*, 1996) *cited in* (Mcmillan, 2010). Qualitative data analysis began with preparation of the data, which meant organising the data, documents, field notes. Exploring the qualitative data was next and involved making notes about early observations as well as developing codes.

Data analysis then involved coding the data by reading the raw data (field notes, interview transcripts, research etc.) and assigning codes to small portions of the text. The next step involved grouping the codes together to form themes. To get a detailed computed generated analysis, SPSS (version 19) was utilised in the data analysis process. Use of SPSS aided in the findings being presented in a logical and coherent way in the form of rich descriptive narratives, discussions of the themes, and tables, figures, diagrams, or visual models.

The study also took note of emergent themes. The goal of much qualitative analysis is to go beyond description and become interpretive. This means that the researcher looked beyond what the individual/respondents had said or done to try and

understand and interpret the meaning behind it and of the attitudes and values that influence this meaning (Rodwell, 1998 *cited in* Clissett, 2008).

4.9 Ethical Considerations

Because this study dealt with human beings, it was necessary to understand the ethical and legal responsibilities of conducting research (McMillan, 2010). Primarily, ethics clearance was sought from the University of Fort Hare. Having obtained ethics clearance from the University of Fort Hare, the next step entailed seeking clearance from the Department of Agriculture District office in Sibasa Vhembe district.

Considering that the study was conducted in a rural setting, clearance was also obtained from the chieftainship of Thulamela. The study observed informed consent where, assurances of confidentiality and anonymity were given to all participants. Respondents were thoroughly briefed on the purpose of the study, the intended use of the data obtained from them as well as the potential result of the study.

4.10 Summary

This chapter gave presented the methodology, the research design, data collection and data analysis techniques used in the study. This study utilised qualitative research techniques due to their flexibility in application. Purposive sampling methods were also utilised to identify respondents and these allowed for quick and easy identification of the respondents. The depth of knowledge obtained from using qualitative research techniques and the capturing of emotions from the respondents make qualitative research techniques an important source of obtaining data.

Chapter Five

Findings and Discussion

5.1 Introduction

The following is a presentation of findings obtained in the study in line with the research objective, which was to:

> explore adaptation mechanisms and adaptation options employed by rural small-scale farmers in the Vhembe District to achieve food security in the midst of climate change as well as analysing the role of the state in building capacity of rural small-scale farmers to adapt to climate change;

Presentation of findings and discussion was done concurrently according to set themes that speak to the objective of the study.

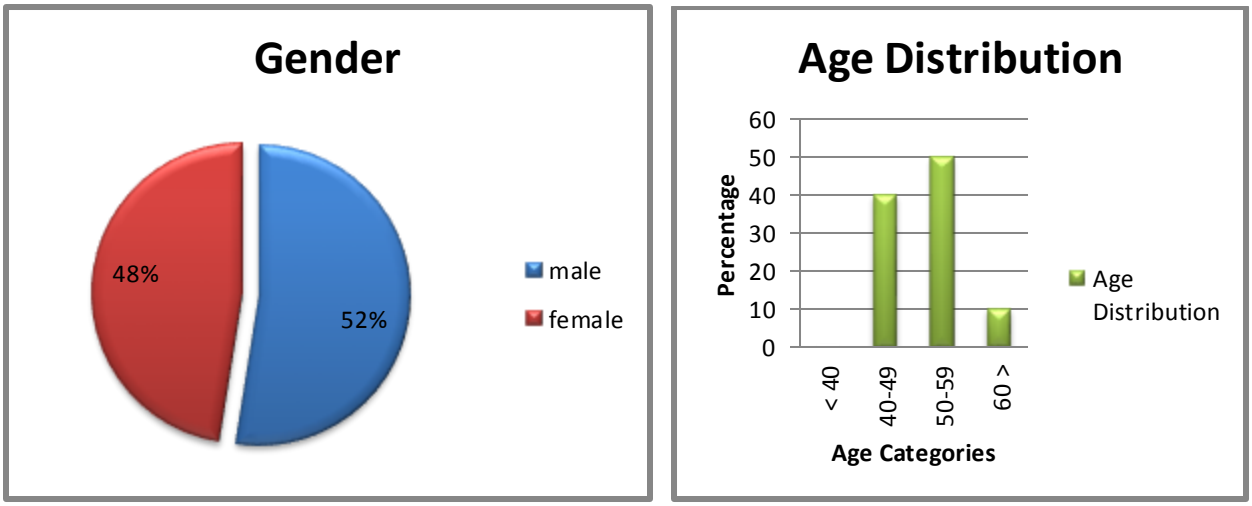
5.2 Household Demographics

The study made firm efforts to observe issues of gender, by purposively targeting female farmers. This is considering that globally women make up to 61% of all those involved in farming but usually excluded from the success stories of agriculture (Altman *et al*, 2009). They mostly have the same reasons for participating in agriculture, except for the 'extra source of food' reason, in which case they exceed men by two thirds.

As far as women outnumber men as subsistence producers, this is consistent with the prevalent stereotype of homeland agriculture; what is perhaps surprising is that commercially oriented black farmers are equally likely to be women as men (Altman

et al, 2009). Of interest the high numbers of women in subsistence agriculture at Dzindi were also as a result of spouse deaths leading to widow led families who find agriculture as a panacea to both food and income availability.

Figure 9: Household Demographics at Dzindi



Gender statistics in this study found 21 respondents being male whilst the 19 were females. This was indicative of the respondents who were successfully approached to take part in the study and consented to taking part as well. Age distribution saw 40 percent of respondents being between 40-49 years, with a majority 50% being between 50-59 years whilst the remaining 10% were above 60 years old.

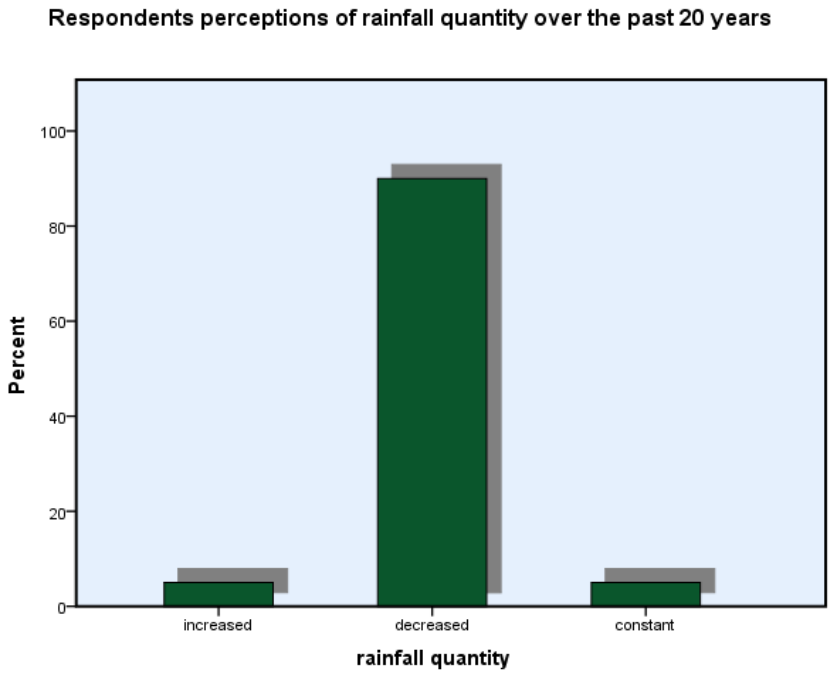
Age dynamics resulting in a high number of respondents being over 40 years old divulged that most did not manage to attain minimum education due to growing up in poor families in the midst of apartheid. This resulted in them following the "rural norm" where agriculture stood as the way to eke a survival. All respondents have stayed in the area for the past 30 years. 95% percent of respondents indicated that they were full time small-scale farmers with the rest taking farming as a part time job, that is are employed in other full time jobs.

5.3Local awareness and perception of climate variability and trends related to climate change (over the past 20 years)

Respondents were interviewed on their awareness and perceptions of climate change, and trends that include, food production, temperature among other climate induced factors influencing their livelihood. Findings indicated that farmers are quite aware that climate change is taking place owing to their comprehension of factors that define climate change. Though in some cases farmers did not know what exactly climate change entailed in theory, a discussion of the effect of prevailing weather conditions over the past 20 years brought out a subtle comprehension of what climate change is. However, in some instances different trends were noted by different farmers, there was significant evidence to prove that agriculture and the livelihoods were affected by climate changes.

According to the respondents, rainfall quantities over the past 20 years have since been taking a decline. The majority of respondents stated that, from their experience as farmers they have noted that rainfall quantities are not as they were years back indicating that rainfall quantities have been decreasing over the past 20 years. Perceptions were that the rainfall season has changed. Accordingly, there were indications that the rainfall season was now starting around late November to December, whereas the farmers had been accustomed to a rainy season beginning around the months of September to October.

Figure 9: Perception of Rainfall Quantity over the Past 20 Years



Out of the 40 respondents interviewed overall, 85 % stated that the rainfall period had shifted. Such a shift in the rainfall cycle has made it difficult for the traditional rainfall forecasting to take place, further affecting the planting dynamics of the farmers. The famers noted that the change in rainfall season has affected the duration of the rainfall. They indicated that the rainfall duration is now shorter with 90% of the respondents indicating that the rainfall duration in was now shorter.However,respondents indicated that there has been a growing trend of increasing winter rains a scenario, which has been welcomed by the farmers. It is clear that, these changes in the rainfall patterns in the area have affected agricultural activities in the area. All respondents confirmed that, the prevailing climatic conditions have had a serious effect on the farming activities.

Figure 10: Farmers at Dzindi Smallholder Irrigation Scheme

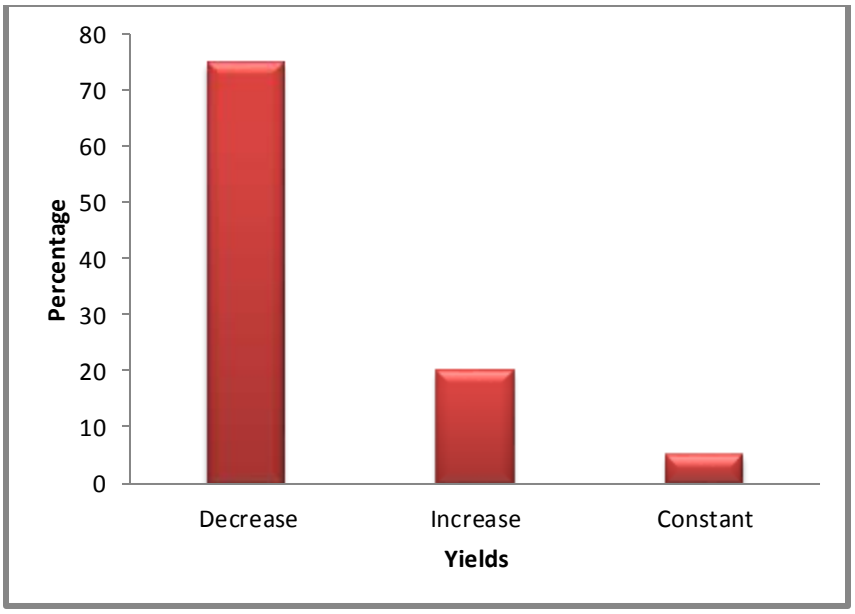
Source: Fieldwork Research at Dzindi Smallholder Irrigation Scheme

Regarding trends concerning temperature all respondents indicated that temperatures had drastically been rising, stating that it had become warmer by the years. The impacts of high temperatures have been rapid evaporation of water in their irrigated fields, as well as the rapid drying up of water sources. Respondents indicated that there is a proliferation of pest and diseases affecting crops due to the hot climatic conditions and inadequate rains. Moorhead (2009) substantiates this deducing that, "plants are sensitive to high temperatures during critical stages such as flowering and seed development.

Often combined with drought, high temperatures can mean disaster to farmers' fields" (Moorhead, 2009). Respondents indicated that there has been increased incidence of erratic or extreme rains leading to mild droughts and flash flooding respectively. The impact of both flooding and drought was unquestionable, as these led to severe crop damages result in low yields and in some cases no yields. Such

scenarios are critical as they severely reduce household food stock therefore heavily compromising on the household's livelihoods.

Figure 11: Agricultural Production at Dzindi



Agricultural production has suffered at Dzindi as a direct result of climate change more importantly reducing entitlement to food. Asked if yields had increased or decreased over the past 20 years, 75 % of the respondents indicated that yields had steadily decreased. Only 5 % indicated that their yields had remained constant. Respondents indicated that over time, inadequate rainwater coupled by limited irrigation water had drastically affected crop production, forcing them to come up with some form of adaptation mechanisms that will be discussed later in this chapter. However, some respondents indicated that yields had increased over time due to the advent of inorganic fertilisers as well as increasing demand for market gardening produce.

An important factor influencing production at Dzindi is agricultural finance. Most of the farmers are full time farmers and receive state old age grants, which are not

adequate to meet both household and farming needs. However, some of the respondents indicated they worked for the civil service and therefore had access to a stable income, therefore allowing them to obtain fertilisers and seed regularly. For example, the co-operative tractor owned tractor at Dzindi broke down 2 years back meaning farmers have to pay for a contracted tractor,a scenario that has significantly increased their transport and tillage costs. Inadequate funding and poor equipment has resulted in some of the farmers' not meeting planting deadlines and resultantly failing to obtain sufficient yields.

Figure 12: Access is to Finance is a Critical Factor Influencing Small-Scale Agricultural Activities

Source: Fieldwork Research at Dzindi Smallholder Irrigation Scheme

Rural development efforts have seen large supermarket chains in the nearby Thohoyandou town contracting some of the farmers to produce vegetables. Supermarkets like Spar, Pick' n Pay and Shoprite have played an important role in assisting farmers to obtain income, though the relationship that exists remains a business relationship, without any other social investment to farmers at the scheme.

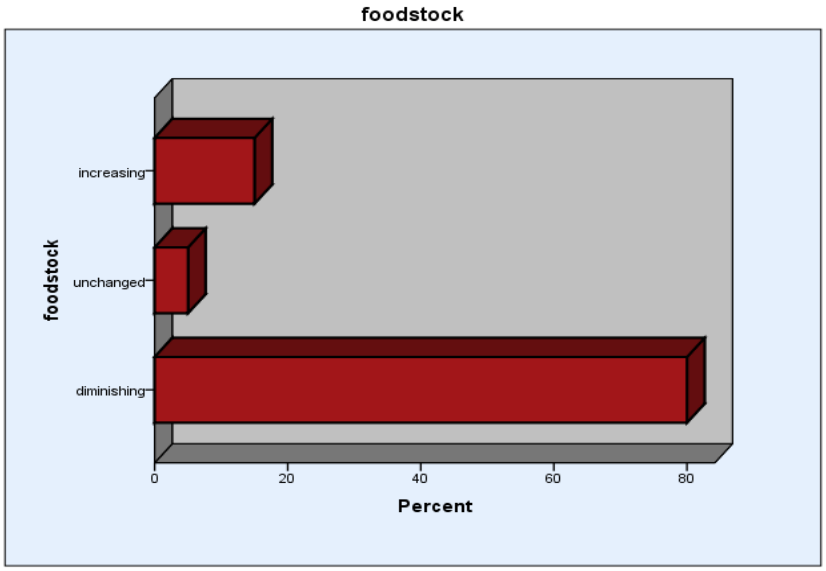
Earlier indications from the farmers were that they had resorted to reducing their production space, a measure meant to curb losses as well as maximise irrigation. Such measures were implemented to sustain their farming activities.

5.4Consequences and Impacts of Climate Related Changes and Trends

The advent of climate change resultantly requires a shift from the status quo. Thus, it is inevitable that communities face challenges resulting from negative climatic conditions. Asked on the different impacts of climate related changes and trends on agricultural produce, respondents indicated that there was a growing trend towards winter farming due to the rather favourable weather conditions in winter. Seventy-five percent of respondents confirmed that, they now resorted to stepping up their production in winter and this was motivated by the fact that lower day temperatures are favourable for their irrigated crops to retain moisture. This was also done to utilise the winter rains, which respondents stated were becoming more pronounced in some instances.

Generally, there was an indication that the household food stock was diminishing particular in the summer (hard season). Eighty percent of the respondents stated that their household food stock was diminishing, with only 15 % indicating an increase whilst 5% stated that food stock remained constant.Asked how respondents perceived their livelihoods in the future with the prevailing climatic changes, 80% of the respondents indicated that, their livelihoods were severely under threat, seeing that irrigation seemed to be the only avenue to successful small-scale farming, as the rains are no more reliable.

Figure 13: Status of Food Stock within Households



However, irrigation water is getting scarcer and scarcer and is threatened by increased demand by households, farmers, and livestock. Food sufficiency, health, income, and standard of living will be negatively affected. Apart from climate, changes there were some other factors that negatively influenced their earning of living, standard of living, and health. Respondents indicated that, lack of adequate farming equipment, inadequate training, lack of capacity, poor agricultural soils all teamed up to affect their farming activities.

5.5Responses to Climate Change and Adaptation Options

From the analysis of the data, a number of adaptation mechanisms were identified, most of which were in direct response to the climate changes. Concerning responses to climate change and adaptation options respondents indicated that, irrigation was key to their adaptation efforts due to the erratic rainfall patterns. All respondents interviewed practised irrigation. However, other options like high yielding crop

varieties, commodity exchange, reducing production space to maximise irrigation and planting drought resistant crop varieties are some of the options respondents indicated they practised to adapt to climate change.

ConcerningHigh Yielding Varieties (HYVs) of maize, these have been successful in Southern Africa from their inception in the 1960s. After 28 years of research, the Southern Rhodesian agricultural service bred the maize hybrid SR52 in 1960. The brand was adopted by 90% of commercial farmers in Rhodesia and Zambia within 10 years (Gabre-Madhin, 2001; Misselhorn, 2005).

Figure 14: Adaptation Strategies Employed by Farmers at Dzindi

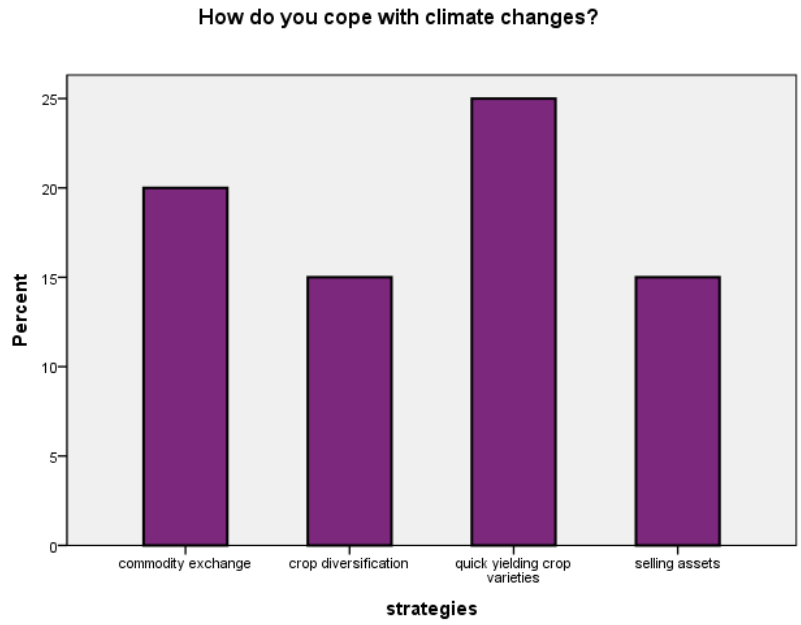


Illustration showing adaptation strategies employed by farmers at Dzindi. However respondents indicated they practised more multiple strategies at once.

The impact on productivity of these early successes are considered by some commentators to have been limited due to the lack of location specific breeding (Evenson and Gollins, 2001). After 1980, the research began focusing on the needs of smallholder farmers, as well as support for improved seed marketing, credit

availability and agricultural extension (Misselhorn, 2005). HYVs that were bred specifically for African conditions were also becoming available. National research programmes in Zambia began in the mid-1970s and in Malawi in the 1980s (Misselhorn, 2005).

International agricultural research bodies, such as the International Maize and Wheat Improvement Center [CIMMYT] (Misselhorn, 2005), extensively supported research programmes in southern Africa. Over a third of the maize area in southern Africa is estimated to be under high yielding crop varieties (HYVs). Studies have proved that hybrid maize typically increases yields by 40% over local varieties under farmer conditions, and open-pollinating varieties increase yields by 15-25% (Misselhorn, 2005). HYVs have become very critical to small-scale agriculture at Dzindi scheme, coming as an alternative due to the worsening climatic conditions. However more research needs to be done on the application of HYVs at Dzindi in the advent of climate change.

Figure 15: Successful High Yield Maize (HYV) Variety at Dzindi Scheme

Source: Fieldwork Research at Dzindi Smallholder Irrigation Scheme

Basic strategies for reducing the impacts of climate change included early morning or late night irrigation to avoid extreme terrestrial radiation and severe evaporation during the day. Other farmers still practised mulching, but lack of adequate grassland made this a challenge. Target irrigation was practised as it ensured that only the crops get irrigation water other than watering the whole field. Respondents also indicated that drought resistant crop varieties were becoming more popular amongst farmers although other farmers still remained pragmatic in planting maize which is the stable food in that area.

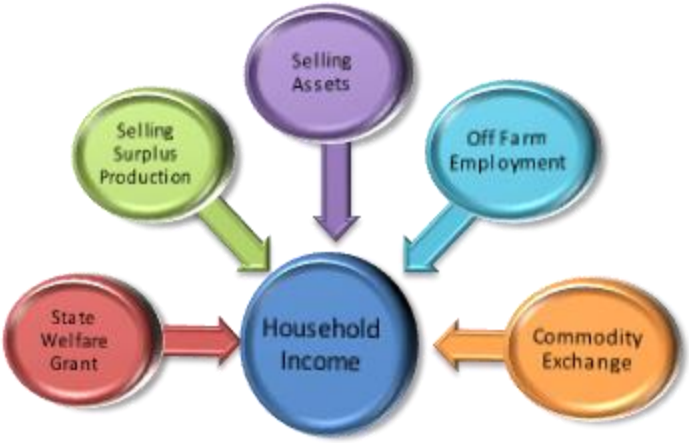
Asked on what methods farmers used for managing and using water sustainably, there is some form of control mechanism put in place to manage irrigation. Upon consultation with the Department of Agriculture in the Vhembe district, effective irrigation strategies have been introduced, where farmers have been encouraged to resort to drip irrigating their crops. Eighty percent of the respondents indicated that they were practising drip irrigation to use the scarce irrigation water sustainably.

Officially, irrigation is permitted between 6am to 6pm, to allow the storage dam to fill up overnight. Other control strategies include avoidingovernight irrigation so that the reservoirs fill up during the evening. Respondents indicated that during winter they usually resort to irrigating once a day. However respondents indicated that, in summer when temperatures are extreme they are forced to irrigate twice a day, to curb severe crop stress due to lack of water and high temperatures. This is despite the high demand for water from other farmers in different sectors of the co-operative.

Findings indicate that though a distribution plan is set out on the distribution of irrigation water to different field blocks, respondents indicated that those on the main

distribution line and closer to the storage dam benefitted more than the others. Due to the worn out furrows, whichchannel water, there is a lot of water loss along the way, disadvantaging farmers with further away fields. Therefore, to curb this farmers with fields far from the dam indicated that they in most instances work overnight at their field to utilise better water flow during the night though this is officially prohibited as well as secure their fields from theft.

Figure 16: Alternative Sources of Household Income



With production diminishing, alternatives have been pursued to cushion households from hunger. Households have resorted to other income generating methods to obtain household income for food purchases among other needs. Other ways of increasing household income identified included off-farm employment, selling surplus produce as well as Government welfare grants. Fifty-five percent of respondents indicated that they sold any surplus produce from their fields, with 15 indicating that they received a state welfare grant whilst 25% sought part-time employment to increase their household income. Another strategy was commodity exchange, where the farmers amongst themselves exchanged different commodities subject to need and availability.

Under extreme conditions farmers indicated that to survive, they did sell some of their assets that include livestock in order to obtain income, food for the household as well as inputs for their farming activities. This is influenced by the fact that, the farmers lack any form of back-up insurance save for those who receive state grants which are however not adequate to meet all those needs. This indicates that the impacts of climate change therefore are wide ranging and complex.

5.6Barriers or Constraints to Adaptation

Funding stands out as a grave factor hindering adaptation efforts by small-scale farmers. Farmers indicated that they did not have the financial resources to implement. Adaptation requires significant financing, but the issue of adaptation funding has drawn many debates at the Conference of Parties (COP). Developed nations have rejected proposals for them to contribute more funding so as to safeguard poor developing nations who remain the worst affected by climate change whilst being the least contributors of greenhouse gases.

Therefore, adaptation finance is a serious threat towards meaning adaptation efforts being implemented.Lack of adequate water has made the sharing of irrigation water a challenge.Due to the set-up of the scheme and irrigation network, other farmers have more access to the reduced water than others do. This is despite the control measures employed to share irrigation water sustainably amongst all farmers.Thus, lack of co-operation by fellow farmers in some instances made it a challenge for other farmers to obtain adequate water for their fields.

5.7 Understanding of Food Security and Strategies Employed to achieve Household Food Security

Respondents indicated that food was available in their households though at time it was a challenge. Food availability was enhanced by yields obtained from their fields, but they resorted to purchasing food most of the times. Food availability tends out to be strongly influenced by food production and the capacity to produce further determines the availability of food in the household. Due to the erratic rainfall and the decreasing yields, food purchasing has become a strongly aspect of ascertaining household food availability.

Asked on their perspective in terms of food access, all respondents indicated that they had access to food, and that it was relatively easy, though it came with its challenges too. Considering that purchasing food was costly considering their large dependence base as well as the low-income base, access to food became a challenge is they did not have adequate yields. Respondents also indicated that food was never adequate for their households. Though managing to access food, adequacy was questionable, as they indicated that, they at least managed to obtain basic quantities to keep their families going.

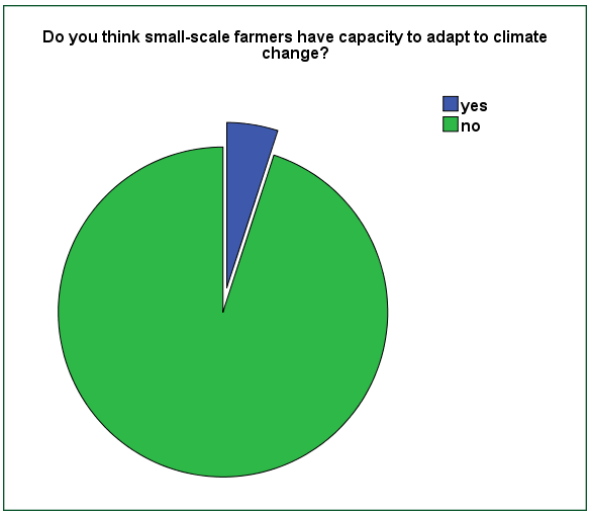
Findings indicated that food stability was not entirely linked to activities in the fields but to access to funding as well as employment. Though irrigation guaranteed all year farming, this did not fully translate into some of the farmers having stable food supplies all year round in their household. Factors like access to finance to purchase seed, fertilisers also play a part in food production. Some farmers indicated that they do not have adequate funding to purchase inputs therefore leading them producing

little. Those who are capable produce all year round leading to food stability within their households. Failure to obtain significant yields led to instability. In some cases, the little obtained was sold to obtain income to finance other household needs.

5.8 The Role of Government in Building Capacity of Small-Scale Farmers to Adapt to Climate Change

The role of the government in building capacity of farmers to adapt to climate change is central to the success of climate change adaptation. Considering that most small-scale farmers are relatively poor, it remains the constitutional right of small-scale farmers to receive due assistance from the government. Asked if small-scale farmers had the capacity to adapt to climate change, 95% of the respondents indicated that this was impossible without third party support, in the form of the Government and non-government organisations. Reasons cited by the respondents included, lack of capacity and funding, inadequate knowledge, but a paltry 5% indicated that they believed small-scale farmers had the capacity to adapt.

Figure 17: Small-Scale Farmers on their Capacity to Adapt to Climate Change



Despite the Government, not doing enough to assist farmers to adapt to climate change respondents indicated that the Department of Agriculture assisted them with agricultural extension services. However, they felt that much more needed to be done by the extension officers in educating them on climate change adaptation so that they explore more viable adaptation options where necessary.

However, the Government has in some instances implemented measures to support small-scale farmers by the periodic supply of inputs to the farmers. Respondents indicated that in some instances, they did receive seed from the Government through the Department of Agriculture, however this has not had a direct effect in terms of them adapting to climate change. Farmers still feel the Government has not done enough to support their efforts to continue farming. Of interest is a finding that no technical awareness programmes have been done to educate farmers on what climate change really entails.

Having indicated that the Government seems not doing enough to assist farmers to adapt to climate change, 95 % of the respondents suggested that the Government needs to come to the party and assist them to protect their livelihoods. Respondents indicated the need for more boreholes, training and capacity building, availing modern farming implements, as well as financing agricultural inputs. Despite climate changes affecting their farming activities, farmers are hopeful that if they get adequate guidance and support, they will adapt fairly enough to keep their farming activities going on, as well as securing their livelihoods.

5.9Summary

The study findings indicated that climate change is happening and surely taking its toll on small-scale farmers at Dzindi scheme. Generally respondents indicated that rainfall has certainly become erratic over the past 20 years and temperatures have soared highly therefore making it difficult to carry agricultural activity. A number of adaptation strategies were stated, where reducing production space to minimise irrigation, employing high yielding crop varieties and drought resistant crop varieties, selling assets, commodity exchange and alternative employment stood among a host of strategies farmers have employed to minimise the effects of climate change.

Farming activities at Dzindi are enhanced with irrigation and this has seen many control measures being implemented to share the dwindling water from the Dzindi River. Indications from the farmers were that Government has not assisted them in their efforts to adapt to climate changes. Small-scale farmers lack capacity to adapt to climate change with lack of adequate finance being a major obstacle. Climate change adaptation efforts require close co-operation between all stakeholders involved and the bridge that exists between policy and implementation on the part of the Government remain challenges hampering adaptation efforts by small-scale farmers.

Chapter Six

Conclusion and Recommendations

6.1 Introduction

The previous chapter gave a detailed analysis of the methodology and research techniques used to conduct this study. This chapter presents the conclusion and recommendations.

6.2 Conclusions

The study sought to establish the adaptation mechanisms employed by small-scale farmers at Dzindi. This also involved establishing the role of Government in assisting small-scale farmers to adapt to climate change. Adaptation is influenced by a globally changing climate and indications at Dzindi proved that climate change has been responsible for the challenges being faced by farmers in the area.

Basic strategies for reducing the impact of climate change included early morning or late night irrigation to avoid extreme terrestrial radiation and severe evaporation during the day. Other farmers still practised mulching, but lack of adequate grassland made this a challenge. Target irrigation was practised as it ensured that only the crops get irrigation water other than watering the whole field. Respondents also indicated that drought resistant crop varieties were becoming more popular amongst farmers although other farmers still remained pragmatic in planting maize which is the stable food in that area.

It remains the prerogative of all stakeholders, the government, non-governmental organisations, and farmers to come up with workable interventions in order to assist small-scale farmers to adapt. Such engagement is critical in making use of indigenous knowledge and strategies implemented by some of the farmers and adopt or perfect them through further research. Above all, without adequate funding and political will, climate change adaptation will remain a critical challenge with severe reaching consequences.

Other avenues of adapting to climate change involved other income generating activities. Such ways of increasing household income identified included off-farm employment, selling surplus produce as well as state welfare grants. Fifty-five percent of respondents indicated that they sold any surplus produce from their fields, with 15% indicating that they received a state welfare grant whilst 25% sought part-time employment to increase their household income. Another strategy was commodity exchange, where the farmers amongst themselves exchanged different commodities subject to need and availability.

Funding stands out as a critical factor affecting adaptation efforts by small-scale farmers at Dzindi scheme. Farmers indicated that they did not have the financial resources to implement other adaptation strategies for example introducing high yielding varieties (HYVs). Climate change adaptation requires significant financing, but the issue of adaptation funding has drawn many debates at the Conference of Parties (COP).

Adaptationchallenges faced by farmers at Dzindi are closely compounded by lack of Government support. The Government has not done enough to assist farmers to

adapt to climate change, 95 % of the respondents suggested that the Government needs to come to the party and assist them to protect their livelihoods. Though the Department of Agriculture from time to time has granted extension services, respondents feel these have not improved their capacity to adapt to climate change. Instead,respondents indicated the need for more boreholes, training and capacity building, availing modern farming equipment, as well as financing agricultural inputs. Despite climate changes affecting their farming activities, farmers are hopeful that if they get adequate guidance and support, they will adapt fairly enough to keep their farming activities going on, as well as securing their livelihoods.

6.3Recommendations

Based on the conclusions above the following section presents recommendations meant to address the above issues and challenges. The results of this study suggest that a lot of work still needs to be done in terms climate change adaptation. The study indicates that the various stakeholders with key interests in climate change need to work in synergy and make consented efforts to battle climate change. Climate change is a reality and is already taking its toll on agricultural activity, leaving small-scale farmers at Dzindi scheme extremely vulnerable to food insecurity. It is evident that small-scale farmers at Dzindi scheme lack capacity to adapt to climate change without the support of Government and non-government organisations. The following policy and program suggestions have been put forth.

Need for a Pre-emptive Climate Change Policy

There is a need for a more proactive approach in terms of increasing capacity of the vulnerable masses to manage to adapt to the effects of climate change. Though on paper good ideas have been laid out towards tackling climate change, not much has been done on the ground. Given the current uncertainty about location-specific effects of climate change, good development policies and programs are also the best climate-change adaptation investments (Nelson *et al*, 2009). Building capacity through empowering policy is a critical step in addressing the devastating effects of climate change. Accordingly, adaptation to climate change is achievable when individuals, communities have the means to adapt.

Increase Investment for Small-Scale Farming

Deficiencyin funds was indicated as a major obstacle affecting both production and adaptation efforts. Other scholars have even lobbied for greater investments in agricultural science and technology in the absence of climate change to meet the demands of a world population expected to reach 9 billion by 2050 (World Bank, 2008). Small-scale farmers are key in the food security circles and increasing their capabilities to produce will go a long way towards increasing both household food security and local food security. It has been argued that one of the key lessons of the Green Revolution is that improved agricultural productivity, even if not targeted to the poorest of the poor, can be a powerful mechanism for alleviating poverty indirectly by creating jobs and lowering food prices (Nelson *et al*, 2009).

Investments in irrigation infrastructure are critical, especially to improve the efficiency of water use, but care must be taken to avoid investments in places where water availability is likely to decline (Nelson *et al*, 2009). It is worth noting that drip irrigation stands as an important way of efficiently irrigating crops yet sustainably conserving scarce water resources. However, this requires adequate investment to be a success.

Restructuring Research and Extension Programs.

There is need to rejuvenate research and extension programmes in a bid to tackle climate change effectively. Therefore, frequent research targeting potential options, best practises are critical if the effects of climate change are to be mitigated. It is of note that extension programs can play a key role in information sharing by transferring technology, facilitating interaction, building capacity among farmers, and encouraging farmers to form national research work (Nelson *et al*, 2009).

Small-scale farmers themselves can be an operational information-sharing mechanism and have the potential to offer cost-effective links between government efforts and farmer activities. Their own networks are important in moulding extension services that specifically address climate-change adaptation including disseminating local cultivars of drought-resistant crop varieties, teaching improved management systems, and gathering information to facilitate. Extension services could support coping strategies by increasing awareness of them and their utility for reducing climate related risks and helping farm households to develop the knowledge and skills needed to adopt and apply them effectively.

Prioritise Climate Change Adaptation in the National Policy Framework and Budget

Considering that climate change adaptation requires significant funding, it is in the best interest of Government to allocate adequate resources towards adaptation efforts. Climate change is a threat to national, global food security and its impact stretches further than food security. Therefore, serious political will is required to allow for successful adaptation efforts by farmers as well as other individuals.

6.4 Concluding Remarks

Small-scale farmers at Dzindi have successfully employed high yielding varieties, drip irrigation, irrigation control mechanisms, drought resistant crop varieties, mulching and off-farm employment as climate adaptation strategies. This however requires commitment from the Government and communities towards tapping into local knowledge and developing these local strategies as well as funding. However, the least contributor of carbon emissionsAfrica remains the most vulnerable and most affected. Africa needs to become vigilant in addressing climate change issues at grassroots levels considering that the poorer who are at the periphery are the most vulnerable and affected by climate change.

References:

Adepetu, A. 2000. The Vulnerability Of Rural Sahelian Households To Drought: Options For Adaptation, A Final Report Submitted To Assessments Of Impacts And Adaptations To Climate Change (AIACC), Project No. AF 92 Published By the International START Secretariat, Washington DC, USA.

Adger, W. Neil, and P. Mick Kelly. 1999. Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change* 4:253-266.

Adger, W. Paavola, J and Huq, S. 2006: *Toward Justice in Adaptation to Climate Change*. In: Adger, W.N./ Paavola, J./Huq, S./Mace, M.J.: *Fairness in Adaptation to Climate Change.* Cambridge: Cambridge University Press, pp. 1-20.

Agrawal, A. 2008. The Role of Local Institutions in Adaptation to Climate Change. Paper prepared for the Social Dimensions of Climate Change, Social Development Department, The World Bank, Washington DC.

Akpalu, W., Hassan, R. M., and Ringler, C. 2009. Climate Variability and Maize Yield in South Africa: Results from GME and MELE Methods, IFPRI Discussion Paper No. 843 Washington, DC.

Akpalu, W., R. M. Hassan, and C. Ringler. 2009. Climate Variability and Maize Yield in South Africa: Results from GME and MELE Methods, IFPRI Discussion Paper No. 843 Washington, DC.

Altman, M., Hart, T., and Peter Jacobs. 2009. *Food Security in South Africa. Centre for Poverty, Employment and Growth*. Human Sciences Research Council. Pretoria.

Baer, P., Kartha, S., Athanasiou, T., and Kemp-Benedict, E. 2008. “The Greenhouse Development Rights Framework: Drawing attention to inequality within nations in the global policy debate”. *Development and Change*. Institute of Social Studies, The Hague.

Balaghia, R., Badjeckb, M.C., Bakaric, D., De Pauwd, E., De Wite, A., Defournyf, P., Donatog, S., Gommesh, R., Jlibenea, M., Raveloi, A.C., Sivakumarj, M.V.K., Telahigueg, N., and B. Tychon. 2010. “Managing Climatic Risks for Enhanced Food Security: KeyInformation Capabilities”. *Procedia Environmental Sciences* 1: 313–323.

Bals, C., Harmeling, S., and Windfuhr, M. 2008. Climate Change, Food Security and the Right to Adequate Food. Diakonisches Werk der EKD e.V. Stuttgart.

Bamberger, Michael. 2000. *Integrating Quantitative and Qualitative Research in Development Projects*. World Bank, Washington DC.

Barnett, J., Matthew, R. A., and O’Brien, K. (2008). Global environmental change and human security. In H.G. Brauch, et al. (Eds.), Reconceptualizing security in the 21st century. Berlin: Springer.

Bohle, Hans G., Thomas E. Downing, and Michael J. Watts. 1994. “Climate change and social vulnerability : Toward a sociology and geography of food insecurity”. *Global Environmental Change* 4 (1):37-48.

Bonti-Ankomah, S. 2001. Addressing food insecurity in South Africa, The National Institute for Economic Policy, Paper presented at the SARPN conference on Land Reform and Poverty Alleviation in Southern Africa. Pretoria.

Bryant, R.C., B. Smit, M. Brklacich, R.T. Johnston, J. Smithers, Q. Chiotti, and B. Singh. 2000. “Adaptation in Canadian agriculture to climatic variability and change”. *Climatic Change* 45:181–201.

Brown and Higgins, N. 2009. “Markets, Climate Change, And Food Security In West Africa”.*Environment. Science. Technology*. 43: 8016–8020.

Brown M. E., and Funk, C. 2008. “Food Security under Climate Change”.*Science* 319: 580

Bryan, E., Temesgen, T., Deressa, Glwadys A. Gbetibouo, and Ringler, C. 2009. “Adaptation to Climate Change in Ethiopia and South Africa: Options and Constraints”. *Environmental Science and Policy*. 12:413-426.

Busby, J. 2010. *After Copenhagen: Climate governance and the road ahead. Council on Foreign Relations*. International Institution and Global Governance Programme. New York.

Chambers, R. and Conway, G. 1992. *Sustainable rural livelihoods: practical concepts for the 21st century*. IDS Discussion Paper 296. University of Sussex, Brighton:Institute of Development Studies.

Chattopadhyay, N. 2008. *Climate Change and Food Security in India*.International Symposium on Climate Change and Food Security in South Asia August 25-30, Dhaka, Bangladesh.

Clay, E. 2002.Food Security: Concepts and Measurement, the Overseas Development Institute, London, UK, for the FAO Expert Consultation on Trade and Food Security: Conceptualizing the Linkages, Rome, 11-12 July 2002.

Corbett, J. 1988. “Famine and Household Coping Strategies”. *World Development* 16(9): 1,092–1,112.

D. Lee. 2009. *Climate change: Impact on agriculture and costs of adaptation*. Washington, D.C.: International Food Policy Research Institute.

DAFF. 2010. *Food Security and Vulnerability Assesment in South Africa*. Pretoria.

Darwin, R. 2001. Climate Change and Food Security, Agriculture Information Bulletin Number 765-8 available online at http://www.ers.usda.gov/publications/aib765/aib765-8.pdf.

Davies. 1993. “Are Coping Strategies a Cop-Out?”. *IDS Bulletin* 24(4).

De Klerk, M., Drimie, S., Aliber, M., Mini, S., Mokoena, R., Randela, R., Modisele, S., Vogel, C., De Swardt., C and Kistern, J. 2004. Food security in South Africa: Key policy issues for the medium term [WWW document] URL: http://www.hsrc.ac.za/research/output/.

De Waal, A. 1989. *Famine That Kills: Darfur, Sudan, 1984–1985*. Oxford: Clarendon Press.

Department for International Development (DFID). 2004. *The Impact of Climate Change on the Vulnerability of the Poor: Key Sheet No.3.* Policy Division. DFID. UK.

Department of Agriculture, Forestry and Fisheries [DAFF]. 2002. *The Integrated Food Security Strategy for South Africa*. Pretoria.

Department of Environmental Affairs and Tourism. 2003. *South African Country Study on Climate Change Synthesis Report for the Vulnerability and Adaptation Assessment Section*. Pretoria.

Desanker, Paul, and Christopher Magadza. 2001. Africa. In Climate Change 2001: Impacts, Adaptation And Vulnerability, Edited By I.P.O.C. Change. Geneva: IPCC.

Devereux, S and Edwards, J. 2004. “Climate Change and Food Security”.*IDS Bulletin*35 (3):22-30.

Devereux, S, Baulch, B, Hussein, K, Shoham, J, Sida, H and Wilcock, D. 2004.Improving the Analysis of Food Insecurity: Food Security Measurement,

Livelihoods Approaches, and Policy Applications in FIVIMS. http://www.fivims.net/documents/Final%20Paper5.pdf.

Devereux, S. 2001. “Sen’s Entitlement Approach: Critiques and Counter-critiques”.*Oxford Development Studies* 29 (3): 245-263.

Devereux, S. 2006. Identification of Methods and Tools for Emergency Assessments to Distinguish Between Chronic and Transitory Food Insecurity and to Evaluate the Effects of Various Types and Combinations of Shocks on These Different Groups, Word Food Programme, Emergency Assessments Branch (ODAN), Rome.

Dilley, M. 2000. “Reducing Vulnerability to Climate Variability in Southern Africa: The Growing Role of Climate Information”. *Climatic Change*45 (1):63-73.

Dodman, D. Ayers, J and Saleemul Huq. 2009. *Building Resilience, in State of the World: Into a Warming World*. The World Watch Institute.

Drinkwater, M., Kokwe, M and McEwan, M. 1992. Nutrition and household food security in farming systems research: Southern and eastern Africa regional workshop: Mansa, Zambia, 10-14 August 1992: workshop commentary.

Du Toit, Andries and Gina Ziervogel. 2004. Vulnerability and food insecurity: Background concepts for informing the development of a national FIVIMS for South Africa.

Ellis F. 2000. *Rural Livelihoods and Diversity in Developing Countries*. Oxford University Press, Oxford, UK.

Ellis, F. 1998. “Household Strategies and Rural Livelihood Diversification” *Journal of Development Studies*: 35 (1): 1-38.

Ericksen, P. 2006. A Food Systems Approach to Understanding Food Security, GECAFS International Project Office; NERC - Centre for Ecology, Wallingford, United Kingdom.

Ericksen, P. J. 2008. "Conceptualising Food Systems for Global Environmental Change Research".*Global Environmental Change*18 (1):234-245. 2008.

Ericksen, P. J. 2008. "What Is The Vulnerability Of A Food System To Global Environmental Change?"*Ecology and Society*13 (2):14.

Eriksen, Siri, and Lars Otto Naess. 2003. *Pro-poor climate adaptation: Norwegian development cooperation and climate change adaptation - an assessment of issues, strategies, and potential entry points*. Oslo: CICERO.

Eriksen. S and Kevin O'Brien. 2007. "Vulnerability, poverty and the need for sustainable adaptation measures". *Clim Policy*, 7: 337–352.

Evans, A. 2008. *Rising Food Prices: Drivers And Implications For Development*. London: Chatham House.

Food and Agriculture Organization of the United Nations (FAO). 2007. *Adaptation to Climate Change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities.* Rome, FAO.
ftp://ftp.fao.org/docrep/fao/009/j9271e/j9271e.pdf.

FAO. 1996. *Rome Declaration and World Food Summit Plan of Action*. Rome. Available at:www.fao.org/docrep/003/X8346E/x8346e02.htm#P1_10.

FAO. 2002. *The State of Food Insecurity in the World 2001*. Rome: FAO.

FAO. 2006. *Food Security Policy Brief. Issue 2*. FAO: Rome.

FAO. 2007. *Adaptation to Climate Change in Agriculture, Forestry, and Fisheries: Perspective, Framework, and Priorities*. Interdepartmental Working Group on ClimateChange, Editor. Rome.

FAO. 2008. *Climate Change and Food Security: A Framework Document*. FAO: Rome.

FAO. 2010. *The State of Food Insecurity in the World:Addressing Food Insecurity In Protracted Crises*. FAO: Rome.

Food and Agricultural Organisation (FAO). 2009. Global Agriculture Towards 2050, High Level Expert Forum - How To Feed The World In 2050office Of The Director, Agricultural Development Economics Division Economic And Social Development Department Viale Delle Terme Di Caracalla, 00153 Rome, Italy.

Food and Agriculture Organization of the United Nations (FAO). 2009. More People Than Ever Are Victims of Hunger. Press Release, June 19. http://www.fao.org/fileadmin/user_upload/newsroom/docs/press%20 release 20 june-en.pdf.

Francisco H, A. 2008. “Adaptation to Climate Change Needs and Opportunities in Southeast Asia”. *SEAN Economic Bulletin*. 25 (1): 7-19.

Frankenburger, T.R. 1992. *Indicators and Data Collection Methods for Assessing Household Food Security*. In: S. Maxwell and T. Frankenburger, eds. *Household food security: Concepts, indicators, and measurement: A technical review.* UNICEF and IFAD, New York

Gbetibouo G, A. 2009. Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability, IFPRI Discussion Paper 00849.

GEF. 2009. *Implementation of Results-Based Management Under the Least Developed Countries Fund and The Special Climate Change Fund. LDCF/SCCF Council Meeting*. Washington, D.C.

Haan, Nicholas, Nisar Majid, and James Darcy. 2006. *Review of Emergency Food Security Assessment Practice in Ethiopia*. United Nations World Food Programme (WFP).

Hassan, A. 2010. ICARDA: Sustainable Livelihoods and Food Security under Changing Climate in Dry Areas. Expert Group Meeting on Promoting Best Practices On Sustainable Rural Likelihoods in the Escwa Region, Beirut, Lebanon.

Heather E. Thompson, Lea Berrang-Ford, and Ford J, D. 2010. "Climate Change and Food Security in Sub-Saharan Africa: A Systematic Literature Review". *Sustainability,2*: 2719-2733.

Hendriks, S.L. 2005. "The challenges facing empirical estimation of the households food (in) security in South Africa". *Development Southern Africa*, 22 (1): 103 – 123.

Hisali, E, Birungi, P, and Faisal Buyinza. 2011. "Adaptation to climate change in Uganda: Evidence from micro level data". *Global Environmental Change* 21 (2011) 1245–1261.

Holzmann, P. with Boudreau, T, Holt, J., Lawrence, M. and O'Donnell, M. (2008) The Household Economy Approach. A Guide for Programme Planners and Policy-Makers. London: Save The Children (UK).

Hoste, J. 2010. Where Was United Africa in the Climate Change Negotiations? Africa Policy Brief No.2.Egmont Royal Institute for International Relations. http://www.egmontinstitute.be/papers/10/afr/2010-feb-afr.p.brief-hoste-climate-change.pdfcited 20 October 2010.

HSRC (Human Sciences Research Council). 1997. Code of research ethics. Pretoria: HSRC. http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf.

Human Science Research Council. 2004. Fact Sheet: Poverty in South Africa. Pretoria. URL:http://www.sarpn.org.za/documents/d0000990/.

Human Sciences Research Council. 2004. Food Security in South Africa: Key Policy Issues for the Medium Term. http://www.hsrc.ac.za/Document-471.phtml.

Huq, S. 2001. “Climate Change and Bangladesh”. *Science*, (294):1617.

Huq, S. and J.M. Ayers. 2007. *Critical list: the 100 nations most vulnerable to climate change, in IIED Sustainable Development Opinion*. International Institute of Environment and Development: London.

Huq, Saleemul and Jessica Ayers. 2007. *Climate Change Impacts and Responses in Bangladesh*. International Institute for Environment and Development:London.

Huq, Saleemul and Jessica Ayers. 2008. *Climate Change Impacts and Responses in Bangladesh*. Policy Department Economy and Science DG Internal Policies European Parliament. Brussells.

IFAD. 2001. *Rural Poverty Report 2001: The Challenge of Ending Rural Poverty*. IFAD. Rome.

IFAD. 2009. Research and Innovation for Smallholder Farmers in the Context of Climate Change. Discussion paper prepared for the Round Table organized during the Thirty-second session of IFAD’s Governing Council, 18 February 2009. http://www.ifad.org/events/gc/32/roundtables/3.pdf.

IFPRI. 2008. New Study Identifies Farmers’ Options and Obstacles to Adapting to Climate Change. Press Release, November 12, 2008. http://www.ifpri.org/pressrel/2008/20081112.asp.

IFPRI. 2009. *Climate Change Impact on Agriculture and Costs of Adaptation*. International Food Policy Research Institute Washington, D.C.

Ingram, J. S. I., and M. Brklacich. 2002. “Global Environmental Change and Food Systems – GECAFS: A New Interdisciplinary Research Project”. *Die Erde* 132:S427-435.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate change 2001: impacts, adaptation, and vulnerability. Contribution of Working Group II to the Third Assessment Report of the IPCC.

IPCC. 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Geneva: IPCC.

IPCC. 2001. *IPCC 3rd Assessment Report - Climate Change 2001: Working Group II: Impacts, Adaptation and Vulnerability.*Geneva: IPCC
Available online at http://www.ipcc.ch/ipccreports/ index.htm.

IPCC. 2007. *Fourth Assessment Report, Summary for Policymakers, the Intergovernmental Panel on Climate Change (IPCC)*. Geneva: IPCC

IPCC. 2007. IPCC 4th Assessment Report - Climate Change 2007. Working Group II on “Impacts, Adaptation, and Vulnerability”. http://www.ipcc-wg2.org.

Jacobs P.T, Altman M, Hart T. 2009. “The Status of Household Food Security Targets in South Africa”. *Agrekon* 48(4).

Kelly, P.M., Adger, W.N. 2000. “Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation”. *Climate Change* 47: 325-352.

Klein, R and Tol, R. 1997. *Adaptation to Climate Change: Options and Technologies: An Overview Paper*. Institute for Environmental Studies, Amsterdam.

Koch, Josee. 2011. *The food security policy context in South Africa.* IPC-IG country studies no 21. International Policy Centre for Inclusive Growth: Brasilia.

Kumamoto, Mihoko and Mills, Anthony. 2011. *What African Countries Perceive to be Key Adaptation Priorities: Results From 20 Countries in the Africa Adaptation Programme*. Paper presented for Panel 4: National and International Policy – Linking policy and practice at the Climate Change Symposium

Lobell, D and M. Burke (Eds.)"Climate Change And Food Security".*Advances in Global Change Research*: 37

Lobell, D., Burke, M., Tebaldi, C., Mastrandrea, M., Falcon, W., and Rosamond L. Naylor. 2008. *Science* 319 (5863): 607-610

Lobell, D. Burke, M. Tebaldi, C. Mastrandrea, M. Falcon, W and Rosamond L. Naylor. 2008. "Prioritizing Climate Change Adaptation Needs for Food Security in 2030".*Science:* 319 (5863): 607-610.

Ludi, E. 2009. *Climate Change, Water and Food Security*. ODI: UK. Available from http://www.odi.org.uk/resources/download/3148.pdf.

Madzwamuse, Masego. 2010. *Climate Governance in Africa: Adaptation Strategies and Institutions*: Hienrich Boll Stiftung.

Majake, M.P. 2005. *Evaluation of the impact of a household food security in Qwaqwa using a Coping Strategy Index*. Unpublished M Agric (Food Security), African Centre for Food Security, University of KwaZulu Natal, Pietermaritzburg.

Maliwichi, L. Bourne, L. Mokoena, L. 2003. "Expenditure patterns on food and non-food items of Khayelitsha households, Western Cape, South Africa". *International Journal of Consumer Studies*27 (3): 227.

Maxwell, Simon. 1990. "Food security in developing countries: issues and options for the 1990s". *IDS Bulletin*, 21(3): 2-13

Maxwell S, Smith M. 1992.*Household Food Security: A Conceptual Review (Part 1)*. In: Maxwell S, Frankenberger T, eds. *Household Food Security: Concepts,Indicators, and Measurements*. Rome: IFAD

Maxwell, D.G. 1995. Measuring Food Security: The frequency and severity of coping strategies. [WWW document] URL: http://www.ifpri.org/divis/ Accessed 26 July 2011.

Maxwell, S, and T. Frankenberger. 1992. *Household Food Security: Concepts, Indicators, Measurements: A Technical Review*. Rome: International Fund for Agricultural Development/United Nations Children's Fund.

Mcdevitt, A. 2009. Helpdesk Research Report: Climate Change and Zimbabwe. Governance and Social Development Resource Centre.

Mcmillan, J and Schumacher, S. 2010. Research in education evidence based inquiry 7th ed. Pearson Education: USA

Mercy Corps. 2007. *Climate Challenges – Bridging the Knowledge Gap*. Mercy Corps Climate Change Unit, Edinburgh.

Misselhorn, Alison. 2005. *Background Information on Food Security Initiatives in South Africa*. DAFF: Pretoria

Mjonono, Mfusi. 2008. *An Investigation Of Household Food Insecurity Coping Strategies In Umbumbulu, Submitted in partial fulfilment of the degree of MSc Agric (Food Security)*. African Centre for Food Security, School of Agricultural Science and Agribusiness, Faculty of Science and Agriculture. University of KwaZulu-Natal: Pietermaritzburg.

Moehner, A. and R. Klein. 2007. The Global Environment Facility: Funding for Adaptation of Adapting to Funds? , in Climate and Energy Working Paper, S.E.I. (SEI). Stockholm Environment Institute (SEI): Stockholm.

Mohamed, Suleiman Shehe. 2006. *Livelihoods of Plot Holder Homesteads at the Dzindi Smallholder Canal Irrigation Scheme*.Ph.D. dissertation, Tshwane University of Technology.

Mokwena, Lebogang. 2009. *Municipal Responses to Climate Change in South Africa The case of eThekwini, the City of Cape Town, and the City of Johannesburg.* Research report 113. Centre for Policy Studies.

Monde, Nomakhaya. 2003. "Household food security in rural areas of Central Eastern Cape : the case of Guquka in Victoria East and Koloni in Middledrift districts". (PhD)(Agric Econs) Thesis, University of Fort Hare.

Moorhead. A, 2009, *Climate, Agriculture, and Food Security: A Strategy for Change*. Alliance of the CGIAR Centers.

Morrell, W, and Scialabba, N. 2009. FAO, In Cooperation With The Pacific Expert Group On Climate Change And Food Security, Climate Change And Food Security In The Pacific, Food And Agriculture Organization Of The United Nations, Rome.

Nelson, G.C., Rosegrant, M.W., J. Koo, R. Robertson, T. Sulser, T. Zhu, C. Ringler, S. Msangi, A. Palazzo, M. Batka, M. Magalhaes, R. Valmonte-Santos, M. Ewing, and Ngigi, S.N. 2009. *Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa*. The MDG Centre for East and Southern Africa, The Earth Institute at Columbia University, New York. 189p

Nhemachena, C., Hassan, R., 2008. *Micro-level analysis of farmers' adaptation to climate change in Southern Africa*. IFPRI Discussion Paper 00714.

Nyong, A. 2008. Agriculture And Climate Change Emissions: Potential Mitigation And Adaptation Measures In The Agricultural Sector, Expert Meeting On Climate Change –The Role Of Food And Agricultural Trade UNFCCC Cop 14, Poznan, Poland.

O'Brien, K. (Ed.). 2000. Developing Strategies for Climate Change: The UNEP Country Studies on Climate Change Impacts and Adaptations Assessment. Report 2000: 2. Oslo: CICERO/UNEP.

O'Brien, K., and Hochachka, G. 2010. "Integral Adaptation to Climate Change". *Journal of Integral Theory and Practice*, 5(1): 89-102.

O'Brien, Karen. 2008. Responding to Climate Change: The Need for an Integral Approach, DRAFT Chapter Submitted to Integral Theory Anthology.

ODI. 2001. *Economic Theory, Freedom, and Human Rights: The Work of Amartya Sen*.Overseas Development Institute: UK.

Oldewage-Theron, H., Dicks, E.G., and Napier, C.E. 2006. "Poverty, household food insecurity and nutrition: Coping strategies in an informal settlement in the Vaal Triangle, South Africa". *Public Health*, 120 (9): 795-804.

Olmos, Santiago. 2001. *Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Methods*. Climate Change Knowledge Network Foundation Paper.

Orindi, V. 2009.Joto Afrika: Adapting to Climate Change in Africa. Vol.1.

Oxfam. 2008. *Turning Carbon into Gold*, Oxfam Briefing Paper 123. Oxfam International Secretariat: Oxford

Oxfam. 2009.*Climate Change and Gender Justice*. Practical Action Publishing Ltd .UK.

Pamela Baxter and Susan Jack. 2008. "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers".*The Qualitative Report:* 13 (4): 544-559.

Parry, M., Rosenzweig, C., Iglesias, A., Fischer, G., and Matthew Livermore. 1999. "Climate change and world food security: a new assessment". *Global Environmental Change* 9 (Special issue):S51-S67.

Paul, B. K. 1998. "Coping Mechanisms Practised by Drought Victims (1994/5) in North Bengal, Bangladesh". *Applied Geography*, 18(4): 355-373

Pauw, K and Mncube, L. 2007. The impact of growth and redistribution on poverty and inequality in South Africa. [WWW document] URL: http://www.commerce.uct.ac.za/research_units

Rahim, Aminur. 2011. "Rights to Food with a Human Face in the Global South".*Journal of Asian and African Studies* 46: 237-249.

Richards, Michael. 2003. *Poverty Reduction, Equity and Global Governance Synergies or Contradictions?* Overseas Development Institute. UK

Ringler, C. 2008. "The Impact of Climate Variability and Climate Change on Water and Food Outcomes: A Framework for Analysis, How can African Agriculture Adapt to Climate Change? Insights from Ethiopia and South Africa". *IFPRI Research Brief*: 15(1).

Ringler, C., Zhu, T., Cai, X., Koo, J., and Wang, D. 2010. Climate Change Impacts on Food Security in Sub-Saharan Africa. IFPRI Discussion Paper 01042.

Roberts, J. Stadelmann, M and Saleemul Huq. 2010. Copenhagen's climate finance promise: six questions. International Institute for Environment and Development Briefing Paper. Available online http://pubs.iied.org/pdfs/17071IIED.pdf

Rose, D and Charlton, E. 2001. "Prevalence of household food poverty in South Africa: Results from a large, nationally representative survey". *Public Health Nutrition*, 5(3): 383–389.

Rose, D and Charlton, E. 2002. “Quantitative indicators from a food expenditure survey can be used to target the food insecure in South Africa”. *The Journal of Nutrition*, 11(132):35-42.

Rosegrant, M and Cline, S. 2003.“Global food security: challenges and policies”. *Science* 302: 1917–1919.

Save the Children. 2005. “The Household Economy Approach – A Resource Manual for Practitioners”, available at www.savethechildren.org.uk/foodsecurity/publications/manual.htm

Schmidhuber, J and Muller, A. 2009. “Climate Change: Food Security and Future Conflict”.*Technology:* 11 (3).

Sen, A. 1981. *Poverty and Famine: An Essay on Entitlements and Deprivation*. Oxford: Carendon Press.

South African Weather Service. (2009).Global Warming/Climate Change: South Africa Available at: http://saweatherobserver.blogspot.com/2009/08/global-warmingclimate-change-south.html.

Stephen N. Ngigi. 2009. *Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa.* UNON, Publishing Services Section, Nairobi.

Stern, N. 2007. *How Climate Change Will Affect People Around The World. In: The Economics of Climate Change: The Stern .Review*(Pp. 65-103). Cambridge University Press.

Teddlie, Charles and Yu, Fen. 2007. ‘Mixed Methods Sampling: A Typology With Examples.” *Journal of Mixed Methods Research* 1; 77.

Thomas, D, Twyman, C, Osbahr, H, and Bruce Hewitson. 2007. “Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa”. *Climatic Change* 83:301–322.

Thompson, H, E, Berrang-Ford L, and Ford G.D. 2010.“Climate Change and Food Security in Sub-Saharan Africa: A Systematic Literature Review”.*Sustainability*, 2: 2719-2733.

Tongco, Dolores.2007.“Purposive Sampling as a Tool for Informant Selection”.*Ethnobotany Research and Applications* 5:147-158.

Transparency International. 2011. *Global Corruption Report: Climate Change*. Earthscan Ltd, UK.

UNFCCC. 2006. Climate Change: Impacts, Vulnerabilities, and Adaptation in Developing Countries. Chapter IV: IV. Regional Impacts of and Vulnerabilities to Climate Change (Africa), pp. 18-26. UNFCCC. unfccc.int/resource/ docs/publications/impacts.pdf.

UNFCCC. 2007. *The Kyoto Protocol Mechanisms Unfccc:International Emissions Trading Clean Development Mechanism Joint Implementation*. Climate Change Secretariat (UNFCCC). Bonn.

UNFCCC. 2007. *Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries*. Climate Change Secretariat (UNFCCC). Bonn.

UNFCCC. 2010. *Adaptation Assessment, Planning And Practice: An OverviewFrom The Nairobi Work Programme On Impacts, Vulnerability And Adaptation To Climate Change*. Climate Change Secretariat (UNFCCC). Bonn.

Valenzuela, Ernesto, and Kym Anderson. 2011. Climate Change and Food Security to 2050: A Global Economy-wide Perspective, Centre for International Economic Studies School of Economics, University of Adelaide.

Van Averbeke, W., Letsoalo, S.S., Mohamed, S.S. and Khosa, T.B. 2004. *Analysis of the situation at Dzindi Irrigation Scheme. WRC project K5/1464//4*. Pretoria: Department of Crop Sciences, Tshwane University of Technology.

Vincent, K and Cull, T. 2009. *Background on the Debates and Documentation of Research on Climate Change and Food Security in Southern Africa Report.* SADC Climate Change Research Networking Workshop, Cape Town.

Vincent, K and Cull, T. 2009. Research Projects on Climate Change and Food Security in the SADC Region, "Understanding the Linkages between Climate Change, Human Health, Water and Food Security: Research and Knowledge Sharing For Southern Africa" Cape Town.

Vink, N and Kirsten, J. 2003. "Policy successes and policy failures in agriculture and land reform in South Africa: The 1990s". *South African Journal of Economic History*, 18(1 and 2): 96-117

Vink, N and Kirsten, J. 2003. "Agriculture in the National Economy", in *The Challenge of Change: Agriculture, Land and the South African Economy* vol 1. University of Natal Press. Pp 3-20

Von Grebmer, K, Nestorova, B, Quisumbing, A, Fertziger, R, Fritschel, H, Pandya-Lorch. R, Johannes. Y. 2009. *Global Hunger Index, the Challenge of Hunger: Focus On Financial Crisis and Gender Inequality*. Bonn, Washington.

Water and Energy Conservation Systems. 2011.*What is Climate Change*? Retrieved 26/05/2011, from http://www.watersafe.co.za/2011/01/19/what-is-climate-change.

World Bank. 2007. *World Development Report 2008*. World Bank: Washington DC.

World Bank. 2007. *World Development Report 2008: Agriculture for Development*. Washington, DC: World Bank.

World Bank. 2008. *Rising Food Prices Spell Hunger for Millions Across Africa*. http://go.worldbank.org/BJL6ZL4X70.

World Food Programme. 2009. Distinguishing between chronic and transitory food insecurity in emergency food security assessments (EFSA). Emergency Food Security Assessments (EFSAs). Technical guidance sheet no. 5.
http://home.wfp.org/stellent/groups/public/documents/manual_guide

Yin, R. 2003. Case study research: Design and methods (3rd Ed.). *Thousand Oaks, CA: Sage Publications.*

Young, H. Jaspars, S Brown, R. Frize, J, and Hisham Khogali. 2001. *Food-security assessments in emergencies: a livelihoods approach*.Humanitarian Practice Network (HPN).Overseas Development Institute: London.

Yu, B., Zhu, T., Breisinger, C., and Manh Hai, N. 2010. "Impacts of Climate Change on Agriculture and Policy Options for Adaptation: The Case of Vietnam". *IFPRI Discussion Paper* 01015.

Ziervogel G, Nyong A, Osman B, Conde C, Cortés S, and Tom Downing. 2006. "Climate Variability and Changes: Implications for Household Food Security".*AIACC Working Paper* No. 20.

Ziervogel, G and Zermoglio, F. 2009. "Climate-change scenarios and the development of adaptation strategies in Africa: challenges and opportunities". *Clim Res*, 40:133–146.

Ziervogel, G., Taylor, A., Thomalla, F., Takama, T. and Quinn, C. 2006.*Adapting to climate, water and health stresses: insights from Sekhukhune, South Africa*. Stockholm Environmental Institute Report, Oxford, United Kingdom.

Ziervogel, Gina and Polly J. Ericksen. 2010. *Adapting to climate change to sustain food security*, Volume 1. John Wiley and Sons, Ltd.

List of Appendices

Appendix 1

Questionnaire

For official use only

Interview no.		
Interviewer:		**Language interview conducted in:**

Introduction

This questionnaire seeks to obtain information on climate change adaptation and food security strategies employed by small-scale farmers, their perceptions of climate change, and the role of the government in building capacity of small-scale farmers to adapt to climate change.

This interview is entirely anonymous. No one will know your name and so you may speak quite freely to the interviewer. We thank you for your time and assistance in our work.

1. General Information/Household Bio-data

1.1. Please indicate where the interview is taking place, for example, the name of the village township or other local settlement/ community.

……
……
……

1.2. How long have you lived in this area?

……
……
……

1.3. Sex

Male	Female

1.4. What is your age?

20 to 30	
30 to 40	
40 to 50	
50 to 60	
60 to 70	
Older than 70 years	

1.5. What is your main occupation?

Teacher	
Farmer	
Self-employed (specify)	
Employee in private company	

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2. Local Awareness and Perception of Climate Variability and Trends Related to Climate Change (Over The Past 20 Years)

2.1. How can you evaluate rainfall in terms of quantity, period and duration during the past 20 years?

Rainfall	Observations
Quantity	
Period	
Duration	

2.2. Do you think climate has affected your agricultural activities? Explain?

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……
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……

2.3. In the past 20 years, do you think your agricultural yields have increased or decreased? Why?

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……

2.4. If rainfall has become erratic in your area what have been the impact on crops?

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2.5. What interventions have you undertaken to sustain small-scale farming?

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……
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2.6. In your opinion what are the general trends about temperature?

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……

2.7. In your opinion what are the impacts of the situation on the populations overall existence, the way they lived it and suggestions for addressing the problems

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……

……
……

2.8. In your opinion, how would be the rainfall and the temperature in the future?

……
……
……
……
……

2.9. Have you experienced flooding in this area during the past 20 years?

Yes	no

2.10. If yes, how would you classify flooding within this area?

Frequent	
Rare	
Important	
Constant	
Little	

2.11. What has been the impact of flooding on your livelihoods and suggestions for addressing the problems)

.....
.....
.....

.....

.....

.....

2.12. What is the situation with reference to drought in this area?

Frequent	
Rare	
Severe	
Constant	

2.13. What has been the impact of drought on your livelihoods and suggestions for addressing the problem)

……

……

……

……

……

……

2.14. Comment on the quantity, abundance of water sources and the quality of water in the past 20 years

Water source	observations
Quantity	
Abundance	
Quality of the water	

Numerous, Constant, Fewer, Good, Bad

2.15. Which of these climate changes may entail important problems in daily life? Why?

……
……
……
……

3. Consequences and Impacts of Climate Related Changes and Trends- with Particular Attention to Livelihoods and Socio-Economic Impacts

3.1. What are the different impacts of climate related changes and trends on agricultural produce?

……
……
……
……
……

3.2. Comment on changes in terms of food stock and the summer period (hard season)

Food stock

		Observations (reasons)
Diminishing		
Unchanged		
Increasing		

3.3. Comment on the above

……
……
……

……
……

3.4. Changes occurring in terms of the economy, income generating activities:

Cultivation

Income-generating activities	At present	5 years ago	10 years ago	15 years ago	20 years ago	observations
Income-generating						
varieties						

3.5. How do you perceive your livelihoods in the future with these climate changes (food sufficiency, health, income, standard of living…?)

……
……
……
……

3.6. Apart from climate changes, what may be the other reasons, which can negatively influence the earning of living, nutrition, standard of living, and health?

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……
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……

4. Responses to Climate Change and Adaptation Options Employed

4.1. How do you cope with climate change?

……
……
……
……
……
……

4.2. What strategies do you use for multiplying crops?

Barrage	
Fertilizers	
Technologies	
Other	

4.3. What methods do you use to prevent soil erosion (Drs)?

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……
……

4.4. What methods do you use for managing and using water in a sustainable way?

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……
……

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……
……

4.5. Other means used for increasing family income?

……
……
……
……

5. Barriers or Principal Constraints to Adaptation, Climate Change and Implementation of Interventions to Reduce Vulnerability/ Facilitate Adaptation

5.1. What are the basic strategies for reducing the drawbacks of climate changes?

……
……
……
……....

5.2. What may be the constraints to the implementation of these strategies?

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……
……
……

5.3. What other possible solutions or suggestions do you propose for enabling the basic population to cope with climate changes?

……
……
……
……

6. Understanding of Food Security and Strategies Employed to Achieve Household Food Security

6.1. How would you classify the following aspects of food security in your household?

6.1.1. **Availability:**

……

……

……

6.1.2. Access:

……

……

……

6.1.3. Adequacy:

……

……

……

6.1.4. Stability:

……

……

……

7. Role of the Government in Building Capacity of Small Scale Farmers to Adapt to Climate Change

7.1. Do you think small-scale farmers have the capacity to adapt to climate change?

Yes	no

7.1.1. Explain

……

……

……

……

7.2. Are there any government agencies helping you with agricultural extension services?

Yes	no

7.2.1. If yes, name them

……
……
……

7.3. What has the government done to help you adapt to climate change?

……
……
……
……

7.4. Do you think enough has been done to help small-scale farmers to adapt to climate change?

……
……
……
……

7.5. What do you think must be done to help small-scale farmers adapt to climate change?

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……
……

Concluding Remarks

Do you want to add any final or concluding remarks?

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……
……
……

THANK YOU FOR YOUR VALUABLE TIME AND YOUR PARTICIPATION IN THIS IMPORTANT RESEARCH PROJECT.

Appendix 2

Ethics Research Confidentiality and Consent Form

I Blessing Munyaradzi Chigavazira am a student at the University of Fort Hare, **Registration 201013866**, studying for a Master of Social Science Degree in Development Studies. I hereby seek to conduct an interview with you as a requirement of my masters' course, fieldwork exercise.

The study seeks to obtain information on climate change adaptation and food security strategies employed by small-scale farmers, their perceptions of climate change, and the role of the government in building capacity of small-scale farmers to adapt to climate change. It is my hope that the results of this study will benefit your community and possibly other communities in the future.

Please understand that you are not being forced to take part in this study and the choice whether to participate or notare yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you do not want to go on with the interview. If you do this, there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there willbe no "come-backs" from the answers you give.

The interview will last around 45 minutes.I will be asking you a questions and ask that you are as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature. I will be asking some questions that you may not have thought about before, and which involve thinking

about the past or the future. We know that you cannot be certain about the answers to these questions but we ask that you try to think about these questions. When it comes to answering questions, there are no right and wrong answers. When we ask questions about the future,we are not interested in what you think the best thing would be to do, but what you think would actually happen.

It is my hope that I will come back to this area once we have completed our study to inform you and your communityof what the results are and discuss our findings and proposals around the research and what this means for people in this area.

CONSENT

I hereby agree to participate in research regarding …….. I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continueand that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues that may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if possible, feedback will be given to my community on the results of the completed research.

……..

Signature of participant **Date**:……..

I hereby agree to the tape recording of my participation in the study

……..

Signature of participant	**Date**:……..

Source: Govan Mbeki research and development Center, University of Fort Hare

Appendix 3

Department of Development Studies
University of Fort Hare
P O Box X1314
Alice

Department of Agriculture
Vhembe District Office

Sibasa

7 December 2011

Re: **REQUEST TO BE GRANTED PERMISSION TO CONDUCT ACADEMIC RESEARCH**

I hereby request your permission to undertake an academic research in your area. I am a postgraduate student enrolled with the University of Fort Hare and registered as student number 201013866. I am currently working towards attaining a master of social science degree in development studies. As a requirement of the course I look to conducting field research in your area to obtain information on my research area. My research topic is **Adapting to Climate Change to achieve Household Food Security: A Case Study of small-scale farmers in the Vhembe District in the Limpopo Province of South Africa)**

The objective of the study are to To explore adaptation mechanisms and adaptation options employed by rural small-scale farmers in the Vhembe District to achieve food security in the midst of climate change as well as reflecting on the role of the state in building capacity of rural small-scale farmers to adapt to climate change

This study seeks to contribute towards the practice of climate change adaptation in South Africa and sub-Saharan Africa in a bid to improve on the different mechanisms ad coming up with best practices. This is considering that climate change is a discourse is relatively new in terms of research, and thus much more dynamics still need to be researched on. Government Departments working on agriculture, environment, climate change and food security, civil society organisations as well as academics are likely to benefit from the findings of this study, which will open up to more informed research and debate on the climate change adaptation best practises.

I therefore seek clearance to undertake this academic research in the Vhembe district

Yours sincerely

Blessing Munyaradzi Chigavazira

07/12/2011

Appendix 4

University of Fort Hare

DEVELOPMENT STUDIES DEPARTMENT

Alice (main) Campus:
Private Bag X 1314, Alice, 5700
Ground Floor, Henderson Hall , Alice, 5700
Tel: +27 (0) 40 602 2562 • Fax: +27 (0) 86 627 4870
Email: cmanyonta@ufh.ac.za / pmonyai@ufh.ac.za

University of Fort Hare
Together in Excellence

TO WHOM IT MAY CONCERN

This letter serves to confirm that, Blessing Munyaradzi Chigavazira is a registered student (201013866) with the University of Fort Hare in the Department of Development Studies. He is currently registered for a Master of Social Science Degree in Development Studies,where the degree is a full research component.

For him to satisfy the requirements of the degree, Blessing is obliged to carry out a fieldwork exercise, in order to obtain data, which serves as the results of his study. Blessing is pursuing a research topic entitled: **Adapting to Climate Change to achieve Household Food Security: A Case Study of small-scale farmers in the Vhembe District in the Limpopo Province of South Africa)**

The objective of the study is to explore adaptation mechanisms and adaptation options employed by rural small-scale farmers in the Vhembe District to achieve food security in the midst of climate change as well as reflecting on the role of the state in building capacity of rural small-scale farmers in the district to adapt to climate change

The Department of Development Studies will appreciate all efforts to assist the student in the process of conducting his fieldwork in your district.

Yours sincerely

Dr C. Hofisi.

2011 -12- 03

073 922 3488