

AN INVESTIGATION OF COMMUNAL FARMERS'S LIVELIHOODS AND
CLIMATE CHANGE CHALLENGES AND OPPORTUNITIES IN MAKONDE RURAL
DISTRICT OF ZIMBABWE

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Declaration

I, the undersigned ISHUMAEL SANGO student number 44928734 hereby declare that this thesis is my own original work with the exception of quotations and references which are attributed on their sources. This thesis has not been previously submitted to any other university and will not be presented at any other university for similar or other degree award.

Signature.....

Date.....

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Dedication

I dedicate this work to my wife, Phili Sango and my three children Tinomukudza, Tafara and Mazvita Sango. I pass my sincere gratitude to my beloved family for giving me the encouragement, support and inspiration. May God bless them all?

It is my wish that my children will draw inspiration from this work as they pursue their individual academic endeavors.

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List of Acronyms

°C	Degrees Celsius
AREX	Agricultural Research and Extension Services
EMA	Environmental Management Agency
FCTZ	Farm Community Trust of Zimbabwe
GHG	Greenhouse Gases
GIS	Geographical Information Systems
ICRAF	International Centre for Research in Agro-forestry
IPCC	Intergovernmental Panel on Climate Change
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MRDC	Makonde Rural District Council
NCAR	National Center for Atmospheric Research
NGOs	Nongovernmental Organisations
NCAR	National Center for Atmospheric Research
PAR	Pressure and Release Model
SADC	Southern Africa Development Community
SPSS	Statistical Package for Social Sciences
TAR	Third Assessment Report
TroFCCA	Tropical Forest and Climate Change Adaptation
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
ZDMS	Zimbabwe Department of Meteorological Services (Met Office)
ZimVAC	Zimbabwe Vulnerability Assessment Committee

Abstract

As the debate on the impacts of global climate change goes on at global and regional scale, climate change impacts are already being felt at local level. The thesis aims at exploring climate change as a driver of environmental and smallholder farmers' livelihood vulnerability in Makonde District of Zimbabwe. Specifically the study seeks to: determine climate change trends and manifestations; evaluate household-level impacts of climate change and associated environmental changes on smallholder farmers' livelihoods and lastly; to investigate the extent of household-level coping and adaptation strategies to climate change in the Makonde rural community in Zimbabwe, especially farmers in Makonde Communal Lands. Given the fact that the subject under study is multidimensional in scope, a mix of research methods was adopted in this case study. Whilst it is largely qualitative in design, the study involved some quantitative data and thus, a triangulation of different data sources and data gathering instruments was employed. The instruments used include; key informant interviews, structured observations and a household questionnaire survey. The analysis was based on a final sample of 434 out of the originally anticipated 500 households. In addition to the households' sample, were twenty key informants and transect walk observations. The qualitative data was analyzed by means of coding, memoing, descriptions, typologies, taxonomies and visual representations, whilst quantitative data was processed through the Statistical Package for Social Sciences (SPSS) and complimented by Microsoft Excel to generate various forms of descriptive statistics. The findings suggest that climate change in the Makonde Rural District that includes the Makonde Communal Lands has been significant during the past thirty years. The climate change has contributed to significant local environmental stresses affecting local resources such as forests, fauna, water, pastures and soil among other natural assets. The local livelihoods show high levels of vulnerability to climate change due to notable low adaptive capacity. The high level of vulnerability to changing climate is exposing the study population to increased prevalence of: poverty, crop and livestock failures, food insecurity, malnutrition, disease and rural urban migration among other impacts. The study concludes that the factors creating barriers to climate change adaptation are related those contributing to poverty and holding back sustainable local development. Among the key suggestions to enhance the community's climate change adaptation capacity, the thesis presents an establishment of a government-driven, multi-dimensional and multi-stakeholder intervention mechanism to help local communities manage their vulnerability.

CHAPTER ONE: INTRODUCTION

1.0 INTRODUCTION

Climate is among the most vital environmental aspects that the human community is endowed with. Climate implies the long-term average of the individual weather conditions that communities experience every day (Davies, 2011). It is among the most important determinants of survival and human livelihoods as it determines both how and where human communities live, which foods they can grow, the sources of water for domestic, industrial and other purposes, and how societies and economic activities are organized (IPCC, 2007). Climate as a factor of life is particularly strong to low income rural communities whose livelihoods heavily depend on rain-fed subsistence agriculture like those in the focus of this study, the Makonde Communal Lands of Zimbabwe.

During the course of human civilization, communities in all parts of the world have evolved ways of earning livelihoods and supplying their needs for food, water, shelter and other goods and services that are adapted to benefit from the climates in which they live (Kulkarmi and Leary, 2007). However, the climate is ever variable and changeable, and deviations that are too far from the observed normal averages can be disruptive and/ or even hazardous (Tol *et al.*, 2004). It is such major climatic deviations that are becoming increasingly characteristic of the current state of the world environment. In particular, it is anthropogenic climate change that has since become one of the most striking environmental challenges affecting the modern world (Weart, 2004).

The United Nations Framework Convention on Climate Change (UNFCCC) (2002 p. 30), defines climate change as a “change of climate that is attributed directly or indirectly to human activity that alters the composition of global atmosphere and that is in addition to natural climate variability observed over comparable time periods”. Climate change is defined by a number of factors, including: temperature, humidity, rainfall, air pressure and wind and severe weather events (Kandji *et al.*, 2006; Schneider *et al.*, 2007; Brown *et al.*, 2012).

Due to the vital role that climate plays to human life and other life forms and process, all of the world population is vulnerable to the unprecedented climate variability and changes taking place today. Whilst the vulnerability is of varying degrees from community to community, generally the

entire world community is affected through connections to each other (Tol *et al.*, 2004). Leichenko and O'Brien (2001) point out that climate change is exposing world communities, particularly subsistent farmers to new and unfamiliar conditions. Whilst some communities may be in a position to take advantage of these changes, many more are facing increased vulnerability, particularly in the developing world such as sub-Saharan Africa (Thornton *et al.*, 2006; Chagutah, 2010). It is the potentially high vulnerability to climate change of the technically disadvantaged rural communities that has guided the focus of this particular thesis. The study therefore seeks to investigate climate change challenges and opportunities for rural farmers and households in the Makonde Communal Lands of Zimbabwe.

Whilst it is commonly recognized that humans are active agents in responding to climate change and that the adaptive capacity of people will determine their levels of risk to climate change, determining adaptive capacity in the face of climate change is highly context-specific. The capacity varies depending on a complex web of biophysical and socio-economic circumstances (Thomas and Twyman, 2005). Due to the context-specific pattern of climate change vulnerability, Ellis and Freeman (2005) suggest that the assessments of vulnerability and adaptive capacity to climate change must be carried out at the local level. It is for this reason that the scope of the thesis is confined within the specific context of the Makonde Communal Lands of Zimbabwe.

In general terms, climate change has got direct impacts on the biophysical world, which in turn happens to be the vital asset for human survival and economics. The state of the biophysical environment determines the productivity and availability of ecosystem services and goods to the human environment, livelihoods and wellbeing (Thomas and Twyman, 2005). Southern Africa, to which Zimbabwe belongs, is a predominantly semi-arid region with high rainfall variability, characterized by frequent droughts and floods. Sub Saharan Africa in which the study area lies, is also widely recognized as one of the most vulnerable regions to climate change because of low levels of adaptive capacity, particularly among rural communities, combined with a high dependence on rain-fed agriculture (IPCC, 2007; Brown *et al.*, (2012). Agriculture in the region is particularly important in both the formal and informal economy, in sustaining rural livelihoods and in food security.

With reference to the high vulnerability status of sub-Saharan Africa, Anselm *et al.*, (2010) observe that whilst farmers in some regions may benefit from longer growing seasons and higher yields, the general consequences for Africa are expected to be adverse. The agricultural system in practice is directly dependent on the climatic variables of temperature and rainfall, whose changing trends are posing new challenges for various crops, regions and farming systems (Ziervogel and Calder, 2003; Moyo *et al.*, 2012). Trend analysis of temperatures across southern Africa reveals that annual minimum and maximum temperatures have increased at an average rate of 0.057^o C per decade and 0.046^o C per decade, respectively between 1901 and 2009. Further analysis reveals that the periods of most rapid warming occur post 1970. Existing evidence for rainfall trends suggests moderate decreases in annual rainfall over parts of Southern Africa (Unganai, 2009). There is also evidence from other studies that inter-annual rainfall variability over southern Africa has increased since the late 1960s and that droughts have become more intense and widespread in the region (Fauchereau *et al.*, 2003; Brown *et al.*, 2012).

Concerns about climate change and its associated environmental degradation are therefore receiving increasing attention particularly in Africa also because a large proportion of the rural population lives in already ecologically vulnerable areas (Leichenko and O'brien, 2001; Hunter, 2001; Unganai, 2009). The impact is particularly adverse for the poor and the marginalized, who do not have the means to withstand drastic changes (Ziervogel and Calder, 2003; Obrien and Leichenko, 2003). Evidence from the IPCC suggests that areas south of the Sahara are likely to emerge as the most vulnerable to climate change by 2100, with likely agricultural losses of between two and seven percent of the affected countries' gross domestic product (GDP) (Aguilar *et al.*, 2005). It is this worrying observation that has informed the decision to pursue this particular study.

With regards to the future outlook of climate change and its potential impacts, there is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global greenhouse gas (GHG) emissions will continue to grow into the next century (Agrawal, 2005; IPCC, 2007). Based on the foregone conclusion that climate change would continue for centuries due to the time scales associated with climate processes and feedbacks, even if GHG concentrations were to be stabilized (Mirza, 2003; IPCC, 2007), this

precarious climate change future calls for innovative livelihood strategies to cope with and adapt to the changing environment (Carney, 1998; Sherbinin, 2006).

In the specific context of climate change, adapting therefore means taking action to adjust to a new set of climatic attributes, either different from those already existing, or changed parameters of existing attributes (Klein, 2003). With increasing awareness of detrimental human impact on the environment as cause for risk to humans, adaptation is being promoted as a concept for guiding policy to ensure sustainable development, reduce vulnerability and minimise risk to humans from climate change (Smit and Skinner, 2002). Developing countries in general and poor rural communities such as the Makonde Communal Lands population, in particular, are often regarded as having the lowest adaptive capacity. The low adaptive capacity is based on the lack of access to technology, the least degree of development of social institutions, as well as the highest historical and existing stresses associated with climate change (Sagar and Banuri, 1999; Smit and Pilifosova, 2001). In this case, adaptive capacity is seen as being inversely correlated with vulnerability.

The socioeconomic implication of climate change and associated ecosystem degradation is based on the fact that climate shapes human cultures and livelihoods and it largely determines food production and its variability, in turn causing environmental and socioeconomic stresses in the affected region. Forests and other natural resources are crucial assets among the rural communities of Zimbabwe and other poor countries. This is also because of the critical ecological and socio-economic functions they perform (O'Brien and Leichenko, 2003; Chagutah, 2010). Although the areas that are vulnerable to extreme weather events are generally known, there is still a lack of reliable information about how current and future changes in temperature and precipitation regimes will affect specific locations and communities like the case of Makonde Communal Lands. Furthermore, specific work is anticipated to help reduce the current knowledge gap that is attributable to the prevailing inherent risk associated with investments in agriculture and other weather-dependent livelihoods.

1.1 STATEMENT OF THE PROBLEM

Whilst the debate on the potential impacts of global climate changes is becoming intensive especially at international and regional level, the impacts of these changes are already most felt at

community and household levels. The changes are exposing rural peasants of Makonde Communal Lands and the rest of Zimbabwe to new and unfamiliar conditions with most of them facing increased vulnerability.

The Zimbabwe Department of Meteorological Services (ZDMS) (2007) points out that the country has experienced a warming averaging two degrees Celsius in the last 30 years and precipitation patterns also show a reduction of 30% in rainfall. Zimbabwe is experiencing more hot days and fewer cold days, and the amount of precipitation it receives is deviating from the mean more frequently (GoZ-UNDP/GEF, 2009). Given its already compromised agro-ecological status, coupled with generally low household income, climate change in the Makonde District and Makonde Communal Lands is equally exposing the local ecosystems and peasant livelihoods to increased vulnerability.

The national economic challenges that Zimbabwe has been facing in the past 15 years have forced the government to cut down on the national budget allocation to social services and rural development (Unganai, 2009). Given this economic scenario, the smallholder farmers in the Makonde Communal Lands are left to fend for themselves, with no option but to adopt at local level, a variety of livelihood strategies for survival. Using the Makonde Communal Lands as a case study, this thesis seeks to investigate the climate change challenges and opportunities for rural farmers at both the household and community levels.

1.2 AIM AND OBJECTIVES OF THE STUDY

The thesis aims to investigate communal farmers' livelihoods in the context of climate change challenges and opportunities in Makonde Rural District, Zimbabwe. This aim will be accomplished through the following set of specific objectives;

1. To determine climate change trends and manifestations in the Makonde Communal Lands over the period 1962 – 2008.
2. To evaluate the impacts of climate and associated environmental changes on households' livelihoods in Makonde Communal Lands.

3. To investigate the levels of coping (adaptation) strategies and resilience levels to climate change of the Makonde community, particularly at the household level.

1.3 RESEARCH QUESTIONS

The study seeks to answer the following research questions:

1. What is the climate change trend recorded and experienced in the Makonde Communal Lands during the period 1962 to 2008?
2. What climate change-induced biophysical changes have occurred in the Makonde Communal Lands during the stated period?
3. What are the household-level impacts of climate change on the rural community of the Makonde Communal Lands?
4. What household-level coping and/ or adaptation strategies to climate change are being adopted in the Makonde Communal Lands?

1.4 SIGNIFICANCE OF THE STUDY

The key concern of this study is that for rural livelihoods to be sustainable, especially given the growing evidence of climate change and its potential overallly negative impacts. There is clearly a need to learn to manage vulnerable communities. There is a need to be able to understand and/or manage climate change–related hazards, natural resilience and acquired resilience. Such understanding helps to open up opportunities for improving our overall vulnerability since it forces people to examine the multi dimensional nature of global climate change and its local level impacts.

The study is intended to highlight the adversity of the downstream externalities of global climate change, particularly upon the largely poor and vulnerable rural households and communities of Zimbabwe and the developing world at large. In terms of knowledge gap, studies on the consequences of climate change at local community level particularly in Africa are still very few and scarce. Until fairly recently, work investigating the impacts of and responses to climate change tended to be more prolific in the northern hemisphere (Davies, 2011). The long history of negligence of research on climate change impacts in the South is ironical in the sense that the tropical South is considered the most vulnerable to climate change. It is this ironical research gap

in the South that has strengthened the thesis' inspiration to focus on this particular subject and within the context of a community belonging to the potentially vulnerable sub Saharan Africa.

While the body of knowledge on climate change, impacts, vulnerability and adaptation is undergoing a significant build up over recent years, every local community has its own associated challenges regarding to climate change. This has made it very difficult to draw upon past studies to address climate change related impacts in a separate local context. The IPCC Climate Change Assessment (2007) stresses that most of the research on agriculture and climate change has focused on crop production in different regions. The linkages between these analysis and the broader issues of sustainable development and food security in countries suffering from extreme poverty and malnutrition are, however, not sufficiently understood. In the case of Zimbabwean studies, climate change impacts from the national perspective have been assessed mostly at sectoral level such as in forestry, water resources, agriculture, and human settlement (Chagutah, 2010). Among such scope of study, is that of Matarira *et al* (1999) whose research focused on '*Zimbabwe Climate Impacts on Maize Production*'. To this end there is, therefore, a need for more research on micro-level climate change impacts on livelihoods in order not only to fill the academic and philosophical gap but also to incite policy debate towards guaranteeing livelihood resilience to external shocks such as climate change (Salih, 2001; Chagutah, 2010; Brown *et al.*, 2012). Such locally specific research seeks to pursue the idea of Vogel (2001) who suggests that 'Virtual reality' need to be informed by 'real cases' implying that environmental change assessments need to be 'ground-truthed'.

With regards to research focus, Davies (2011) observes that until recently, most assessments of the impact of climate change on human wellbeing have mainly focused on the implications for the production and global supply of food, paying little attention on other components of the food chain. What has, therefore, been missing in most studies so far is a broader view on the multiple effects that global warming and climate change have on the entirety of the food systems and food security of communities (Chagutah, 2010). This thesis comes in with a systems approach that is intended to cover the multidimensional and multi-sectoral nature of climate change impacts on the biophysical and socio-economic setting of human livelihoods and the associated adaptation options.

The systems approach to climate change assessment is in line with the observation made by Smit and Pilifosova (2001) that risks of climate change generally viewed as adverse impacts, are determined by the interaction of three factors. The three factors include: hazard exposure represented by the changing climatic variables; sensitivity or biophysical vulnerability to that exposure; and the adaptive capacity or the social vulnerability of people living in that environment. Determining such a complex set of risks of climate change impacts is the central concern of this thesis. This particular focus of study is considered important for prioritizing places and people where adaptation intervention is required. The main focus of this thesis, therefore, is on the wider social vulnerability of rural livelihoods to climate change impacts. Social vulnerability in this case refers to the susceptibility of households or communities to the effects of climate change and their ability to cope with, adapt to and overcome these (Adger *et al.*, 2004; Brown *et al.*, 2012).

The findings of the study are anticipated to contribute to a body of knowledge to furnish academia, global leaders, policy makers, local authorities and planners with a comprehensive understanding of the local livelihoods dynamics to climate change impacts. According to Salih (2001) a comprehensive understanding of the local challenges and resulting livelihoods forms the basis for the effective designing of intervention measures to address given challenges in ways appropriate to the local circumstances.

The study seeks science-based strategic solutions that will help to enhance the adaptive capacity of agricultural and other rural land use systems to climate change for the peasant communities and policy makers to better manage land, the environment and food security in low income nations such as Zimbabwe. It is anticipated to provide a point of departure and reference for future researchers and practitioners in the field of local level climate change and associated impact trends.

1.5 THE STUDY AREA

Makonde Rural District lies in Mashonaland West Region in the north western part of the country. It stretches over an area of 8531 km² with a population of 167436 (CSO, 2005). The rural district is divided into four main land use categories namely: the Doma National Park to the northern extreme of the district; the Large Scale Commercial Farming Area which covers the large central part of the district stretching across the Chinhoyi–Chirundu high way; the urban areas (Mhangura, to the

North, Lion's Den and Alaska at the centre and Chinhoyi to the south eastern margin and the last land use category in the district is the Makonde Communal Lands covering the southern section of the district and it is this area in particular which constitutes the area of concern for this study. Figures 1.1 shows the geographical situation of the Makonde Communal Lands in Makonde Rural District.

In terms of historical background, the Makonde Communal Lands as a geographical and socio-economic unit are a product of the colonial legacy. Following the 1890s' occupation of the country by the British, the white settlers set aside native reserves solely for occupation by Africans under the traditional tenure system. This created the dual subdivision of the country (then known as Southern Rhodesia) into two racially-based agrarian structures. One was the white settler commercial areas in the more accessible and agro-ecologically productive regions I to III, while the other constituted remote native reserves on poorer soils and hot and dry low land regions IV and V of the country (Ranger, 1983; Murombedzi, 2003).

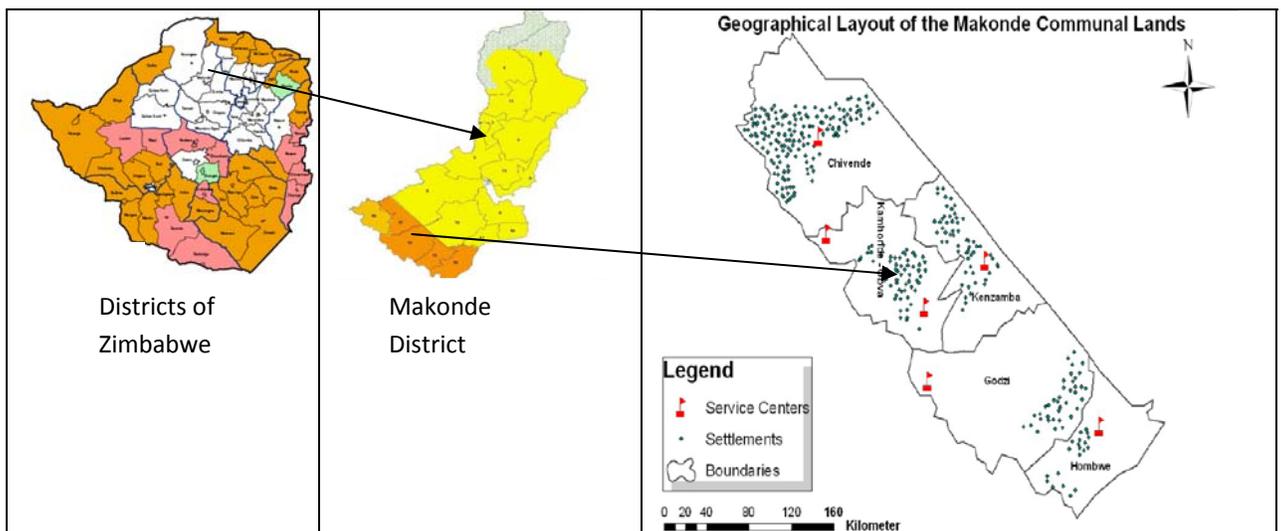


Figure 1: Geographical Situation of the Makonde Communal Lands

Source: Adapted from Department of the Surveyor General (2012)

The resettlement exercise saw the majority natives being alienated and overcrowded as the population grew from an estimated 400,000 in 1900 to about 940,000 by 1926. Over the years of colonialism, pressure began to be felt within the reserves and the early signs of environmental

degradation began to set in (Bromley and Cernea, 1989). From then onwards, several acts of parliament were passed in order to consolidate the colonial government's objectives on agriculture. Among the key legislative instruments consolidating the marginalization of native farmers was the Land Apportionment Act of 1931 that formalized the dual agrarian structure. In the process, a white agricultural policy was launched, which promoted commercial farming. A department of agriculture was set up in 1908 to implement agricultural policy for white commercial farmers (Scoones and Wilson, 1989). The policy was aimed at providing government support to the commercial farming areas and their white occupants. For example, from 1935 to 1956, a 50% subsidy plus free technical support program was launched to allow white farmers to build soil and water conservation and irrigation works. On the other hand, no support was rendered to the communal farming lands, and the smallholder native farmers (Ibid).

Due to growing population pressure on local land resources, a new law; the Tribal Trust Land Act of 1967 was enacted. The act restored traditional leaders' (chiefs) authority to allocate land previously denied them under the Land Husbandry Act. The efforts to achieving a "balance" between demands for arable, pasture and forest land proved increasingly impossible under the ongoing pressures on land. By allowing cultivation in areas previously designated for grazing only, it created a situation in which the burgeoning population and their livestock had to compete for marginal and limited land resources. As the population grew, so did the need for arable land, which meant carving further into the already dwindling pasture resources for livestock. As more land was converted into arable, and as the demand for additional draught power rose, an ever increasing number of livestock had to survive on less and less grazing land. Eventually, overstocking was considered characteristic of most communal areas and the single most important factor contributing to their environmental degradation (Scoones and Wilson, 1989; Murphree, 1991; Chagutah, 2010).

What made local environmental management initiatives even more difficult was the traditional right of access to the common property resources the villagers indiscriminately claimed. This issue degenerated into a dilemma of the commons whereby there was virtually no control mechanism over access and use of local natural resources, with everyone claiming to be exercising their traditional right (Ranger, 1983).

A combination of factors that include: the naturally stressed ecosystems, rapid population growth pressure and the unregulated access to and use of land resources has had a heavy toll on the state of the environment in Makonde and other communal lands in Zimbabwe (Unganai, 2009). The rapidly increasing population pressure is largely responsible for the massive deforestation and cultivation of marginal and fragile environments in Makonde. It is one of the ironies of Zimbabwean history that the Native Reserves and other institutions created by the colonial administration were largely preserved by the nationalist forces that came to power in 1980 (Murombedzi, 2003; Unganai, 2009; Chagutah, 2010).

According to Doré (1993), the colonial legacy of this dual agrarian structure therefore prevailed through the Zimbabwe Independence and continues to exist today. The dual agrarian structure still prevails in the form of the remote; drought prone Makonde Communal Lands, juxtaposed by the well-served agro-ecologically advantaged Makonde Commercial Farming Area. At independence, Zimbabwe inherited an agricultural sector characterized by two different systems, namely, the commercial sector exclusively for the whites and the communal areas for blacks. The commercial sector had access to better and larger pieces of land compared to the blacks. The Tribal Trust Land Act survived largely intact after Independence, resurfacing as the Communal Areas Act of 1982 (Zinyama, 1986; Bromley and Cernea, 1989). In keeping with its nationalist and socialist ideological roots, the new government saw the communal areas as the arena for collective action and the embodiment of a uniquely African socialism (Guveya and Chikandi, 1996).

The Makonde Communal Lands are currently under the jurisdiction of the Makonde Rural District council. The council is in control over cropping, conservation and organization of land into cropping, grazing and forestry land. In topographic terms, communal lands are hilly and rolling, with sandy soils. The area receives summer rains and no winter rains. The population in the Makonde Communal lands is mostly constituted by semi-subsistent smallholder farmers who depend on their annual produce as the main source of income. Other livelihood strategies households tend to adopt include gold panning and a wide range of forest resource-based trade activities.

The Makonde Communal Lands are endowed with marginal surface water resources and largely depend on borehole sources most of the year, with seasonal stream discharges especially in the

southern extreme. The majority of the smallholder farmers have limited economic resources and a low level of technology thus exacerbating their highly vulnerable status to environmental and other hazards. The lack of agricultural and other infrastructure and budgetary constraints to effectively provide support services to the smallholder farmers has a potential to exacerbate food insecurity in the study area (ZimVac, 2008).

During the past decade, Zimbabwe has experienced economic difficulties which escalated in 2008. The unprecedented deterioration of the economic environment during this decade affected the wellbeing of the majority of Zimbabwean, particularly as it resulted in a sharp decrease in funding for social services in real terms over the years (Unganai, 2009; Brown *et al.*, 2012). The suppressed economic growth has led to weakened social protection system and service provision, with adverse welfare consequences particularly to the economically disadvantaged smallholder communal farmers such as the Makonde community (Ibid).

1.6 SCOPE OF THE STUDY

The study will be confined to the Makonde Communal Lands of Zimbabwe. The communal lands cover a narrow belt along the southern end of the Makonde District, sharing its northern border with the Makonde Commercial Farming Area. The study area is divided into six wards which include; Chivende to the north, Kamhonde, Obva, Kenzamba, Godzi and Hombwe to the South. The wards are altogether divided into ten villages, upon which the study's framework for stratified sampling is based. The subjects of the study will be mostly the smallholder farmers across the ten villages (Figure 1.2).

Thematically, the study will focus on the following phenomena: the meteorological; biophysical; land use and socioeconomic aspects manifesting in the study area. Besides the households in the community as key subjects in the study, the survey covered various institutions that include: the Department of Meteorological Services (Met Office); The Environmental Management Agency (EMA); the Department of Agricultural Research and Extension Services (AREX), the Department of Social Services; the Makonde Rural District Council (MRDC); and two nongovernmental organizations (NGOs) operating in the study area.

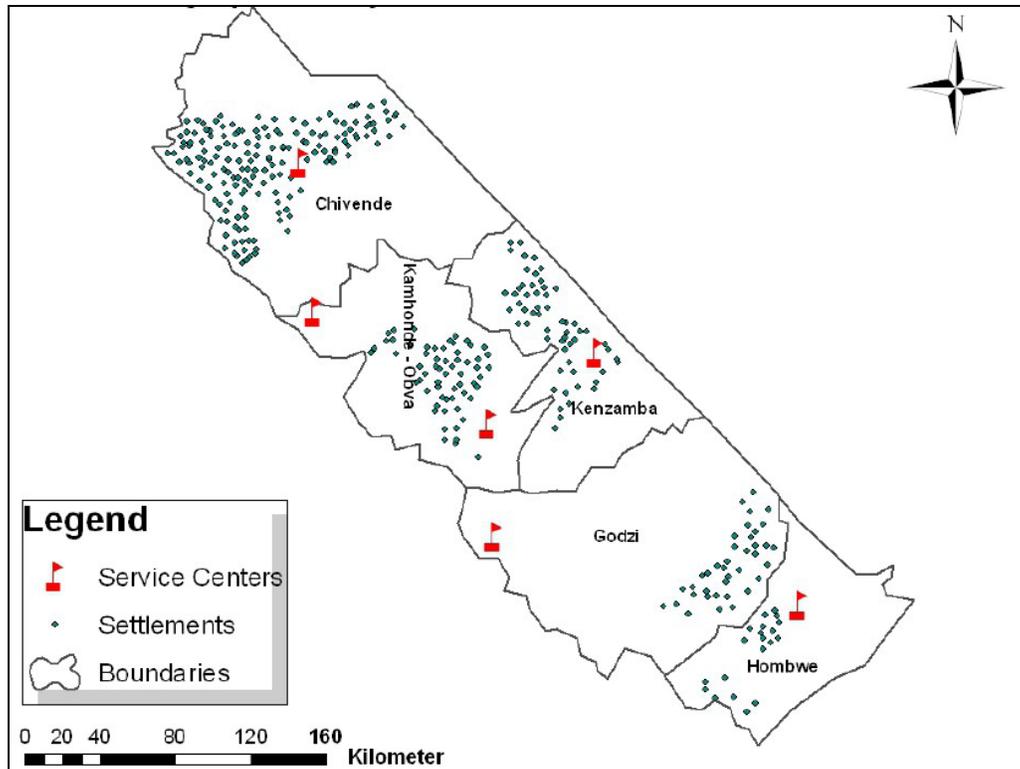


Figure 1: Geographical Layout of the Makonde Communal Lands

Source: Vector Data Adapted from Department of the Surveyor General

1.7 THESIS OUTLINE

The thesis is made up of five chapters,

Chapter one has introduced the study, highlighting the thesis focus through its main and specific objectives, research questions and the significance of the study. It also provides a background description of the study area and scope of the study. Chapter two gives a review of both theoretical and empirical literature on the issue of climate change as a global phenomenon with climate change trends and impacts as observed at various geographical scales. The concepts and patterns of livelihood vulnerability to climate change are discussed in relationship with adaptive capacity and adaptation strategies from a regional and context specific perspective. Challenges and opportunities for sustainable adaptation to climate are presented especially in the context of rural agro-based communities of the developing world. Chapter three provides details on the epistemological and entomological alignment of the study, the research design, data collection strategies, instruments and procedures. It also outlines the data analysis's techniques employed in

generating the research results. Chapter four presents data and discussion of research findings. Chapter five provides a summary of the thesis, conclusions and suggestions for sustainable climate change adaptation for government, other pertinent stakeholders and the community. Suggestions are also provided for future research towards further enriching the body of knowledge related to climate change, impacts, livelihood vulnerability and adaptation at local level.

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

This chapter is aimed at providing both the theoretical framework and empirical background to inform the research. The literature to be reviewed will cover a broad spectrum of aspects, ranging from the actual and projected environmental changes in general and climate change and variability at global, regional and micro-scales. It will also cover aspects of rural livelihood vulnerability and coping and/ or adaptation to climate variability and change under different scenarios and socio-economic circumstances. Challenges and opportunities for sustainable rural livelihood and coping with, and adaptation to climate change impacts will also be reviewed across different systems and scales.

2.1 GLOBAL AND SUB SAHARAN AFRICA CLIMATE CHANGE TRENDS

Among the most striking environmental challenges affecting the earth is anthropogenic climate change (Weart, 2004). Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where according to the UNFCCC (2002 p. 30), "climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of global atmosphere and that is in addition to natural climate variability observed over comparable time periods". Climate change implies much more than how warm or cool global temperatures are. Whereas 'global warming' refers to increasing global temperatures, "climate change" refers to regional conditions. Climate change is defined by a number of factors, including: temperature, humidity, rainfall, air pressure and wind and severe weather events (Kandji *et al.*, 2006; Schneider *et al.*, 2007; Brown *et al.*, 2012).

Smith *et al.* (2001) identified a couple of 'reasons for concern' about climate change and showed schematically how their seriousness would increase with global mean temperature change. Some of the reasons include: far reaching damage to ecosystems and their respective services upon which economies and human survival depends; the increasing frequency and severity of extreme climatic and other natural events; the unequal distribution of climate change impacts, whereby low income populations, mostly the rural, who make up the bulk of the population in less developed

countries are the most vulnerable to climate change vagaries (Archer, 2010). With regards to the threatened systems, Desanker *et al.* (2001) concluded with confidence that an increase in global mean temperature of 2°C above 1990 levels or less would harm several such ecosystems. They further indicated that the frequency and magnitude of many extreme climate-related events will increase with a temperature increase of less than 2°C above 1990 levels (Adger *et al.*, 2004; Agrawal, 2005).

The IPCC (2007) points out that the average temperature of the earth's surface has risen by 0.74°C since the late 1800s and added that it is expected to go up another 1.8°C to 4°C by the year 2100 if no action is taken. That's a fast and intense change in geological time. Even if it "only" gets another 1.8°C hotter, it would be a larger increase in temperature than any century-long trend in the last 10,000 years (Tol *et al.*, 2005; Christensen *et al.*, 2007).

Eleven of the last 12 years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) given in the Third Assessment Report (TAR). The linear warming trend over the 50 years from 1956 to 2005 (0.13 [0.10 to 0.16]°C per decade) is nearly twice that for the 100 years from 1906 to 2005 (Agrawal, 2005; Eriksen *et al.*, 2005; Yamin *et al.*, 2005).

The average Arctic temperatures have increased at almost twice the global average rate in the past 100 years. Global average sea level rose at an average rate of 1.3 to 2.3mm per year during 1961 to 2003 and at an average rate of about 2.4 to 3.8 mm per year from 1993 to 2003. Since 1993, there have been decreases in glaciers and ice caps contributing about 28 percent of sea level rise and losses from the polar ice sheets contributing the remainder (Fischer *et al.*, 2005; Tol *et al.*, 2005). In addition, higher temperatures cause ocean volume to expand. As the bright white of ice and snow give way to dark sea green, less and less rays from the sun are reflected back into space, intensifying the heating (IPCC, 2007).

The above-stated physical changes are among key examples of potential vicious cycles identified by scientists that might see the global climate warming at a rate beyond human imagination. The increasing consumption of fossil fuels to power the economies of the world; and the fact that almost

all modern human endeavors produce carbon dioxide will make climate change extremely complex and intricately tied up in other difficult issues such as poverty, economic development and population growth (Yohe and Schlesinger, 2002; Agrawal, 2005).

After the overwhelming evidence of anthropogenic climate change risks and associated implications on the global community, the United Nations created the United Nations Framework Convention on Climate Change (UNFCCC). As far as international agreements went, negotiation of the Convention was fast, especially one on such a vastly complex issue and this was in response to a clear message that global warming was happening and something had to be done about it (Schneider *et al.*, 2007).

With reference to climate change trends being experienced in Sub-Saharan Africa, Chishakwe (2010) and Archer *et al.*, (2010) observe that the region has been experiencing a warming trend over the past few decades. This is consistent with the global trend of temperature rise in the 1970s, 1980s and the 1990s. Smith *et al.* (2001), suggest that temperatures in the sub-region have risen by over 0.5^o C over the last 100 years. Between 1950 and 2000, Namibia, for an example, experienced warming at a rate of 0.023^o C per year (Government of Namibia, 2002). The Indian Ocean has also warmed more than 1^o C since 1950. During this period, the region has also experienced a downward trend in rainfall (National Center for Atmospheric Research (NCAR), 2005). This has been characterized by below-normal rainfalls and frequent droughts. For example, between 1988 and 1992 the sub-region experienced over 15 drought events (Glantz, 1997).

In sub-Saharan Africa, where there is a heavy reliance on natural resources for livelihoods, 61 percent of the population lives in ecologically vulnerable areas characterized by a high degree of climatic variability and sensitivity, as well as a low degree of resilience (UNEP, 2002; Brown *et al.*, 2012). With reference to climate variability in the region, Ziervogel and Calder (2003) point out that there is evidence of year to year rainfall variability that ranges between 30 and 35 percent, implying that most livelihoods in dryland (or semi-arid) areas of the region are not only precarious but often unsustainable since they are already at the edge of subsistence. Rainfall in the region in the early 1990s was 20 percent lower than that of the 1970s, with significant droughts in the 1980s, early 1990s, and in 2002 (Chenje and Johnson, 1996; Chagutah, 2010).

It is widely accepted, based on future climate modeling findings that the sub-region's climate will be hotter and drier in the future than it is today. Ragab and Prudhomme (2002) observed that by 2050, the sub region's average annual temperature is expected to increase by between 1.5 and 2.5°C for countries in the Southern end of the sub-region if compared to the 1961 – 1990 average. The NCAR (2005) study also concludes that the monsoons across southern Africa could be 10–20 percent drier than the 1950 – 1999 average. Annual regional precipitation is expected to drop by 10 percent, with greater reductions in the northern part of the sub-region than in the southern part (Ziervogel and Calder, 2003).

2.2 REASONS FOR CONCERN ABOUT ANTHROPOGENIC CLIMATE CHANGE

In general terms, climate change has got direct impacts on the biophysical world, which in turn happens to be the vital asset for human survival and economics. The state of the biophysical environment determines the productivity and availability of ecosystem services and goods to the human environment, livelihoods and wellbeing (Thomas and Twyman, 2005; Unganai, 2009).

Among the biophysical elements affected by climate change is amount of rainfall received, and its temporal distribution. Since the industrial revolution, there have been significant changes in precipitation patterns globally. It now rains much more in eastern parts of North and South America, northern Europe and northern and central Asia, but less in the Sahel, Mediterranean, southern Africa and parts of southern Asia (Ziervogel and Calder, 2003). Globally, the area affected by drought is likely to have increased since the 1970s (Dixon *et al.*, 2003; Chappell and Agnew, 2004). This has seen the increasing prevalence and severity of the extremes of floods in some regions and drought in others, whilst other regions experience both in an alternate pattern. Both extremes constitute a big risk to the economies, livelihoods, food security, health and general well being of the affected regions and communities. Floods in Europe, North America and Australia have become uncharacteristically more frequent and more disastrous in the past decade than ever before.

The increasing frequency and severity of drought events in sub Saharan Africa and newly affected regions such as southern Europe, Central and southern USA is a major cause for concern. This has seen a growing proportion of the African population becoming food and water-insecure,

especially given the fact that more than 75 percent of the population in the region depends on rain-fed agriculture (Ziervogel and Calder, 2003; Archer *et al.*, 2010). Water scarcity is becoming increasingly acute in several parts of the Mediterranean region, including major cities such as Madrid.

In terms of temperatures, the world is becoming hotter. Over the past 50 years, cold days, cold nights and frosts have become less frequent over most land areas, while hot days and hot nights have become more frequent (Christie and Hanlon, 2001). It is likely that heat waves have become more frequent over most land areas. This has seen increasing incidents of deaths and serious illnesses being recorded in Europe, and North America, among other social and economic consequences (Chappell and Agnew, 2004; Burke *et al.*, 2006). Global warming is causing accelerated melting of major glaciers, which in turn triggers unprecedented rising of sea level. This has in turn seen a consequent inundation of low lying coastal and island areas in many sites worldwide since 1975. Many small islands such as the Maldives are already running the risk of losing a significant part of their territories through inundations (Davidson *et al.*, 2003; Bryceson, 2002).

Another cause for concern is the significant increase in intensity, frequency and geographical spread of tropical cyclone activities in the North Atlantic, Pacific and Eastern Indian Ocean since about 1970. Warming ocean surfaces and air constitute major fuels for cyclones and hurricanes that have on an annual basis ravaged the coastal and island areas of the stated oceans, causing significant loss of life, damage to property and the local economies (Few *et al.*, 2004).

In terms of the seasons; there is very high confidence that recent warming is strongly affecting terrestrial biological systems, including such changes as earlier timing of spring events, such as leaf-unfolding, bird migration and egg-laying; and pole-ward and upward shifts in ranges in plant and animal species (Thomas and Twyman, 2005). Spring events are increasingly coming earlier in the year and plants and animals are moving to higher altitudes and latitudes because of recent warming trends. Other effects of regional climate changes on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers (Ibid). The variability of seasons is also another major challenge facing smallholder farming communities

of the South, whose agricultural practices depends on meteorological seasonality. As the seasons become more variable and unpredictable, smallholder farmers, who constitute the bulk of the rural community in sub-Saharan Africa are suffering crop failures due to poor timing of rainfall events, land preparation, planting and harvesting periods (Thornton *et al.*, 2006; Moyo *et al.*, 2012).

Scientists have also observed climate-induced changes in at least 420 physical processes and biological species or communities. Since 1970 studies on observed trends in the physical and biological environment and their relationship to regional climate changes have been increased greatly since the TAR. Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases (Midgley *et al.*, 2002; O'Brien *et al.*, 2004). The fact that a large majority of populations in less developed countries directly depend on ecosystem goods and services for their livelihoods, will see more and more of them plunging into poverty as a result of climate change-induced ecosystem degradation (Dixon *et al.*, 2003; Brown *et al.*, 2012).

In their study, Rosenzweig *et al.* (2007) concluded that over the last three decades, human - induced warming has had a discernable influence on many physical and biological systems. Schneider *et al.* (2007) add that regional temperature trends had already affected species and ecosystems around the world. They concluded that climate change would result in the extinction of many species and a reduction in the diversity of ecosystems (Thuiller *et al.*, 2008). About 20-30 percent of plant and animal species is likely to find itself at higher risk of extinction if the global average temperature goes up by more than 1.5 to 2.5°C (Midgley *et al.*, 2002).

2.3 LIVELIHOOD VULNERABILITY TO CLIMATE CHANGE

Salih (2001) and Barraclough (2005) agree that some obvious linkage exists between climate change and society including its impact on the vulnerable populations often unable to build resilience to long term recurrence of climate hazards. Given the growing evidence of climate change in different regions of the world including sub-Saharan Africa (Archer *et al.*, 2010), a useful starting point in the analysis of climate change and its impact on environmental and livelihood vulnerability is to adopt a conceptual framework that links global climate change with local level

impacts in environmental and socioeconomic terms. Livelihood vulnerability will be employed as the key term to assess the climate change impacts at local level (Rajasree, 2010).

With regards to the world population's potential vulnerability to climate change, Kulkarni and Leary (2007), suggest that people of the world have evolved ways of earning livelihoods and supplying their needs for food, water, shelter and other goods and services that are adapted to benefit from the climates in which they live. But the climate is ever variable and changeable, and deviations that are too far from the norm can be disruptive, or even hazardous. It is such major climatic deviations that are becoming increasingly characteristic of the current state of the world environment. All of the world population is vulnerable to the unprecedented climate variabilities and changes taking place today, though to varying degrees, directly and through our connections to each other as a world community (Tol *et al.*, 2004). Leichenko and Obrien (2004), and Moyo *et al.* (2012) agree in their studies that climate change is exposing world communities, particularly subsistent farmers to new and unfamiliar conditions. Whilst some farmers may be in a position to take advantage of these changes, many more are facing increased vulnerability, particularly in the developing world (Ziervogel and Calder, 2003; Thornton *et al.*, 2006; Archer *et al.*, 2010).

According to Ayers (2011), climate change impacts are projected to undermine prospects for sustainable development in many nations and parts of the world. Sustainable development is increasingly understood to encompass economic, environmental and social sustainability. Key concepts are quality of life and survivability. Loss of biodiversity may reduce the options for economic growth and development available to future generations (Rajasree, 2010). Declining biodiversity may have an impact on the functioning and resilience (the ability to handle stress and adapt to change) of both natural and human systems (Biggs *et al.*, 2004; Uganai, 2009). This could lead to increased costs caused by drought, flood damage, mudslides, fire and pests. In addition, loss of ecosystem services such as water provision, nutrient cycling and pollination may impact adversely on human welfare (Thornton *et al.*, 2006). Loss of ecosystem function and resilience is of particular concern in the light of predicted global warming and the anticipated, but largely unknown, impact this will have on climate, local weather conditions, sea level and human health (Archer *et al.*, 2010).

The Millennium Ecosystem Assessment (2005) came up with a framework to determine the role of ecosystem services in sustaining human well-being and development needs. The assessment approach helps to examine the environment through the framework of ecosystem services and with this; it becomes much easier to identify how changes in ecosystems influence human well-being and to provide information in a form that decision-makers can weigh alongside other social and economic information. The Millennium Ecosystem Assessment (MEA) was designed as an integrated assessment to cut across sectors, involving natural science and social science perspectives. It is a multi-scale assessment, which includes component assessments undertaken at multiple spatial scales ranging from global, sub-global, regional, and national, basin to local levels. Another important feature of the MEA is the emphasis on including different knowledge systems, apart from scientific knowledge (Chagutah, 2009).

The MEA embraces the sustainable livelihoods conceptual framework in its approach. It relies on a variety of data collection methods, involving a combination of quantitative and qualitative indicators of sustainable livelihoods. Conceptually, 'livelihoods' imply the means, activities, entitlements and assets by which people make a living. It entails a sum of ways in which a household makes its living (UNECA, 2002). It does not refer to just jobs *per se*, but the wide, infinitely diverse range of activities, people engage in to make their living. In addition to activities, livelihoods consist of assets (Helmore & Singh, 2001; Chagutah, 2010).

According to Ellis and Freeman (2005), the term livelihood assessment attempts to capture not just what people do in order to make a living, but extends to the resources that provide them with the capability to build a satisfactory living, the risk factors that they must consider in managing their resources and the institutional and policy contexts that either helps or hinders them in their pursuit of a viable or improved living.

In the livelihoods framework approach, resources are referred to as assets, implying stocks of different types of capital that can be used directly or indirectly to generate livelihoods. There are five typologies of capital identified by the sustainable livelihoods framework. The types include; natural capital, financial capital, social capital, human capital and physical capital. Assets in this particular context, are defined as not only natural capital (i.e., land water, common-property resources, flora, fauna), but also social capital (i.e., community, family, social networks, and

traditions, participation, empowerment), human capital (i.e., knowledge, entrepreneurship, skills) and physical (i.e., roads, bridges, markets, schools, and other infrastructure) (Ellis and Freeman, 2005; Chagutah, 2010).

The International Institute for Sustainable Development (IISD) defines sustainable livelihoods as being 'concerned with people's capacities to generate and maintain their means of living, enhance their wellbeing, and that of future generations' (Chambers and Conway, 1992; MEA, 2005). Healthy, productive and protective environments, social systems and economies altogether, form the basis of sustainable human livelihood (Ayers, 2011).

A livelihood assessment as a research subject is one of the ways to understand livelihood systems and it involves analysis of the coping and adaptive strategies pursued by households and communities as a response to external shocks and stresses such as climate variability and change (Beg *et al.*, 2002). In the context of climate change, a livelihood assessment is therefore to do with livelihood vulnerability to climate change. Within the context of global climate and associated environmental change, vulnerability is now assessed and applied as a key factor for determining the spatial and societal distribution of the greatest impacts (Brooks *et al.*, 2005). Contrary to the notion of selective vulnerability to climate change, Liverman (1994) argues that almost everything and everyone is vulnerable to global change.

Originating in risk, hazards and disaster studies, the concept of vulnerability has gained considerable popularity in global environmental change studies in the last decade (see for example, Wisner *et al.*, 2004; Cutter, 1996; Cannon, 1994; Archer *et al.*, 2010). This is evident by the frequent use of the term in environment and development contexts, and attempts to quantify vulnerability through indices and maps (Vogel, 2001), such as the UN World Food Programme's vulnerability analysis and mapping, the UN Food and Agriculture Organisation's vulnerability index for assessing potential impacts of sea level rise on populations and agriculture, and the environmental vulnerability index developed by the South Pacific Applied Geosciences Commission for SIDS (Beg *et al.*, 2002; Benson and Clay, 2004; Brooks *et al.*, 2005).

Vulnerability implies the susceptibility of a system to disturbances and loss, determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt (Ashley & Carney,

1999). The South Pacific Applied Geosciences Commission (SOPAC, 2006, p. 3) defines vulnerability as “the tendency of something to be damaged”. It adds that “the idea of vulnerability applies equally well to physical entities such as (people, ecosystems, coastlines) and to abstract concepts such as; social systems, economic systems, and countries”. In other words the local environment and human livelihoods are equally assumed to be vulnerable to global climate changes (Chikozho, 2010; Rajasree, 2010).

Several researchers particularly focusing on ‘vulnerability to climate change’ have emerged and among them include; Downing *et al.* (2001), Moss *et al.* (2001), Brooks (2004), Downing and Patwardhan (2003), O’Brien *et al.* (2004), Uganai (2009), Chagutah (2010) and Brown *et al.* (2012). Several authors have also emphasised that the term ‘vulnerability’ can only be used meaningfully with reference to a particular vulnerable situation, that is within the assessment context. Downing and Patwardhan (2003) present formal nomenclature for vulnerability of social systems that includes ‘the threat, the region, the sector, the population group, the consequence, and the time period’. Fussel and Klein (2004) and Brooks (2004) describe climate-related vulnerability assessments based on the characteristics of the vulnerable *system*, the type and number of *stressors* and their *root causes*, *their effects* on the system and the *time horizon* of the assessment (Nicolls *et al.*, 1999; Brown *et al.*, 2012).

Watts and Bohle suggest that vulnerability can be defined “in terms of exposure, capacity and potentiality” (1993: 45), and they add that vulnerability is “an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perturbations” (1994: 37). For instance, Wisner *et al.* (2004: 11) define vulnerability based on “the characteristic of a household or community in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard”. To them, vulnerability “involves a combination of factors that determine the degree to which someone’s life, livelihood, property and other assets are put at risk by a discrete and identifiable event in nature and in society” (Wisner *et al.*, 2004: 11). Similarly, Chambers observes that vulnerability “refers to exposure to contingencies and stress, and difficulty in coping with them” (1989: 1).

According to the Zimbabwe Vulnerability Assessment Committee (ZimVAC, 2008, p 48),

Household vulnerability is a function of a mix of factors such as household size and composition, access to land and other natural resources, knowledge/management/skills, infrastructure, institutional capacity and the level of diversity of the household livelihood as well as the role of governments in making available safety nets.

In this instance, vulnerability cannot be treated as a static condition as it can be influenced by both internal and external factors some of which are beyond the capacity of the household to anticipate (Aguilar, *et al.*, 2005). Household vulnerability is a function of household or the community's adaptive capacity, which implies the ability to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (Agrawal, 2008; Smit and Wandel 2006; Chagutah, 2010).

The above-stated frameworks of vulnerability specify (i) the system (natural/ human) (or region and /or population group and/ or sector) and (ii) the hazards (or threats or stressors) considered. They also include (iii) the consequences (or effects or valued attributes or variables of concern), and (iv) a temporal reference (over 30 or more years). These are therefore taken as the four fundamental dimensions to describe the context of a vulnerability assessment of climate change impacts (Downing and Patwardhan, 2003).

There is also a two dimensional classification scheme for vulnerability factors (Archer et al., 2010) that consistently integrates the various frameworks suggested in earlier literature. These are the 'external' and 'internal' sources of vulnerability to environmental hazards. External implies the external stressors that a system is exposed to, whilst internal stands for the properties of the vulnerable system or community, including socio economic resources and characteristics of households or a community. (Chambers, 1989; Ellis, 2000; Sanchez-Rodriguez, 2002).

Moss *et al.* (2001) identifies three dimensions of vulnerability to climate change: (i) The physical-environmental dimension, which accounts for biophysical changes. It refers to climatic conditions in a region and to the biophysical impacts of climate change, such as changes in agricultural productivity and ecosystem services productivity and diversity; (ii) The socio-economic dimension refers to 'a region's capacity to recover from extreme events and adapt to change over the longer

term' and (iii) Involves the external assistance, defined as 'the degree to which a region may be assisted in its attempts to adapt to change through its allies and trading partners, diasporic communities in other regions or international arrangements to provide aid'. According to IPCC (2007), determining which impacts of climate change are potentially 'key' and what is 'dangerous' is a dynamic process involving, inter-alia, combining scientific knowledge with factual and normative elements (Patwardhan *et al.*, 2003; Dessai *et al.*, 2004; Pittini and Rahman, 2004). Normative criteria are influenced by the perception of risk, which depends on the cultural and social context of the affected community (Reilly and Schimmelpfening, 1999).

Of interest to adaptation to climate change are natural systems (ecosystems) and human systems, which have interacting and interdependent functions. From this perspective, an extensive pattern of factors that ultimately determine vulnerability becomes apparent. Vulnerability interlinks the physical environment, natural hazards and risk with socio-economic factors such as development, culture and religion (Wisner *et al.*, 2004). In reference to its links with poverty, many scholars agree that vulnerability is not caused solely by poverty (Chambers, 1989), but rather triggered by a "complex mesh of factors" (Kelly and Adger, 2000: 341).

The IPCC (2007) and Archer *et al.* (2010) identify seven criteria that may be used to identify key vulnerabilities to climate change. These include: magnitude of impacts; timing of impacts; persistence and reversibility of impacts; potential for adaptation; and the Importance of the system(s) at risk.

In terms of scale, internal vulnerability factors refer to characteristics of the vulnerable system or community itself. It implies vulnerability factors that can be controlled by the community in question, such as the local land use, among other local practices/ traditions. All other vulnerability factors are denoted as external (Blaikie *et al.*, 1994). Vulnerability does not imply damage or disaster, but rather the conditions that would increase the chance of damage and disaster occurring. Simply being "vulnerable" therefore, does not necessarily indicate that a community is experiencing adverse effects (Wisner *et al.*, 2004; Archer *et al.*, 2010). Vulnerability is system-specific, meaning it refers to a particular group or system's vulnerability to a particular hazard (Brooks *et al.*, 2005). Vulnerability has got a differential characteristic; this is well reflected in the Pressure and

Release (PAR) model, developed by Blaikie *et al.* (1994), where differences in root causes are shown to determine the extent to which people are vulnerable.

The PAR model emphasizes the inequitable distribution of impacts, and is a useful entry point for understanding the complex nature of climate change risk and its application in the context of development (Cannon, 1994). A typical example of the differential impacts of hazards due to different levels of vulnerability is the loss of life and livelihood disruption after a tropical cyclone or drought spell in rural sub-Saharan Africa, compared with the impacts in the rural United States. While the overall financial cost of the impacts may be higher in the United States, greater security networks such as insurance will be available to most affected citizens. In sub-Saharan Africa, Uganai (2009) argues that the financial cost of the impacts may be low, but the relative cost for the individuals will be higher, as they often have no capacity to cope with the risk and recover from incurred damages or losses.

Over the last few decades efforts have been made to undertake climate change adaptation research by means of impact assessment research (Burton *et al.*, 2002). The IPCC proposed such an Impact assessment approach to adaptation, but many researchers have expressed reservations about the validity of its findings. The criticism argued that the impact assessment approach to determining adaptation measures was based on the impacts of climate change rather than on vulnerability of the communities in question (Burton *et al.*, 2002). Since this criticism of the impact assessment approach, many researchers have begun to underscore the importance of vulnerability studies for the development of adaptation measures. Regarding livelihood and food security studies, Bohle *et al.* (1994:37) argue that “it may be most important to assess present vulnerability to infer lessons for coping with future challenges of global climate change”.

It is necessary also to recognise that vulnerability does not imply complete lack of resilience or capacity to adapt to changes. To Chambers (1989: 1), vulnerability has two sides: “an external side of risks, shocks, and stress to which an individual or household is subject; and an internal side which is defenselessness, meaning a lack of means to cope without damaging loss”. Similarly, Davies observes that “people in vulnerable systems are more likely to pursue adaptive strategies, seeking to use all available options at all times to maximise the trade-

off between increasing resilience and reducing sensitivity" (1996: 63). Nevertheless, this does not imply that such strategies will always be successful, and in fact it is the lack of success that defines the vulnerability of those in question. This observation underscores that the poor often have a repertoire of responses to improve their immediate conditions, although these do not guarantee that overall or long-term vulnerability is ultimately decreased. From the perspective of autonomous adaptations and coping strategies, vulnerable people are not always helpless at least, although some of their strategies may be maladaptive. Vulnerability has therefore increasingly become a useful concept to incorporate among governmental and non-governmental institutions that are engaged in humanitarian and capacity building activities (Chagutah, 2010). Addressing factors that contribute to climate change vulnerability will ultimately therefore also facilitate climate change adaptation processes (Kelly and Adger, 2000; Donald *et al.*, 2012).

2.4 SECTORAL VULNERABILITY TO CLIMATE CHANGE

The IPCC (2007) has established four main domains of vulnerability to climate change impacts and these include: natural resources, coastal areas and small islands, rural economy and food systems, and finally human health. It is predicted that climate change will remain one of the major drivers of change in biodiversity patterns in the future (Schneider, *et al.*, 2007). Thuiller *et al.* (2008) suggest that among the key lessons about vulnerability to emerge from climate change scenarios are:

- Climate variability, extremes and change are a danger now, not just in the distant future
- The danger is greatest where natural ecosystems are severely degraded and human systems are failing and therefore incapable of effective response
- A household's access to water, land and other resources are important determinants of its vulnerability
- Heightened water scarcity that impedes development is a critical concern for areas that may become drier.
- Some ecosystems and many of their species may be lost to climate change, with consequent losses of goods and services to human communities
- The livelihoods and food security of the rural poor are threatened by climate change. The threat is particularly great for, but not limited to, rural poor in drought –prone rural dryland areas

- Vulnerability to adverse health impacts is greatest where health care systems are weak and programs for disease surveillance and prevention are lacking.

Based on the noted climate change trends so far and the projections made, the implications on economies, human health and general well being are projected to be far reaching. Below is an IPCC (2012) summary of some of the climate change impacts already affecting and projected to affect our living planet:

Agricultural yields are expected to drop in most tropical and sub-tropical regions (and in temperate regions, too) if the projected temperature increase is more than a few degrees. Crop productivity is projected to increase slightly at mid-to high latitudes for local mean temperature increases of up to 1 to 3°C depending on the crop, and then decrease beyond that in some regions (medium confidence). At lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1 to 2°C), which would increase the risk of hunger (medium confidence). Globally, the potential for food production is projected to increase with increases in local average temperature over a range of 1 to 3°C, but above this range, food production potential is projected to decrease (Kurukulasuriya, and Mendelsohn, 2006). Agricultural production in the tropical regions is also projected to be affected, for example, by changing river flows (from ice pack behavior) and rainfall patterns. Also expected to undermine production are the projected changes in behavior of pests and that of friendly species required for pollination and pest-control (Reilly and Schimmelpfenning, 1999; Fischer *et al.*, 2005).

In terms of potential impact on health, The IPCC (2012) point out that the health status of millions of people is projected to be affected through, for example, increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrhoeal diseases; increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone in urban areas related to climate change; and the altered spatial distribution of some infectious diseases (Archer *et al.*, 2010). Diseases, especially those carried by vectors like mosquitoes, could spread to new areas in the world (Githeko, 2006; Brown *et al.*, 2012). Many mosquito species, such as those which carry malaria and dengue, survive and breed more efficiently in hotter temperatures. The consequences are far reaching when a disease is introduced

to a population with no previous contact and therefore little to no immunity to it (Ayer, 2011). Also cases of excess heat-related mortality, due to heatstroke in Europe are likely to rise, including earlier onset of and increases in seasonal production of allergenic pollen in Northern Hemisphere high and mid-latitudes (Connor *et al.*, 2006). Critically important will be factors that directly shape the health of populations such as education, health care, public health initiatives, and infrastructure and economic development (Yohe *et al.*, 2007).

With regards to potential impacts on water resources, Christensen *et al.* (2007) suggest that climate change will exacerbate current stresses on water resources from population growth and economic and land-use change, including urbanisation. On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by meltwater from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives (Bounoua *et al.*, 2000, Burke *et al.*, 2006).

Changes in precipitation and temperature lead to changes in runoff and water availability. Runoff and consequent river discharge are projected to increase by 10 to 40% in higher latitudes and other populous areas in East and South-East Asia due to the thawing of ice caps. Such areas are expected to suffer increased flood risks and disasters. On the other hand, some mid latitude and dry tropical regions are likely to see a decrease in runoff and river discharge by 10 to 30% due to decreases in rainfall and higher rates of evapo-transpiration (Arnell, 2004). Many semi-arid areas (e.g. the Mediterranean Basin, western United States, southern Africa and north-eastern Brazil) will suffer a decrease in water resources due to climate change. Drought-affected areas are projected to increase in extent, with the potential for adverse impacts on multiple sectors, e.g. agriculture, water supply, energy production and health. Regionally, large increases in irrigation water demand as a result of climate changes are projected (Bryceson, 2002; Arnell, 2004).

Clark *et al.* (2006) has observed that the negative impacts of climate change on freshwater systems outweigh its benefits. Areas in which runoff is projected to decline face a reduction in the

value of the services provided by water resources. The beneficial impacts of increased annual runoff in some areas are likely to be tempered by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality and flood risk (Few *et al.*, 2004).

According to studies by Leemans and Eickhout (2004), increased temperatures will further affect the physical, chemical and biological properties of freshwater lakes and rivers, with predominantly adverse impacts on many individual freshwater species, community composition and water quality. In coastal areas, sea level rise will exacerbate water resource constraints due to increased salinisation of groundwater supplies. Millions of people are expected to be exposed to increasing water stress as ice packs that feed melt-water into rivers that keep millions of people alive, shrink progressively over the decades; or pump extra water into the rivers in the summer, causing damaging, unprecedented flooding (Chappell and Agnew, 2004).

With regards to the possible impacts on regional economies, industry, settlements and society in many parts are projected to suffer stresses. The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources and those in areas prone to extreme weather events, especially where rapid urbanisation is occurring. Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas (Burke *et al.*, 2006).

Extinctions are expected from the current warming trends. Large numbers of plant and animal species, already weakened by pollution and loss of habitat, probably will not survive the next 100 years (Rosenzweig *et al.*, 2007).

2.5 SPATIAL PATTERNS OF VULNERABILITY TO CLIMATE CHANGE

Yohe *et al.* (2007) suggest that the climate change impacts vary from region to region. They further suggest that there are sharp differences across regions with regards the distribution of climate change impacts and vulnerabilities. It is noted with a high degree of certainty that those in the weakest economic position are often the most vulnerable to climate change and are frequently the most susceptible to climate-related damages, especially when they face multiple stresses. There is increasing evidence of greater vulnerability of specific groups such as the poor and elderly not only in developing but also in developed countries (Smith *et al.*, 2001).

According to a study by Smith *et al.* (2001) the distribution of impacts will be uneven and that low-latitude, less-developed areas are generally at greatest risk due to both higher sensitivity and lower adaptive capacity. However, recent work has shown that vulnerability to climate change is also highly variable within individual countries. As a consequence, some population groups in developed countries are also highly vulnerable even to a warming of less than 2°C). For instance, indigenous populations in high-latitude areas are already faced with significant adverse impacts from climate change to date, and the increasing number of coastal dwellers, particularly in areas subject to tropical cyclones, is facing increasing risks (Christensen *et al.*, 2007). There is high confidence that warming of 1 to 2°C above 1990-2000 levels would include key negative impacts in some regions of the world (e.g., Arctic nations, small islands), and pose new and significant threats to certain highly vulnerable population groups in other regions (e.g., high-altitude communities, coastal-zone communities with significant poverty levels), with increasing levels of adverse impacts and confidence in this conclusion at higher levels of temperature increase.

When compared to other regions of the world, IPCC (2007) suggests that sub-Saharan Africa is warming at a rate faster than the global average, and increasing aridity in many countries. By 2020, between 75 and 250 million of people are projected to be exposed to increased water stress due to climate change. According to Chishakwe (2010), the extreme climatic events that the sub-region has been experiencing; especially the El Nino related droughts are negatively impacting the inhabitants and economies of Southern Africa. For example the El Nino events that occurred between 1965 and 1997 resulted in significant decreases in agricultural production, thereby accentuating the food insecurity situation in the sub-region. Furthermore the warming of the Pacific Ocean in 1991 and 1992 caused one of the worst droughts the sub-region has ever experienced in the last century (Glantz, 1997; Brown, *et al.*, 2012). Since 2001, consecutive dry spells in some areas of the sub – region also led to food shortages. For example, in 2001 and 2002 six countries, namely Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe, faced a food deficit of about 1.2 million tones of cereals and non-food requirements. These were estimated to cost US\$ 611 million (SADC, 2002). The 2002 and 2003 drought resulted in a food deficit of 3.3 million tones, with an estimated 14.4 million people in need of assistance (Ziervogel and Calder, 2003; kandji *et al.*, 2006).

Climate variability has been observed and is projected to have severe macroeconomic consequences in the sub-Saharan Africa especially in the form of increasing prevalence of droughts and floods (Unganai, 2009; Brown *et al.*, 2012). For instance, the GDP for Zimbabwe dropped by 3 percent and 11% due to the 1983 and 1992 droughts respectively (Kandji *et al.*, 2006). The same drought events cost the Zambian Government US\$300 million, which caused a US\$ 1.7 billion deficit in 1992 and translated into a 39% drop in agricultural output and a 2.8 percent decline in the country's GDP (Government of Zambia, 1996.).

Anselm *et al.* (2010) reiterate that whilst farmers in some regions may benefit from longer growing seasons and higher yields, the general consequences for Africa are expected to be adverse and particularly adverse for the poor and the marginalized, which do not have the means to withstand drastic changes. Evidence from the IPCC suggests that areas south of the Sahara are likely to emerge as the most vulnerable to climate change by 2100, with likely agricultural losses of between 2 and 7 percent of affected countries' GDP. Africa has a higher proportion of people living in poverty than any other region of the world (Unganai, 2009; Moyo *et al.*, 2012). Across the whole region, rural poverty still accounts for 90% of total poverty and approximately 80% of the poor still depend on agriculture or farm labour for their livelihood. Of even more concern, the total number of poor people is increasing (Otive, 2006). For instance, the UN human poverty index in 1999 placed Nigeria amongst the 25 poorest nations in the world (UNEP, 2002). Presently, it is estimated that two thirds of the 120 million or 80 million Nigerians are poor (Garba, 2006). Poverty results in shortened lifespan (Anselm *et al.*, 2010).

With regards to prospects towards attaining the MDGs for the region, an additional warming of the globe can adversely influence attainment of the MDGs. This can be illustrated by, among other things, reduction in soil moisture and water runoff to rivers caused by a warmer and drier climate that is triggered by increased frequency and intensity of El Nino events (kandji *et al.*, 2006). This may affect crop production, which is critical in ensuring food security and poverty reduction (Goal 1 of MDGs). Loss of biological diversity, land degradation and desertification can also occur as a result of increased aridity (kandji *et al.*, 2006). This could impact on environmental sustainability (Goal 7 of the MDGs). The realization of goal 6 of the MDGs may be affected through the increase

in water and vector- borne diseases as a result of long term rise in temperatures and occasional floods caused by El Nino events (Kandji *et al.*, 2006).

Increased frequency of climatic disasters can force more children out of school due to increased poverty, food shortages, remoteness and isolation, and child abandonment. This may in turn affect the attainment of goal 2 of the MDGs. Anthropology studies have revealed that when anticipated climate-induced disasters occur, women often get a disproportionate share of burden because they have fewer opportunities than men. Disaster events often affect women more severely than men, further undermining their education and development and in the process, affecting their welfare and that of their children. Disasters included the climate change-induced ones, therefore, directly constrain the realization of the MDGs 3, 4 and 5 (Kandji *et al.*, 2006). Most of the economies in the sub region depend on agriculture and natural resources to the effect that intense and frequent droughts will impact on the critical sectors of national economies (Chaguta, 2010; Donald *et al.*, 2012; Moyo *et al.*, 2012). The consequences of a collapsed economy together with cost associated with disaster response operations may reduce the ability of governments to invest in important socio-economic sectors. This may hinder the achievement of MDGs 1 – 7 (Thomas and Twyman, 2005; Kandji *et al.*, 2006; Ayers, 2011).

Besides a projected drop in food security in Africa, the IPCC (2012) suggest that towards the end of the 21st century, projected sea level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5 to 10 percent of GDP. By 2080, an increase of 5 to 8 percent of arid and semi-arid land in Africa is projected.

2.5.1 The Rural Context of Vulnerability to Climate Change

According to World Bank (2006) three out of every four of the world's poor today live in the rural areas and this is projected to continue for the foreseeable future. A long history of development aid and poverty alleviation initiatives has largely not been successful in altering the stubborn reality of rural poverty. According to Chambers (1989) the rural people are less seen and even less in the nature of their poverty understood. There exist cores and peripheries of knowledge, which reflect a gradient between extremes of wealth to extremes of poverty. On one hand, there is a coexistence of the rich, urban, industrial, high status cores, whilst at the other; there is a concentration of the rural poor agricultural low status peripheries. Both nationally and internationally, there is a

manifestation of centripetal forces which draws resources and opportunities away from the peripheries (rural areas) towards the cores (urban areas).

Chambers (1989) adds that small farmers of the South face a vicious cycle of vulnerability, intervention, disease and environmental degradation. One question of global concern is: what are the challenges of rural livelihood that are intimately dependent on land and natural resources? To get a comprehensive answer to this question, there is need for research that involves an interdisciplinary analysis of rural realities in Africa, Latin America and Asia. In sub-Saharan Africa and a vast part of Asia, agriculture and natural resources constitute the basic provision of food and income. A weak diversification momentum of the rural communities' economy is a big constrain that undermine their prospects of reducing the uncertainty and vulnerability facing them. Of particular concern is the unpredictable natural, especially the climatic conditions tend to add to the situation of rural insecurity that at times is manifested in natural disasters and the subsequent need for emergency assistance (Kanji *et al.*, 2006; Brown *et al.*, 2012).

According to Uganai (2009) and Chagutah (2010), it is noted that besides the adverse natural living environment of rural communities, the regions south of the Sahara are often characterized by weak institutional support and poor governance. This has seen the struggling rural communities having to continuously rely on primitive indigenous institutions and norms for guidance in their livelihoods and resource allocation. They further add that outcomes are complex and tend to vary between agro-ecological systems, between and within countries and between continents and regions. Over the past 30 years, efforts have been made to understand rural development from a local perspective. This has been based on the growing realization that rural household livelihood strategies and dynamics were increasingly being linked not only to agricultural production but also, to wider productive and institutional setting involving aspects of governance (Cernea, 1995; Davies 2011).

Looking at rural livelihoods provides a detailed view of how the poor reduce (*ex ante*) and cope with (*ex post*) a variety of risks in meeting their basic needs for life. A variety of on-farm and off-farm activities, which together provide a variety of exchange entitlements for food and income maintain livelihood systems (Legesse, 2006).

Bird and Shepherd (2003) suggest that there are strong links between household assets, livelihoods and poverty. Several studies have been carried out to assess the determinants of rural poverty and income in Sub-Saharan African countries. The results summarized from ten country-based studies show that the trends on assets and income are quite consistent across the studies. Both livestock assets and agricultural land holdings are strongly and positively correlated with income in almost all studies (Dixon *et al.*, 2003; Ellis and Bahiingwa 2001; Bird and Shepherd 2003).

Dolan (2005) in her study of rural livelihoods in Uganda, concluded that agrarian-based activities are critical to the livelihood strategies of rural households; 90 per cent of rural women and 53 per cent of rural men in rural Uganda are engaged in agricultural production, with women responsible for 80 per cent of food crop and more than half of all cash crop production (Bird and Shepherd, 2003). With reference to non-farm income activities, while agriculture is an important constituent of household livelihood activities, over the last decade new avenues for income generation have emerged. In Uganda there is increasing evidence that that households are diversifying in response to poverty push factors, as well as pull factors related to the fast growing economy. In many districts, households seldom specialize in one income earning activity but rather are sustained through a range of income generation and labour allocation strategies, in large part due to declining soil fertility, crop and livestock failures, increasing land fragmentation and climate change in recent years (Ellis and Bahingwa 2003; Brown *et al.*, 2012).

Ellis (2000) in his study of rural livelihoods and diversity in developing countries, suggest that livelihood diversification is important as a survival strategy of households in developing countries. He adds that although farming is still of central importance, on its own, it is increasingly unable to provide a sufficient means of survival in rural areas especially given the climate variability and change trends experienced in the region (Chagutah, 2010; Davies, 2011).

According to Anselm *et al.* (2010), as the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent (Zoellick 2009), which results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007). Smallholder farmers in Africa constitute the bulk of the poor. They consistently face the prospects of tragic crop failures, reduced agricultural productivity, increased hunger,

malnutrition and diseases (Zoellick, 2009). It is projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (Thornton *et al.*, 2006), particularly because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. As the people of Africa strive to overcome poverty and advance economic growth, this phenomenon threatens to deepen vulnerabilities, erode hard-won livelihood gains and seriously undermine prospects for development (IPCC, 2007; Zoellick, 2009).

There has been considerable evolution in the production and consumption patterns associated with the traditional Zimbabwean and other African livelihoods and this is attributable to increasing influence and aspiration of modernity within traditional communities (Salih, 2001). This trend has significantly increased pressure on local natural resources, thus contributing to rural vulnerability and an array of socio-cultural, economic and political insecurity, particularly in the face of aridisation and climate warming (Downing, 1991).

2.6 ADAPTATION TO CLIMATE CHANGE

With regards to the future outlook of climate change and its potential impacts, there is agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global greenhouse gas (GHG) emissions will continue to grow into the next century (Agrawal, 2005; IPCC, 2007). Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Based on the foregone conclusion that anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if GHG concentrations were to be stabilized (Mirza, 2003; IPCC, 2007), this precarious climate change future calls for innovative livelihood strategies to cope with and adapt to the changing environment (Carney, 1998; Sherbinin, 2006; Chagutah, 2010).

In the specific context of climate change, adapting therefore means taking action to adjust to a new set of climatic attributes, either different from those already existing, or changed parameters of existing attributes (Unganai, 2009; Ayers, 2011). With increasing awareness of detrimental human impact on the environment as cause for risk to humans, adaptation has since shifted from being a natural wildlife process in evolution in response to environmental changes, to being promoted as a concept for guiding policy to ensure sustainable development, reduce

vulnerability and minimise risk to humans from climate change (Klein, 2003; Smit and Skinner, 2002).

The IPCC defines adaptation as “adjustment in ecological, social, or economic systems in response to actual or expected climatic stresses and their effects or impacts” (IPCC, 2007: 881). This definition includes reference to both anticipatory and reactive adaptation. Most importantly, the IPCC definition also includes both climate change and climate variability. Carney (1998) and Smit *et al.* (2001) concur that adaptation to climate change 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. It is important to note that successful adaptation to a changing environment is a function of the means available to the affected community and this is to do with adaptive capacity (Fankhauser, 1998; Pittock and Jones, 2000).

According to the IPCC, adaptive capacity is defined as the “ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences” (IPCC WG II, 2001: 72). Adaptive capacity is considered to be one of the characteristics (or “determinants”) of a system that would influence the occurrence and nature of adaptations (Smit *et al.*, 2000: 236). Other determinants include sensitivity, vulnerability, susceptibility, coping range, stability, resilience, and flexibility (Smit *et al.*, 2000; Adger *et al.*, 2004).

Developing countries are often regarded as having the lowest adaptive capacity, as they tend to have the least access to technology, the least degree of development of social institutions, as well as the highest historical and existing stresses associated with climate change (Sagar and Banuri, 1999; Smit and Pilifosova, 2001; Chagutah, 2010). In this case, adaptive capacity is seen as being inversely correlated with vulnerability. Therefore, in theory a society with high adaptive capacity experiences successful adaptation and low vulnerability to climate change. Downing *et al.* (2001) suggest formal indicators of both vulnerability and adaptive capacity to determine vulnerable situations and these include factors such as income, infrastructure, education, and state of civil society among others. Klein (2003) and Yohe and Tol (2002) identify other potential indicators of adaptive capacity, including: insurance mechanisms; access to public health facilities; community organisations; existing planning regulations at

national and local levels; institutional and decision-making frameworks; and existing warning and protection from natural hazards.

Bringing the factors of adaptive capacity decisively into the realm of development, the IPCC notes that adaptive capacity to deal with climate risks is closely related to sustainable development and equity (Smit and Pilifosova, 2001; Uganai, 2009). Among the key determinants of adaptive capacity to climate change and sustainable development, Smith and Pilifosova (2001) suggest the following factors: Improved access to resources; reduction of poverty; improved education and information; improved infrastructure; active participation by concerned parties, especially to ensure that actions match local needs and resources; and improved institutional capacity and efficiency (Moyo *et al.*, 2012).

With regards to the definitional conflicts of the concept of adaptation, Schipper (2004) suggest that in some instances, coping and adapting may be used synonymously, but some hold that there are distinct differences between these terms (Davies, 1996; Rennie and Singh, 1996). Similarly, whereas in the risk context “mitigation” is used to describe responsive, post-event actions, such as adaptive measures, in the climate change language, mitigation refers to abatement of greenhouse gas emissions, something considered as a preventative action, and often contrasted with adaptation to climate change (Schipper, 2004).

Coping measures are generally considered to be short-term to ward off immediate danger, rather than to adjust to continuous or permanent threats or changes (Fankhauser, 1998). The IPCC suggests a “coping range”, defined as the “variation in climatic stimuli that a system can absorb without producing significant impacts” (Smit *et al.*, 2001: 75). This definition indicates that there are limits to coping, which imply that in going beyond these, a system will break down. In the context of climate change, coping is not a sustainable solution that allows for adjustment, but rather a temporary response. Nevertheless, coping strategies are considered to be part of the portfolio of options for responding to events and threats, particularly for poor households and communities (Burton *et al.*, 1993; Chambers, 1989). For some, coping strategies may contribute to initiating processes of adaptation to hazards (Yamin *et al.*, 2005), such that coping actions will eventually become part of “normal” behaviour, although their different time-scales may create challenges for basing adaptation strategies on existing coping methods (Davies, 1996).

From this perspective, coping strategies are the actions taken when faced with unfavorable conditions, and not part of an ideal livelihood strategy. In support of this, Davies describes coping as a response to “abnormal seasons or years” (1996: 60). The other perspective holds that coping strategies may not necessarily indicate adverse conditions to which an adjustment needs to be made, but rather a normal component of survival in fluctuating conditions, faced particularly by subsistence farmers in developing countries (Adger and Vincent, 2005; Blaikie *et al.*, 1994). Some hold that coping strategies can be associated with increasing long-term vulnerability (Frankenberger and Goldstein, 1990) or the introduction of a different state of vulnerability (Fankhauser, 1998) through the implementation of actions which fulfill short-term needs and do not explicitly consider the consequences of these actions, such as excessive resource extraction or selling off assets during drought (Fankhauser, 1998). Such strategies can also be damaging to the environment, in the long run leading to natural resource depletion or other problems that could compound the adverse impacts of hazards (Frankenberger and Goldstein, 1990; Chagutah, 2010).

Davies (1996) suggests that coping strategies constitute a potential basis for the development of adaptation measures. The author further observes that coping and adapting to climate change are simply two different and relative ways to respond to risk that cannot be interchanged. It is therefore, argued that a combination of coping strategies and adaptation may optimise the trade-off between reducing sensitivity and increasing resilience and ultimately be necessary as part of a response package to climate variability and change (Unganai, 2009).

With regards to the operationalisation framework of adaptation, FAO (2008) proposes a number of practices for sustainable climate change adaptation that can be put into action particularly in the food and agriculture sector. These include; protecting local food supplies, assets and livelihoods against the effects of increasing weather variability and increased frequency and intensity of extreme weather events through general: risk management; conserving local resources such as forest, soil, water and pasture; introducing tree crops to provide food, fodder and energy and enhance cash incomes; improved management of cultivated and pasture land; livestock

diversification towards small ruminants; protecting ecosystems to enhance environmental services through use of degraded or marginal lands for forestry, food, fodder and fuels

FAO further recommends some steps to be followed in the selection of adaptation options and designing strategies to operationalise them. The suggested framework for climate change adaptation is as follows: putting in place legal and institutional elements; policy and planning elements; livelihood elements; cropping, livestock, forestry, fisheries and integrated farming system elements; ecosystem conservation elements and linking climate change adaptation processes with technologies that promote carbon sequestration and substitutes for fossil fuels.

In their study on climate change adaptation challenges in Nigeria, Mortimore and Adams (2001) suggest five major elements of adaptation in rural farming community. These include: allocating farm labor across the season in ways that follow unpredictable intra-season rainfall variations; making use of biodiversity in cultivated crops and wild plants; increasing integration of livestock into farming systems (at a cost of increased labor demands); working land harder, in terms of labor input per hectare, without increasing external non-labor inputs; and diversifying livelihoods. Other authors have mentioned on-farm storage of food and feed, strategic use of fallow, and late planting of legume crops when cereals fail as drought responses.

In terms of the key vulnerabilities identified, it is clear that when adaptation potential is greater, the more the system is under human management and control. Drastic or rapid geophysical changes leave little room for human-managed adaptation. Fortunately these changes are likely to unfold relatively slowly, thus allowing more time for adaptation to their eventual impacts. In comparing the adaptive capacity of biological systems with that of social systems, Leemans and Eickhout (2004) suggest that the understanding of impacts, adaptive capacity, and the costs of adaptation is weaker in social systems than in biological systems, and the uncertainties are high. This is especially the case for synergistic or cross-cutting impacts, that include related impacts in water regimes, droughts and floods, pest infestations and plant diseases, human health, the reliability of infrastructure, poor governance, as well as other non-climate-related stresses (Leemans and Eickhout, 2004; Smith *et al.*, 2001).

A general conclusion on the basis of the present understanding is that for market and social systems there is considerable adaptation potential, but the economic costs are potentially large, largely unknown and unequally distributed, as is the adaptation potential itself. For biological and geophysical systems, the adaptation potential is much less than in social and market systems, because impacts are more direct and therefore appears more rapidly. A large proportion of the future increase in key vulnerabilities is likely to be recorded first in biological systems although it does not mean that key vulnerabilities will not occur in social and market systems. They depend on biological systems, and as ecosystems are affected by mounting stresses from climate change and concomitant factors such as habitat fractionation, and the spread of plant diseases and pest infestations, then the follow-on, second-order effects on human health and safety, livelihoods and prosperity, will be considerable (Leemans and Eickhout, 2004; Smith, 2001).

One important aspect that is necessary to assess climate change impacts and responses in a given geographical area, particularly in low income regions is to consider adaptation patterns at the livelihood scale. This is because most adaptations will manifest in the form of household-level interventions, where there is a household level modification of behavior and activities to reduce the negative climate change impacts. Others however would seek external support from higher scale, such as a policy interventions, or provision of a subsidy for acquisition or maintenance of certain assets.

Farming households are likely to start by changing agricultural strategies to cope better with local change. This might involve adopting early-maturing seed varieties, reducing evaporation through mulching, destocking, water harvesting and decreasing soil erosion through wind barriers.

2.6.1 Maladaptation to Climate Change

Desanker *et al.* (2001: 80) defines maladaptation as “any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.” Smit *et al.* (2000) offers an example of maladaptation: the abandonment of marginal farms after years of repeated droughts could be considered failure at the level of the individual farm, but as an adaptation for the entire agricultural sector, because the better-quality farms remain active, and therefore the overall quality and chance of survival during droughts rises. In fact, maladaptation may not only

increase vulnerability, but can generate new risks. Often, poorly planned strategies will result in negative consequences for all, or only for some groups. Kates (2000) and Oliver-Smith (2004) highlight the fine line between what can be perceived by one group as an adaptation, and what is experienced by another as increased peril. Actions taken in attempt to minimise risk that have negative ancillary impacts could be considered maladaptive. However, such is the outcome of many policies not directly related to climate change or adaptation, for example globalisation, and therefore it is important to define more specifically that maladaptation refers to processes of adaptation that result in greater vulnerability (Unganai, 2009; Ayers, 2011). The threat of maladaptation teaches us that the impacts of specific measures aimed at increasing the ability of one group to adapt or cope with certain changing conditions must therefore also be considered in a larger picture. The concept of maladaptation also has links to discussions on the role of stakeholders in development projects and programmes, and to this extent contributes to shaking the already precarious relationship between environment and the poor (Bryceson, 2002).

2.7 EMPIRICAL LOCAL EXPERIENCES OF CLIMATE CHANGE: VULNERABILITY AND ADAPTATION

In order to appreciate the realities surrounding climate variability and change, and the actual experiences of the people to the associated environmental changes, there is need to focus on micro - level empirical evidence. This is in line with the earlier discussed argument that the term 'vulnerability' can only be used meaningfully with reference to a particular vulnerable situation, which should consider the local geographical and socio-economic context, together with other aspects such as assets and other drivers (both internal and external) of vulnerability (Archer *et al.*, 2010).

A number of case studies have been reviewed in order to embrace the full scope of vulnerability to climate variability and change and these are discussed in the following sub-section.

2.7.1 Exploring Adaptation to Climate Change: a case of El Salvador.

In an attempt to support the adaptation theory within the context of the UNFCCC's adaptation framework, Schipper (2004) conducted a case study on El Salvador. The aim was to establish how vulnerable communities respond to climatic hazards. El Salvador was selected as a developing country that is highly prone to climatic hazards and seasonal variability. The objectives of the case

study were to: (1) examine how vulnerable societies are affected by climatic hazards and what response measures are taken, if any, (2) identify any challenges to responding to climate change and variability, (3) explore whether adaptation is taking place on the local or national levels, and (4) examine the relationship between adaptation and development in the context of El Salvador. Schipper's epistemological perspective was based on the view that a case study does not adhere strictly to any single research methodology, and her approach is based on three major components: interviews, policy analysis and literature review. Because the research aims to understand links between development and adaptation, local rural communities were seen as the most appropriate unit of analysis as they are the ones who directly interact with, depend on, and are affected by local environmental change. Her national perspective was intended to examine the context, including national policies that would have impacts on local level response measures.

Schipper's field work yielded various sources and types of data and this included field notes, audio recordings, printed documents and other printed information, which were all processed and analyzed by means of qualitative techniques. Some quantitative data such as crop yields, livestock herds and hectares were also analyzed generating percentages and other statistics.

Findings from the case study suggest that poor communities do respond to climate variability and hazards. Types of responses included those related to agricultural practices such as sowing a second crop, waiting for the rains to come before sowing, harvesting before heavy rains are expected, or practicing traditional irrigation techniques. Other measures include stocking strategic food reserves in silos in case of crop failure and storing food stocks on raised shelves in case of floods. Given the prevalence of flood disasters, families keep fewer animals and sell most of their livestock before the rainy season, save the money and purchase new animals when the dry season starts. Individuals might take a second off-farm job or abandon cultivation altogether and seek other sources of income. For many who fail to adjust to the recurrence of climate risks in the villages, they migrate either temporarily or permanently. One other common response measure is waiting for external assistance such as government and NGOs. There is an overall tendency of consistent dependence on outside agents as cause for self – victimization and the analysis suggest

that the role of NGOs is among the factors that present challenges to sustainable adaptation process to climate variability and change in El Salvador.

With regards to the implication of the study, Schipper (2004) noted that whereas adaptation appears to be both existing and feasible in the villages, it is clear that factors creating barriers to climate change adaptation are essentially the same as those contributing to poverty and holding back sustainable local development. The types of measures and changes necessary to facilitate adaptation would therefore as a direct consequence reduce vulnerability and risk, and enhance sustainable development. With this Schipper (2004) concluded that adaptation to climate change and development are closely linked, but that adaptation cannot take place without a sustainable development process in place. The outcomes of a sustainable development process where risk and vulnerability are also reduced would generate an adaptation process to climate change in rural El Salvador. Adaptation to climate change could represent a new opportunity to revisit some long standing problems of environment and development. With the emergence of clear evidence of climate change, adaptation appears as a tool to approach the new environment agenda. Therefore, promotion of adaptation to climate change by policy makers can be seen as an attempt to integrate flexibility required for facing a changing environment into more demanding development processes.

The thesis contributes a new interpretation of adaptation policy, whereby an adaptation paradigm is viewed as an effective framework for supporting sustainable development and risk and vulnerability reduction to climate change.

2.7.2 Adaptation Challenges to Climate Change Impacts in the River Offin Basin in Rural Ghana.

In Ghana, Gyampoh *et al.* (2009) found that the changes in climate imply difficult times ahead for the vulnerable peasants, especially based on the fact that they depend heavily and directly on the 'climate-sensitive' natural resources for their livelihoods. The Offin river basin has got a semi-humid tropical climate and semi-moist deciduous forest. The community setting is largely rural and mostly composed of subsistence farmers. Agriculture in the basin is mostly rain fed cropping with limited livestock rearing. The community depends on rivers, streams and rainfall for their water needs and a significant proportion engages in petty trade as livelihood options to cope with the agro-based livelihood challenges. The community is experiencing significant climate change. In

the basin, mean annual temperatures have been observed to have increased by about 1^o C over the past 40 years, while rainfall and runoff have decreased by approximately 20 and 30% respectively. The community has been observing and feeling the effects of declining rainfall amounts, rising mean temperature levels, increasing drought frequency and intensity and declining rainfall reliability for agricultural purposes.

Partly as a result of reduced rainfall amounts, compounded by forest and land degradation, discharges in all water bodies in the basin have been dropping, whilst some streams have completely dried up, certain traditionally perennial transforming into seasonal systems. This has seen the basin communities having to endure the new challenge of increasing scarcity of water and associated resources in the face of increasing community demand for water. What exacerbates their vulnerability is that they lack appropriate assets and technologies to cope with the adverse changes in climate and associated weather extremes. Recent crop failures especially since the year 2000 have been attributed to dropping rainfall amounts, prolonged dry spells during the cropping season and increasing variability and unreliability of the rains during the critical crop growing season. Over the years the farmers have been employing traditional means of predicting the arrival of rainfall and droughts. However during recent years, the beginning of the rainy season has become increasingly unpredictable. In addition to the problem of timing, prolonged dry spells have caused drought situations, with increased soil moisture stress for crop growth. This has generated increased cases of crop failure in the basin.

When crops fail, money spent on land preparation, seed and other input purchases and planting is lost and household savings are depleted. In conclusion the study notes that generally, people can withstand occasional poor harvests but have trouble coping with consistently bad ones.

2.7.3 Climate Change and Variability in Tanzania

Mary and Majule (2009) carried out a study on the impacts of climate change and variability in Tanzania. The study was carried out in two districts in central Tanzania. The overall objective of the study was to understand local communities' perceptions on climate and variability issues and establish its impacts and adaptation strategies within the agricultural sector. Findings show that the local people perceived the changes in temperature and rainfall pattern and that the changes have affected crop and livestock productivity. The analysis shows that there has been a decrease in

rainfall between 1922 and 2007, whereas mean maximum and minimum temperatures increased by 1.9^o C and 0.2^o C respectively. An average annual temperature increase of 0.7^o C between 1984 and 2004 was realized. There was also an observation that access to assets by households is a critical determinant of the level of vulnerability to climate change effects.

The agricultural sector is key to both local and national economic development in Tanzania and as such over 70% of the population depends on subsistence agriculture, which is almost entirely rain fed. It accounts for an average of 50% of gross national product and about 66% of total export earnings. The study reveals that agriculture, forestry, water, coastal resources, livestock and human health have been adversely affected by climate change. The specific stressors of climate change in the study manifest in the form of increasing frequency of floods, drought, erratic rains and other extreme events. It is noted with concern that famine resulting from either floods or drought has become increasingly common since the mid 1990s and is undermining food security especially in areas where crop production and livestock keeping are critically important to food security and rural livelihoods. In the Dodoma District, the occurrence of dry spells during critical crop growing periods contributed considerably to crop failure, food scarcity and declining rural income.

With regards to community adaptation options to increasing cases of drought and famine in Tanzania's Manyoni District, Ngana (1983) concluded that, whilst climate change is a global phenomenon, adaptation is largely site-and context-specific. The district is a typical rural area of Tanzania with about 55 percent of the population being mostly food insecure. The district is semi-arid experiencing low rainfall and short rainy seasons which are often erratic with fairly widespread drought of one in every four years. The annual mean, maximum and minimum monthly daily temperatures are 24.4^o C (November) and 19.3^o C (July) respectively. The community perception on the most important factors undermining farming livelihoods was ranked as; increasingly unpredictable and falling amounts of rainfall, with unclear onset and ending; rising mean temperatures and pest prevalence and increasing frequency, severity and duration of droughts.

The profile of major economic activities in the study suggests that farming is the core livelihood accounting for 61.8% of the total population. The communities practice cropping and livestock rearing. Petty business was taken as the 3rd ranking source of income. Households with more

active petty business had a greater chance of climate change impact resilience than those without. Nevertheless the petty business was only a marginal buffer to climate change impacts with the majority of household livelihoods standing no chance to be sustained by off-farm activities, thus placing villagers at a state of high vulnerability to climate change impacts. The petty business included selling of local brew (also dependent on farm yields as raw material), mainly done by woman. The other commonly growing activity was the production of charcoal, and the collection and selling of firewood (natural resource-based). Others though on a small scale engage in bee keeping. The conclusion of the study is that all the livelihoods (including off – farm) in the district are climate change-sensitive and this implies that adaptation options to climate change in the district are hardly sustainable.

2.7.4 Micro Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa.

This study was carried out by Nhemachena and Hassan (2011). The authors concur that agricultural production remains the main source of livelihood for rural communities in sub-Saharan countries, providing employment to more than 60% of the population and contributing about 30% of GDP. They observed that smallholder farmers tend to have a low capacity to adapt to changes in climatic conditions, policies that help these farmers adapt to global warming and associated extremes are particularly important (Brown *et al.*, 2012)

Using cross-sectional survey data for South Africa, Zambia and Zimbabwe, the study finds that most farmers detect a rise in temperature over the past 20 years, drier conditions, and pronounced changes in the timing of rains and frequency of droughts. In response to these perceived changes in climate, 67% of the survey respondents are adopting some form of adaptation. Common adaptation measures include diversifying crops, planting different crops or crop varieties, replacing farm activities with non-farm activities, changing planting and harvesting dates, increasing the use of irrigation, and increasing the use of water and soil conservation techniques. Among the farmers' barriers to sustainable adaptation measures, include; lack of credit, lack of information on climate, and insufficient access to inputs (Unganai, 2009).

With regards to the determinants of farmers' use of adaptation strategies, they find that awareness of climate change, access to credit, markets, and free extension services increased the likelihood

of farmers adopting sustainable adaptation measures. They also noted that access to technology and equipment including animal power enhanced adaptive capacity.

The type of farming system also determines farmers' use of adaptation strategies: those in mixed crop and livestock farming, as well as those engaged in subsistence farming, are more likely to adapt to changing climatic conditions than are farmers in specialized farming systems. Finally, the study finds that female headed households are more likely to take up adaptation options than male – headed households. In most rural smallholder farming communities, women do much of the agricultural work and therefore tend to have more farming experience and information on various management practices. Farming experience increases the probability of uptake of all adaptation options. It is important to note that much of the adaptation options that rural communities have are mostly forest resource–based (Moyo *et al.*, 2012).

Besides various other services they derive from forest and other natural resources, the rural population in Southern Africa especially depend on locally made household implements. Such implements include, among them, the axe and hoe handles, pestles and mortars, cooking sticks, plates and bowls, ox yokes, ox-carts, drums, and hunting tools (Hulme and Sheard, 1999; Moyo *et al.*, 2012). Labor and income-based activities like carpentry, carving and other craft work, roof mending, thatching, and selling wood fuel, thatching grass, wild fruit, and vegetables constitute the largest source of forest/woodland based income for poorer households in Zimbabwe and Southern Africa (Berkes, *et al.*, 2003). Access to forest and woodland resources is therefore crucial for survival for most peasant households. In the light of the growing impacts of climate change, poverty levels in the Southern Africa Development Committee (SADC) region are likely to rise and as such, forests and woodland resources will assume greater role to play in livelihood sustainability (Chagutah, 2010; Davies, 2011).

2.7.5 Climate Change Impacts on Crop Land Use in Botswana

Mwiturubani and Van Wyke (2010) carried out the above-stated study and their findings suggest a trend towards reduced rainfall amounts and variability across Botswana, which is associated with a drop in the number of rainy days. In response to progressive fall in rainfall, there has been extensive variability in land cultivation over time and a significant decrease in land cultivation across the nation over the years, with a high correlation of 0.8 between land cultivation and annual

rainfall. The analysis of the monthly rainfall trends for eight stations in the study area over 30 years suggest a shift towards drier conditions, especially during the months of January, February and March, the latter part of the crucial growing season for an agricultural rural economy. The results suggest that climate change is already affecting Botswana through progressive decreases in rainfall, and with this, less land is being cultivated, which, in turn, threatens the already precarious food security situation in the country.

This critical finding of the study begs an important question concerning adaptation in the rain – fed farming communities of Botswana: What policies can help the country's dry area farmers to adapt to climate change rather than abandon their land? The study suggests that the government has got an important role to play. Increasing investment in applied research in dry land agriculture. There is also need for the development and expansion of agricultural extension services to promote climate resilient agricultural practices and livelihood diversification (Ayers, 2011).

2.7.6 South African Farming Sector's Vulnerability to Climate Change and Variability.

Gbetibouo and Ringler (2011) carried out a study on the level of vulnerability to climate change in South Africa's farming sector by developing a nationwide provincial level vulnerability profile. In the study, particular attention was given to the underlying socio economic and institutional factors that undermine farmers' response to and cope with climate hazards. In the study vulnerability is conceptualized as a function of three factors: exposure, sensitivity, and adaptive capacity. Exposure can be interested as the direct danger (stressor) together with nature and extent of changes in a region's climate variables (temperature, precipitation and extreme weather events). Sensitivity describes the human–environmental conditions that exacerbate or ameliorate the hazard, or trigger an impact. Exposure and sensitivity are intricately (intrinsically) linked and mutually influence potential impacts. Adaptive capacity represents the potential to implement adaptation measures in efforts to avert potential impacts. Several indicators representing these three components were selected to facilitate the study's examination of vulnerability in South Africa.

In their findings, they conclude that Coastal provinces exhibit high exposure to extreme events of cyclones whilst the Western Cape is more exposed to drought. The most sensitive provinces are

the Eastern Cape, kwazulu Natal, and the Limpopo and this is mainly due to their high proportion of small holder subsistence farmers in the provinces and high dependency on agricultural livelihoods. Inappropriate land uses in these provinces have severely degraded land and reduced production capacity (Archer *et al.*, 2010).

The least sensitive provinces are the Western Cape and the Free State, whereby the common feature of the region is a low percentage of subsistence farmers and the least populated rural areas. They have better infrastructure, higher levels of literacy, and lower unemployment rates. In addition the high degree of crop diversification, low levels of land degradation, and a high reliance on irrigation help to raise their adaptive capacity to climate change impacts (Gbetibouo, and Ringler, 2011).

Combining the indicators for sensitivity and exposure, Kwazulu Natal, Limpopo are predicted to suffer the largest impacts of climate change and variability. They have the largest exposure and the highest sensitivity. Indicators of adaptive capacity differ considerably across the nine provinces. Capacity is greatest in the Western Cape Province due to combined effects of well developed infrastructure, high literacy rates and income levels, low unemployment levels and HIV prevalence, and relatively high capital wealth. The opposite is true for the Kwazulu Natal and the Limpopo Province due to a high dependency on agriculture, and high levels of unemployment (Archer *et al.*, 2010).

2.7.7 Climate Change and Variability Impacts in Bangladesh

This study was carried out by the World Bank (2010) and its findings suggest that Bangladesh is trapped between the Himalayas in the north and the encroaching Bay of Bengal to the south. Its geographical setting has made it among the worst affected nations by climate change over two decades from 1990. It incurred a total loss worth 2.9 billion dollars due to a series of extreme climate events between 1990 and 2008. The country is highly vulnerable to natural disasters due to both the frequency of extreme climate events and its high population density. Floods are the most frequent and cause the greatest economic and human losses to the country. The flooding problems are exacerbated by high discharge and sediment transported by three major rivers- the Ganges, Bramahputra and Megha traversing the flood - plain nation. Other frequent extreme events come in the form of rising temperatures, droughts, storms, pests and diseases. The climate variability and

change in Bangladesh are already affecting many sectors, including water resources, agriculture and food security, ecosystems and biodiversity, human health and settlements in coastal zones (Ayers, 2011). Many environmental and developmental problems will be exacerbated by climate change. Crop yields are predicted to fall by up to 30 per cent, creating a very high risk of hunger. Predicted temperature increases will cause increased rate of melting of glaciers in the Himalayas, exacerbating flooding and reduced and unreliable river flow in the long term. In the short term, the global warming increases risk of flooding, erosion, mudslides during the wet season whilst in the longer term, global warming could lead to disappearance of many glaciers that feed many rivers in South Asia (Ayers, 2011).

2.8 INSTITUTIONAL RESPONSES TO CLIMATE CHANGE RISKS

Ever since the emergence of clear evidence of climate change and its ecological and socio economic implications, institutions at all levels have faced difficulties in establishing effective intervention. The political challenge represented by addressing climate change notwithstanding, scientific uncertainties regarding the characteristics and impacts of future climate change also contribute to delaying action. These uncertainties relate to questions about magnitude, frequency and other characteristics of climatic processes expected to be affected, as well as to questions regarding the impacts of the changes (Schipper, 2004).

According to the MEA (2005), the most feasible way to mitigate and adapt to climate change impacts is to seek intervention mechanisms to contain the continued degradation of ecosystem services. The challenge of reversing the degradation of ecosystem while meeting increasing demands for ecological services can be partially met under some scenarios considered by the MEA (Biggs *et al.*, 2004; Chagutah, 2010). The assessment shows that with appropriate actions it is possible to reverse the degradation of many ecosystem services over the next 50 years, but the changes in policy and practice required are substantial and require political commitment for investment. The overall aims of the MEA are to contribute to improved decision-making concerning ecosystem management and human well-being, and to build capacity for scientific assessments to enhance sustainable synergies between ecosystems and human well being (Munasinghe and Swart, 2000; Unganai, 2009).

The MEA suggest two categories of options for sustainable ecosystem management and adaptation to climate change. These are; the cross-cutting options and sector specific options. The cross-cutting options involve changes in institutional and environmental governance framework, for instance by properly designing institutions to deal with the management of common pool resources, property rights, access rights, user rights, pollution control, application of polluter and user pays principles among others (Ashley and Carney, 1999).

Integrating ecosystem management goals within other sectors and within broader development planning frameworks will help to develop a climate resilient economy. This needs support in the form of integration among multilateral environmental agreements and between environmental agreements and other international economic and social institutions. There is need also for increased accountability and transparency of governmental and private sector performance on decisions that have an impact on ecosystems, including through greater involvement of concerned stakeholders in decision making. Integration of policies laws and markets to guard against market failure (Munasinghe and Swart, 2000). This approach is based on the argument that environmental exploitation and subsequent degradation have a close link with sustainable development. Changes in the status of environmental resources either negatively or positively affect sustainable development (Serageldin, 1995; Brown *et al.*, 2012). Dixon *et al.* (2003) further argue that livelihood is sustainable when it can cope and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future whilst not undermining the natural resource base. It is therefore important to achieve stability between the environment and the economy, considering the extent of their mutual dependence (Biggs *et al.*, 2004; Chagutah, 2010).

Regarding the growing climate change-based threats to rural livelihoods, Chagutah (2010) and Ayers (2011) warn that in the absence of a quick intervention of appropriate measures involving every nation and citizen of the world, the gains so far recorded towards sustainable development and the achievement of the millennium development goals (MDGs) would be reversed. Campbell, *et al* (2003) argue that whilst the impacts of climate change are generally wide spread, it is the poor rural communities (such as those in the Makonde District) who are affected hardest as their traditions and livelihoods get eroded whilst they do not have the capacity to mitigate the impacts nor have alternative livelihood strategies for sustainable survival. The loss of ecosystem functions

and resilience is of particular concern in the light of predicted global warming and the anticipated, but largely unknown, impact this will have on the environment itself, local weather conditions, water resources and local livelihoods (Yohe *et al.*, 2007; Uganai, 2009; Brown *et al.*, 2012).

Sector specific responses include attention to the agricultural sector, whereby there is need for the removal of production subsidies that have adverse economic, social and environmental effects. There is need also to invest in, and diffusion of, agricultural science and technology that can sustain the necessary increase of food supply without harmful tradeoffs involving excessive use of water, nutrients, or pesticides. There is need for use of response policies that recognize the role of women in the production and use of food and that are designed to empower women and access to and control of resources necessary for food security (Chagutah, 2009; Ayers, 2011). Lastly to strengthen the resilience of the agricultural sector there is need for an application of a mix of regulatory and incentive–and market–based mechanisms to reduce over use of land, nutrients and water (Moyo *et al.*, 2012).

In the water sector, there is need for a framework to promote the payments for ecosystem services provided by watersheds; improved allocation of rights to freshwater resources to align incentives with conservation needs; increased transparency of information regarding water management and improved representation of marginalized stakeholders; development of water markets; increased emphasis on the use of natural environment and measures other than dams and levees for flood control; and a need to invest in science and technology to increase the efficiency of water use in agriculture (Biggs *et al.*, 2004; MEA, 2005)

In forestry whereby there is need for a number of reforms among which include an integration of agreed sustainable forest management practices in financial institutions, trade rules, global environment programs, and global security decision making. There is need also to facilitate the empowerment of local communities in support of initiatives for sustainable use of forest products; these initiatives are collectively more significant than efforts led by governments or international processes but require their support to spread (Chagutah, 2010; Ayers, 2011). A number of case studies have been conducted in Zimbabwe highlighting the high potential that rural communities have to successfully manage climate vulnerability. Through appropriate external support, some

communities in drought-prone rural districts such as Chiredzi and Mberengwa have been successful in their community-based climate change adaptation projects (Chagutah, 2010; Brown, 2012). With the guidance and support of local NGOs, a participatory approach was utilized to empower beneficiaries to take the leading role in planning, monitoring and evaluation of their own projects and encouraged the community to make their own decisions, consulting with development partners and government experts for technical advice when desired. The core aim of the Community-based Adaptation (CBA) projects was to enhance community livelihoods and promote more sustainable natural resource management practices (Brown *et al.*, 2012). The case studies demonstrate how CBA has enabled poor people to assess their vulnerability, to identify the degree to which climatic change and variability affects their communities and livelihoods, and to identify locally-relevant adaptation strategies that build on indigenous knowledge and cultural practices.

Lastly it is important to consider the reform of forest governance and development of country-led strategically-focused national forest programs negotiated by stakeholders. Adger *et al.* (2004) argue that sustainable development initiatives have got the potential to empower people by broadening the range of strategy options. One critical area is that of diversifying livelihood choices, which reduce vulnerability. There is need to consider the holistic nature of people's lives that is based on their use of multiple livelihood strategies (Uganai, 2009). This calls for institutional and technical responses which are not limited by sectoral boundaries (Munasinghe and Swart, 2000).

Other responses include social behavioral responses which entail improvement on population policy, public education, civil society actions, and empowerment of communities, women, and youth can be instrumental in responding to the problem of ecosystem degradation. Technological response is also necessary given the growing demand for ecosystem services and other increased pressures on ecosystems. The development and diffusion of technologies designed to increase the efficiency of resource use or reduce the impacts of drivers such as climate change and nutrient loading are essential. This should include; promotion of technologies that result in increased crop yields, and resistance to drought, heat stress, pests and disease are essential, but careful considerations have to be put in place to avoid or mitigate the negative ecological, social and other externalities of their application; restoration or rehabilitation of ecosystem services and the

promotion of technologies that increase energy use efficiency and reduce GHG emissions (Desanker *et al.*, 2001; MEA, 2005).

The other is knowledge response whereby effective management of ecosystems is constrained both by the lack of knowledge and information about different aspects of climate change and associated ecosystems responses. There is therefore need to promote the development of a body of knowledge about the status and economic value of ecosystems and their influence on social systems (Chagutah, 2010; Moyo *et al.*, 2012). This is essential in the decision making and management of the relationship between the biophysical and socio-economic components of regional systems (Munasinghe and Swart, 2000). This will in turn enhance and sustain human and institutional capacity (in agriculture, forestry, fisheries and other natural resources sectors) for assessing the consequences of ecosystem change for human well-being and acting on such assessments for sustainable adaptation (Biggs *et al.*, 2004; Davies, 2011).

For sustainable options cope with and adapt to climate variability and change initiatives embracing the Sustainable Rural livelihoods Framework (SRLF) as presented by Carney (1998) deserve strong consideration. The aim of the SRLF is to improve the understanding within key government and local authorities of institutional support that is required to promote sustainable livelihoods. It also aims at enhancing the policy makers' understanding of important policy elements for supporting sustainable livelihoods (Ayers, 2011). Cameron (1999) reiterates that the SRLF is a people centered approach to research and policy formulation and has since had positive influence on rural development policies in many countries. It is vital in the understanding of rural lives in their totality, including varied, lived experiences of continuity and change. In the livelihoods framework, all households are seen as utilizing changing patterns of natural, produced, human, social and financial wealth to create sustainable livelihood.

From the perspective of the role of government, Chagutah (2010) and Brown *et al.* (2012), suggest the need for multilevel policy-making and investment. They add that policymaking and investment at all levels must fundamentally support participatory and inclusive decision-making processes in order to ensure that adaptation strategies address the needs of poor women and men. The argument behind this suggestion is based on the understanding that strengthening the ability of

local groups to negotiate to get more, rather than less, from local (and national) political processes requires making a more substantive institutional investment (Ayers, 2011). In order to strengthen the institutional framework in climate change adaptation strategies, Ayers (2011) suggests the need to introduce the concept and practice of climate governance, which is proving relevant for integrated planning and policy-making across a variety of sectors and stakeholders. Climate governance recognises that national policy frameworks (as supported by the UNFCCC) facilitate a strong top-down approach that requires coordinated governance institutions that are able to translate higher-level policy into local action plans. This good governance instrument is believed to create an organizational environment that promotes and strengthens vertical and horizontal integration of decisions, plans and projects, which would in turn, allow two-way benefits: locally-led or bottom-up where local initiatives influence national action and nationally-led or top-down where enabling frameworks empower local layers (Chagutah, 2010; Ayers, 2011; Brown *et al.*, 2012)

2.9 CONCLUSIONS

The chapter discussed theoretical and empirical literature on the growing evidence of climate change affecting the world. The concepts, trends and spatial patterns of climate variability and climate change were introduced and discussed. From the perspective of socio-economic implications, temperature and rainfall are the two key climate variables most notable in climate change assessments. A combination of both scientific and observed evidence suggests that global mean temperatures are steadily rising since the beginning of the 20th century. In terms of rainfall amounts, there is a notable declining trend in many parts of the world, with a steady increase in rainfall variability in the form of the increasing frequency and severity of droughts and floods.

Due to the fact that climate is among the most important determinants of human survival, livelihoods and culture, all of the world population is vulnerable to the unprecedented climate variability and changes taking place today. The global and local impacts of climate change are multi-dimensional starting with direct impacts on the biophysical world, which in turn happens to be the vital asset for local livelihoods, economies and human wellbeing. From the perspective of local level livelihoods assessment, there are three dimensions of vulnerability to climate change which include: the physical–environmental dimension, the socio–economic dimension and the availability

and nature of external assistance. Of interest therefore for adaptation to climate change are natural systems and human systems, which have interacting and interdependent functions.

Whilst the entire globe is subjected to climate change impacts, the distribution of the impacts is uneven. The low-latitude, less-developed parts of the world are generally at greatest risk due to both higher sensitivity and lower adaptive capacity. Whilst some regions and communities may be in a position to adapt to the changing climate, many parts of the world and their inhabitants are facing increased vulnerability. Sub-Saharan Africa, among other less developed regions is particularly vulnerable to climate change. The majority of the populations in sub-Saharan Africa and other less developed regions are rural subsistent farmers whose livelihood depends mostly on rain-fed agriculture and climate-sensitive natural resources-based livelihoods. The review also noted that in an effort to cope with climate change impacts some communities run the risk of plunging into maladaptation. Due lack of knowledge, technical and other material assets, many rural communities of the South adopt climate change coping actions that in the short or long term generate negative ancillary impacts to the wellbeing of the same or other communities. A combination of local actions together with wrong policy interventions and other external forces are often resulting in greater vulnerability to climate change.

A number of institutional responses to climate change risks have been discussed in the chapter. The responses include the need for an ecosystem approach and sustainable livelihoods framework approach to assessing vulnerability to climate change and designing adaptation strategies. One other lesson learnt from the review was the realization that research on climate change: vulnerability and adaptation must strive to be context-specific because the adaptive capacity varies depending on a complex web of biophysical and socio-economic circumstances. It is this local level perspective of livelihood vulnerability that has informed the case study approach adopted by the thesis to focus on the Makonde Communal Lands of Zimbabwe.

CHAPTER THREE: METHODOLOGY

3.0 INTRODUCTION

The research sought to explore climate change as a driver of environmental and smallholder farmers' livelihood vulnerability in Makonde District of Zimbabwe. Based on the research aim, the following specific objectives were spelt out: To determine climate change trends and manifestations in the Makonde Communal lands; to evaluate household-level impacts of climate change and associated environmental changes on smallholder farmers' livelihoods in the Makonde Communal lands; and to investigate the extent of household-level coping and adaptation strategies to climate change by the Makonde rural community.

Hence to address the outlined aim and research objectives, an appropriate mix of research methods were carefully selected. The research methods employed were deemed to be adequate in covering the wider spectrum of key variables to measure climate change trends, related biophysical impacts and subsequent human responses in the form of land use, livelihoods, coping and adaptation strategies among others in the communal lands-part of the Makonde District.

3.1 STRATEGY OF INQUIRY

The broad research strategy used in this research is qualitative in nature. A qualitative methodology of inquiry is rooted in the phenomenological paradigm as opposed to the positivist school of thought (Corbetta, 2003). The phenomenological paradigm emphasizes understanding, analyzing and describing phenomena without necessarily relying on quantitative measurements and statistics (Dawson, 2007). In direct contrast to positivism, phenomenological approaches accept subjectivity as opposed to objectivity. Phenomenology also allows for interpretation of events and phenomena such as those identified in the investigation of rural livelihoods and climate change challenges and opportunities in the Makonde District of Zimbabwe as opposed to strict quantitative measurements. The phenomenological approach is characterized by a focus on qualitative interpretation of people's perceptions and meanings attached to social phenomena, attitudes, beliefs and value systems (Lincoln and Guba, 2000).

Within the context of this research, social phenomena such as personal experiences, beliefs, attitudes and opinions of the leadership and members of the smallholder Makonde community,

local authorities and experts were investigated. According to Leedy (1989), the qualitative research methodology might be considered a “warm” approach to the central problem of research as this kind of research investigates issues identified earlier in addition to interpersonal relationships, meanings construction, experiences and associated thoughts or feelings. With this, the researcher attempted to attain rich, deep, real and valid data on climate change experiences and responses in the Makonde communal lands. The quantitative methodology on the other hand is “cold” and decisions are made with the coldness of a steel rule (Leedy, 1989; Dawson, 2007). Quantitative methodologies manipulate variables by constructing hypotheses and testing them against the hard facts of reality and as such the use of quantitative techniques in this particular research was only limited to addressing the meteorological aspects of climate change as dictated by the first objective and research question of the thesis.

The study included the gathering, analysis and interpretation of climatic data with emphasis on the past and current scenarios, with little reference to climate modeling for potential future impacts. This position was taken because of the inherent weaknesses associated with climate modeling for the future ‘scenarios’. Smit and Pilifosova (2001) argue that assumptions put forward in climate modeling fail to match with behaviors, both natural and human. There is a distinction between rational behavior under perfect information and rational behavior under uncertainty which is characteristic of local climate change and human responses such as those that were likely in the Makonde communal lands. Efficient adaptation techniques are only theoretically possible and not without uncertainty, as individuals may not necessarily behave rationally nor be willing to act with imperfect information (Yohe and Neumann, 1997; Smit and Pilifosova, 2001).

Whilst the study is generally dominated by the qualitative methodological perspective of inquiry, the complex nature of the subject matter under study calls for strategic flexibility in the field. The subject under study is complex in the sense that it covers several dimensions including; the biophysical, socio-cultural, economic and political aspects altogether constituting a rural livelihood system. Among the biophysical variables covered, are meteorological data that is mostly quantitative in nature. Besides the environmental data, the study on the other hand elicits socio-economic data concerning land use, livelihood, and personal experiences and opinions, which can either, be quantitative or qualitative in form. In this regard, a mixed method approach was therefore

considered the most appropriate for the study. Newman and Benz (1998), point out that a mixed methods approach has come of age, and to include only the qualitative or the quantitative methods falls short of major approaches being used today in social and human sciences. Given the growing complexity of human civilization the situation today is less of quantitative versus qualitative and more of how research practices lie somewhere on a continuum between the two quantitative and qualitative methods (Newman and Benz, 1998; Tashakkori and Teddle, 1998).

The mixed approach is in agreement with pragmatic knowledge claims which derive from the works of Pierce, James, Mead and Dewey (Greene *et al.*, 1989). Other contributors to the paradigm include Spradley (1980), Bryman (1988) and Patton (1990). The approach is also rooted in the argument that knowledge claims arise from actions, situations and consequences rather than antecedent conditions as in the positivist philosophy. The ontology of this particular thesis therefore is rooted in the interpretivist paradigm whose underlying assumption upholds the notion that reality is not simply to be observed, but rather to be interpreted (Schwandt, 2000; Corbetta, 2003). In the human sciences to which my thesis belongs, there is no such detachment between the observer and the object under study and knowledge can therefore be obtained only through the process of comprehension. In the case of natural sciences; we explain it, whilst life of the mind calls for understanding (Bailey, 2007; Bryman, 2012).

There is concern with applications that is, what works and the associated problems (Patton, 1990). Rather than the method being the most important aspect as within the postpositivist framework, it is the problem that is the most important. Researchers are then required to use a variety of approaches possible in order to understand the problem holistically. Bryman (1988) and Corbetta (2003) concur with this argument and suggest that the distinction between quantitative and qualitative research is really a technical matter whereby the choice between them has to do with their suitability in answering particular research questions.

The research question-based criteria in selecting the methodology apply quite perfectly with this thesis. For instance the first question related to climate change trends and patterns in the Makonde district calls for the acquisition and analysis of quantitative meteorological data. The second research question on the climate change impacts involves both quantitative and qualitative data whilst the third on coping and adaptation strategies mostly relies on qualitative data. This

constitutes the philosophical underpinning for mixed methods of inquiry (Rossman and Wilson, 1985; Greene and Casracelli, 1997). There is therefore need to focus more on the research problem on social sciences research like this one focusing on Makonde Communal lands and then using the pluralistic approach to derive knowledge about the problem such as the case with climate change, associated environmental impacts and livelihood responses.

Crotty (1998) provides a list of knowledge claims rooted in pragmatism and they include the following:

- The study is not committed to any one system of philosophy and reality, which applies to mixed methods of research and inquiries should draw liberally from both the quantitative and qualitative methods;
- The world is not an absolute unity as it is multi dimensional and so calls for mixed approaches / strategies for inquiry in recognition of the fact that the truth is what works at the time and thus a combination of research methods help to provide the best understanding of the research problem;
- To support the multidimensional context of the Makonde study, there is an argument that research always occurs in natural, social, historical, political and other contexts and as such, the mixed research methods open the door to multiple methods, different world views and different assumptions and to different forms of data collection and analysis (Crotty, 1998).

Based on the multispectral nature of the data collected and analysed, the study can also be attributed to a multidisciplinary research. The fact that the study is exploring climate and associated environmental change, and human responses requires that the research does not emerge from any single discipline. While a mono-disciplinary approach allows empirical evidence to be tested within a known and confined spectrum of theories, environmental change, particularly climate change cannot be pigeonholed as either a natural or social science issue. Hence the study of such phenomena calls for an inherently interdisciplinary approach (Newby, 1997; Creswell, 2003; Bryman, 2012).

The study looks at the impacts of climate change in developing countries from the perspective that requires both an examination of natural risks within a given developmental context. Hence it

recognizes that the livelihood challenges being experienced are not exclusively attributable to climatic and environmental conditions alone, but rather, that socioeconomic, cultural and other factors also have influence to the prevailing livelihood constraints (Aguilar *et al.*, 2005). In order to develop appropriate mechanisms for addressing the prevailing livelihood vulnerability to climate change in a given local context, both social and natural science perspectives must come together in policy formulation (Patton, 1990).

The framework for this thesis is therefore based on beliefs about environment and development that touch on theories of political ecology. Benton (1998) makes the case for social theory to challenge technical versions of environmental management, and suggest an interdisciplinary approach as a mode of enquiry for addressing environmental problems. Such an approach not only avoids limiting the researcher to one set of theories, but also offers a broad range of methodologies for data collection and analysis. In pursuit of the mixed method research design two main approaches were therefore adopted. Based on lessons learnt from Schipper's (2004) case study, (Section 2.7.1) a case study approach was adopted as the principal data generation instrument. To complement the case study option, a historical-descriptive approach was also employed. Both these two methodologies will each be considered in much depth in the next sessions starting with the case study approach.

3.1.1 The Case Study Approach

The case study approach concerns itself with the use of specific cases and case material to analyze elements of a particular subject matter, derive some lessons and draw conclusions and recommendations (Yin, 1994; Stake, 1995). In most instances the conclusions drawn are context specific and cannot be generalized to other contexts. Schipper (2004) defines the case study approach as a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence. In the case of this particular research, the case study aims to investigate how vulnerable communities in Makonde Communal lands of Zimbabwe respond to the prevailing climate variability and change. As a developing country, Zimbabwe is prone to the risk of climate variability and change. In addition, Zimbabwe is a party to the UNFCCC and for these reasons among others; it is strongly considered as deserving research commitment in the field of climate change, associated

biophysical and socio economic impacts, coping and adaptation strategies at the local and national context.

A case study research also allows the researcher to examine theoretical underpinnings empirically (Yin, 1994; Schipper, 2004). The use of case studies made it possible for this particular Makonde study to observe salient climate change trends and consequent livelihood impacts, challenges and opportunities that are specific to the Makonde community over the period of between July and September 2012. This is anticipated to enable the researcher to get in-depth knowledge about the realities and key factors for livelihood implications of climate change at the local level. Zimbabwe in general and Makonde communal lands in particular, were taken as a case study that provides insights into the real life climate change trends and their associated livelihood, policy and institutional implications.

As expected of a case study, a mix of data collection instruments was employed in the study including: key informant interviews; household questionnaires; documentation and archives and field observations. This was in line with Yin's (2004) suggestion that evidence for case studies are derived from six premises which include: archives, interviews, observation, documentation, participants-observation and physical artifacts which in this case relates to land use pattern changes in the Makonde Communal lands. The details regarding the nature of instruments employed, their advantages and disadvantages as well as how the disadvantages were addressed in the research are discussed under each of the sections dealing with a with a particular instrument in the coming sections.

Whilst the case study was a preferred approach in this particular study, it is important to recognize the inherent weaknesses of this approach in order to put in place measures to mitigate the potential implications on the validity and reliability the research (Yin, 2004). It is generally noted that the applicability of the measure of reliability in case studies is questionable (Hall and Hall, 1996). The findings of case studies are often context specific and so in many instances may not be applied to generalize (Yin, 2004). This also applies to this particular study whose findings on community vulnerability and adaptation to climate change may not necessarily be replicated in similar studies on other communities who may have a different geographical, historical, socioeconomic and political setting (Stake, 1995).

The concern of this study is to highlight the fact that whilst the global climate change and its projected impacts on the human population is generally unquestionable, the level of vulnerability to climate change varies from community to community depending on a complexity of geographical, social, economic and political factors. The idea behind my case study approach in the case of the Makonde communal lands in Zimbabwe is to zoom out this small geographical unit from the generalized global picture of human vulnerability to climate change. In the process, the case study seeks to unveil in detail, the desperate livelihood situation that certain communities and regions are trapped in. The study therefore has no intention to generalize its findings and even in the interpretation of the research data, it will not be tempted to generalize the findings of how the Makonde community is vulnerable to, coping with and adapting to climate change. Despite the generalisability constraint associated with case studies, Hall and Hall (1996) indicate that field researchers generally hope that their work will have some implication beyond an understanding of the specific setting, as important as that might be. I do share similar belief in my study that the phenomenon of climate change and its impacts in the Makonde Communal lands, and the corresponding community responses, and adaptation attempts, do have relevance for other economically and technically-challenged smallholder farmers elsewhere in the climate change-vulnerable world.

The study area, with a total of 10 villages was surveyed and specific biophysical and cultural scenarios of climate change impacts and associated livelihood implications were covered. The study was conducted during the July to September 2012 and focused on the climate change processes and patterns, community experiences, coping and adaptation strategies during the past 30 years. This 30 year period was assumed to provide a complete picture of climate variability and change and the consequent environmental and social vulnerability and the coping and adaptation practices in the Study area.

3.1.2 Historical-descriptive Method

Phenomenology encourages use of descriptive narratives to build a comprehensive story around local level phenomena such as climate change patterns and associated impacts (Baker, 1994). My study borrows from this epistemological perspective and finds the historical-descriptive approach providing the opportunity to dig deep into the past and reveal other factors that may, at face value, appear

unimportant to the climate change–livelihoods dynamics (Leedy, 1989). Historical research is viewed by Savitt (1980) as a method that enables charting of the past, and a better understanding of the present. The research approach is basically descriptive, involving the narration of events and experiences in time sequence. The historical perspective in my study enabled a comparative analysis of climatic events, experiences and coping strategies in a single place (the Makonde communal lands) through time. The approach also made use of analytical description in an historical context to analyze the climate change trends and the socio economic implications over time.

The historical perspective is based on the assumption that through an understanding of past events, one can better describe and understand the present with a view to making informed predictions about the future. Leedy (1989), states that historical research intently looks at the currents and counter-currents of present and past events and at human thoughts and acts. It seeks to trace them through the tangled web of life with the hope of unraveling some of its knots, of discerning dynamics that add rationality and meaning to the whole. In this particular study, different sources of historical evidence were captured and they include; oral narratives of selected elders in the Makonde communal lands.

A total of ten elders were selected by means of snow balling method and an unstructured interview was conducted for each (Marshall and Rossman, 1999; Creswell, 2003). The unstructured interviews allowed the elders to freely give a historical account of their lives, experiences, and shifting livelihood coping strategies to the climate change trends in the district over the past decades (see Appendix 10). The interviews were augmented by archival material such as meteorological data and land use maps, and artifact evidence in the area (Savitt, 1980). This historical perspective has been employed to describe and analyze the climate change trends and indicators experienced by smallholder farmers in the Makonde communal lands. Policies and associated institutional response initiatives that have emerged in this regard have been analyzed and described. The approach has raised the opportunity to dig deeper into the local past and gain a detailed understanding of the climate change-related livelihood trends, resultant innovations, their physical, social and technical attributes as well as the emerging challenges and opportunities at local, national and regional level.

In the application of the historical perspective in research, Savitt (1980) warns that attention should be given to the distinction between primary and secondary data sources as a means of minimizing the gap between the actor and the observer. It is noted that drawing a line between primary and

secondary data sources is difficult because it does not necessarily follow that an old document is primary source of data. In my research, whilst meteorological data (for the past 30 years) obtained from the Meteorological office and interview responses were considered primary, some government documents about the district such as historical, agro ecological, demographic and other reports were secondary sources.

3.2 DATA GATHERING TOOLS

The research employed instruments primarily developed from social anthropology, combining theoretical research with actual field-based observations and other data collection tools. While the actual field data gathering task was confined to the Makonde district, focusing on evident climate change trends, their impacts and livelihood responses, the review of literature did extend its coverage to the national, regional and global scales to enhance an assessment of the role of the physical, historical, socio-economic, policy and institutional variables in the climate change-livelihood dynamics. As earlier indicated in section 3.1.1, a mix of data collection tools was adopted and this included secondary data gathering that came in the form of a review of documents and various forms of published literature and primary data collection involving a mix of instruments including: semi-structured key informant interviews, direct observations through transect walks, and a household questionnaire survey.

3.2. 1 Literature Review

This involved the gathering of published and unpublished documentary evidence to analyse the manifestations and impacts of climatic change on the environment and the world communities at various scales. A comprehensive literature survey was conducted to develop and identify some of the key variables and attributes associated with climate change trends and corresponding livelihood responses. In this particular search, the geographical scaling approach was applied, involving a staggered focus on the global, regional and lastly local scale scenarios on climate change and associated biophysical and socio economic implications (see Section 2.1, 2.5 and 2.7) The review has helped in the identification and development of a theoretical framework for analyzing the climate change trends, the biophysical implications and associated socio-economic and institutional dynamics, particularly in the smallholder farmers' livelihood contexts.

Within the theoretical framework, concepts of rural livelihood, vulnerability, coping with, and adaptation to climate change have been addressed. Included in this regard are the methodological aspects of the Sustainable Livelihoods Assessment Framework (SLAF) and the Millennium Ecosystem Assessment (MEA) (see Section 2.3). In addition to the theoretical framework of the subject under study, empirical literature has also been extensively covered in recognition of the importance of understanding local level evidence and patterns of climate change manifestations and associated micro scale livelihood impacts, coping and adaptation strategies. In line with the case study approach that this particular thesis is pursuing, the review of empirical literature has also focused on case studies related to different climate change scenarios, biophysical and socio economic settings. Some European, Asian, American and African contexts were reviewed in order to develop some insight of the regional perspective of climate change indicators; livelihood vulnerability and adaptation to the consequent environmental changes (see Section 2.5, 2.51 and 2.7).

From a regional perspective, the review started with an analysis of NCAR's (2005) *A Continent Split by Climate Change*, SADC's (2008) *The Impact of Climate Change on Poverty Situation in the SADC Region* and Chishakwe's (2010) SADC Climate Change Outlook among others. The review of the Zimbabwean scenario included the Zimbabwe Environment Outlook which is Zimbabwe's Third State of the Environment Report, the 2011 and 2012 Zimbabwe Rural Livelihoods Assessment Reports by the Zimbabwe Vulnerability Assessment Committee (ZIMVAC) and other published works such as by Matarira (1999), Makadho (1996), Chagutah (2010) and Brown et al. (2012).

3.2.2 Key Informant Interviews

Key informant interviews are among the critical instruments employed in both the case study and historical approaches that have been adopted in this study. Interviewing entails the collection of verbal data from participants. It involves asking questions for the purpose of seeking information related to the research. Among the various types of interviews, the semi-structured option was considered for the key informants after considering a number of advantages associated with this method (Fontana & Frey, 1994). Semi-structured interview is whereby a researcher would like to enjoy some level of flexibility regarding how an interview is administered but at the same time wish to maintain some structure over its parameters. For the purpose of structure, an interview guide

was prepared with specific questions that were organized by topics but were not necessarily asked in a specific order. This enabled the interviewer to engage in dialogue with the interviewee, rather than simply asking questions whilst at the same time giving wide amplitude to respondents (Fontana and Frey, 1994). The approach provided the interviewer the opportunity to be actively involved in the cognitive process given the expectations of the interpretive paradigm that which frames this particular research (Bailey, 2007). With the semi-structured interview, the perspectives of the key informants were fully elicited as it provided unlimited amplitude in what they had to say based on their expertise, experience and knowledge concerning the climate change scenario in Makonde district, as opposed to the highly structured questions associated with a structured interview. Giving wide amplitude to respondents can result in very fruitful caches of information (Bailey, 2007).

By means of purposive sampling, a number of institutions were identified based on their special involvement or engagement in the issues of climate change, rural development, livelihoods and natural resources management. These institutions included the following ministries: Local Government (and the Makonde Rural District Council); Agriculture and Land Resettlement (Agricultural Research and Extension Services); the Environment and Tourism (Environmental Management Authority and the Department of Meteorological Services); the Ministry of Public Service and Social Welfare (see Appendixes 9, 4, 5, 3 and 6 respectively).

Other key informants included Non Governmental Organizations (NGOs) whose operations in the area are concerned with the subject under study. Among the NGOs were Caritas (a Catholic Relief Service) and the Farm Community Trust of Zimbabwe (see Appendixes 8 and 7). Both organizations are currently actively involved in humanitarian assistance involving farmers' capacity building, water supply provision, disease control, and general poverty alleviation in the Makonde Communal area. The key informants provided vital information about the climate change patterns, their biophysical impacts and local level, policy and institutional responses to the problem as applicable to the scope of their responsibilities. Some provided scientific facts and views about local climate change trends, and the agro-ecological and socio economic responses and implications in the country in general and Makonde district in particular.

In order to enhance the productivity of the historical descriptive approach that the study adopted, a snowballing sampling technique was employed to identify the local elders (of age 65 and above) in the villages with a long history of stay and living experience in the study area. I used a small pool of initial informants to nominate from within their respective villages, potential participants who meet the age eligibility criteria and could potentially provide a rich historical profile of local climate change, its impacts and associated community experiences, coping and adaptation strategies (Marshall and Rossman, 1999; Creswell, 2003). This particular group of at least one elder from each of the ten villages has been surveyed by use of oral history technique, guided by an open ended unstructured interview guide to get a detailed insight of the climate change-related biophysical and livelihood changes that have taken place over at least the past thirty years.

It is important to note that the interactive nature of semi-structured interviews was adopted in the field survey but not without its own shortcomings. The absence of standardization in semi-structured interviews tend to run the risk that the interview might end up being a typical conversation, with the interviewer doing much of the talking (Fontana and Frey, 1994). This particular challenge was overcome through the rigorous training and a series of trials for the interviews. A pilot interview was conducted to refine the questions and to memorize the questions in order to make sure there was consistent eye contact with the respondent, rather than becoming obsessed with reading the next questions. A balancing act was emphasized in the training and consistently required in the process between allowing the key informant talking amplitude, making sure that he/ she does not digress away from relevant issues, whilst at the same the interviewer's controlling role would not risk dismissing too soon the interviewee's talk that seems irrelevant (Miles and Huberman, 1994). The other challenge was to do with the absence of standard questions, which would lead in difficulties to compare answers if not all participants are asked the same questions. The issue here is that key informants are data sources with unique expertise, roles and responsibilities in their respective sectors and so questions were supposed to be customized in accordance to the key informant's role and field of interest.

In the case of interviews for the elders, each was considered to have his/ her own age, personal experience and knowledge regarding climate change, local vulnerability and adaptation. The individual accounts in their personal contexts were considered as an enriching data source with

regards to the historical profiling of climate change in the area. Nevertheless the triangulation with other data collection instruments helped to level off the weakness and associated data errors attributable to unstructured key informant interviews.

3.2.3 Household Questionnaire Survey

Besides the key informant interviews, the questionnaire is one major instrument that has been put into use to elicit data from households in the case study. The questionnaire survey as a tool was adopted in this particular study because of a number of advantages attributed to it. It is the most appropriate and cost effective method in surveying a large sample population as in this particular case whereby 434 out of the targeted 500 households were surveyed. Its cost effectiveness in dealing with the large sample size is based on its standardized, highly structured design (see Appendix 2), whereby the researcher asks, in specific order, precise questions of interest to him or her and this often includes planned probes to make sure that each question of each interviewee is asked in the same way (Ian, 1996; Lincoln & Guba, 2000).

The questionnaire survey instrument applied in this particular study enabled a capture of some quantitative data in the field survey. This is in agreement with Bailey (2007) who noted that the structured nature of questionnaires generates some data that is amenable to being transformed into quantitative data and analysed using statistical techniques. The responses to some questions can be organized such that frequencies and non parametric tests of statistical significance can be calculated and reported. The incorporation of quantitative data collection in the questionnaire survey of my study strengthens the mixed nature of my research methodology. In support of the mixing of qualitative methods with quantitative methods in research, Corbetta (2003) points out that the quantitative and qualitative techniques yield different kinds of knowledge in a given research project and that this is not a handicap at all but rather, it is actually an advantage. Only a multi-faceted, differentiated approach can provide a complete vision of social reality, whereby, looking at either of the two traditions, there is no absolute 'true' representation of reality (Corbetta, 2003). In addition to the above-stated advantages, the data from a standardized questionnaire survey enables a sound comparative analysis of responses given the fact that every sampled household is asked the same questions (Ian, 1996). A target sample totaling 500 households was primarily considered and given the data collection costs and other constrains, a sample of 500 households

was viewed as significantly representative of the population under study. A stratified sampling framework was employed for this purpose on all the listed villages in order to provide an opportunity for equitable representation of all the villages under study. Table 3.1 shows the number of households per village that were targeted for the survey. Out of the targeted sample size of 500 households for the questionnaire survey, as much as 434 households were successfully surveyed. The failure to have a 100 percent response rate from this particular survey (86.8 percent response rate) was mostly attributable to the reluctance of member/s present at some sampled households to participate in the survey. Observed reasons for the reluctance to participate in the survey included, fear, suspicion, lack of time and general truancy especially among youths delegated to participate in the survey. From the pattern observed in the response rates across the 10 villages, some degree of uniformity was notable across the study area as the numbers of unsuccessful responses were roughly proportional to the respective targeted sample sizes.

Given the randomly scattered pattern of occurrence of homesteads in each village, a simple random sampling technique was applied. The household survey sought to elicit socio-economic characteristics of households, knowledge and experience of local climate change trends, the consequent biophysical changes and the household means of livelihood, coping and adaptation mechanisms to local climate variability and change. It also sought information regarding opportunities for and sustainability of both internal and external assistance that is available to the community to enhance their coping and adaptation strategies to climate change. Whilst in the field, a quick production of questionnaires in Shona language was done to accommodate some villagers who demanded an unassisted scrutiny of the questions for them to participate independently from the assistance of interviewers.

During the course of the questionnaire survey, briefings were regularly conducted to clarify tasks, potential difficulties and solutions and to check on progress, identify and solve unforeseen problems encountered in the survey exercise.

Whilst the questionnaire survey method was adopted based on the earlier stated advantages, a couple of its inherent weaknesses were also weighed before considering the adoption of the instrument. One significant shortcoming is that questionnaires are predominantly of highly structured character, meaning that the researcher determines the questions, controls their order

and pace, and tries to keep the respondent on track (Bailey, 2007). Due to the highly standardised nature of questionnaire surveys as noted earlier, the tool lacks flexibility whereby while in the field, despite the emerging need, the researcher would not be allowed to deviate from the sequence of questions or question wording; not to give the interviewee any of personal views; not to interpret the meaning of a question or give clarifications; and not to improvise by adding answer categories or making word changes (Fontana & Frey, 1994). With the same, a researcher cannot be guaranteed of eliciting the full perspectives of the sampled households in the setting when the participants are limited in what they can say by the highly structured nature of the questions inherent in questionnaires (Lincoln and Guba, 2000; Bailey, 2007).

Corbetta (2003) warned that a researcher who wishes to explore social reality by posing questions to social actors faces two dilemmas and the dilemmas are as follows; The tension between the view that social reality is objectively knowable (an objectivist position) and that knowledge can only be generated by the interaction between the researcher and the study object (constructivist position); The other dilemma is to do with concern on the reliability of the verbal behavior, which in turn brings about two potential problems that include; social desirability and non attitude. Social desirability entails the tendency to give a more socially or culturally acceptable response rather than the actual truth while the non attitude refers to the problem of participants giving casual responses as a result of a lack of informed opinion. These negative tendencies among participants have the potential to generate significant levels of data error (Ilan, 1996; Corbetta, 2003; Bailey, 2007).

To avoid misleading responses from the questionnaire survey, a number of measures were taken in my field survey including the following: providing the appropriate syntax, language, and content in phrasing the questions; standardizing the time aspect, memory effects, question order and number of response options. Also in order to guarantee little or minimal occurrence of the above-noted potential bias and data errors in the questionnaire survey, the actual data collection was preceded by a pilot survey and interviewer training. The research found it necessary to undertake a questionnaire trial in order to determine what exactly to ask and also to familiarize with possible responses. This was especially important in the case of the standardized questionnaires' closed-ended questions (Bailey, 2007). The trials of the questions and specific parts of the questionnaire were conducted on the Makonde study population in the form of a couple of individual and focused

groups from the area, acquaintances and colleagues in order to tackle the problem of clarity, understanding and the various aspects and nuances of the subject of climate change and associated local experiences, coping and adaptation strategies (Corbetta, 2003). The Pretesting of the final version of the questionnaire on a sample of subjects with similar characteristics as the members of the study population was conducted taking care to cover key groups such as age, gender, level of education and livelihood categories. The Pretest also helped to determine the duration of each interview which was averaged at 30 minutes (Bailey, 2007).

The next exercise preceding the actual survey concerns with the Interviewer training. The training's main objective was to address interviewer features which have a potential to jeopardize the success and validity of the research. Aspects of appearance, gender, dress, general code of conduct and other ethical considerations in research were covered in order to develop a character in the interviewers that is neutral but appealing to the potential subjects (Bailey, 2007; Bryman, 2012). In the process, the interviewers acquainted themselves with the project goals and objectives in order to generate their inspiration to ensure a positive psychological disposition of the interviewers towards their data collection task. It was also aimed at creating an understanding among interviewers the type of interactions that take place between the researcher and the subject and the potential influences arising.

The data errors associated with the earlier noted problems of social desirability and non - attitude among the subjects were addressed through the rephrasing and structuring of the questionnaire and training of the interviewers so that they play a central role in translating, elaborating, clarifying but in such a way that there is minimal interview effect on the respondent's answers (Fontana and Frey, 1994; Bailey, 2007). There was need to standardize interviewer behavior and limiting the interviewer's discretionary power. This was achieved for instance, through emphasizing the avoidance of certain behaviors that tend to express approval or disapproval of what the subjects say, and also learning to respond in non - committal words or gestures whenever an interviewee looks for some reaction. At the same time, interviewers were trained to make sure that the respondent cooperates positively, without suffering lapses of attention and interest, always understands what the question mean and does not make gross mistakes in answering. The training also involved encouraging interviewers to adopt a friendly, but neutral, attitude, one that is basically

permissive and implicitly able to get across the idea that there are not correct or wrong answers (Fontana and Frey, 1994; Bailey, 2007). The training was also an opportunity to establish standard clarifications to questions in case of subjects facing difficulties in understanding.

With regards to other inherent problems of questionnaire surveys to do with low response or return rates and the tendency for self selection as identified by Bailey (2007), commitment was guaranteed to make sure that as many questionnaires as possible are conducted through face to face interviews. As opposed to self administered questionnaires in which there is a tendency of low percentage of returns (often well below 50%) due to absence of a Mechanism or force to urge compliance (Bailey, 2007), a face to face approach was adopted to ensure the presence of the presence of the interviewer to provide encouragement, instructions and clarifications and thus ensure that all questionnaires are completed and handed in. Self selection is whereby without the active role of the interviewer on the ground, as in the case of postal questionnaires, those who freely accept and comply within the sample population are likely to be more motivated, better educated, males, and perhaps younger. It consequently becomes doubtful whether the data obtained can actually be extended to the whole population (Bailey, 2007; Bryman, 2012). In the absence of the interviewer, the chances also to have someone else outside the sample framework to be asked to complete the questionnaire are high. The presence of the interviewer and his or her active role in the Makonde case study helped to guard against self selection and other types of sample biases. Given the lengthy nature of the questionnaires the monitored and assisted option makes the work easy and also the prevalence of low level of education with a significant part of the population in the Makonde Communal lands being illiterate to semi – illiterate, a self administered option was found to be unwise.

Among other challenges associated with household surveys are the issues of confidentiality and anonymity of the potential participants, both of which constitute the most compelling argument used to overcome the subject of mistrust (Strauss and Corbin, 1998; Bailey, 2007). This calls for a well calculated arrangement for initial contact with the potential participants which constitutes the most delicate part of surveys. It is the moment when the subject is to decide whether to participate or not in the survey. This is normally associated with the feelings of suspicion, mistrust, and insecurity among the subjects. Besides the impression that the interviewer should give as earlier

pointed out, one way of securing the confidence, and hence cooperation to participate in the survey among participants is to guarantee anonymity to their participation. The most obvious trick is to avoid taking the personal identity or names of the participants during the cognitive process. Instead of participants' names, the participants were given coded numbers. Whilst a 'strictly anonymous' study design is considered one in which it is impossible to trace data or information back to the research subject from whom it was obtained, the coded numbers will however enable me to revisit research environment and specific participants in case need arises (Marshall and Rossman, 1999).

3.2.4 Transact Walks and Direct Observations

Field observations through transact walks were conducted in and across the ten villages in the study area to identify specific climate change and associated biophysical indicators and livelihood responses in the area. Observation is major form of data collection for field research besides the process of obtaining members' accounts about the situation within a setting through interviews and interactions (Bailey, 2007; Bryman, 2012). It is a technique in which the researcher employs explicitly a set of checklist to observe and record field phenomena (Bryman, 2012). The observation in my research was overt implying that it was done openly, intentionally and without any attempt at concealment. The researcher's status in the survey was of a non participant observer, though actively involved in the field through interaction, interviewing, and writing field notes (Bailey, 2007).

One major advantage of observation as a tool in data collection is that it allows phenomena and behavior to be observed directly, unlike in other tools where behavior for instance is only inferred. With other survey techniques, respondents frequently report their behavior, but there are good reasons for thinking that such reports may not be accurate. Structured observation constitutes a possible solution in that it entails the direct observation of behavior (Bryman, 2012).

Building upon the work of Spradley (1980) there are three key targets for observations and these include; physical surroundings (space and objects); the actors (people involved) and their act, actions and activities they do and thirdly, the goals (things) that people are trying to accomplish, including the feelings and emotions felt and expressed. The data collected in the observation process constituted a major component of analysis (Crotty, 1998).

The setting of interest in the observation of this particular field research had no clearly defined boundaries but was amorphous and not confined to a specific setting in the Makonde study area. Aspects for observation in the case study included: land use, biophysical conditions, livelihoods and living conditions, artifacts and other indicators of climate change including coping and adaptation strategies. Whilst the focus and locations of the observation were predetermined, nevertheless phenomena and events outside the realm of the checklist were not ignored in the entire cognitive process. Land use and other livelihood practices relating to climate change impacts in the Makonde communal were observed directly by the researcher/s. Direct observations have also been conducted at community and household level to gain a deeper understanding of local climate change–livelihoods dynamics. Specific natural and cultural spatial units were purposively selected for detailed observation. The units include: woodlands, pastureland, water and associated resources, arable land, homesteads, public facilities such as schools, health centers, commercial and other land use activities under the potential influence of climate variability and change. An observation checklist was used as a standardised instrument in this particular exercise. The tool enabled the researcher to produce a consolidated biophysical and socio economic description of the climate change trends, impacts and livelihood responses in the study sites as a means of ground - truthing to the earlier data collected by means of other instruments (see Appendix 13).

3.3 RESEARCH ASSISTANTS

A total of five research assistants were recruited, with each to cover roughly two villages. The assistants were recruited from among the teaching staff members from local schools in the Makonde Communal area. This selection criterion was considered appropriate in the sense that the individuals are familiar to the study area in geographical and cultural terms. Teachers are considered to have the necessary level of maturity, intellect, and professional conduct that is expected of in addressing the challenges associated with quality household surveys. It is important to note that in Zimbabwe and several other countries, for the same reasons as noted above, teachers are among the most preferred choices to administer vital programs such as national census and elections.

It is worth noting that out of the five assistants engaged, four of them had past experience as enumerators and polling officers in the national census and elections of Zimbabwe respectively. Based

on their academic and professional attributes, in addition to the work experience and social status, the selected research assistants proved to be cost effective in winning the attention and cooperation of potential participants in the study area because of the respect they already command among most community members across different age, sex and other social groups. The selection criteria used for the research assistants (among teachers) significantly reduced the technical, time and other demands for training on questionnaire survey and associated code of conduct. Whilst the bulk of questionnaires were in English, the research assistants found it manageable even in cases where the respondents were illiterate and so needed detailed assistance in providing informed responses.

3.4 SAMPLING

Makonde district is divided into two administrative units, which are the Makonde Rural District Council (MRDC) and Chinhoyi Urban Municipality. The focus of this study was on the Makonde rural sector for the reasons that the rural, which is largely dependent on rain-fed agriculture is more directly climate-sensitive than the urban sector. For this reason, climate change impacts are anticipated to be more conspicuous in the rural areas than the urban areas. The MRDC comprises 13 wards categorized into two farming systems, which are; large scale commercial farming area with seven wards and the native smallholder farming area dominated by a communal farming tenure system, with six wards (Section 1.6). Given the fact that the large scale commercial farming area is ecologically advantaged as it largely lies in the wetter agro- ecological Region 2a, and the fact that it is significantly endowed with irrigation infrastructure, the anticipated climate change impacts on the local livelihoods is assumed relatively negligible. On the other hand, the communal farming areas mostly dominated by low income semi-subsistent farming households are assumed to be the most vulnerable to climate impacts. Besides, the socio-economic characteristics of the households themselves, the territory designated as communal lands in agro-ecological terms, is marginal, especially with respect to rainfall amounts and unreliability.

There is clear evidence that the white settlers who administered the partitioning of Zimbabwe's rural land into large scale commercial farming areas (designated for white settlers) and the communal lands (Tribal Trust lands), which were set aside for the natives was racially motivated (Section 1.5). The large scale commercial farming areas took almost all the vast fertile lands in favorable agro-ecological regions 1, 2 and the better part of 3 and the majority natives were

alienated onto scattered patches of marginal areas across the country. It is this colonial legacy that explains the occurrence of the Makonde Communal lands, which happen to be the area of focus for this particular study. It characteristically lies within the agro-ecological region 3 and 4 given the marginal climatic and soil conditions dominating in the area.

In the face of climate variability and climate change, the Makonde communal lands is subject to significant vulnerability based on the baseline biophysical conditions and also the inherent capacity constraints to cope with and adapt to climate change associated with the local population. One other underlying factor exposing the Makonde communal lands to significant vulnerability to climate variability and change is the fact that no major water resource development infrastructure has been erected in this part of the district to enhance water resources storage and availability for domestic, cropping and livestock uses, especially during rainfall-scarce seasons and years.

It is this perceived livelihood vulnerability to climate variability and change in the Makonde smallholder communal farming area that inspired the researcher to take this as the case study. The study area (Makonde Communal Lands) comprises six wards which include; Chivende to the north, Kamhonde, Obva, Kenzamba, Godzi and Hombwe to the South (Section 1.6). The wards are altogether divided into ten villages, upon which the study's framework for stratified sampling is based. The ten villages are: Chitomborwizi, Matoranjera, Rwenambo, Mburungwe, Matashu, Teteguru, Magonde, Machiridza, Murindagomo and Musona. The populations and samples for the respective villages are shown in the table 3.1. The Table shows both the targeted sample size and the actual sample size for all the 10 villages as has been explained in section 3.2.3.

Based on the principles of an ecosystem approach (section 2.3 and 2.8), there is an intimate relationship between rural livelihoods and the natural environment which provide ecosystem services and goods to the community. It is important to note that the methodology for vulnerability assessment must represent and highlight the coupled environment-human system and the dynamic interactions between these two components (Nkem *et al*, 2007).

Table 3: Sampling Frame

	Village	Type of farming System	Number of Households	Total Population	% of Total HHs	Targeted Sample	Actual Sample
1	Chitomborwizi,	Small scale	263	1538	3.85	20	17
2	Matoranjera	Small scale	319	1902	4.68	25	21
3	Rwenambo	Small scale	228	1395	3.34	15	11
4	Mburungwe	Small scale	198	1209	2.90	15	12
5	Matashu	Communal	951	5300	13.94	70	64
6	Teteguru	Communal	751	4300	11.01	55	49
7	Magonde	Communal	955	5460	13.10	70	62
8	Machiridza	Communal	1102	6546	16.15	80	68
9	Murindagomo	Communal	972	5624	14.25	70	74
10	Musona	Communal	1084	6150	15.89	80	66
	Total		6823	39424	100	500	434

Source: Adapted from Makonde Rural District Council

The methodology approach recognizes the areas linking the human system to the ecosystem, the sectors linked to the ecosystem, the ecosystem services involved in the sector and the human system benefitting from these ecosystem services (TroFCCA, 2006). Assessments of vulnerability therefore require the establishment of matching equivalences in the terminologies frequently used in the two components. This ecosystem approach to rural livelihoods assessment and rural development is in concurrence to the earlier suggestion given in section 2.8. From an institutional and organizational perspective, the suggestion prescribes an Integration of ecosystem management goals within sectors and within broader development planning frameworks to help

develop a climate resilient economy. This needs support in the form of integration among multilateral environmental agreements and between environmental agreements and other economic and social institutions (Serageldin, 1995; Munasingeh and Swart, 2000).

There is need to make a connection between livelihoods attributes and the ecosystem services available. A set of interrelated issues can be deduced and these include; Climate change impacts on forests and how they affect the provisioning of ecosystem services; Climate change impacts on livelihoods and how they affect the use of consumption patterns of ecosystem services under climate change impacts (Nkem et al 2007). The method requires that the vulnerability of these sectors be evaluated through the assessment of the natural ecosystem services connected to these sectors with great emphasis on how climate change impacts on forests and other land resources may affect ecosystem services and consequently the identified sectors (Tao and Wall, 2010). There is therefore need to promote the development of a body of knowledge about the status and economic value of ecosystems and their influence on social systems. This knowledge-based approach is essential in the decision making and management of the relationship between the biophysical and socio-economic components of local and regional livelihood systems (Biggs *et al.*, 2004).

It is on the above scenario that the survey was organised into two categories. One will focus on environmental vulnerability assessment in the area (with variables such as: temperature, rainfall patterns and variability, forest resource coverage and productivity, water and related resources and soil type /fertility among others). The other category would focus on livelihood vulnerability assessment whereby attention is paid to social variables such as household numbers and size, diversity and productivity of crops cultivated and the acreage under food crops, livestock, yields, type /number of non-farm activities and their related productivity and sustainability, food demand / supply and pricing trends among others.

3.5 ETHICAL CONSIDERATIONS

Research ethics were formed in anthropology to protect those who (human and non-human) are being researched and to protect the researcher from topics or events that may be unsafe or may make either party feel uncomfortable. Ethics imply norms for conduct that distinguish between acceptable and unacceptable behavior and helps researchers grapple with ethical dilemmas

through providing important insights, concepts, tools, principles, and methods that can be useful in resolving these dilemmas (Lincoln and Guba, 1985; King et al., 1994).

Among the critical steps in the researcher's endeavor for ethical considerations was the need to seek written consent and authority from the local authority for the study area (Makonde Rural District Council) and key informants in the study. The written consent in this regard was successfully issued. With regards the consent of households, the Makonde Rural District Administer, as the gate - keeper to the rural district has issued the research with the assurance for the necessary support and cooperation by his subordinates in the study area. This includes the traditional leaders and their subjects who work under the DA's authority. The research has therefore been granted authority, access to, and cooperation from the community leaders and their respective members, the district schools, health centers and other institutions operating in the district.

Once approval was granted by the UNISA's College of Agriculture and Environmental Sciences Ethics Committee, the research team got to the study area, reached up to targeted grass roots participants for the study and accordingly, their individual consent was solicited and granted during the pilot study which was carried out in the last two weeks of July 2012.

Given the high regard accorded to the need to guarantee anonymity and confidentiality to the participants in order to enhance the willingness of the human subjects to participate in the survey (Bailey, 2007; Bryman, 2012), the study is committed to this research principle. Whilst it is this particular research's belief that most (not necessarily all) of the data and information collected is hardly classified as sensitive, confidentiality in particular and anonymity to a certain level have been a matter of serious consideration to the entire research process.

With regards to anonymity, a 'strictly anonymous' study design is considered as one in which it is impossible to trace data or information back to the research subject from whom it was obtained (Bryman, 1988; 2012). In an effort to address the anonymity dilemma, the data collection instruments in the survey did not require the personal names of the human subjects. In the case of key informants, name/s of office or organization have been taken note of whilst for questionnaires and historical profiling, code numbers were adopted (see section 3.2.3). This is intended to sustain

some degree of anonymity to the human subjects in the study, whilst at the same time allowing the possibility of a revisit to the study area and the intended participants whenever academic need arises.

The study was therefore committed to 'utmost confidentiality' to research participation. In addition the study was strictly committed to the privacy of human subjects and the information attributable to them. Guarantee was therefore ascertained to protect all identifiable information about a person, (such as notes or photo of the person) and to agreements about how data are to be handled in keeping with subjects' interest in controlling the access of others to information about themselves.

The study made sure that fears and concerns of participants are positively considered and respected. A balance will have to be established between the concern for the integrity of data on one hand, and risk to privacy or confidentiality and anonymity on the other.

In terms of gender sensitivity, the need for a gender balance in the survey was taken seriously particularly based on the argument that women and men face different vulnerabilities to climate change and environmental degradation (Agrawal, 1998; UNEP, 2002). In the face of climate variation and climate change, when floods strike or droughts persist, women are among the first to feel the impacts on their livelihoods and daily lives. As managers of household resources, they often struggle to secure water, fuel and food. As small-scale farmers, women tend to have far fewer resources than men to cope with crop failures and other climate change- induced scarcities or pursue methods of farming more adapted to climate shifts. Rural man on the other hand should not be overlooked as they are also equally in constant struggle, interacting with and dependent on the climate-sensitive natural resources to meet their every day needs. Both sexes share a fair share of importance in terms of representation in the survey on the rural livelihoods and climate change challenges and opportunities in Makonde communal lands.

3.6 ANALYSIS

After the field survey, the next step in the research project is to undertake the process of analyzing the myriad of information collected. Data analysis is a multipronged process that every researcher embarks on to make sense of the data: break it down, study its components, investigate its importance, and interpret its meanings (Patton, 1999; Bailey, 2007). The analysis of data helps to

structure the production of the final manuscript. Miles and Huberman (1994) suggest that from the perspective of quantitative research, field work generates a bunch of numbers, whilst in the case of qualitative research; field work generates a bunch of words. The techniques of data analysis vary depending on the nature of data. Now that this particular research on challenges and opportunities of climate change impacts on smallholder livelihoods in Makonde is of mixed character, it called for the adoption of both qualitative and quantitative data analysis techniques. With regards to this hybrid approach to data analysis, Bailey (2007) points out that the analytical techniques are not mutually exclusive. For instance they almost all include the element of description. The differences among them are subtle which makes choosing the most appropriate technique more difficult. In many instances choosing more than one technique is more appropriate or even required (Tashakkori and Teddle, 1998; Bailey, 2007). My study, which is multi-sectoral in scope, found it appropriate to employ a triangulation of various data collection methods, thus generating a myriad of data and as such, both qualitative and quantitative data analysis techniques were required.

In the case of data that was obtained from the questionnaire survey, a software program namely the Statistical Package for Social Sciences (SPSS) was employed to code (see Appendix 1), enter, organize, analyze the data and generate various forms of presentation of the survey results . SPSS was complimented by Microsoft Excel particularly to help enhance the graphical presentation of results. The findings of the study are supported by various types of charts, graphs and histograms. Cross tabulations and *t-tests* were applied where relevant. From the perspective of quantitative data, correlations and cross cutting issues were sought and presented. In order to understand the biophysical and socioeconomic dynamics in the case study,

On the other hand, qualitative data obtained from the various interviews and structured observation were manually compiled, organized and classified on the basis of research questions and related variables. As suggested by Flick (2002) and Bailey (2007), memoing, descriptions, typologies, taxonomies, visual representations and themes were the key techniques used to analyze qualitative data. The analysis of qualitative data also involved detailed descriptions and classifications that provide insights into research questions. The descriptions were considered as an important analytical technique in making the observed available to the reader. The creation of typologies was among the ways of analyzing qualitative data, helping to make sense of large

amounts of data through grouping of items that share common characteristics (Strauss and Corbin, 1990; Flick, 2002). The grouped data was then given labels such as; meteorological climate change trends; climate change impacts-biophysical, social, economic; coping and adaptation strategies among other sets. The typological technique aided in highlighting the Makonde climate change, vulnerability and adaptation setting. The creation of taxonomies highlighted the hierarchical and other relationships among categories and subcategories of research themes.

Visual representations were also employed to analyse data helping to organize the data visually in order to gain insight into the setting (Lincoln and Guba, 2000). This included; conceptual maps, tables, and charts. The visual aids do not only serve as visual representations of the studied but also serve as a generative analytic technique through the illustrating of patterns and levels of interaction between climate change, consequent biophysical changes, livelihood impacts, and responses (Ian, 1996; Bailey, 2007).

Basic geographical Information Systems (GIS) was employed as a means to integrate different components of the prevailing environmental conditions and community wellbeing. The analysis also involved an evaluation of the natural ecosystem services connected to local livelihood sectors with great emphasis on how climate change impacts on forests and other land resources and in turn how these influence the identified livelihood sectors.

In an effort to make sure that the readers of the thesis will unquestionably judge the fruits of the work done; there was need to seek answers to questions concerning the validity, reliability, and generalisability of the study. With respect to the task involved in this regard, Guba and Lincoln (1994) acknowledge that a measure of these concepts is more complex than they appear particularly for qualitative research.

Bailey (2007) suggests that measure of trust-worthiness, not validity is more practical in qualitative research and he adds that validity is an evaluative criterion that isn't applicable to qualitative research. Within the interpretive paradigm to which this Makonde study largely belongs, instead of validity, the concept of trustworthiness is considered as the overarching evaluative standard for field research (Guba and Lincoln, 1994).

Trustworthiness requires conducting and presenting the research in such a way that the reader can believe, or trust, the results and be convinced that the research is worthy of his or her attention (Lincoln and Guba, 2000, Bailey, 2007). Whilst one might not agree with the researcher, the reader must appreciate how the researcher arrived at the conclusion he or she made. In order to satisfy this measure of trustworthiness therefore, the Makonde study makes an effort, at a minimum, to communicate in detail the procedures used and the decisions made throughout the research process. A detailed methods section in the final manuscript will be provided, as well as to connect the work to larger issues within the discipline of climate change, community vulnerability and adaptation.

With regards to internal validity, there is need for an accurate representation of the setting to prove internal validity. This, from the perspective qualitative research, implies credibility or believability – authenticity and plausibility of results (Miles and Huberman, 1994). For the reader to judge the results of the Makonde study as credible the methods used to collect and analyse the data must be seen as appropriate and rigorous and the content of the final manuscript must be shown to have been derived from the data (Lincoln and Guba, 2000; Patton, 1999). In seeking to prove the external validity of my study, which implies the ability to generalize from a sample to a larger population or from one setting to another, Bailey (2007) warned that this is difficult to achieve for field research. In fact, the very strength of field research based on strong focus on local conditions, specialized knowledge, depth in accounts, and highly contextualized understanding of a setting as was the case with the Makonde study, can decrease the degree of external validity. Consequently, in order to achieve high external validity, field researchers might have to sacrifice internal validity, a trade off that many find themselves unwilling to make (Lincoln and Guba, 1985). There is no claim therefore that the geographical, social, economic and political conditions associated with climate change vulnerability, mitigation and adaptation here are representative of the same phenomena elsewhere. Given the fact that field researchers generally hope that their work will have some implication beyond an understanding of the specific setting, as important as that might be (Patton, 1999), I do believe, however, that the phenomenon of climate change and its impacts in the Makonde Communal lands, and the corresponding community responses, and adaptation attempts, do have relevance for other economically and technically-challenged smallholder farmers elsewhere in the world.

3.7 CONCLUSION

The multidimensional nature of my study on climate change and associated human responses has proven that it cannot be achieved by a single research perspective. A mixed research design was found to be necessary in order to address the biophysical, historical, socioeconomic and political concerns of my research questions. Experience obtained in the field survey also suggests that one method of data collection may produce various types of data including both qualitative and quantitative data. This held true for almost all field work methods employed in my study including document searches, the questionnaire survey and even field observations. While the data produced through these methods may have been predominantly qualitative in character, there was no reason to presume that it was exclusively so. In practice therefore, the research on my case study involved a range of methods producing a variety of data. The analysis of my data as such found it necessary to employ both quantitative and qualitative techniques. Whilst quantitative approaches were powerful precisely because of the complex mathematical operations that they permit, they meant nothing in themselves unless they were based on meaningful qualitative conceptualizations. Both science and social science without qualitative data would not connect up with the world in which we live (Ian, 1996). It is this school of thought that has informed my study's ontological standing of interpretivism.

CHAPTER FOUR: PRESENTATION OF DATA AND DISCUSSION OF FINDINGS

4.0 INTRODUCTION

This chapter seeks to present the data and discuss the findings of the research on rural livelihoods and climate change challenges and opportunities in Makonde communal lands in Zimbabwe. The data and findings are organized and presented in accordance with the research questions of the thesis. In this regard, the chapter is mainly centered on four research question-based aspects that are; the climate change trends and patterns experienced over the past 30 years in Makonde communal lands; the climate change-induced environmental changes and associated socio-economic impacts on local households; and lastly, the household coping strategies to climate change in Makonde communal lands.

The data presented was gathered through a mix of instruments ranging from document review, a questionnaire survey, key informant interviews and structured non-participant observations. Given the complexity of the subject under study, a wide range of issues was of interest in the survey, ranging from meteorological, biophysical, land use, to a variety of socio-economic variables. From this multi-dimensional perspective, both qualitative and quantitative data were generated depending on the research question, source and nature of data and the data collection instrument employed.

In terms of response rate, the survey was reasonably successful according to plan. A total of 434 households were successfully surveyed out of the targeted 500 households (see section 3.2.3), 20 elders were successfully interviewed, and 10 local school heads, two officials from local health centers, two Nongovernmental organizations, and 5 critical government agents were also successfully surveyed. Due to financial and time constraints, the above-stated sample size was assumed to be feasible and optimally representative of the biophysical and socioeconomic phenomena under study.

Before addressing the core results and discussion of the findings, the descriptive data of the sampled population is presented in order to provide the socio-economic background and organization of the case study. In terms of the mode of presentation, various techniques are

employed including frequent summary tables and figures of results in order to enhance the reader's appreciation of patterns in the mass of data presented.

Besides the presentation of results, the chapter provides an analysis of the data to highlight the research findings. This will involve a mix of verbal descriptions, statistical and associated graphical illustrations, and other supporting evidence for each variable under scrutiny. It is important to note at this point that the findings of the research will be discussed within the context of the literature reviewed in chapter 2 as a way of raising some of the implications of the results obtained.

In brief, the key findings of the research suggest that climate change in the Makonde district has been significant during the past thirty years. The mean annual temperatures recorded since 1962 show an increasingly warming trend. In terms of rainfall pattern, the mean rainfall amounts recorded during the same period illustrate increasing annual rainfall variability, with a falling trend over the recent decades. The changing climate being experienced in the area has triggered a system of local environmental stresses involving; the degradation of forest resources and biodiversity, water resources, pastures and soil fertility in the study area. The population in the Makonde communal lands is agrarian, heavily dependent on rain-fed agriculture and local natural resources for livelihood, food and income. Faced with the changing climate, particularly related to the increasing frequency and severity of drought spells, the local livelihoods show high levels of vulnerability. The study population being largely subsistent and using traditional farming techniques, has revealed low adaptation capacity to climate change. The Makonde population is consequently struggling to cope with the climate change-induced livelihood hardships of food insecurity, water resources depletion, falling income and increasingly scarce natural resource-based livelihood options.

The climate change-driven environmental and socioeconomic conditions in the Makonde communal lands is made even more precarious by the lack of effective external support to complement the community's struggling coping strategies. The government institutions are struggling to provide any sustained climate change adaptation strategies to the affected communities. A few nongovernmental organizations operational in the study area are making efforts to promote climate resilient farming practices and rural livelihoods diversification. Due to

large extent of rural livelihood vulnerability in the local and other districts in the country and the budgetary constraints, a large part of the community has hardly received any kind of relief support.

In the absence of sustainable rural development and effective adaptation strategies, the rural livelihoods in Zimbabwe's Makonde communal lands show high levels of vulnerability to local climate variability and climate change.

4.1 THE SOCIOECONOMIC DESCRIPTION OF THE STUDY POPULATION

Characteristics of the study population which include; the sex, age, marital status, duration of stay in the village and household family size were examined.

In terms of the sex ratio of the sample population, it is notable that the majority of the respondents were males, making up 57.6% of the total household respondents sampled whilst the female respondents constituted the remaining 42.4%. What was most striking in the study was the generally patriarchal character that remains pervasive in the local rural population. This was observed when each time a data collector visited a homestead where both husband and wife were present; it was the husband who would avail himself for the survey. In the event that the husband was temporarily away, the team would be kindly asked to come back later to meet the husband. It was only when the husband was either residing elsewhere in town or other distant area when the wife would offer herself for the survey. It was notable that in the case of an absent husband, whilst an adult son was present, the adult son or grandson would avail himself for the survey. This left the opportunity to survey female respondents mostly confined to a household scenario whereby the male household head and/ or an adult son or grandson were definitely not present. Among the female respondents, female household heads in the form of widows, divorcees or their daughters dominated. The patriarchal character of the sampled population is further emphasized at examining the status of the respondent in the household. In this regard, husbands took up 36.6% of the total responses, followed by the wives (26.5%); sons (16.6%); daughters (12.2%); and lastly the grandchildren accounting for 8.1 percent.

In terms of gender sensitivity, the ratio of male to female respondents that emerged from the survey is considered to be relatively balanced given the patriarchal nature of the Zimbabwean rural community. The need for a gender balance in the survey was taken seriously particularly based on

the argument that women and men face different vulnerabilities to climate change and environmental degradation (Section 3.6).

In terms of the age structure, out of the 334 household respondents, the majority (31.3%) were in the age group 45-54 years, followed by the older age group of 55-64 with 20%. The really elderly community members of ages above 64 years only make up 8.9 percent. This elderly age group was specifically targeted by the separate interview survey on the elderly in order to capture an in-depth historical profile of climate change experiences in the case study. The fact that more than 60% of the household respondents were above 45 years of age enhanced the reliability and depth of data elicited on the climate change knowledge and experience in the study area over the past 30 years. Figure 4.1 illustrates the age sex population pyramid of the sampled population.

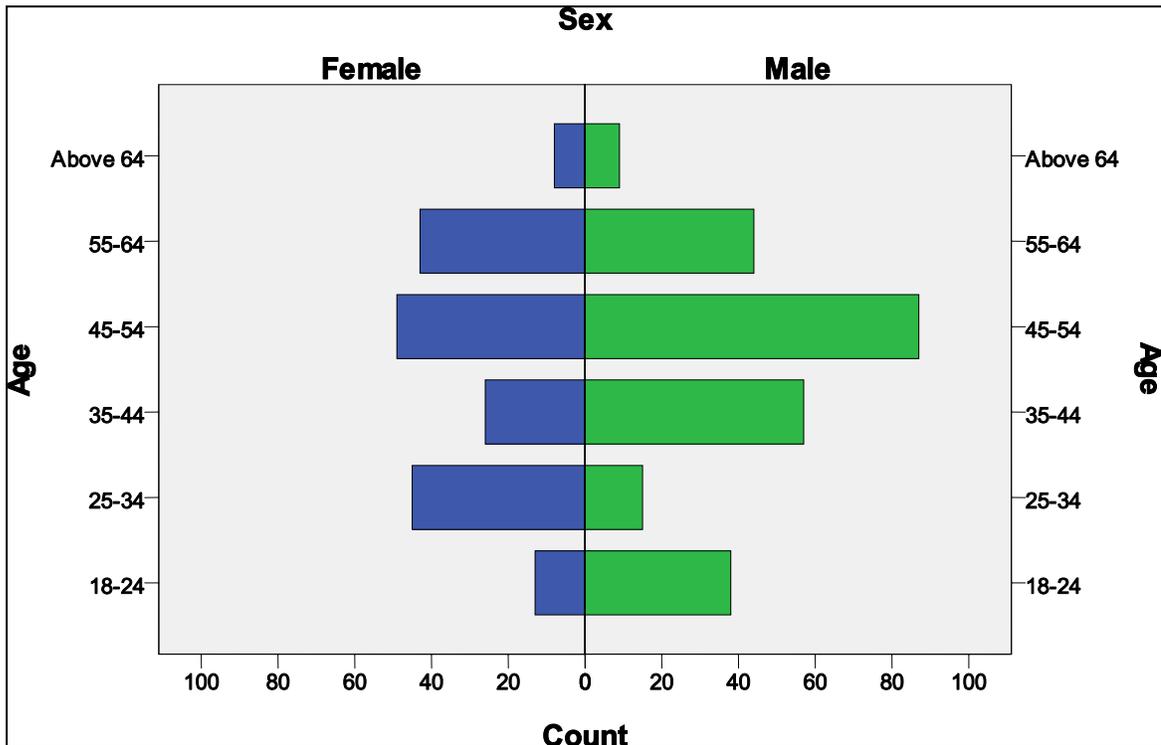


Figure 4: Age Sex Pyramid of the Study Population

Source: Survey Results (August 2012)

Given the fact that the survey subjects are anticipated to have significant duration of stay in the study area in order to provide an informed historical profile of the climate change knowledge and experience of the area, the duration of stay was an important measure among respondents in the survey. In this case, the majority of respondents (31.3%) have lived in the villages under study for more than 40 years with 24.2% having lived for more than 30 years and 27.2% having stayed in the study area for more than 20 years. The stated duration categories altogether making up more than 80% of the total sample population enhanced the reliability of data obtained on the community's knowledge and experience on local climate change trends, consequent environmental changes, household level climate change impacts and community responses and coping strategies to the effects of climate change in the Makonde communal area. Figure 4.2 shows the respective proportions of respondents who have lived in the study for varying periods of time in years.

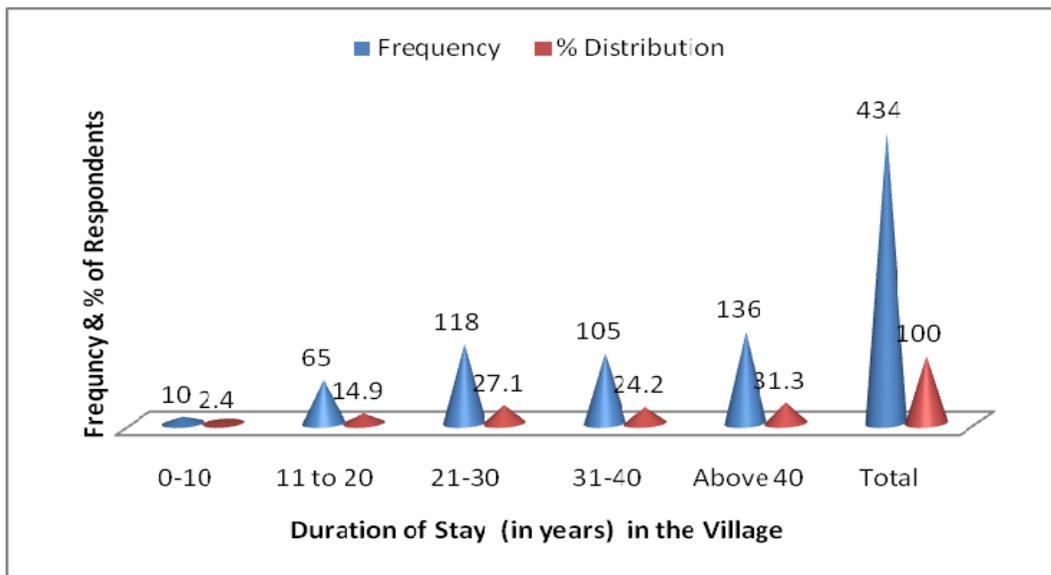


Figure 4.: Duration of the Respondents' Stay (in years) in the Makonde Communal Area

Source: Survey Results (August 2012)

When examining factors that influence household vulnerability to climate change, food insecurity and poverty, family size is a critical variable (See Section 2). In terms of family size of the sampled households, the majority of the sample households (43.8%) have got a family size range of 7-8 members. This large family size is a typical characteristic feature of rural households in Makonde

communal lands, Zimbabwe and most other developing nations, whereby household poverty triggers large family size and on the other hand, large family size exacerbates poverty and food insecurity especially in the face of climate change and other shocks. Figure 4.3 illustrates the distribution of households according to family size.

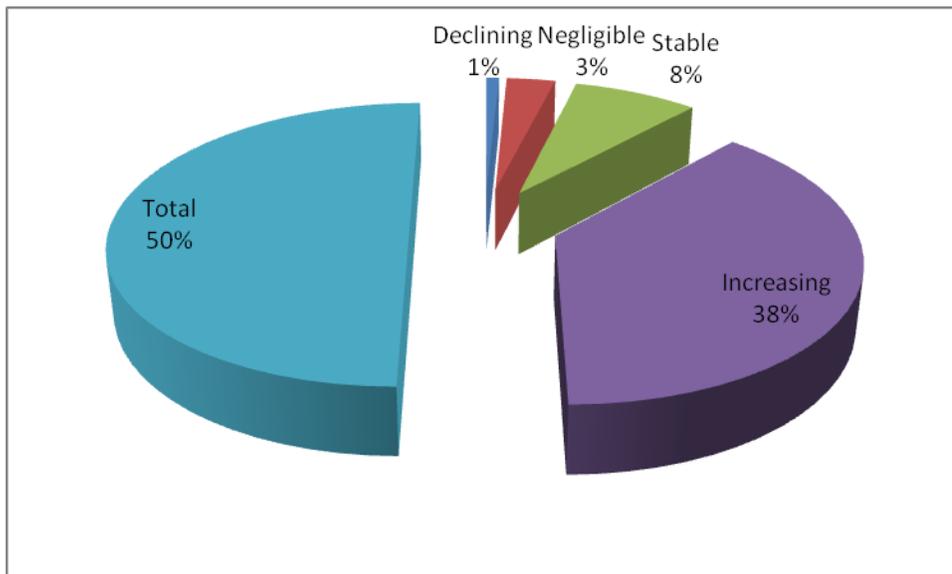


Figure 4.: Distribution of Households according to Family Size

Source: Survey Results (August 2012)

The next largest proportion of households is that of 5-6 members making up 21% of the total households sampled with household of above ten members making up 9.7 percent. Only 7.1 percent of households sampled had a small family size of 4 or less members. The presented characteristics of the study population are important in providing an insight into the local context in which the phenomenon of climate change affects the community. As discussed in Section 2.8, Carney (1998) and Cameron (1999) argue that a sustainable livelihoods framework approach is vital in the understanding of rural lives in their totality, including varied, lived experiences of continuity and change. This particular demographic component was considered vital in the study as a measure to acknowledge the context-specific nature of climate change vulnerability and adaptation discourse.

4.2 CLIMATE CHANGE TRENDS IN THE MAKONDE COMMUNAL LANDS

In line with a **systems approach** to the study on rural livelihoods and climate change challenges and opportunities in the Makonde communal lands, it was found necessary to start looking at the phenomenon and trends of climate change as the key determinant variable in the study. The question whether there was any climate change experienced in the area and what trends of change have been observable was examined. As indicated in Section 2.1, among the most striking environmental challenges affecting the earth is anthropogenic climate change (Weart, 2004). The findings of the study on climate change trends in the Makonde communal lands suggest that there is a progressive warming of the temperature conditions, falling of rainfall amounts and increasing variability of rainfall received between and within rainfall seasons. The analyzed rainfall and temperature data that were obtained from the Department of Meteorological Services generated a pattern that clearly confirms the changing climate in the district. Figures 4.4 and 4.5 respectively show the temperature and rainfall patterns experienced over a period of 36 years (since 1962) in the Makonde Rural District.

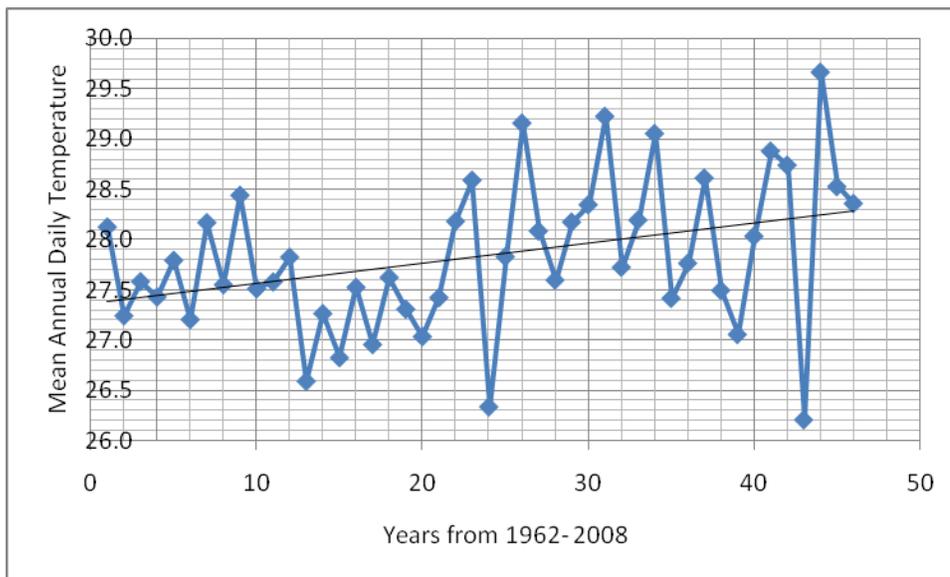


Figure 4: Mean Annual Temperature Changes in Makonde Rural District (1962-2008)

Source: Department of Meteorological Services (August 2012)

Whilst there is significant inter-annual variability in mean temperature between 1962 and 2008 as shown in the Figure 4.4, the trends displayed show a departure (or anomalies) from the general average and the anomalies are mostly positive. The anomalies as shown in the figure are larger in more recent years (beginning in the 1980s), suggesting that the rate of increase of mean temperature is increasing overtime. This is consistent with detected increases in global and regional annual surface temperatures discussed earlier in Section 2.1. Trend analysis of temperature in the study area reveals an increase in both annual maximum and minimum temperatures between 1962 and 2008. Further analysis show that the periods of most rapid warming occurred since the early 1980s to date than the earlier decades under review.

In terms of rainfall, the patterns of annual rainfall between 1962 and 2008 shown in Figure 4.5 are in agreement with already gathered evidence of rainfall trends, which suggest a progressive decrease in annual rainfall over Southern Africa (Section 2.1). The extreme dips notable in the Figure 4.5 symbolize the increasing inter-annual rainfall variability associated with increasingly frequent and severe drought spells over the past twenty years. This in other words implies the alternating patterns of below normal (most frequent) to above normal rainfall periods thus revealing the trends of both climate variability and climate change in the Makonde communal lands.

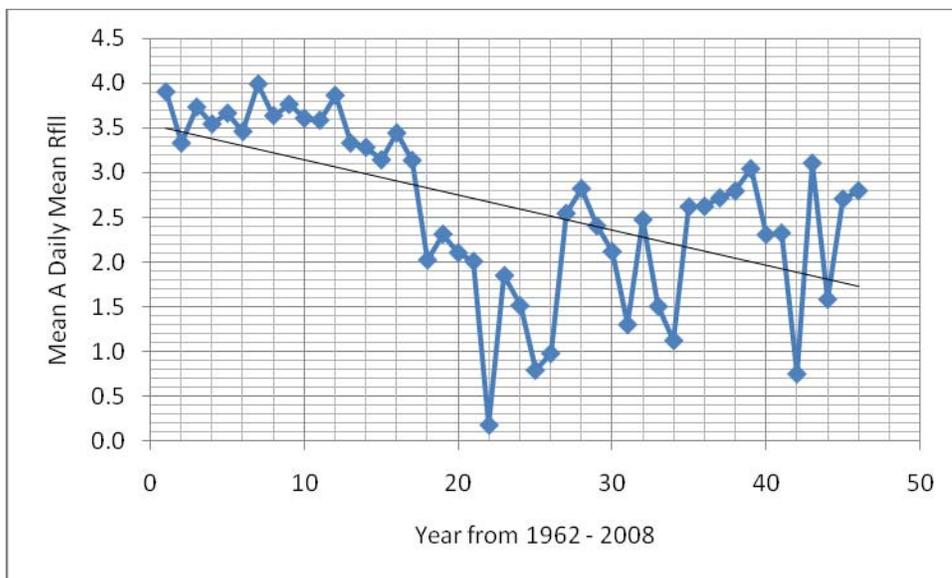


Figure 4: Mean Annual Rainfall Changes in Makonde Rural District (1962-2008)

Source: Department of Meteorological Services (August 20012)

From the perspective of indigenous knowledge systems, community experiences, knowledge and perceptions on climate change in the area were examined in the field. All key informants ranging from: the Environmental Management Authority, Agriculture Research and Extension Services, Makonde Rural District Council, local leaders and the Non Governmental Organizations operational in the study area concurred that there was significant climate change occurring, with progressively warming temperatures and falling rainfall amounts. The most outstanding indicator of climate change among the key informants was the increasing frequency and severity of drought spells occurring in the Makonde communal lands. The household questionnaire survey revealed a similar result whereby awareness of varying and changing climate is almost 100 percent among households.

Community climate change awareness was also investigated (Figure 4.6). Figure 4.6 shows that only 0.8 percent of community members are not aware of the changing climate in the district. The majority 66.4% of the study population have experienced significant climate change, with 28.6 suggesting that the climate change is intensifying. Specifically, about 63% of the sampled population suggested that there has been a significant change in the climate. About 80% indicated that they experienced progressive fall in mean annual rainfall amounts in the past 30 years. In terms of the prevalence and severity of drought spells over the past years, a total of 49.3% and 44.2% of the community indicated they either often or very often experienced drought spells over the past years (Figure 4.7). An estimated 76.3% of the sample suggested an increasing severity of the drought spells.

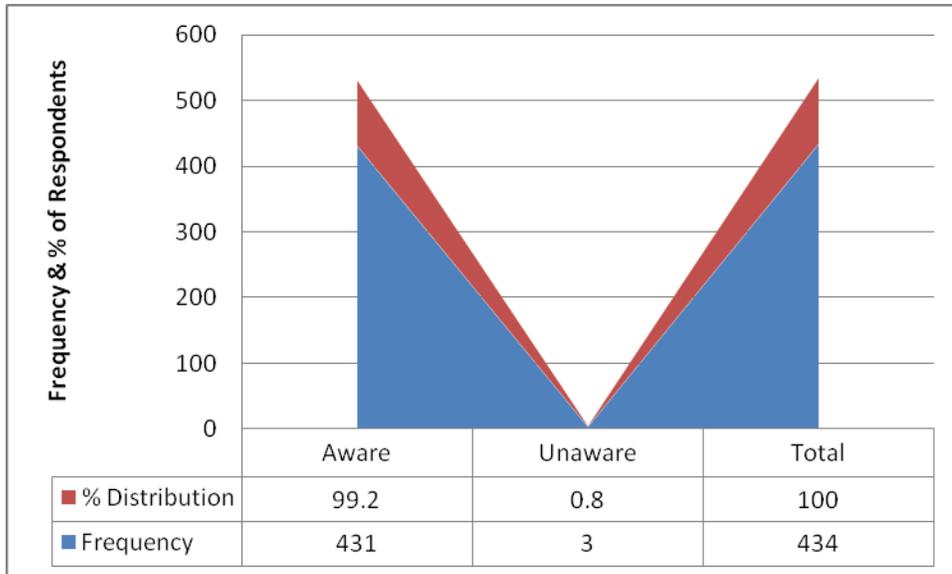


Figure 4: Community Experience and Awareness of Local Climate Change in Makonde District

Source: Field Survey (August 2013)

Given the observational record of the scientifically available temperature and rainfall changes for the Makonde Rural District over a period of at least 30 years, examined parallel with the community experiences and indigenous knowledge systems on climate change, the study concludes that there is significant climate change in Makonde communal lands. In spatial terms, climate change in the study area happens to be more severe in the North Eastern part of the study area covering Villages 17 and 18 in the Kenzamba area. This part of the study area experiences more severe drought spells because of its extreme northerly position towards the drier agro-ecological region 4. The soils are more sodic and water resources are generally much scarcer than in the southern and central parts of the study area.

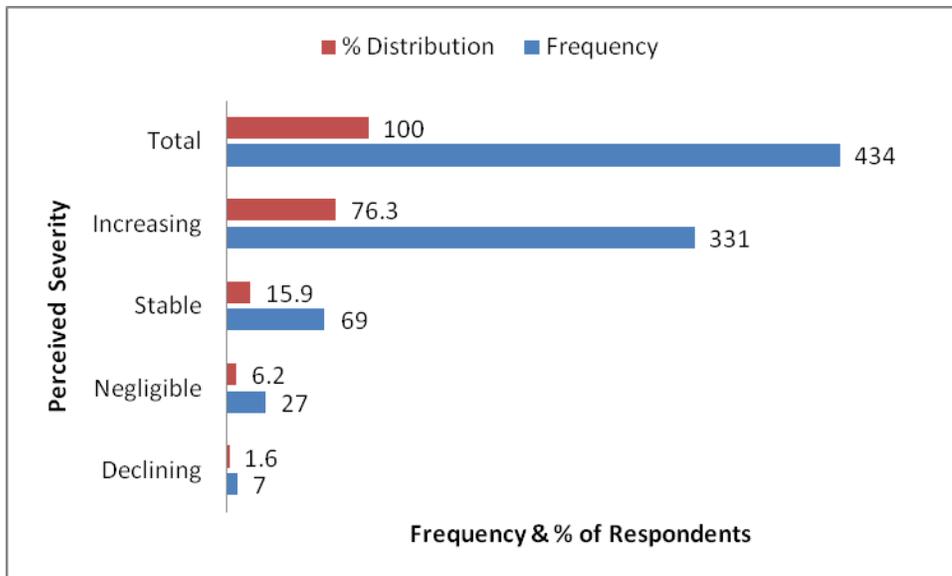


Figure 4: Community Perception on the Severity of Drought Spells over the Years

Source: Survey Results (August 2012)

4.3 IMPACTS OF CLIMATE CHANGE IN MAKONDE COMMUNAL LANDS

With climate change trends having been evidenced in the study area, the next question that the study asked was on climate change impacts on the biophysical, and socio economic environment of the study area. As has been earlier indicated in Section 2.2, climate change has direct impacts on the biophysical environment, which in turn happens to be the vital asset for human survival and economics. The state of the biophysical environment determines the productivity and availability of ecosystem services and goods to the human environment, livelihoods and wellbeing. In light of this association between climate and related environmental resources on one hand and livelihoods on the other, MEA (2005) suggest that climate change variables influence biophysical factors, such as plant and animal growth, water cycles, biodiversity and nutrient cycling, and the ways in which these are managed, through agricultural practices and other land use for food production and local livelihoods. **It is this systems approach** that the study has pursued in examining climate change and rural livelihoods challenges and opportunities in the Makonde Communal Lands.

4.3.1 The Biophysical Impacts of Climate Change in Makonde Communal Lands

The Millennium Ecosystem Assessment (2005) in Section 2.2 came up with a framework to determine the role of ecosystem services in sustaining human well-being and development needs.

The assessment approach helps to examine the environment through the framework of ecosystem services and with this; it becomes much easier to identify how changes in climate and ecosystems influence human well-being. In particular reference to rural livelihoods discussed in Section 2.5.1, Dixon *et al.* (2003) and Schneider *et al.* (2007) observed that the majority of populations in Sub Saharan Africa are rural peasants who directly depend on ecosystem goods and services for their livelihoods. With climate change and its impacts, more and more of them are expected to plunge into poverty as a result of climate change-induced ecosystem degradation. The smallholder farmers in Makonde communal lands happen to belong to this vulnerable group and situation. The findings of the study agree with the observations made in Sections 2.2 that Climate change is exposing subsistent farmers to new and unfamiliar conditions thus resulting in them facing increased vulnerability to food insecurity and poverty.

Among the major environmental components affected by the changing climate in the case study are water resources. As much as 79% of the study population has experienced significant impact of local climate on local wetlands, springs, rivers and streams. With regards to domestic water supply, 64.3% are experiencing a decline in availability, 30.6% are experiencing seasonal availability, with 5.1 percent suggesting a complete dry up of their local water sources. With regards to the state of drinking water (Figure 4.8) as much as 41% of the community perceives it as poor, 20.7% as deteriorating, whilst 10.6 apiece perceive it as very poor and critically poor. In terms of water supply for livestock and irrigation purposes, 40.1% of households sampled suggested that it has become poor, with 11.3% and 11.1% perceiving it as very poor and critically scarce respectively. A total of 32.7% of the sampled population is experiencing a deterioration of the water supply whereas only 4.8 percent find it as good and reliable. This small percentage which faces no problems in livestock and irrigation water supply happens to be situated in the area to the southern tip of the communal area (Hombwe – Mukohwe) where they enjoy the privilege of accessing the small earth dam that was built for the St Rupert's Mission Hospital. The Southern tip of the study area borders with the relatively humid agro-ecological region II to the south of Makonde Rural District.

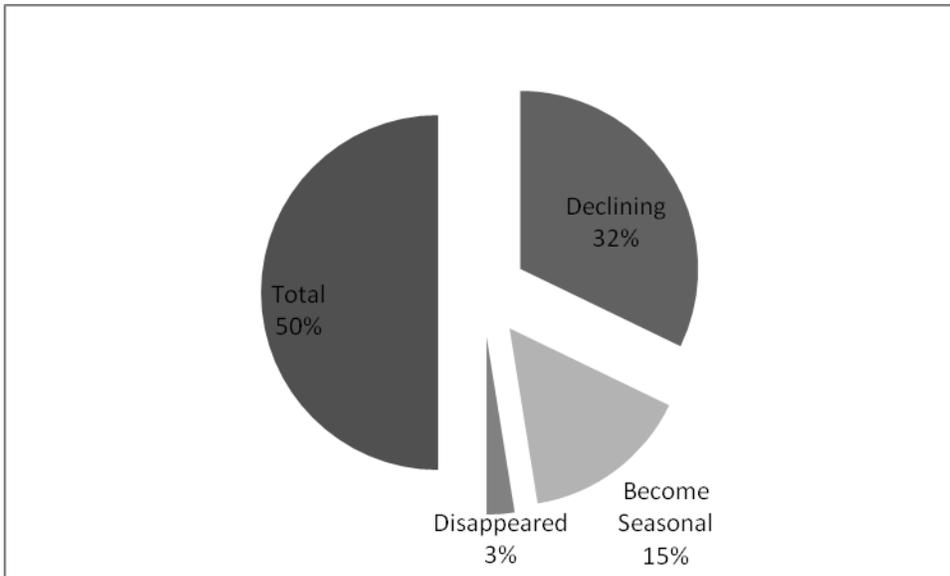


Figure 4: Local Community Perceptions on the State of Drinking Water

Source: Survey Results (August 2012)

The other biophysical resource that is critical in sustaining rural livelihoods is forest resources for food, wood, medicinal and other domestic purposes. Figure 4.9 illustrates community perceptions on the climate change impacts on wild food and other resources whereby 47.5% of the Makonde community has experienced a growing scarcity of forest resources for various domestic purposes. A further 41.9% suggested that the resources were now very scarce due to the persistent drought spells undermining ecosystem recovery and productivity. The traditional wild fruits which used to be in abundance were now very scarce with many species for fruits, wood source and traditional medicine having disappeared from the local agro-systems. In terms of wild animals, elders recall old times when there used to be an abundance of small antelopes, bush bucks and other small mammals, birds and fish contributing to a rich food reserve for the community. What remains according to the elders, are the baboons and monkeys which due to growing scarcity of wild food sources, are increasingly encroaching onto crop fields and homesteads thus further threatening the declining crop yields and domestic small livestock such as goats, chicken and rabbits. With regards to pasture, 48.6% of the sampled population has experienced a declining availability and quality of livestock pasture.

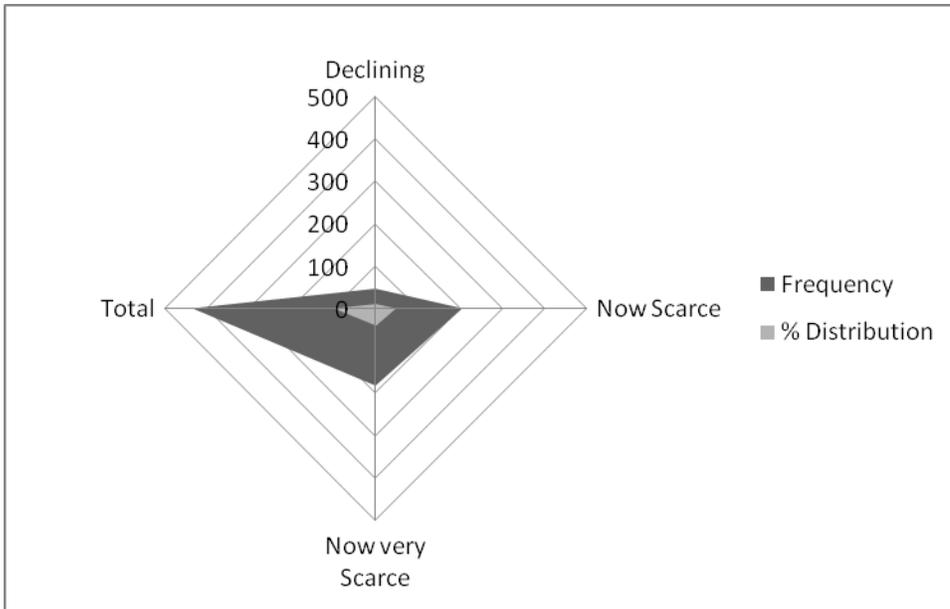


Figure 4: Community Perceptions on the Impacts Climate Change on Forest Resources

Source: Survey Results (August 2012)

4.3.2 The Household-level Impacts of Climate Change in Makonde Communal Lands.

As discussed in Section 2.5.1 many scholars such as Ellis (2000), Cernea (1995) and Anselm et al. (2010) among others have observed that agrarian-based activities are critical to the livelihood strategies of rural households such as the Makonde community. From the perspective of a rural setting of smallholder farmers, climate change has got a direct effect on all food security dimensions which include: food availability, food accessibility, and food systems stability. It will also have an impact on human health, livelihood assets, food production and distribution channels, as well as income, purchasing power and market flows. Chambers (1989) adds that smallholder farmers of the South face a vicious cycle of vulnerability, intervention, disease and environmental degradation that is exacerbated by climate change. There is a complexity of rural livelihood challenges that are intimately dependent on climate, land and natural resources as the basic source of rural livelihoods. In order to get a comprehensive understanding of rural livelihoods, there therefore need for research that involves an interdisciplinary analysis of rural realities. This is the kind of approach that has been employed to examine household-level climate change impacts in Makonde communal lands.

Among the critical aspects of rural livelihoods in Makonde, is household access to water resources for human consumption, livestock and irrigation and for other everyday needs. As noted in Section 4.3.1 water resources in the study area are undergoing a steady deterioration in terms of quantity and quality. Over 70% of the sampled households suggested that the state of water for domestic purposes has become poor to very poor, with only about 17% of the population satisfied by the state of domestic sources while only 4.8 percent of the sampled households are satisfied by the availability and quality of water supply for livestock and irrigation purposes.

As a result of the general aridity of the Makonde Communal Lands, surface water resources have largely dried up leaving the local authority and communities having to rely on underground water obtained through deep borehole drilling. Given the high cost of borehole drilling; only a few boreholes have been installed mostly at local schools and health centers not exceeding 10 facilities. Figure 4.10 shows the pattern of household access and types of domestic water sources in the study area. The large majority of households in the study area (79%) only have boreholes as their source of water for domestic and other uses. Deep wells in the wetter southern areas account for 15%. Other sources such as springs, and streams account for 2.8, apiece. The fact that the majority of households across the 10 villages have to rely on about 10 boreholes widely scattered across the study area implies a long walking distance for many households to the nearest borehole. Long queues are also experienced at the boreholes especially during the dry season when the yielding capacity of the boreholes drops and some in the drier north actually go dry during long drought spells. This water situation undermines productivity, household food security, health, social well being and other livelihoods such as fishing and construction. Women sufferer the most when it comes to scarcity of water for domestic use, whereby they have to travel long distances to fetch water and spend long hours waiting in queues for their turn at the few available water sources.

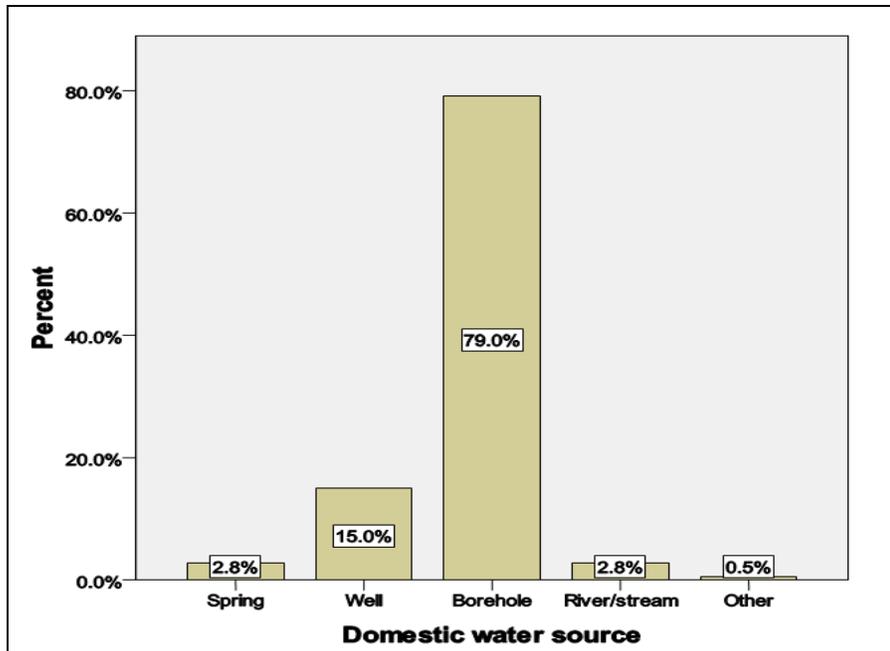


Figure 4: Patterns of Household Access to Domestic Water Sources

Source: Survey Results (August 2012)

The other important natural asset that the Makonde rural livelihoods depend on heavily is the forest resources. Forest resources in the study area are under threat from climate change and other climate change-induced pressures such as excessive wood harvesting, gold panning, and veldt fires. A wide range of forest resources such as wild food are particularly important to rural households that struggle to produce food or secure an income in the face of climate change. The changing rainfall and temperature regimes have had an impact on the availability of many forest resources such as food, wood, and other livelihood assets in the area. The depletion of wild food resources has not only exacerbated the insecurity of the community, but also the dietary requirements that tend to push up the prevalence of malnutrition especially among the infants. In addition, the growing scarcity of wild food sources has pushed baboons, monkeys, wild pigs and other wild life towards encroaching onto crop fields, and domestic livestock for food. This has intensified food insecurity among smallholder farmers and the conflicts between the community and the wild animals. More productive time is often spent guarding the crop against invasion by wild pests. Opportunities for supplementary income from harvesting and resale of forest fruits, timber and other resources were initially overexploited and in the long run, there is nothing more to

exploit thus plunging more households into poverty. This is a case of a vicious cycle of climate change-induced maladaptation and intensified forest resource degradation, thus further pushing the community into a state of increased vulnerability to climate change impacts.

Livelihoods according to Cernea (1995) as discussed under Section 2.5.1.1 can be defined as the bundle of different types of assets, abilities and activities that enable a person or household to survive and one of the most critical aspects of human life and well being is food security. Accordingly, food security constitutes one of the measures of climate change-induced livelihood challenges and opportunities in the case study. Climate change impacts on local crop yields were examined and the result suggests that all the smallholder farmers surveyed experienced a dropping trend in crop yields. As much as 69.4% of sampled households suggested that the drop in crop yields over the past 30 years has been significant whilst 30.6% experienced a little drop. The variation in the yields coincides with the microclimatic variations within the study area, whereby the conditions in the extreme north including; Kenzamba, Obva and Kamonde (Figure 1.2) are much drier with more severe droughts than the southern section.

As pointed out by FAO (2008) in Section 2.5.1, agriculture-based livelihood systems that are already vulnerable to climate change face immediate risk of increased crop failure, loss of livestock and other natural shocks, increasing water scarcities and destruction of other productive assets such as forest resources. This observation has been noted in the Makonde case study. Changing climate in the villages is associated with increasing incidents of crop failure (Figure 4.11). As much as 63.1% of the households have often experienced crop failure, 14.7% suggesting that the crop failure is becoming increasingly more often. About 21.9% who seldom experience crop failure and 0.2% experiencing no crop failure at all are the agro-ecologically advantaged smallholder farmers in the study area mostly confined to the southern tip of the case study area as earlier explained.

In terms of temporal variation in household food insecurity over the year, the Department of Social Services has established four notable periods during the year (April to June, June-September, October-December and January-March). The April to June period has the smallest food insecure households accounting for about 19% of the total and the number of food insecure households begins to dramatically increase from June-September, October-December with the highest peak of food insecure households being recorded during the January-March quarter, accounting for almost

93% of the total households. Whilst the overall district's food insecurity situation looks good with 2% of the total being food insecure, the separation of the Makonde communal land, brings the desperate situation in which the communal farmers are away from the more humid, more fertile commercial part of Makonde (to the west) with a significant part being under irrigation. The advantaged 0.2 percent of the local households has experienced no consequence from crop failure and this reflects some degree of resilience to climate change impacts among the group. It is suggestive of successful household coping or even adaptation strategies to the effects of climate change within this privileged group.

The possible climate change adaptation strategies among the privileged relate to livelihood diversification outside the traditional agro-based survival. This includes access to external support in the form of remittances from family members gainfully employed elsewhere or engaged in other profitable off-farm activities locally. Households in this category include; local school teachers, health staff, other public servants, and households operating commercial and other enterprises in the area. Their food supplies and other subsistence are not entirely dependent on local farming activities but on other non-farm income, either local or external. The issue of family size can also play a significant influence on the severity of consequences of household crop failure whereby larger families are likely to face more severe scarcity problems compared to smaller families as was earlier discussed in Section 4.1.

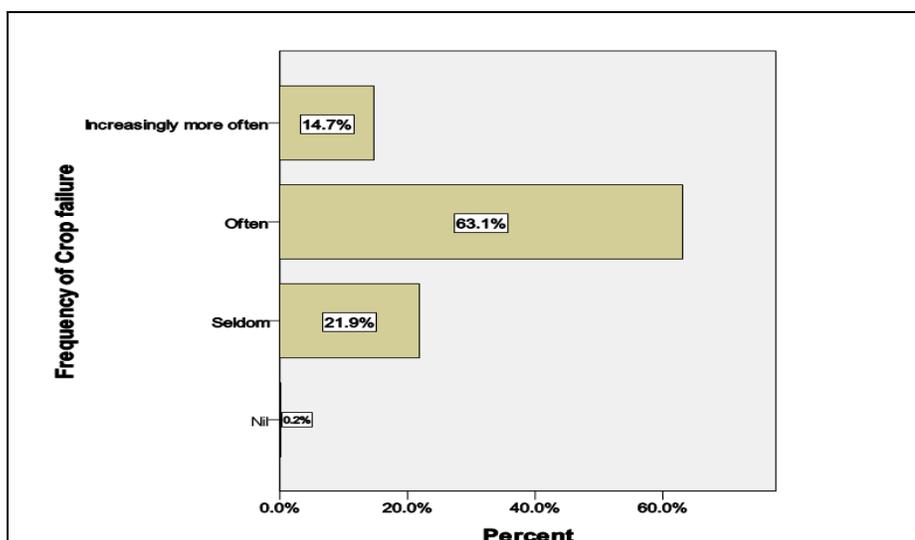


Figure 4: Community Perception on the Frequency of Climate Change-induced Crop Failure

Source: Survey Results (August 2012)

The Department of Social Services has got a role in supporting smallholder farmer's welfare in the district. Through an interview, the department provided a statistical perspective of the food security situation in the Makonde communal lands. It has observed that crop production in the study area has been mostly below normal and even dwindling to critical levels among most households over the past thirty years. The situation has been most critical during the years: 1982/3, 1987/88, 1992/3/ 1997/8, 2002/3, 2007/8, 2009/10 and 2012. On average households in the Makonde communal lands could only harvest cereal food crops that could only last for one to three months thus resulting in 10 months of cereal deficit. Major non-cereal production income activities are gold panning, cotton farming, livestock sales and market gardening (see Figure 4.12).

Among the major assets that support rural livelihoods and sustain household wellbeing is livestock ownership. Among the ecosystem services that the community traditionally enjoys is the pasture for livestock and this is similarly under threat from the climate change-ecosystem degradation interface. About 32% and 19.4% of the community suggest that the pasture was now scarce and very scarce respectively. The combined climate change impact of increasing water scarcity, forest depletion and declining pasture availability and quality has seriously undermined livestock productivity, variety, health and numbers in the local villages. As much as 49.8% of the surveyed households incurred significant losses in livestock size, particularly during the series of drought periods earlier indicated.

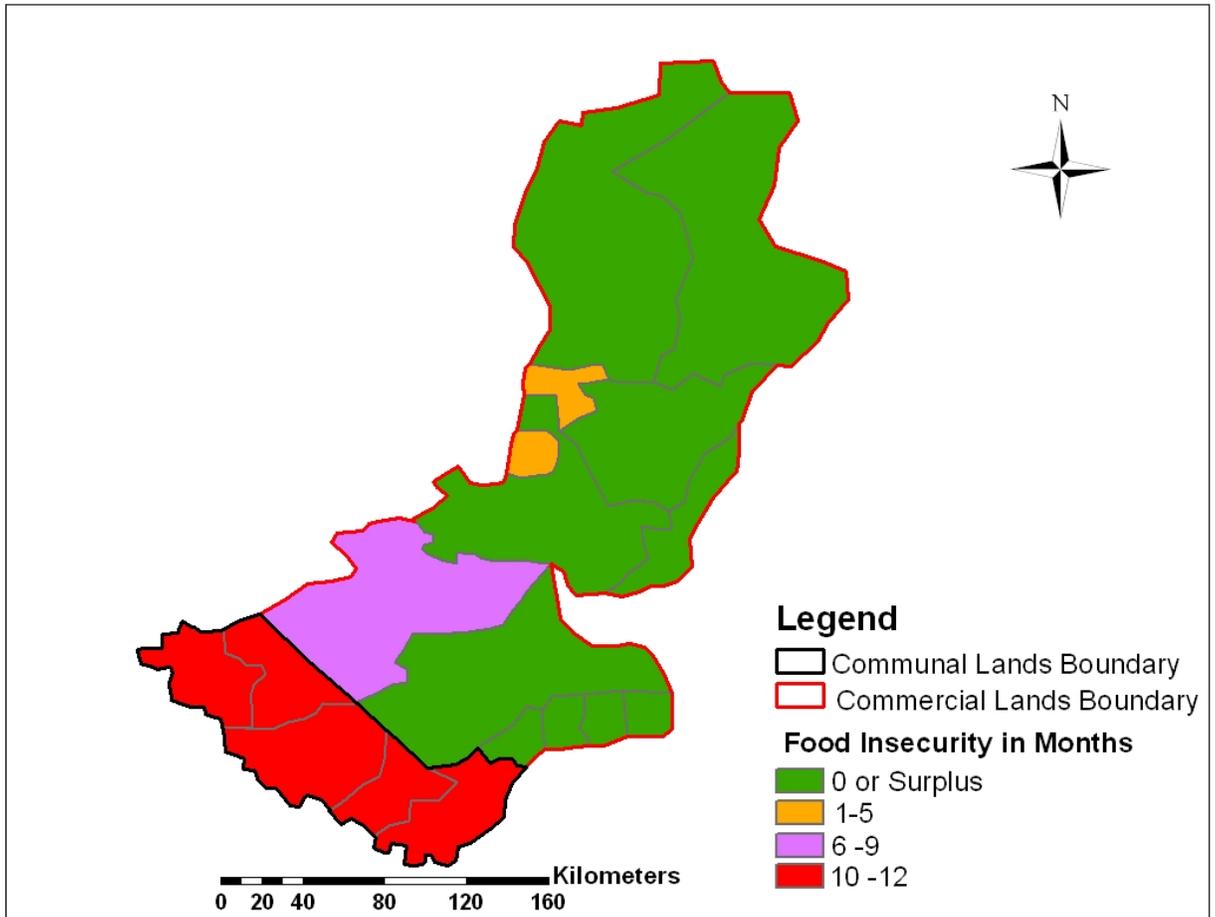


Figure 4: Makonde Communal Household Cereal Deficit (in Months) after own Production

Source: Adapted from ZimVac Interim Assessment (2012)

An estimated 49.5% of the sampled households conceded that the health and quality of the remaining livestock had dropped significantly and this affected their income prospects when it comes to trade and the productivity of drought power in their farming and other domestic activities. The combined effect of climate change-induced food shortages and increasing risk of loss of livestock from drought and disease has seen many households forced to sell off their livestock at uneconomically low prices.

The sale of livestock is normally a last resort in the face of looming food and income crisis. Having exhausted all options to cope with food crisis, including food handouts and casual labor, households are forced to look up to the open market for grain where the price tends to be

exorbitant depending on the scarcity situation. This has seen some desperate communal households being forced to exchange their full grown ox for a paltry 300kg of maize grain, a goat for 45kg and chicken for 8kg. In the more agriculturally favorable northern part outside the study area an ox can fetch up to 1080kg of maize grain, a goat 180kg and a chicken 108kg. With this untraditional trading of livestock, the livestock among communal households has been dwindling over the years without any prospect for recovery. The District Agricultural Research and Extension (AREX) officer indicated that about 59% of households did not own any cattle, with only about 13% owning more than 5 herds of cattle. Of the 59% that did not own cattle, the majority lost them to droughts whilst others had to sell off their stock out of either food security pressures or as a way of preventing total loss from the dying livestock as was the El Salvador case discussed in Section 2.7.1.

As has been indicated earlier, the 6.5 percent of households who have experienced no effect in livestock health and size are mostly confined to the South Eastern tip of the district, where the conditions are more humid, being geographically linked to the agro-ecological region II, with higher, more reliable rainfall and richer agro-ecosystems.

The issue discussed in Section 2.5.1.1 on rural livelihoods vulnerability to climate change is perfectly revealed in the Makonde case study. The majority of rural households remain heavily dependent on subsistence farming whereby households are highly vulnerable to climate change. The survey results show that they have very limited capacity to cope with the climate change-induced crop and livestock failure. Figure 4.13 shows the gloomy picture in this regard.

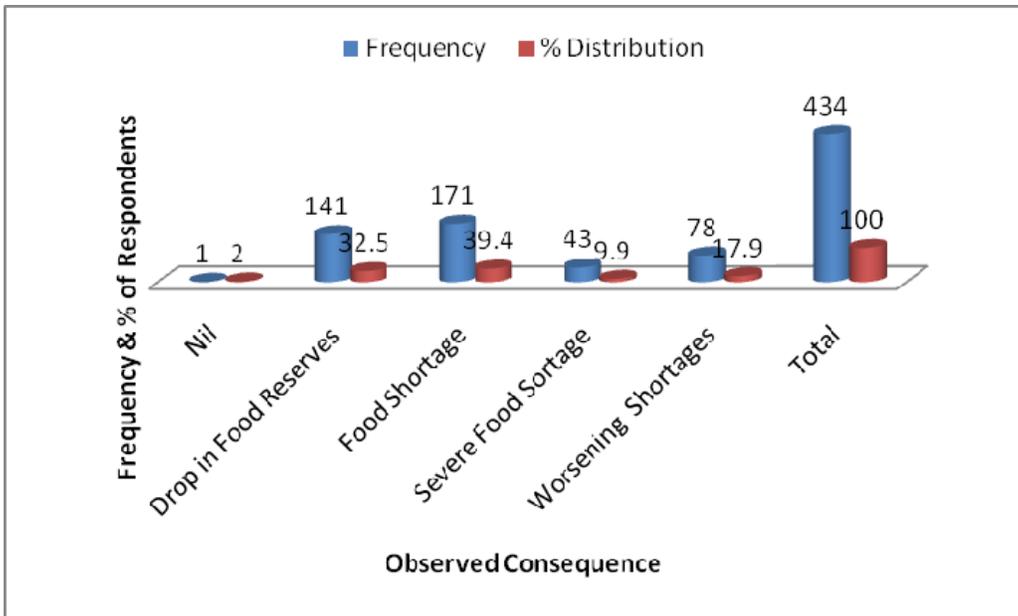


Figure 4: Household-level Consequences of Climate Change-Induced Farm Failure

Source: Survey Results (August 2012)

Figure 4.14 show the pattern whereby as much as 39.4% of the households suffer food shortages, whilst 18% and 9.9% experience worsening food shortage and severe food shortage respectively. A proportion of 32.5% of the community have experienced a drop in household food reserves implying a possible cut in the consumption and dietary patterns of households affected.

As a result of the evident interplay of climate change impacts and climate change-induced pressures on local livelihoods and general household well being, the survey examined the general wellbeing of households in the field. Almost 60% of the households are on the receiving end of climate change impacts, adversely affecting their wellbeing (Figure 4.14). A proportion of about 32% of the households conceded to experiencing severe effects of climate change involving crop failure, livestock losses and scarcity of water and other natural resources. The relatively privileged eight percent and two percent of households have experienced negligible and no effects of climate change respectively.

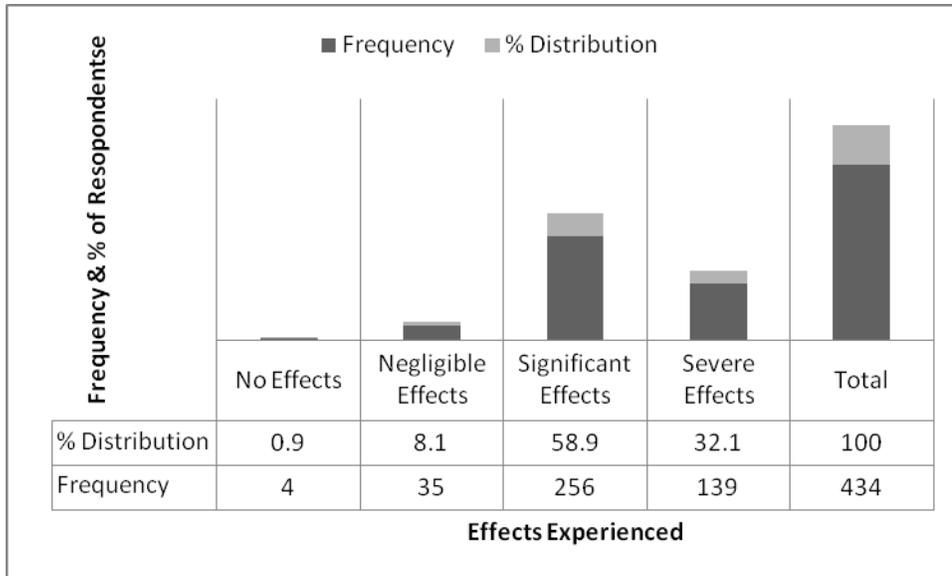


Figure 4: Climate Change Impacts on Local Household Wellbeing

Source: Survey Results (August 2013)

The resilience from climate change impacts among the eight and two percent of the sampled households can be explained by the occurrence of livelihood diversity. It can be assumed that the households are only partly reliant on agro-based income activities. As has been indicated earlier, the group includes: school teachers, health workers, other public servants and other households engaged in profitable off-farm activities that generate a steady income that keeps them sustaining their wellbeing even in times of climate change-induced shocks.

4.4 HOUSEHOLD-LEVEL COPING STRATEGIES TO CLIMATE CHANGE

As has been noted in Section 2.6, anthropogenic climate change would continue for centuries due to the time scales associated with climate processes and feedbacks, even if the best possible climate change mitigation measures were to be put into effect (Mirza, 2003; IPCC, 2007). This precarious climate change future calls for innovative livelihood strategies to cope with and adapt to the changing environment (Carney, 1998; Sherbinin, 2006). The situation is even more precarious for the more marginalized communities such as the Makonde peasants. For the foreseeable future they have no option but to at minimum, cope with or ideally, adapt to the changing climate. The

thesis sought to answer its third question related to what coping strategies the Makonde communal lands households have to climate change impacts.

Given the status of their farming system, economies, and the prospects of external support, the issue of adaptation to climate change remains a bridge still too far for the local community. What has been observable on the ground during the survey is mostly coping strategies to climate change rather than adaptation. The concept and prospect of adaptation to climate change is associated with a relatively advanced socio-economic situation, which implies the process through which people reduce the adverse effects of climate change on their health and well-being and take advantage of the opportunities that their climatic environment provides (Carney, 1998).

It was further indicated in 2.6 that successful adaptation to a changing environment is a function of the means available to the affected community and this is to do with adaptive capacity (Pittock and Jones, 2000; Smit and Pilifosova, 2001).

The findings of the survey suggest that the Makonde communal lands farmers together with the external support system currently in place lack the adaptive capacity. Nevertheless the community is responding in the best way they can to the climate change impacts and it is this that is referred to as coping strategies, both internal and external. In response to the occurrence of crop failure, the households have got a number of options to cope with the situation (Figure 4.15). In the face of crop failure, the most popular coping option was engaging in 'food for work' projects run by either government or nongovernmental organizations accounting for 18.9% popularity among households.

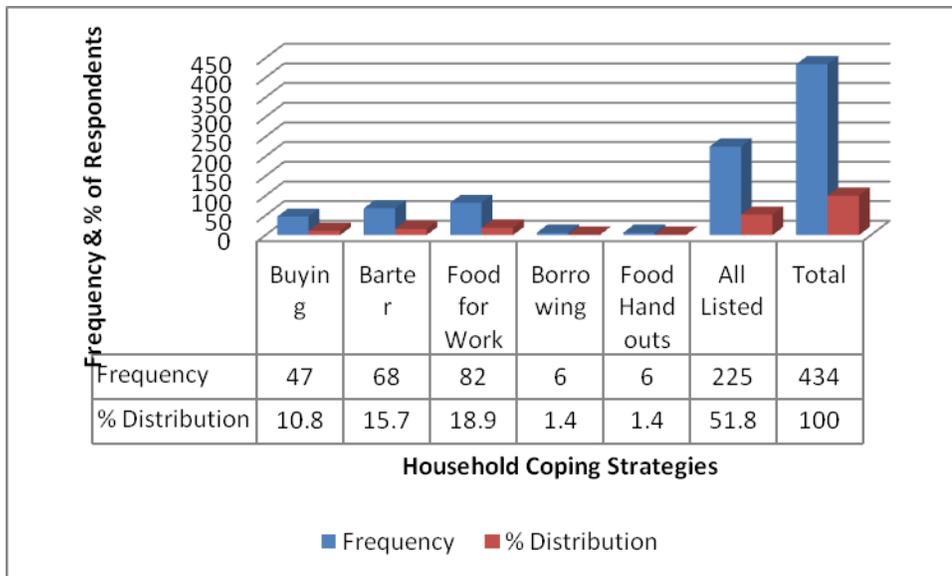


Figure 4: G Household Coping Strategies to Food Crop Failure

Source: Survey Results (August 2012)

The next popular option among the households was barter trade with livestock and other valuables that households possess or produce such as craft work. The other options include buying (10.8%), borrowing and food handouts. It was important to note that 51.8% of the households actually employ all the options to their disposition. The Elders' interview suggested that one other common strategy is: reducing the number of meals taken especially for adults, reducing meal portions, and giving more food to children at the expense of adult consumption. Due to increasing crop failure incidents coupled with input capacity, households are progressively planting less and less hectares of food crops and shifting towards the growing of cotton. One major concern noted by the AREX Officer among this conservative community is that whilst maize is failing as a crop option in the district due to aridisation, the majority of households (80%) continue to plant maize as the most preferred crop variety. The small grains (such as sorghum and millet) that have proven successful in terms of drought resistance and yield remain marginally preferred by most households with only about three percent having adopted the small grains in the last few seasons. The community in the Makonde Rural District like among most Zimbabweans has maize and maize meal as its staple food. The fact that they would expect a maize crop in the field and a maize meal on their table makes shifting to drought resilient crop options such as rapoko or millet culturally inconceivable.

Efforts by AREX and several NGOs to disseminate and promote the growing of the more successful crop varieties in the face climate change have largely failed. According to the local elders, rapoko and millet are shunned by local community members and consumers of food derived from such crops are generally looked down upon as second class households.

As discussed earlier under Section 4.3.3 many households sell off their livestock to obtain money for food purchases or simply barter the livestock for grain. Besides food needs, other reasons to selling cattle include; paying education expenses, pay medical expenses, and other household costs. Forms of casual labor for income most common in the district include: brick molding, fencing, thatching, building, weeding and harvesting (most popular among women) in the neighboring irrigated commercial farms.

The discussion earlier made in 2.5.1.1 suggest that rural livelihoods are heavily dependent on both livestock assets and crop production for both food and income, whereby the agricultural assets are strongly and positively correlated with rural income (Dixon et al., 2003; Bird and Shepherd 2003). This dual role of farm output also applies to the Makonde Community. The crop and livestock failure does not only undermine food security, but also household income. Figure 4.16 illustrates the stressful consequences of loss of farm income as households struggle to cope with the double climate change impact of food insecurity and a lack of income. The common options available to households to cope with loss of farm income include: sale of livestock (14.0%), casual labor (12.0%), barter trade (8.7 percent), craft work and the employment of all the coping options by the majority 60.6% of the households. The impacts of climate change tend to trigger adaptive responses that influence the environmental and socio-economic drivers of food chain performance in both a positive way as well as in negative ways in the form of maladaptation (see Section 2.6.1).

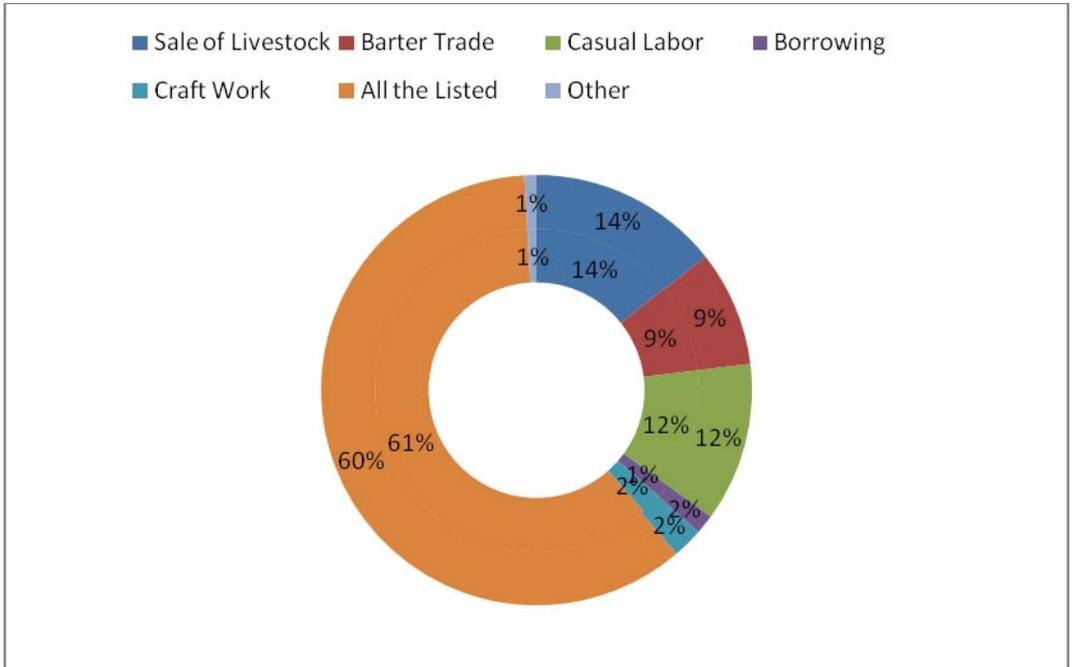


Figure 4: Household Coping Strategies to lack of Farm Income

Source: Survey Results (August 2012)

To highlight the adaptive capacity of the Makonde community, the success levels of the households' coping strategies to climate change impacts were examined. The findings as illustrated in figure 4.18 suggest that the community is struggling to cope with the environmental change-induced food shortages. As much as 72% of the households find their coping strategies being hardly succesful, with 12% absolutely failing to cope with the consequent challenges. Only about 16% of the households claim to be successful in coping with food shortages. In terms of coping strategies to loss of income opportunity 61.8% of the community find their coping strategies hardly successful whilst 17.7% are unsuccesssful in coping with income challenges.

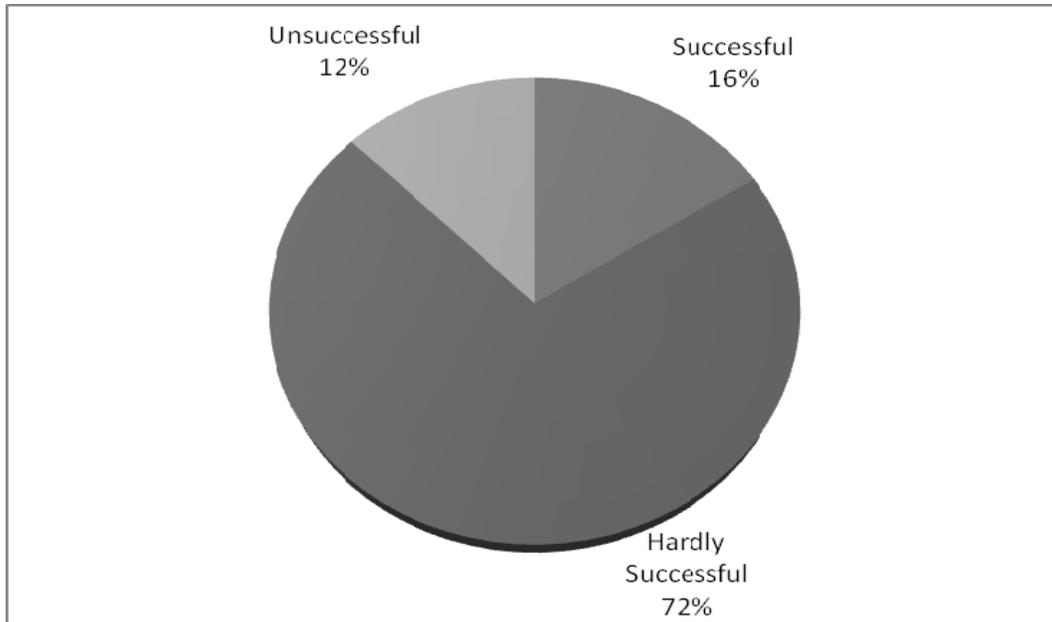


Figure 4: Success Rates for Household Coping Strategies to Climate Change Impacts.

Source: Survey Results (August 2012)

About 20.5% of the sampled households' coping strategies to loss of farm income are successful and this is explained by livelihood diversity among the households which keeps them food and income secure even in times of climate-induced shocks. It is this part of the community that has potential for adaptive capacity to climate change that is mostly derived from external factors such as remittances and waged income.

It is generally assumed that women have got a greater burden of attending to various domestic chores ranging to child care and other housekeeping. This tends to constrain them against livelihood diversification and effective adaptation strategies to climate change. An attempt was made in the analysis to determine whether there are any statistical differences between males and females in the case study in terms of success levels in coping with climate change-induced food shortages (Figure 4.18 and Table 4.1). Figure 4.18 provides a comparative view of success levels between sexes. The assumption put forward in this analysis was; there is no statistical difference between males and females in terms of success rates in food mobilization.

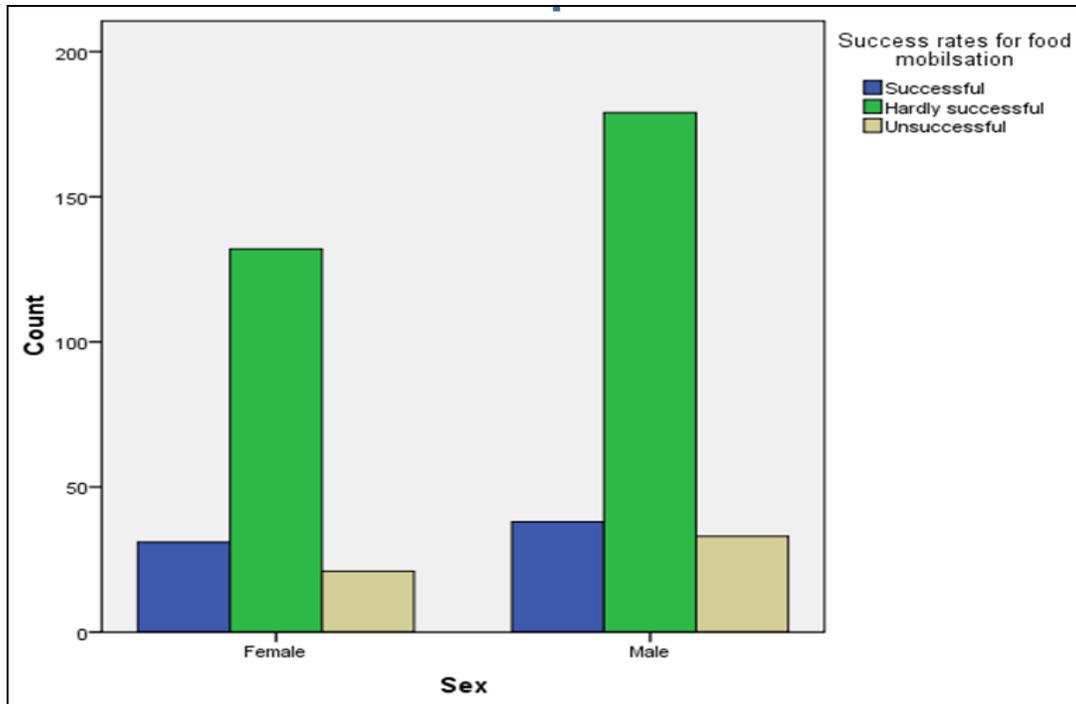


Figure 4: Gender-based Comparative View of Success Levels of Coping Strategies

Source: Survey Results (August 2012)

From table 4.1, the observed significance level for the Pearson Chi-square is 0.797 based on the 5% significance level.

Table 4: Chi-square test to determine differences in coping strategies between genders

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.453 ^a	2	.797
Likelihood Ratio	.455	2	.797
Linear-by-Linear Association	.442	1	.506
N of Valid Cases	434		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 22.89.

With this, the null hypothesis is rejected. It implies that there is a statistical difference between males and females in terms of success rates in food mobilization. The difference is however obscured by the fact that male respondents were more in the survey, and so giving the male group greater frequency in all categories of sex rates.

The influence of household family size on climate change coping strategies was also examined in the case study, based on research work that has partly attributed increased vulnerability to climate change, food insecurity and poverty to large family size (Figure 4.19). Figure 4.19 shows variations of success levels in household food mobilization in case of climate change-induced food shortages and suggests that the households of 7-8 family members have the greatest frequency of all success level categories (successful, hardly successful and unsuccessful).

The households with the smallest family size (0-4) have the lowest frequencies of all the response categories. In order to establish whether there is an association between family size and food shortage coping strategies, a symmetric measure of association was applied and through testing an association by using Pearson's correlation and Kendall's tau-b tests. The results give an indication of a lack of a correlation between family size and food mobilization as evidenced by the P values (of 0.09 and 0.10) Kendall's tau-b and Pearson's Correlation coefficient respectively as shown in Table 4.2.

The marginal correlation that exists (0.01) can be related to two family size categories, 0-4 and above ten members. When the two family categories are isolated from the rest, it tends to suggest that large family size constrains climate change coping capacity. The households with a large family size (above 10), who make up 9.7% of the sampled population are less successful in coping with food shortages than the small family size (of 0-4 members) who make up a smaller number (7.1 percent) of the sample population. This anomalous inverse relationship between these two household categories as shown in Figure 4.19 is suggestive of the potential compromise that large family sizes have on coping capacity to climate change impacts.

According to Downing *et al.* (2001), most developing countries such as Zimbabwe have low adaptive capacity to climate change, as they tend to have the least access to technology and the

least degree of development of social institutions. The results of the case study show a similar low adaptive capacity scenario in the Makonde communal lands. The local rural communities have to confront the harsh consequences of the changing climate with limited to no substantive government and other organizational support. Among the last aspects to be examined in the survey, was the existence and nature of outside support that the Makonde households receive in their fight to cope with and adapt to climate change effects.

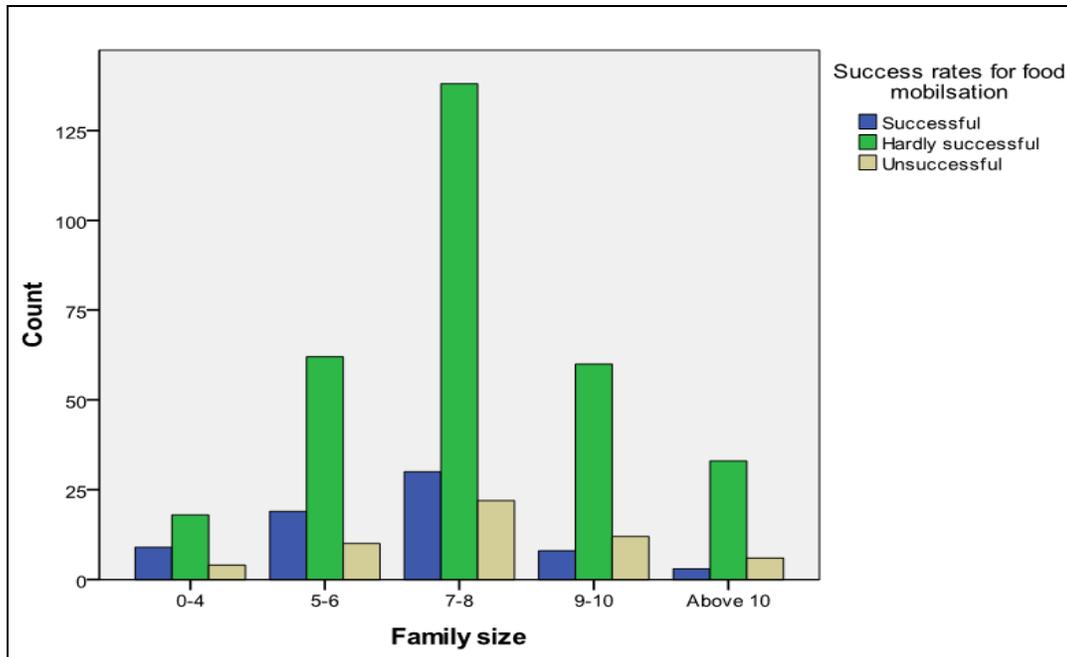


Figure 4: Influence of Family Size on Success Levels Food Mobilisation

Source: Survey Results (August 2012)

As much as 89.2% of the sampled households acknowledged the existence of outside assistance towards climate change adaptation whilst 10.2% suggest a non-existence of outside assistance.

Among the key agents of outside assistance was AREX, which proved to be popular among households with 89% receiving assistance in the form of education and training on climate resilient farming techniques such as conservation farming.

Table 4: Kendall's tau-b and Pearson's Correlation coefficient

Symmetric Measures

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.111	.043	2.595	.009 ^c
	Spearman Correlation	.126	.048	2.630	.009 ^c
Interval by Interval	Pearson's R	.123	.048	2.585	.010 ^c
N of Valid Cases		434			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

The Grain Marketing Board (GMB) is the Zimbabwe government's grain trade and marketing company. Among its central responsibilities, is to ensure the availability of adequate food grain supplies for the local demand either from internal production or from exports during all times. The GMB was popular among households with 88.7% acknowledging its support in supplementary food grain supplies whilst 6.7 percent suggested benefitting from farm input supplies.

A nongovernmental organization called Farm Community Trust of Zimbabwe (FCTZ) was popular for providing a variety of assistance ranging from food supplies, input supplies, water supply development and education with 61.1% suggesting that they receive all these various forms of assistance from the organization.

A Catholic Relief agent called CARITAS provides a similar range of assistance to the local community as that of the FCTZ. An estimated 64.5% of the sampled community acknowledged receiving all the forms of assistance as provided by the FCTZ (Figure 4.20). Among outside assistance providers to the local community, the two nongovernmental organizations namely FCTZ and CARITAS were found to play multiple roles in enhancing the local community's coping capacity to climate change impacts.

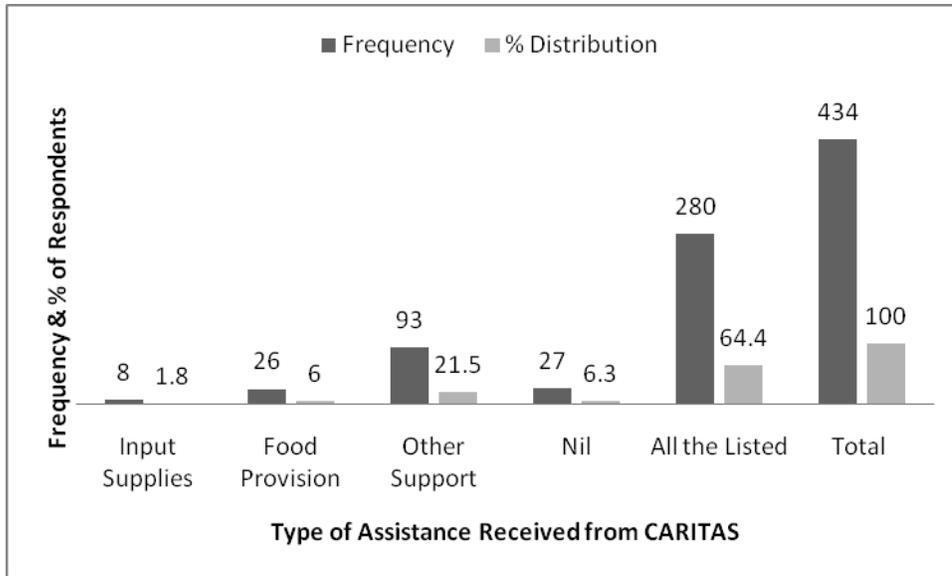


Figure 4: Multiple Roles of CAIRAS in Improving Local Livelihoods

Source: Survey Results (August 2012)

Other agents operational in the area include the Environmental Management Authority (EMA) focusing on the conservation of the natural environment, specifically targeting forest, soils, water, and wild life protection. Efforts are being made through EMA to contain vedt fires, deforestation, and uncontrolled gold panning in the area. Despite its visible operation in the study area, EMA's efforts towards environmental protection are facing challenges. There are two factors that contribute to this failure. The capacity challenges on the part EMA to police illegal activities and enforce environmental laws and the desperation of the community to survive outside the traditional farming activities by resorting to unsustainable resource extraction activities. One typical example is the widespread practice of gold panning on dry river beds, forested areas, pastures and even crop fields which has seen many parts of the communal areas being degraded into a state of disrepair. A process of maladaptation has set in putting the community in an even more vulnerable state to ongoing climate change impacts. In the face of failing agricultural livelihoods, a degraded natural environment, with less water and depleted biological diversity will exacerbate household vulnerability, food insecurity and poverty.

With regards to the evaluation of the assistance offered by the different organizations, AREX has got the highest rating of good from 88.9% of the sampled households. This is followed by NGOS with 61.3% good rating from the community. On the other hand the Makonde Rural District Council has the lowest rating of weak/poor performance from 78.3% of the sampled households followed by the Government agents having the poor rating from 43.3% of the sampled households. The ratings of outside assistance by the local community reflect the precarious situation in which the Makonde Communal livelihoods occur. They are operating and surviving in a situation with the barest indicators of sustainability.

With reference to factors that influence adaptive capacity to climate change the IPCC (2007) in Section 2.6 notes that adaptive capacity to deal with climate risks is closely related to sustainable development. In the same Section, Downing *et al.* (2001) suggest formal indicators of both vulnerability and adaptive capacity to determine vulnerable situations to climate change. The factors include; income, infrastructure, education, and state of civil society among others. Among the key determinants of adaptive capacity to climate change and sustainable development, Smith and Pilifosova (2001) suggest the following factors: improved access to resources; reduction of poverty; improved education and information; improved infrastructure; active participation by concerned parties, especially to ensure that actions match local needs and resources; and improved institutional capacity and efficiency.

One other institutional aspect that is vital in enhancing community adaptive capacity to climate change is the climate change early warning and preparedness system. In Zimbabwe, it is the Department of Meteorological Services that is responsible for providing weather and climate information. In terms of technical capacity to provide sustained early warning system to concerned stakeholders for effective disaster preparedness and management, the department has been off the mark many times in the past with its weather predictions. The predictions are increasingly being questioned by farmers and disaster preparedness organizations. The Met officer conceded that climate change monitoring remains a big challenge in Zimbabwe. With this capacity gap at institutional level, it is the local rain-fed semi-subsistence farmers who are at the receiving end of climate change impacts. It has been common to see warnings of climate hazards such as floods or drought only coming as the phenomenon is already on its way, making it extremely difficult to

prevent any damage or losses to crops, livestock, life or property. The Makonde case study among many other micro scale rural scenarios is far from attaining the above-stated indicators of adaptive capacity to climate change.

4.4.1 Socio-economic Implications of Household Impacts of Climate Change

As a result of the vicious combination of the biophysical and socio-economic vulnerability to climate change observed in the Makonde communal lands, the socio-economic wellbeing of the local households is significantly affected. Besides the growing incidents of food insecurity and general poverty, among households, a linkage of other challenges has affected the local community and households. These include; growing incidents of malnutrition especially among the infants, the growing cases of youths engaging in high risk activities for income such as prostitution, drug trafficking, dangerous gold panning practices, theft and other unhealthy occupations.

The elders and health officials have noted with concern the increasing prevalence of diseases in the community, among which are sexually transmitted diseases, HIV and AIDS among the youth and nutrition deficiency diseases among young children. Due to the increasing scarcity of clean water, the burden of water washed and water borne diseases is increasing in the Makonde communal lands as households are forced to forego basic household and personal hygiene. The other effect of climate change-induced poverty is the disruption of social structures. Young adults leave behind their families in search of paid labor in the nearby commercial farms or towns. In many cases the job seekers encounter even worse living conditions given the economic meltdown and high levels of unemployment and poverty in the urban centers. Much of the climate change hazards fall on women, children and the elderly who have to remain behind but with little or no remittance coming from the hopeful job seekers in town. Domestic violence due to food shortages, marital dislocation, breakdown of extended families and early girl child marriages were among other worrying climate change-related social trends observed.

The ten local school heads in the case study have recorded with concern a growing pattern of school drop outs over the past ten years. There are number factors behind the increasing drop out cases but commonly attributable to failing agricultural livelihoods. Due to the intermittent droughts and associated crop and livestock failures, parents are failing to secure enough income to keep their children at school. Whilst schools have become sensitive to the parents' income challenges

by allowing children to attend school without fees, many especially the young pupils, fail to attend due to chronic hunger. Many school children have been forced to abandon school and pursue income generating activities such as paid labor, vending, gold panning and prostitution to support the families to bring income and food home. The coping strategies in poverty that households engage in bring short term gains that are not sustainable and in many cases detrimental to the long term well being of the individuals and households involved. This is indicative of the vicious cycle of poverty–environmental degradation that the community is trapped in. As the smallholder farmers struggle to cope with climate change impacts they fall into the maladaptation trap rather than adaptation.

4.5 CONCLUSION

The case study on rural livelihoods and climate change challenges and opportunities in Makonde communal lands in Zimbabwe reveals the view that although climate change is a global phenomenon, vulnerability and adaptation to climate change is inevitably and unavoidably local. Based on observational meteorological records over the past 30 years and local community knowledge systems, the smallholder farming community in Makonde Communal lands is experiencing significant climate change. The temperature and rainfall patterns show clearly marked trends of warming and falling mean rainfall amounts since 1962. The changing climate being experienced in the area is attributable to a process of deterioration of local biophysical resources that include: forests; biodiversity; water; pastures and soil fertility. The livelihoods of the population in the Makonde communal lands is based on semi-subsistence rain-fed farming economy, complemented by use of local natural resources for food and income. Faced with the changing climate, particularly related to the increasing frequency and severity of drought spells, the local livelihoods show high levels of vulnerability to food insecurity and poverty. The social, economic and technical constraints associated with the largely traditional farming economy in the Makonde communal lands provides for a low adaptation capacity to climate change. The households in the case study are failing to adapt to the changing climate and consequently are struggling to cope with local climate change and associated hardships. The climate notable climate change-induced livelihood hardships faced by households in the Makonde communal lands include: failing crops and livestock, growing food insecurity, water resources depletion, falling income and increasingly scarce natural resource-based livelihood options.

The vulnerability of the households in the Makonde communal lands to climate change-induced environmental and socio-economic stresses is made even more precarious by the scarcity of sustained external support to complement the households' coping strategies. The government institutions are struggling to provide any sustained climate change adaptation strategies to the communities and households. A few nongovernmental organizations operational in the study area are making efforts to promote climate-resilient farming practices and rural livelihoods diversification. Due to the large extent of rural livelihood vulnerability in the local and other districts in the country and the organizational budgetary constraints, a large part of the community is hardly receiving any kind of relief support. In the absence of sustainable rural development and effective adaptation strategies, the rural livelihoods in Zimbabwe's Makonde communal lands show high levels of vulnerability to local climate variability and climate change.

The high level of vulnerability to climate change noted in the case study brings about a host of socio-economic implications to the households and the community. The socio-economic implications take several dimensions including; food insecurity and malnutrition; lack of access to health, education and other basic services; breakdown of marriages and social structures; increasing disease burden; and the increasing prevalence of coping strategies (in poverty) that are detrimental to the long term well being of individuals, households and communities. As the smallholder farmers in the Makonde communal lands struggle to cope with climate change impacts, they often engage in maladaptation options rather than adaptation, thus exacerbating the poverty-environmental degradation cycle in which they are trapped.

Based on the aim of the thesis to investigate the rural livelihoods and climate challenges and opportunities of climate in the Makonde district, the study concludes that the rural farmers in the Makonde communal lands face adaptive capacity challenges to ongoing climate change and its impacts. The chronic challenges that the community and households face in adapting to local climate change, create a web of cumulative interaction with three dimensions of vulnerability that have been identified in the case study. The dimensions are: the local physical-environmental dimension, the local socio-economic dimension and the external dimension, which entails the weak institutional assistance available to the community from government and development partners. The case study unravels the importance of inquiry into and understanding of the local context of

climate change vulnerability and prospects and challenges for adaptation, away from the global perspective of the climate change discourse. It further reveals the remote situation of most communities from the climate change mitigation and adaptation rhetoric that is associated with the global, regional and even national initiatives such as those of Zimbabwe. The study unravels the fact that vulnerability to climate change is a function not just of biophysical outcomes related to meteorological changes, but also of socio-political and institutional factors that can vary significantly at a relatively fine scale.

In terms of opportunities available to the Makonde rural farmers in the face climate change, the widespread awareness of climate change trends and its agro-ecological impacts among households is a big step forward in terms of establishing an effective local climate change risk management framework. With the support of the ongoing national capacity building initiative in climate change policy making and implementation, and the current interest and capacity of local nongovernmental organizations and disaster management organizations, there is a strong opportunity for effective adaptation mechanisms in Makonde. Now that Zimbabwe is at an advanced stage towards finalising the National Climate Change Response Strategy, there is strong optimism in the eventual creation of climate-resilient economy and livelihoods at regional, national, and local level. Given the emergence and participation of various stakeholders in the current national climate change response discourse, investment towards an integrative, inter-sectoral and multi-sectoral organizational framework will go a long way in bringing to fruition climate-smart rural and urban economy in Zimbabwe.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND SUGGESTIONS

5.0 SUMMARY

This thesis investigated rural livelihoods and climate change challenges and opportunities in Makonde communal lands of Zimbabwe. Specifically the objectives of the study were to: determine the climate change trends in Makonde communal lands; evaluate the environmental and consequent household-level impacts of climate change in Makonde communal lands and; examine the household-level coping and/ or adaptation strategies to climate change of the Makonde rural community.

For operational purposes, the study sought to answer the following questions:

1. What are the climate change trends recorded and experienced in the Makonde communal lands?
2. What climate change-induced biophysical changes have occurred in the Makonde communal lands?
3. What are the household-level impacts of climate change on the rural community of the Makonde communal lands?
4. What household-level coping and/ or adaptation strategies to climate change are being adopted in the Makonde communal lands?

In order to secure answers to the above stated research questions, there was need to decide on the appropriate methodology. The first task was to embark on a comprehensive review of literature to explore the body of knowledge that already exists with regards to the climate change discourse in general, and the impacts of climate variability and change at global, regional and local levels. Besides, a specific focus on climate change impacts on rural livelihoods, both theoretical and empirical literature was also reviewed with respect to the intrinsic relationship that exists between vulnerability and adaptation to climate change. The body of literature reviewed further guided the study in terms of selecting an appropriate methodological approach among the numerous epistemological and entomological options.

The research fitted into a case study approach that focused on a geographically and temporally specified local context (the Makonde Communal Lands of Zimbabwe). The methodology employed

the mixed design to capture the typically multidimensional nature of the subject under study. The study borrowed a lot from the systems theory in order to effectively analyze the different but interrelated components that constitute the subject matter as dictated by the research questions. The study covered diverse aspects that include; the meteorological shifts over time, the consequent local biophysical changes and the socio-economic dynamics of community responses, as well as household coping and adaptation strategies to climate variability and change.

Both qualitative and quantitative data collection methods were employed in the case study. Quantitative meteorological data for the Makonde Rural District recorded over the years between 1962 and 2008 were obtained from the Zimbabwe Department of Meteorological Services. A structured household questionnaire survey was conducted across 10 villages of the study area and a historical profile of climate change was obtained through conducting unstructured interviews with local elders. Interviews were also conducted with relevant ministerial experts and field officers, together with project managers of nongovernmental organizations operating in the Makonde communal lands. Non participant structured observations were further conducted to complement the triangulation of data gathered through other instruments.

Given the fact that the study involved human subjects of various age, gender and other characteristics, ethical considerations were an important input in the study. The individual consent of the targeted subjects was solicited. The issue of guarantee of anonymity and confidentiality to the participants was considered of importance in enhancing the willingness of the subjects to participate in the survey. Whilst it was the study's strong belief that most (not necessarily all) of the data and information envisaged for collection and handling in the study was hardly classified as sensitive, confidentiality in particular and anonymity to a certain level was a matter of serious consideration to the researcher and the research assistants involved.

The analysis of data employed both the qualitative and quantitative techniques. The interview transcripts and field notes were analyzed qualitatively, whilst quantitative techniques were employed to analyze the raw meteorological data and structured questionnaires.

A total of 434 households were successfully surveyed with 20 elders, 10 local school heads, two officials from local health centers, two Nongovernmental organizations representatives, and five

critical government agents also successfully interviewed. Due to financial and time constraints, the above-stated sample size was assumed to be feasible and optimally representative of the biophysical and socioeconomic phenomena under study as discussed in the methodology chapter.

The results of the research suggest that the community in Makonde communal lands has experienced significant climate change over the past three decades. The changing climate has affected the state and productivity of local biophysical resources, upon which the local community heavily depends on for food, livelihoods and income. The progressively warming temperatures and falling mean annual rainfall amounts associated with climate change in the Makonde communal lands has resulted in the increasing incidents of crop and livestock failure among most households. The Makonde communal farmers lack the necessary knowledge, skills, and infrastructure and material resources to equip themselves with effective climate change adaptation strategies. As a consequence, the households are struggling to cope with the impacts of climate change, whose situation is exacerbated by a general lack of access to sustained outside assistance from government and other institutions. The weak adaptive capacity, both internal and external, is exposing the community and households of the Makonde communal lands to increasing vulnerability to food insecurity, poverty and other socio-economic stresses.

5.1 CONCLUSIONS

Climate change is a global phenomenon that is leaving no community unaffected but the most direct, immediate and severe impacts can only be measured at local level. It was the aim of this study to investigate the rural livelihoods and climate change challenges and opportunities in the Makonde communal lands of Zimbabwe. An analysis of meteorological data, questionnaire responses and interview transcripts tapping local community experiences and indigenous knowledge systems led to a conclusion that there has been significant climate change in the study area since 1962. The climate change trends clearly manifest in the form of progressive warming, falling mean annual rainfall amounts and the increasing frequency and severity of drought spells in the Makonde communal lands.

As a consequence of climate change occurring in the Makonde communal lands, the study has noted three dimensions of vulnerability to the changing climate. The first being the physical–

environmental dimension which refers to the emergent local climatic conditions and associated biophysical impacts. The biophysical changes experienced in the area are in the form of the deterioration of ecosystem productivity and diversity. The second dimension of vulnerability observed in the case study relates to the socio-economic, which refers to the local community's capacity to recover from extreme events and adapt to change over the longer term. The third dimension pertains the nature and level of external assistance available to the local community. External assistance implies the degree to which the study area and its community are assisted in its endeavor to cope with and adapt to ongoing climate change.

From the perspective of the biophysical dimension of vulnerability, the changing climate in the Makonde communal lands has had a significant effect on the state, productivity and diversity of local biophysical resources. The survey revealed that local climate change has induced the progressive degradation of local environmental assets such as forests, wildlife, water, pasture and soils. Given the fact that the study population is largely semi-subsistent and that much of their food, income and other household needs are derived from local natural resources, climate change-induced ecosystem degradation has exposed the local community and households to increased vulnerability to food insecurity, poverty and misery.

The socioeconomic dimension of community vulnerability to climate change was found to be most striking in the sense that traditional rain-fed agriculture is the major source of livelihood for the Makonde communal population. The increasing rainfall variability and unreliability over the last 30 years, coupled with the increasing frequency and severity of drought spells in the Makonde communal lands results in increasing incidents of crop and livestock failure. With marginal farming knowledge, skills and material resources, the vast majority of households in the study area have become highly vulnerable to food insecurity and poverty. In the face of climate change-induced failure of subsistence agriculture, the households resort to the extraction of the equally climate-sensitive forest resources for alternative food sources and livelihood. The uncoordinated household coping options tend to put an added strain on the already stressed environmental components. In the process, climate change coping strategies trigger a vicious cycle involving; climate change stressors - failed agriculture – maladaptation - food insecurity and aggravated poverty. From this man-environment state of affair, the study concludes that the interplay of social vulnerability with

biophysical vulnerability in the face of climate change generate a cumulative causation process of aggravation. The cycle of aggravation becomes even more vicious especially without sustained outside intervention from government and other development partners to help break the cycle.

The study further concludes that an investigation of the impacts of vulnerability and adaptation to climate change at local level reveals internal variations at finer scale. In this particular case study, finer variations were noted in terms of: climate change impacts, vulnerability and adaptation to climate change from place to place; from time to time; and from household to household. The Northern part of the Makonde communal lands, a relatively short distance from the southern section was found to receive much less rainfall and more severe droughts than the Southern section. It was by this geographical divide that the northern villages were generally more vulnerable to climate change-induced food insecurity and other stresses than the southern villages. In terms of temporal variations, food insecurity is minimal just after harvest time, during the April to June period then progressively worsens towards the December to March period (just before the next harvest time) when it is most severe. In the face of common climate change scenario, vulnerability to climate change varies from household to household. The study revealed that whilst the majority of sampled households experienced severe consequences of climate change in terms of water availability, crop yields, food shortages and loss of income, there was always a small percentage of households who would experience or suggest negligible or even no climate change-induced consequences on their well being. The household-based variation was attributable to factors such as livelihood and income-base diversification among others whilst other households only depended on the climate-sensitive agricultural livelihoods. Farming knowledge, skills and ownership of households' assets also contributed to the household variations in vulnerability and adaptive capacity to climate change impacts.

A cultural constraint in households' adaptation threshold to climate change emerged in the case study, in the form of persistent preference to maize crop growing despite its evident failure. The local households have maize and maize meal as their staple food and they view the adoption of crop options such as sorghum and millet as inconceivable. This has witnessed many local households being perennially dependent on maize food handouts rather than filling their granaries with crops they despise eating namely sorghum and millet.

From the perspective of the external assistance dimension to vulnerability, prospects for local sustainable development are still remote given the marginal institutional support being availed to the Makonde communal farmers. There is a lack of key determinants of adaptive capacity to climate change and sustainable development in the case study as discussed in Section 2.6. The adaptation determinants that are missing in the Makonde communal lands include: Improved access to resources; reduction of poverty; improved education and information; improved infrastructure; and improved institutional capacity and efficiency to promote sustainable livelihoods. As climate change is projected to go on for the foreseeable future even in the case of a “best climate change mitigation” scenario, the study population is projected to be pushed into even greater vulnerability levels unless some well coordinated, sustainable external assistance is instituted. The nature and magnitude of outside assistance that the community in the Makonde communal lands is receiving is inadequate, unreliable and uncoordinated.

Much of the outside assistance is unsustainable, in the form of short term coping interventions such as food hand outs, input supply and small scale self help projects that remain inherently climate-sensitive. The current outside assistance is lacking the capacity to eliminate the barriers that hold back long term local sustainable rural development. The study therefore concludes that adaptation to climate change and local development are closely linked, whereby adaptation to climate change in Makonde communal lands cannot take place without a sustainable development process in place. The long standing problems of environment and development affecting the community in the Makonde communal lands constitute a major challenge to effective adaptation strategies to climate change in the study area and elsewhere in and outside Zimbabwe.

The three dimensions of vulnerability to climate change noted in the Makonde communal lands interact viciously and have resulted in significant impacts on the socio-economic wellbeing of the local households. The socio-economic implications take several dimensions including; food insecurity and malnutrition; lack of access to health, education and other basic services; breakdown of marriages and social structures; increasing disease burden; and the increasing prevalence of coping strategies (in poverty) that are detrimental to the long term well being of individuals, households and communities. As the smallholder farmers in the Makonde communal lands struggle to cope with climate change impacts, they often engage in maladaptation options

rather than adaptation, thus exacerbating the poverty-environmental degradation cycle in which they are trapped.

5.2 SUGGESTIONS

Given a mix of challenges that the thesis revealed on the impacts of climate change on the Makonde communal farmers' livelihoods, the study wishes to put forward a number of suggestions towards enhanced community and household adaptation to the observed climate change impacts. The suggestions are anticipated to address the multidimensional nature of the challenges ranging from: climate change information gaps; institutional capacity constraints; environmental vulnerability; socio-economic vulnerability and adaptive capacity constraints. Bearing in mind that the case study is not exhaustive in its breadth and depth, suggestions for further research on the climate change-rural livelihoods discourse will be put forward too.

5.2.1 Capacity Building in Climate Change Information Science

Among the key primary challenges noted in the study militating against climate-resilient agricultural production systems, food production and livelihoods was the lack of vital information on climate variability, and current and projected climate changes among farmers and policy makers. The Zimbabwe's Department of Meteorological Services is facing capacity constraints in monitoring, generation and dissemination of weather and climate information that is of vital use in designing agricultural systems and practices that are resilient to climate change and variability. The study suggests concerted efforts from government to provide the necessary capacity building support for institutional, technical and human resources development at national, provincial and local community levels. Specific areas that need capacity building include: weather focusing, climate change monitoring and early warning systems; climate change education; appropriate weather information and dissemination to the farmers. At the local farming level, there is need for the development of medium range weather forecast systems to particularly deal with increasing local rainfall uncertainty and unreliability. The improvement in the national, provincial and community knowledge base is anticipated to promote the use of climate early warning systems and facilitate enhanced adaptation strategies to climate variability and change.

With increased access to conventional climate risk information, it is hoped that farmers can employ the rule of thumb, particularly in making decisions on: when to plant; what to plant; how much to plant; timing of weeding, fertilizer application, and other practices based on concrete forecasted weather information. The most vital weather information at local level include: observed rainfall and medium range rainfall outlooks of within 10 to 14days. This will help to enhance local knowledge systems of climate forecasting which do not seem to have forecasting value but diagnostic rather than prognostic with no obvious specific lead time. Current farming practices generally follow a pre-determined calendar, whereby planting dates are almost constant irrespective of the season and this leads to frequent poor/failed germination, at great cost to farmers.

Efforts should also be made to establish village-level rainfall monitoring sites for instance at local schools, equipped with basic weather recording instruments. Through farmer training, the local community may be able to observe and analyze the local rainfall data for use in their decision making and planning. Through increased extension and the 'learning by doing' approach, a new culture of using locally collected and observed climate data, and the progressive introduction of climate forecast products will help farmers take up medium range and seasonal forecasts. The conventional local weather and climate monitoring initiatives are expected to enhance community awareness to bolster the knowledge levels and providing access to information that could help them make appropriate decisions to reduce climate variability-induced losses. Concrete weather information is expected to improve farmers' decisions on issues such as the appropriate design of water and crop management strategies. This will further provide the necessary support for the incorporation of adaptation to climate change issues into national and local development and risk management plans.

5.2.2 Institutional Capacity Building and Integration for Climate-smart Rural Economy

The challenges that the Makonde communal farmers face in their effort to cope with and adapt to climate change impacts are exacerbated by the lack of sustained support from relevant government institutions. There are a number of government agents who are expected to collectively contribute towards overall rural development. Rural development is a function of an integration of interventions from different but related government agents involved in areas such as: land development and delivery; agriculture; natural resources management; water resources

development; social welfare services; road infrastructure provision; health services and education among others.

In order to have a climate resilient agricultural system and sustainable rural livelihoods, there must be a comprehensive institutional framework for capacity building towards sustainable rural development. The capacity building framework must ensure a coordinated vertical integration in terms of policy delivery, strategies, programs and projects from the national, provincial, district up to the local village level. The capacity building initiatives must involve a good governance framework as a primary public service delivery instrument. Specifically, as suggested by Chagutah (2010), the concept and practice of climate governance must be introduced. This is anticipated to promote decentralization down the national, provincial, district and village level, thus strengthening partnership among government agents, the private sector, international development partners, NGOs and the community in national and local development initiatives that are climate smart and resilient.

There must be some comprehensive plans for agricultural development and food security enshrined in the national development and poverty reduction strategies. Whilst the focus is on rural development, there is need to establish a multi-sectoral approach to strengthen rural-urban linkages and mainstreaming climate change into all development policies and sectors such as: education and training; agriculture and relevant support systems in input supply and marketing; industry, commerce and infrastructure development (Moyo *et al.*, 2012). There is need to strengthen capacity for policy analysis, research and extension in the areas of crops, livestock, mechanization and water resources development and irrigation, agricultural education, forestry, natural resources management and climate change education.

The thesis suggests a need for sustainable land management (SLM) incorporating issues such as: land husbandry; water resources and micro-irrigation management, pasture and forest management; and ecosystem restoration all based on community-based approaches particularly focusing on community-based climate change adaptation projects already pioneered in Chiredzi and Mberengwa districts (Brown *et al.*, 2012). For effectiveness, sustainable community-based land management systems must be guided by a stronger and integrated district-level institutional framework. In this regard, the Makonde Rural District Council must be capacitated in terms of

planning, good governance, land development and delivery, natural resources management, civil engineering and infrastructure development in line to deliver national policies on land, agriculture and the environment; climate and food security among others.

In terms of addressing sectoral challenges, capacity building in the following institutions is recommended:

The Department of Meteorological Services (Met Office) in terms of weather focusing, climate change monitoring and early warning systems; climate change education; and farmer community-friendly weather information and dissemination.

The Department of Agriculture, Research and Extension Services (AREX) require priority attention in terms of capacity building. There is need for improvement in financial and other technical support in research. Research should focus on climate resilient agronomy and extension services; environmentally sound agricultural practices such as conservation agriculture, agro forestry, intercropping; developing and promoting appropriate technologies suitable for different categories of smallholder farmers. AREX must work towards developing community-managed demonstration pilot projects on new crop varieties that are climate resilient such as pearl millet, sorghum and cassava. The department must further complement the MET office in climate change education and the extension of weather forecast products and their application.

Regarding the Zimbabwe Forestry Commission, besides focusing on its traditional business of managing and protecting the commercially-valued state forest assets, it must also increase its investment initiatives towards the common property forest resources in the communal areas. Well established collaborative work between AREX and the Forestry Commission at village level, will help strengthen local communities' capacity to manage climate vulnerability.

The Environmental Management Agent (EMA) needs enhanced capacity building in terms of the framework for the implementation of national environmental policy. There is need to close the gaps in the vertical integration of environmental conservation and management programs and projects from the national hierarchy down to the district and village level. With smoother devolution of environmental management roles towards the village level, more positive action is anticipated in forest, soil and water conservation in the Makonde communal lands. EMA must adopt an all-

inclusive environmental governance approach to promote integrated, multi-sectoral environmental management from national to the local level. The approach will help to mobilize much needed resources; including financial, labor, material and other necessary commitments to support environmental conservation programs and projects in Makonde and other rural districts. EMA's presence and effectiveness at local level requires greater capacity and power in the enforcement, monitoring and policing of environmental laws on forest, soil and water conservation, and small scale mining among other critical environmental concerns. A well equipped, financed and empowered EMA is expected to significantly contribute towards reduced vulnerability of crop and livestock production systems and increased resilience of the livelihoods and agro-ecosystems in the Makonde district. Productive ecosystems, with their array of services; supporting, provisioning, regulating, and cultural are anticipated to provide communities and households with resources and options they can use as insurance in times of climate change crisis.

The need for capacity building of EMA is highlighted by its current leading role in the crafting of the much awaited climate change policy for Zimbabwe. The policy is envisaged to provide a national response strategy to climate change to help deal with climate variability and change impacts in an effective and coordinated manner. Whilst the implementation of this national response strategy is anticipated to provide direction on handling the already felt climate change risks, as of September 2012 the policy formulation progress has been slow, with no indication when the policy would be finalized. Government funding has been very thin and the process has repeatedly stalled with deadlines being repeatedly missed. In order for the policy to become a reality, Zimbabwe needs substantial supporting measures from the national budget, and not to surrender the financial obligations to the donor community. The Government needs to take charge and effectively lead in funding of the climate change policymaking process. With the climate change policy in place, government will be obliged to allocate a budget for climate change at community, sectoral and national levels to the benefit all including the Makonde community. A national climate policy would make it possible to mainstream climate change into national development targets and limit the challenges being faced in addressing mitigation and adaptation as noted in the case study. While the policy will not prevent catastrophes from occurring, it will assist decision-makers to integrate disaster risk reduction into national economic and development planning across sectors. With this

development, the rural farmers in the Makonde communal lands and elsewhere in the country will certainly acquire a greater adaptive capacity to climate variability and change.

The Department of Social services needs capacity building in aspects of: poverty monitoring and evaluation; vulnerability assessments; poverty alleviation; strengthening diversified livelihoods through more self-help options; and working in collaboration with humanitarian organizations to strengthen community-based sustainable livelihoods programs. The thesis suggests a shift of focus from free food handouts towards creating more opportunities for community and household livelihoods within and outside the traditional farming options. The possible off-farm income generating activities include; craft, dress-making, housing, road and small dam construction; borehole maintenance, basic metal and hood work, food processing, soap making, and other cottage industry; rainwater harvesting, and ecosystem rehabilitation projects. The proposed diversification of local livelihoods will generate far reaching benefits in the sense of climate change resilient options on one hand and climate change mitigation to a certain extent.

Other actors with a fair share of responsibility in fostering sustainable livelihoods, food security and poverty alleviation in Makonde communal lands include; NGOs, international development partners and the private sector. There is generally a huge potential in securing assistance from the above-named partners that is on condition that the national and local authorities establish a friendly and accommodating environment for their operation. There is a tendency that when the political atmosphere is volatile, such agents of humanitarian and development assistance withdraw their support from needy communities. The reason is that hosting authorities tend to be obsessed with clientelism and thus politicize the whole issue of humanitarian assistance. The culture of distribution of opportunities, humanitarian and development assistance based on political patronage has adversely affected rural communities including smallholder farmers in the Makonde communal lands. There is need to stop this politically-charged and segregatory practice and replace it with approaches guided by principles of good governance and sustainable livelihoods.

Another aspect that emerged is need for institutional support towards the adoption and increased productivity of new crop varieties that have proven to be climate resilient but generally shunned by local famers. This is with reference to pearl millet, sorghum and cassava among other drought resistant crops. One way of enhancing community adoption of the new crops will be to improve

agricultural marketing services for the new crops. The bias against the new crop proposals equally manifests even at the government grain marketing boards whereby the marketing focus of Zimbabwe's Grain Marketing Board is dominated by maize at the expense of other such crops. With a stronger marketing drive coupled with an attractive producer price, farmers as *economic man* will be quick to adopt the new crops. Initially it might be for commercial purposes and progressively might be adopted as substitute for the maize staple.

Overall, there is a need to mainstream climate change in all programs and plans for institutional capacity building and integration, fostering cross-dialogues between relevant agencies and institutions involved in rural development. Agricultural development, food security and poverty reduction policies, programs and plans must all be climate sensitive and climate smart. This will ensure stronger alignment of development investments with environmental sustainability and climate change adaptation needs to the benefit of the rural farmers in the Makonde communal lands.

5.2.3 Climate-resilient Agro-ecosystems

Among the challenges that the Makonde communal farmers face in their effort to cope with and adapt to climate change impacts is the community and households' failure to sustainably utilize and manage local agro-ecosystems. From a rural economy perspective as is the case with the Makonde communal lands, rain-fed agriculture in combination with local ecosystem services constitute the largest source of livelihoods and wellbeing. Due to a combination of factors, ranging from: climate variability and change stresses; population pressure; poor land, crop and livestock husbandry; and unsustainable natural resources utilization, the state and productivity of the local environmental assets undergoes progressive deterioration. It is such an unsustainable human-environment association that has been observed in the Makonde case study, setting in a vicious cycle of poverty and environmental degradation.

There is a need for national and local government authorities to put in place a framework that allows a multi-stakeholder approach in addressing agricultural and environmental management challenges being faced by the Makonde communal farmers. With a coordinated approach led by AREX, the Forestry Commission and EMA, in association with other relevant governmental and NGO agents, there is need for outside intervention to regulate the local livelihood activities and

practices on the local agro-ecosystem. The thesis therefore suggests strengthening the combination of agricultural, environmental and climate change education to smallholder farmers as a prerequisite to the new vision of sustainable agricultural intensification. This implies a rural livelihoods system that seeks to increase farming yields and sustaining harvests without degrading the ecosystem services that underpin the production systems, practices and local human wellbeing.

Specific initiatives to promote sustainable agricultural intensification may include: crop diversification towards more drought resilient varieties; soil and nutrient management; (rain) water harvesting and micro-scale irrigation; conservation agriculture, intercropping and crop rotation; agro-forestry and agro-biodiversity. The combined outcomes of the named practices will help to eliminate unsustainable agricultural practices through village-based sustainable land management system (SLM) that ensures land is used for its best economic and ecosystem services. The approach must promote community participation and empowerment and in the process, creating a mosaic of diverse but integrated practices to boost agricultural production, sustained ecosystem productivity and strengthening livelihoods. For effective environmental conservation and management at the local level the study suggests more concerted effort in capacity building for the implementation of the environmental policy and the enforcement of supportive legislation. Effectiveness in this regard will however require greater coherence, coordination and integration between agricultural development, food security, environment and climate change policy processes at both the national and local level.

An ecosystems approach to strengthening climate-resilient livelihoods for the Makonde communal farmers is important based on the array of services that ecosystems provide to communities and households in times of climate change-induced stresses. While well managed ecosystems reduce climate change risks and vulnerability, poorly managed ecosystems can exacerbate them by increasing risks of drought, crop and livestock failure and household poverty as currently observed in the Makonde case study.

5.2.4 Climate-resilient Agricultural Systems and Practices for Sustainable Livelihoods.

One critical condition for increased agricultural productivity and food security among smallholder farmers is comprehensive awareness creation to bolster the farmers' knowledge levels on

agricultural land husbandry. The idea is to provide access to information that could help smallholder farmers to make appropriate decisions to reduce climate change-induced farming risks. This involves farmer education and training to fill the capacity gap; providing extension services for distribution of seasonal weather forecasts and local advice on the design of land, soils, water, crop and livestock management practices that are resilient to climate variability and change.

Besides awareness creation, there is a need for the mobilisation of funds to finance the development and rehabilitation of rural agricultural infrastructure; roads, dams, rain harvesting and water storage tanks, boreholes, irrigation, dip tanks, and mechanization. Focus must be on developing rural market facilities and input and other farmer support systems to promote diversified and increased farm productivity. There is a need to invest in a set of water management approaches known as Agricultural Water Management (AWM), which includes; irrigation, rainwater harvesting to help the water-scarce regions to grow enough food in the regions undergoing aridisation. The study suggests the employment of bottom-up and participatory processes in designing farmer-managed demonstration projects on climate risk management and climate resilient farming practices. The farmer-managed approach is anticipated to constitute an effective way of trying adaptation measures that are friendly to the local context. The pilot demonstration should involve the establishment of new crop varieties based on farmer-managed trials, screening the inappropriate and adopting the favorable to the local context. In the process, the approach exposes local farmers to many adaptation options to choose from. The community-based climate risk analysis would help to generate vital knowledge on the temporal and spatial dynamics of drought and its impacts in the project area than could be obtained from modeling per se.

The practice of intercropping should be enhanced where a variety of crops are grown together including the potentially adaptable food crops such as leguminous cow beans, roots, and tubers. Some crops such as cassava have got multi-purposes, whereby besides providing food, they provide shade against excessive soil moisture evaporation, soil stabilization, and even fuel and fiber for domestic use. For the effective adoption of the new crop options, the study suggests the need to put in place supportive mechanisms in terms of planning material, crop promoters, demonstrators and extension services. A sustained year-on-year support is needed for the new innovations, methods and practices to stick with farmers to guarantee success and cumulative

motivation. Extension workers must be increased in number, their mobility improved across the villages and the demonstration sites.

The lessons learnt and successful adaptation trials from demonstration centers should be complimented by removal of barriers to community replication of the innovations. Common barriers notable in the case study area include finance, credit, input bottle necks, and also market opportunities and attractive producer prices among other supportive policies and institutions to attract farmers off the traditional/ unsustainable preferences of maize. From successful trials there is need for up-scaling the adaptation lessons learned outwards to the rest of the villages and other districts and upwards to national policy level.

The thesis suggests that smallholder farmers should be incorporated into value chains to promote agricultural and rural development and thereby transforming rural farmers into entrepreneurs. This can be done by giving the farmers, the necessary resources, skills, knowledge, and accessibility to guaranteed market facilities for their produce as a way to promote increased productivity, and competitiveness. This is anticipated to offer smallholder farmers a chance to work themselves out of food insecurity and poverty. It is generally understood that for the poor rural people in particular, growth originating from agricultural production is much more effective at raising incomes than growth from any other sector.

The study further suggests the promotion of farmer organizations as a vehicle for sustainable agricultural development and strengthening food and income safety nets for vulnerable groups such as the elders, infants, the sick, child-headed families and women. Government in partnership with other development partners should work in partnership to increase support services to farming communities, with special emphasis on women, youths and other vulnerable groups, often lying at the receiving end of climate change impacts. The thesis suggests increased efforts for gender mainstreaming in reinforcing prospects for sustainable livelihoods in rural communities. As farmers, mothers, educators, and innovators, women provide a critical link between food production, consumption, and future progress on food security. Indeed, giving women farmers access to the same resources as their male counterparts could reduce the number of food insecure households.

The proposed multi-sectoral approach in rural development and climate change adaptation strategies will help to add impetus to Zimbabwe's current efforts to attain the UN Millennium Development Goals. This is particularly the case with goals on; eradication of extreme poverty and hunger, promotion of gender equality and empowering women, reducing child mortality, ensuring environmental sustainability and developing a global partnership for development.

5.3 SUGGESTIONS FOR FURTHER RESEARCH

Given the fact that the human-environment interface is in a state of continuous interactive transformation, the need for further research on this dynamic system is unquestionable. The subject on the rural farmers and climate change challenges and opportunities in the Makonde Communal Lands in particular and other vulnerable areas in general will ever require further research. The discourse on climate change, its projections, livelihood vulnerability and adaptation levels is bound to continue, especially based on the fact that the phenomenon is highly variable in both spatial and temporal terms.

Additional research to further develop the ideas and findings of this thesis would be required including both theoretical and empirical work. For further research, the study suggests attention on the exploration of connections between sustainability, risk and uncertainty. Climate change and human sustainability are characterized as the challenge of managing change in dynamic systems riddled with uncertainty. In the climate change-human livelihoods discourse, there are three imperatives namely: constant change, ever present uncertainty and ignorance, and an increasingly stressed affair between humans and the agro-ecosystems.

Future research on vulnerability, adaptive capacity and adaptation will remain of great utility to the wider research community especially seeking to answer questions such as:

- What should be of primary concern in research between biophysical and social vulnerability to climate change, or can there be a fair balance between the two without overlooking the other?
- At what scale should adaptive capacity to climate change be in terms of research scope and what is the dividing line especially considering the role of exogenous factors in facilitating or inhibiting the realization of sub-system capacity to climate change adaptation?

The case study also noted that the understanding of ecosystem dynamics remains limited, whilst socio-economic systems will continue to change, and outside determinants can never be fully anticipated. The knowledge base for the assessment of key vulnerabilities and risks from climate change is evolving rapidly. There are some significant gaps in researchers' knowledge with regards to impacts, the potential and nature of adaptation, and vulnerabilities of human and natural systems. The study suggests a highly interdisciplinary, integrative assessment approach that is able to capture biophysical and socio-economic processes. Better understanding of the underlying dynamics of these changes at varying scales is essential to improve understanding of key vulnerabilities to climate change. The complexity of the subject matter calls for collaborative research to strengthen climate change vulnerability assessments, involving researchers from different backgrounds.

Whilst current impacts of climate change have to a certain extent been determined, the thesis suggests a need for further research focusing at how future development paths and trends could increase or decrease vulnerability to climate change. There is also a need to enrich the body of knowledge on the practical, institutional and technical obstacles to the implementation of the currently considered adaptation strategies. In this case new research approaches might be required with a strong consideration of participatory (learning-by-doing) research approach. This will help the development of theory in parallel with, and supported by, experience from practice.

Most scholarly work has identified resource constraints as being the most significant determinants of adaptation. However, empirical research (including this thesis) on the vulnerability-adaptation interface have mostly not addressed the importance of measurable and alterable psychological factors in determining adaptation. There is therefore a need for further research to draw from the literature in psychology and behavioral economics to develop a socio-cognitive model of private proactive adaptation to climate change. This involves examining the role of psychological steps to taking action in response to risk perception, and the subsequent perceived adaptation strategies and adaptive capacity. Furthermore, future research may be extended onto the influence of culture and ideology on determining climate change risk, vulnerability and adaptation capacity. Observation in this case study suggests that belief systems may represent a considerable constraint on adaptation.

Given the fact that climate change and its potential impacts is a global concern, there is need for further work to assess the role of key international institutions in capacity building for climate change adaptation at local community level. Whilst there is so much rhetoric on sustainable climate change adaptation strategies at international conventions and symposiums, there is little evidence of the trickledown effect of such optimistic ideals and innovations to local settings such the Makonde communal case study. In this regard, there is need to examine the vertical integration and missing links of initiatives and actions such as those from the United Nations Framework Convention on Climate Change through the Global Environment Fund, Climate Development Special Fund, Global Climate Change Alliance, ClimDev Africa under the framework of United Nations Economic Commission for Africa and the National Action Plans for Climate Change Adaptation and Mitigation.

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LIST OF APPENDICES

Appendix : Data Coding Sheet

A. Background Information of Respondent

1. Sex of Respondent: Female – 1; Male - 2

2. Age of Respondent in years: 18-24 – 1; 25-34 – 2; 35-44 – 3; 45-54 – 4; 55-64 – 5;

Above 64 – 6

3. Household Status of Respondent: Husband – 1; Wife – 2; Daughter – 3; Son – 4;

Grand Child – 5; other – 6

4. Duration of stay in years in the Village: 0-10 – 1; 11-20 – 2; 21-30 – 3; 31-40 – 4;

Above 40 – 5

5. Family size: 0-4 – 1; 5-6 – 2; 7-8 – 3; 9-10 – 4; above 10 – 5

6. Age in years of family members:

6.1. *0-10*: 1 – 1; 2 – 2; 3 – 3; 4 – 4; 5 – 5

6.2. *11-18*: 1 – 1; 2 – 2; 3 – 3; 4 – 4; 5 – 5

6.3. *19-30*: 1 – 1; 2 – 2; 3 – 3; 4 – 4; 5 – 5

6.4. *30-40*: 1 – 1; 2 – 2; 3 – 3; 4 – 4; 5 – 5

6.5. *Above 40*: 1 – 1; 2 – 2; 3 – 3; 4 – 4; 5 – 5

B. Climate Change Knowledge and Experience of the Respondent

7. Awareness of the climate change phenomenon: Aware – 1; Unaware – 2

8. Extent of climate change in the area in terms of:

8.1. Mean temperatures: Nil – 1; little – 2; much – 3

8.2. Mean annual rainfall: Nil – 1; little – 2; much – 3

9. Rate of change of temperature in the last 20–30 years: Nil – 1; little rise – 2;

Significant rise – 3; decrease – 4

10. Rate of change of mean annual rainfall in the last 20–30 years: Nil – 1; little drop – 2

Significant drop – 3; Increase – 4

11.1 Degree of inter-annual rainfall variability: Nil – 1; little – 2; high – 3

11.2 Degree of intra-seasonal rainfall variability: Nil – 1; little – 2; high – 3

12. Frequency of drought spells in the area: Nil – 1; little – 2; Often – 3; very often – 4

13. Changes in the frequency of drought spells in the area: Declining – 1; sparse – 2;

Regular – 3; increasing - 4

14. Severity of drought impacts in the area: Declining – 1; negligible – 2; stable – 3;

Increasing – 4

15. Flood events in the area: Occur – 1; Non – 2

16. Frequency of flood event in the area: Seldom – 1; often – 2; very often – 3

C. Climate Change Impacts on the Local Environment

17. Climate change experienced in the area: No climate change – 1;

Negligible climate change – 2; significant climate change – 3; intensifying climate change – 4

18. Other source of climate change knowledge besides experience: Local AREX officers – 1;

Other government agents – 2; NGOs – 3; traditional leaders – 4;

Fellow community members – 5; all of the above – 6

19. Climate change–related impacts observed on:

19.1. Wetlands/ springs: Non – 1; little – 2; much – 3

19.2. Rivers/ streams: Non – 1; little – 2; much – 3

19.3. Wells/ boreholes: Non – 1; little – 2; much – 3

20. Changes that have occurred on:

20.1. Wetlands/ springs: Decline – 1; become seasonal – 2; disappeared – 3

20.2. Rivers/ streams: Decline – 1; become seasonal – 2; disappeared – 3

20.3. Wells/ boreholes: Decline – 1; become seasonal – 2; disappeared – 3

21. Climate change impacts on specified forest resources:

21.1 Wild fruits: Declining – 1; now scarce – 2; now very scarce – 3

21.2 Wood: Declining – 1; now scarce – 2; now very scarce – 3

21.3. Pasture: Declining – 1; now scarce – 2; now very scarce – 3

21.4. Wild animals/ birds: Declining – 1; now scarce – 2; now very scarce – 3

D. Climate Change Impacts on Household Livelihoods

22. The effects of climate change on household wellbeing: No effects – 1;

Negligible effects – 2; significant effects – 3; severe effects – 4

23. Impacts of climate change on household in terms of:

23.1. Crop yields: No change – 1; little drop – 2; significant drop – 3

23.2. Crop varieties: No change – 1; little drop – 2; significant drop – 3

23.3. Livestock: No change – 1; little drop – 2; significant drop – 3

23.4. Grain stocks: No change – 1; little drop – 2; significant drop – 3

24. Frequency of crop failure due to poor rains over the past 20-30 years: Nil – 1; Seldom – 2;

Quite often – 3; increasingly more often – 4

25. Frequency of livestock losses due to drought: Nil – 1; Seldom – 2;

Quite often – 3; increasingly more often – 4

26. Consequences of crop and livestock failure to the household: Nil – 1;

Drop in food reserves – 2; food shortage – 3; severe food shortages – 4;

Worsening incidence of food shortage

27. Other ways by which family is affected by crop/ livestock failure: Loss of income – 1;

inability to buy basic s (medicine, food items, clothing) - 2;

Inability to access basic services (schooling, health, etc) – 3;

Increasing incidence of emigration – 4; other – 5; All of the above – 6

28. Source of water for domestic purposes: Spring – 1; well – 2; borehole – 3;

River/ stream – 4; other – 5

29. The state of water source for the following uses:

29.1. Drinking: good/ reliable – 1; deteriorating – 2; poor – 3; very poor – 4; critically scarce – 5

29.2. For irrigation: good/ reliable – 1; deteriorating – 2; poor – 3; very poor – 4; critically scarce-5

29.3. For livestock: good/ reliable – 1; deteriorating – 2; poor – 3; very poor – 4;

Critically scarce – 5

E. Household Coping Strategies to Changing Climate

30. Household coping strategies to climate change impacts in meeting food needs: Buying – 1; Barter trade – 2; food for work – 3; borrowing – 4; food handouts – 5; other – 6; all - 7

31. Household coping strategies to climate change impacts in meeting income needs: sale
Livestock – 1; barter trade – 2; paid labor – 3; borrowing – 4; hunting / gathering – 5;

Craft work – 6; other – 7; all - 8

32. Success levels of household coping strategies to food shortage: Successful – 1;

Hardly successful – 2; unsuccessful – 3

33. Success levels of household coping strategies to income strains: Successful – 1;

Hardly successful – 2; unsuccessful – 3

34. Assistance received from outside the village: Yes – 1; none – 2

35. Helping institutions and kind of support received:

35.1. AREX: Education and training – 1; Input supplies – 2; food supplies – 3; other support – 4;

No support – 5

35.2. GMB: Education and training – 1; Input supplies – 2; food supplies – 3; other support – 4;

No support – 5

35.3. Other Government agencies: Education and training – 1; Input supplies – 2;

Food supplies – 3; other support – 4; no support – 5

35.4. FCTZ: Education and training – 1; Input supplies – 2; food supplies – 3; other support – 4;

No support – 5

35.5. CARITAS: Education and training – 1; Input supplies – 2; food supplies – 3;

Other support – 4; no support – 5

35.6. Other: Education and training – 1; Input supplies – 2; food supplies – 3; other support – 4;

No support – 5

36. Household evaluation of external assistance provided to support community adaptation to climate change:

36.1. AREX: Good – 1; satisfactory – 2; poor/ weak – 3

36.2. Government: Good – 1; satisfactory – 2; poor/ weak – 3

36.3. NGOs: Good – 1; satisfactory – 2; poor/ weak – 3

36.4. The Makonde District Authority: Good – 1; satisfactory – 2; poor/ weak – 3

37. Suggestions to enhance community adaptation to climate change for:

37.1 The community:

37.2. Government:

37.3 NGOs:

37.4 Others:

Appendix 2: Household Questionnaire Survey

Introduction

Dear Respondents: My name is Ishmael Sango, a student with the University of South Africa (UNISA). I would like to carry out a study in your area (Makonde District Communal) which is part of a requirement towards the fulfillment of my studies for D Litt et Phil in Environmental Management studies with the University.

Whilst the study is purely for academic purposes, it is sincerely anticipated that its findings will filter through to the local, national and regional policy makers as a body of knowledge that will help to make their decision making, planning and management of the climate change challenges and prospects affecting local communities more effective and sustainable.

The study is aimed at exploring the impacts of climate change and associated environmental changes on local livelihoods in the Makonde District, with particular focus on the communal lands.

Specifically, the study would like to

1. To determine climate change trends and manifestations in the Makonde Communal lands.
2. To evaluate the house level - impacts of climate change and associated environmental changes on peasant livelihoods in the Makonde Communal lands.
3. To investigate the adaptation strategies and resilience levels to climate change at household level in the district

This study will only be possible and successful on the basis of your participation as an important source of data.

I am therefore kindly seeking your assistance and cooperation in this regard through sparing part of your valuable time to respond to this questionnaire document. Please be assured that throughout the entire process, the responses you give are purely for academic purposes only and will be treated with utmost confidentiality to protect your rights and privacy.

The questionnaire will be divided into five key sections that are; the background information of the respondent, the respondent's understanding and experience of climate change trends in the area, the environmental impacts of climate in the area, the impacts of

Section B. Climate Change Knowledge and Experience of the Respondent

7. Are you aware of the problem of climate change?

- a) Yes b) No

8. If your answer in 7 is 'Yes', how much climate changes have you experienced in your area in terms of:

- Mean Temperature increase? a) Non b) Little c) Much
Mean annual rainfall amount? d) Non e) Little f) Much

9. In terms of mean temperature, how do you describe the changes you experienced in the last 20 – 30 years in the area?

- a) Nil b) Little rise c) Significant rise d) Decrease

10. In terms of Mean annual rainfall amounts, how do you describe the changes you experienced in the last 20 – 30 years in the area?

- a) Nil b) Little drop c) Significant drop d) Increase

11. How do you describe rainfall variability in the area?

- Between years? a) Non b) Little c) High
Within rain season? a) Non b) Little c) High

12. How often do you experience drought spells in the area?

- a) Nil b) Seldom c) Often d) Very often

13. How do you describe the frequency of drought occurrence in your area?

- a) Declining b) Sparsed c) Regular d) Increasing

14. How do you describe the severity of the drought Impacts in your area?

- a) Declining b) Negligible c) Stable d) Increasing

15. Have you experienced any floods in the area? a) Yes b) No

16. If your answer in Question 15 is 'Yes', how often does flooding occur in your area?

a) Seldom b) Often c) Very often

17. Overall, what is your experience with regards the process of climate change in your area?

a) No Climate change b) Negligible climate change

c) Significant climate d) Intensifying climate change

18. Besides your personal experience, what is the other source of your knowledge about climate change taking place in your area?

a) Local AREX Officers b) Other Government Officials

c) Donor agencies d) Traditional Leaders

e) Other community members f) The media g) All of the above

Section C. Impacts of Climate Change on the Local Environment

19. What climate change – related impacts have you observed on the following local resources:

Wetlands/ springs? a) Non b) Little c) Much

Rivers/ springs? a) Non b) Little c) Much

Wells/ boreholes? a) Non b) Little c) Much

20. If there are any changes in the above stated resources, how do you describe the changes that you have observed on the following:

Wetlands/ springs? a) Declining b) Become seasonal c) Disappeared

Rivers/ springs? a) Declining b) Become seasonal c) Disappeared

Wells/ boreholes? a) Declining b) Become seasonal c) Disappeared

21 What climate – related changes have you observed on the following forest resources:

- | | | | | | | |
|----------------------|--------------|--------------------------|---------------|--------------------------|--------------------|--------------------------|
| Fruits? | a) Declining | <input type="checkbox"/> | b) Now scarce | <input type="checkbox"/> | c) Now very scarce | <input type="checkbox"/> |
| Wood? | a) Declining | <input type="checkbox"/> | b) Now scarce | <input type="checkbox"/> | c) Now very scarce | <input type="checkbox"/> |
| Pasture? | a) Declining | <input type="checkbox"/> | b) Now scarce | <input type="checkbox"/> | c) Now very scarce | <input type="checkbox"/> |
| Wild animals/ birds? | a) Declining | <input type="checkbox"/> | b) N scarce | <input type="checkbox"/> | c) N very scarce | <input type="checkbox"/> |

Section D. Climate Change impacts on Peasant Liveinoods

22. Describe how climate change has affected your life.

- a) No effect b) Negligible effect c) Significantly d) Severely affected

23. With respect to the following farming aspects, describe how climate change has affected your family.

- | | | | | | | |
|----------------|--------------|--------------------------|----------------|--------------------------|---------------------|--------------------------|
| Crop yields | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |
| Crop variety | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |
| Livestock | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |
| Grain reserves | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |

24. Over the past thirty years, how often have you suffered crop failure due to poor rains?

- a) Nil b) Seldom c) Often d) Increasingly more often

24. Over the past thirty years, how often have you suffered livestock losses due to drought?

- a) Nil b) Seldom c) Often d) Increasingly more often

22. Describe how climate change has affected your life.

- a) No effect b) Negligible effect c) Significantly d) Severely affected

23. With respect to the following farming aspects, describe how climate change has affected your family.

- | | | | | | | |
|----------------|--------------|--------------------------|----------------|--------------------------|---------------------|--------------------------|
| Crop yields | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |
| Crop variety | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |
| Livestock | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |
| Grain reserves | a) No change | <input type="checkbox"/> | b) Little drop | <input type="checkbox"/> | c) Significant drop | <input type="checkbox"/> |

24. Over the past thirty years, how often have you suffered crop failure due to poor rains?

- a) Nil b) Seldom c) Often d) Increasingly more often

24. Over the past thirty years, how often have you suffered livestock losses due to drought?

- a) Nil b) Seldom c) Often d) Increasingly more often

22. What consequences is your family suffering due to the above – stated crop failure and/ or livestock losses?

- a) Nil b) Drop in food reserves c) Food shortage
d) Severe food shortages e) Increasing incidence of food shortages

25. In which other ways is your family affected by the above – stated incidence of crop and/ or livestock losses?

- a) Loss of income b) In ability to buy other basic needs (medicine, groceries, and clothes)
c) Inability to access basic services (school, medical, and others)
d) Increasing incidence of family e) All of the above

26. How has climate change affected you in terms of water supply?

- a) No effect b) Negligible effect c) Increasing shortage
d) Has become very scarce

27. What is your source of water for domestic purposes?

- a) Spring b) Well c) Borehole d) River e) Other _____

28. State the status of your water source for the following aspects of your livelihood.

For drinking: a) Good/ Reliable b) Deteriorating

c) Poor d) Very poor e) Critically scarce

For Irrigation: a) Good/ Reliable b) Deteriorating

c) Poor d) Very poor e) Critically scarce

For Livestock: a) Good/ Reliable b) Deteriorating

c) Poor d) Very poor e) Critically scarce

Section D. Household Coping Strategies and Resilience Levels

29. In terms of food supplies, what coping strategies have you adopted to meet family food requirements in case of crop failure?

- a) Buying b) Barter trade c) Food for work
 c) Borrow d) Hunting/ gathering e) Hand outs f) Other _____

30. In terms of income, what coping strategies have you adopted in order to sustain your family needs in case of poor harvests?

- a) Sale livestock b) Barter trade c) Paid labor d) Borrow
 e) Hunting/ gathering for sale f) Craft work g) Other _____

31. How do you describe your coping strategies to sustain family food supplies?

32. How do you describe your coping strategies to supplement family income in case of poor harvests?

- a) Successful b) Hardly successful c) Unsuccessful

33. In the face of the climate change- related challenges affecting the community, are you receiving any kind of help/ support from outside the community?

- a) Yes b) No

34. If your answer in 33 is yes, please fill in the table 1 below to identify the institution and the kind of support you receive.

Table 1 Supportive Institutions towards Local Climate Change Adaptation and Reliance.

Institution	Form of Support			
	a) Education/ Training	b) Input supplies	c) Food supplies	d) Other support (please specify)
AREX				
GMB				
Other GVT				
NGO 1				
NGO 2				
OTHER/s – Please specify				

35. Please indicate below, the supporting institution and give your evaluation of its role in strengthening your community's adaptive capacity to climate change impacts.

_____	a) Good	<input type="checkbox"/>	b) Satisfactory	<input type="checkbox"/>	c) Poor/ week	<input type="checkbox"/>
_____	a) Good	<input type="checkbox"/>	b) Satisfactory	<input type="checkbox"/>	c) Poor/ week	<input type="checkbox"/>
_____	a) Good	<input type="checkbox"/>	b) Satisfactory	<input type="checkbox"/>	c) Poor/ week	<input type="checkbox"/>
_____	a) Good	<input type="checkbox"/>	b) Satisfactory	<input type="checkbox"/>	c) Poor/ week	<input type="checkbox"/>

36. Given the climate change problems, effects and the efforts so far being made to deal with the challenges, please make suggestions to the following institutions, in order to enhance the community's adaptation and resilience levels to climate change.

The Community members should:

The Government should :

The NGOS should

Others (please specify)

_____ Other

Suggestions _____

Thank Very much for your time and cooperation

Yours faithfully

Ishumael Sango (Student Number – 44928734)

PhD Candidate (D Litt et Phil in Environmental Management)

Department of Environmental Sciences

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Appendix 3: Interview Guide for the Department of Meteorological Services

Interview Guide Questions for The Department of Meteorological Services.

1. The Role of the Met office in the face of Climate change and its potential impacts on rural livelihoods
2. The concept of climate change as applicable to the Met Office
3. Whether there is any climate change taking place in Zimbabwe in general and Makonde district in particular (to please provide the national and the Makonde district Climate change scenarios).
4. If there is any climate change occurring in the country/ and Makonde district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
5. Any biophysical changes taking place in Makonde in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
6. Any notable and projected effects of climate change and related environmental changes on the local peasant livelihoods, particularly in Makonde district with regards to:
 - Cropping yields?
 - Cropping varieties?
 - Livestock productivity and variety?
 - Food security?
 - Household income?
 - Household health?
 - Overall household welfare?

7. With regards to rural community coping strategies to climate variability and climate change, any notable elements of maladaptation at the local level?
8. What programs/ projects is the Met office facilitating to enhance the rural Communities' adaptive capacity to climate change related challenges in Zimbabwe, Mashonaland West and Makonde district?
9. What other partners are there in the region, country, Mashonaland West and Makonde District to help enhance climate change mitigation and adaption by rural communities?
10. What are their respective contributions?
11. Evaluate the level of success of the following in building climate change adaptive capacity in Zimbabwe, Masholanad West and Makonde District:
- The Zimbabwe Meteorological services
 - The Government
 - Mashonaland West Regional Authorities and Makonde Rural District Council
 - Local communities
 - NGOs
 - Others
12. What would you suggest towards sustained climate change adaptive capacity for Zimbabwe in general and the Makonde district particular?

Thank You for your time and valuable data

Yours faithfully

Ishumael Sango (Student Number – 44928734)

PhD Candidate (D Litt et Phil in Environmental Management)

Department of Environmental Sciences

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Appendix 4: Interview Guide for the Agricultural Research and Extension Services

Interview Guide Questions for

The Agriculture, Research and Extension Services (AREX) Office.

1. The Role of the Department in terms of rural livelihoods development
2. The Officer's understanding of the concept of climate change
3. Whether there is any climate change taking place in Makonde District
4. If there is any climate change occurring in the district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
5. Other environmental (biophysical changes) taking place in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
6. How much effect has the climate and related environmental changes had on the local peasant livelihoods (to provide statistics where possible) with regards to:
 - Cropping yields?
 - Cropping varieties?
 - Livestock productivity and variety?
 - Food security?
 - Household income?
 - Household health?
 - Overall household welfare?

7. How are households coping with the following climate change – related challenges?

- Increasing water scarcity
- Crop failure
- Food shortages
- Livestock losses
- Reduced household income
- Household health challenges

8. What are the environmental Implications of the household coping strategies to climate change?

9. What are the social implications of the coping strategies to climate change – related challenges?

10. What role is AREX playing to enhance the Community's adaptive capacity to climate change related challenges?

11. What other partners are there in the district to help enhance the Community's adaptive capacity to climate change related challenges?

12. What are their respective contributions?

13. Evaluate the level of success of the following in building climate change adaptive capacity in the district:

- The community
- Government agents
- NGOs
- Others

14. What would you suggest towards sustained climate change adaptive capacity for the Makonde district?

Appendix 5: Interview Guide for Environmental Management Agent

Interview Guide Questions for

The Environmental Management Authority (EMA): Mashonaland West Region.

1. The Role of EMA in promoting rural livelihoods development.
2. The of concept of climate change from the perspective of EMA
3. Whether there is any climate change taking place in Zimbabwe in general and Makonde district in particular (to please provide the national and the Makonde district Climate change scenarios).
4. If there is any climate change occurring in the country/ and Makonde district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
5. Other environmental (biophysical changes) taking place in Makonde in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
6. How much effect has the climate and related environmental changes had on the local peasant livelihoods, particularly in Makonde district (to provide statistics where possible) with regards to:
 - Cropping yields?
 - Cropping varieties?
 - Livestock productivity and variety?
 - Food security?

- Household income?
- Household health?
- Overall household welfare?

7. How are households in Makonde District coping with the following climate change – related challenges?

- Increasing water scarcity
- Crop failure
- Food shortages
- Livestock losses
- Reduced household income
- Household health challenges

8. What are the environmental Implications of the household coping strategies to climate change?

9. What are the social and economic implications of the coping strategies to climate change – related challenges?

10. What programs/ projects is EMA facilitating to enhance the rural Communities' adaptive capacity to climate change related challenges in Zimbabwe, Mashonaland West and Makonde district?

11. What other partners are there in the region, country, Mashonaland West and Makonde District to help enhance climate change mitigation and adaption by rural communities?

12. What are their respective contributions?

13. Evaluate the level of success of the following in building climate change adaptive capacity in Zimbabwe, Masholanad West and Makonde District:

- EMA in particular
- The Government in general
- Mashonaland West Regional Authorities and Makonde Rural District Council
- Local Communities
- NGOs
- Others

14. What would you suggest towards sustained climate change adaptive capacity for Zimbabwe in general and the Makonde district particular?

Thank You for your time and valuable data

Appendix 6: Interview Guide for the Department of Social Services
Interview Guide for the Department of Social Services

Mashonaland West Region

Aspects of my concern in need of assistance from the Department.

1. Any knowledge / experience of the evidence/ indicators of the evidence of climate change in the Masholanad west/ Makonde rural District
2. The notable impacts of climate change (with statistical data where possible) on;
 - a. Food security
 - b. General rural livelihoods in the Makonde District
 - c. Income generation and poverty alleviation
3. Intervention measures by the:
 - a. Department
 - b. Other Government agents
 - c. Other Development Partners and NGOs to alleviate climate change - related and other associated challenges facing the rural communalities.

Thank You

I Sango

Appendix 7: Interview Guide for the Farm Community Trust of Zimbabwe (FCTZ)

Interview Guide Questions for

Farm Community Trust (Mashonaland West)

1. The Role of Farm Community Trust (FCT) in supporting rural livelihoods in the Makonde Rural District
 - Program/s
 - Project/s
2. The organization's understanding of the concept of climate change
3. Whether there is any climate change taking place in Makonde District
4. If there is any climate change occurring in the district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
5. Other environmental (biophysical changes) taking place in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
6. How much effect has the climate and related environmental changes had on the local peasant livelihoods (to provide statistics where possible) with regards to:
 - Cropping yields?
 - Cropping varieties?
 - Livestock productivity and variety?
 - Food security?
 - Household income?
 - Household health?
 - Overall household welfare?

7. How are households coping with the following climate change – related challenges?
- Increasing water scarcity
 - Crop failure
 - Food shortages
 - Livestock losses
 - Reduced household income
 - Household health challenges
8. What are the environmental Implications of the household coping strategies to climate change?
9. What are the social and economic implications of the coping strategies to climate change – related challenges?
10. How does FCT's program or project/s contribute towards enhanced climate change adaptation in the district?
11. How is FCT's work in the district affected by climate change – related challenges in the district?
12. What other partners are there in the district to help enhance the Community's adaptive capacity to climate change related challenges?
13. What are their respective contributions?
14. Evaluate the level of success of the following in building climate change adaptive capacity in the district:
- The community
 - The Government
 - The Local authority
 - NGOs
 - Others
15. What would you suggest towards sustained climate change adaptive capacity for the Makonde district?

Appendix 8: Interview Guide for the CARITAS

Interview Guide Questions for

CARITAS Masholanad West

The Role of Caritas in supporting rural livelihoods in the district

- Program/s
- Project/s

2. The Officer's understanding of the concept of climate change

3. Whether there is any climate change taking place in Makonde District

4. If there is any climate change occurring in the district, are there any indications or records of change in terms of:

- Rainfall amounts
- Rainfall distribution (annual and seasonal)
- Rainfall variability (annual and seasonal)
- Mean annual temperatures
- Annual and seasonal Temperature distribution

5. Other environmental (biophysical changes) taking place in response to climate change, particularly on:

- Forests/ natural vegetation cover
- Water resources
- Animal resources (fish, birds, other beneficial animals)
- Soil resources

6. How much effect has the climate and related environmental changes had on the local peasant livelihoods (to provide statistics where possible) with regards to:

- Cropping yields?
- Cropping varieties?
- Livestock productivity and variety?
- Food security?
- Household income?
- Household health?
- Overall household welfare?

7. How are households coping with the following climate change – related challenges?

- Increasing water scarcity
- Crop failure
- Food shortages
- Livestock losses
- Reduced household income
- Household health challenges

8. What are the environmental Implications of the household coping strategies to climate change?

9. What are the social and economic implications of the coping strategies to climate change – related challenges?

10. How does Caritus’s program or project/s contribute towards enhanced climate change adaptation in the district?

11. How is Caritus’s work in the district affected by climate change – related challenges in the district?

12. What other partners are there in the district to help enhance the Community’s adaptive capacity to climate change related challenges?

13. What are their respective contributions?

14. Evaluate the level of success of the following in building climate change adaptive capacity in the district:

- The community
- The Government
- The Local authority
- NGOs
- Others

15. What would you suggest towards sustained climate change adaptive capacity for the Makonde district?

Appendix 9: Interview Guide for the Makonde Rural District Council

Interview Guide Questions for

The District Administrators' Office (Makonde Rural).

1. The Role of the D A's office in supporting rural livelihoods in the district
2. The Officer's understanding of the concept of climate change
3. Whether there is any climate change taking place in Makonde District
4. If there is any climate change occurring in the district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
5. Other environmental (biophysical changes) taking place in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
6. How much effect has the climate and related environmental changes had on the local peasant livelihoods (to provide statistics where possible) with regards to:
 - Cropping yields?
 - Cropping varieties?
 - Livestock productivity and variety?
 - Food security?
 - Household income?
 - Household health?
 - Overall household welfare?

7. How are households coping with the following climate change – related challenges?

- Increasing water scarcity
- Crop failure
- Food shortages
- Livestock losses
- Reduced household income
- Household health challenges

8. What are the environmental Implications of the household coping strategies to climate change?

9. What are the social and economic implications of the coping strategies to climate change – related challenges?

10. What programs/ projects is the D A's office facilitating to enhance the Community's adaptive capacity to climate change related challenges?

11. What other partners are there in the district to help enhance the Community's adaptive capacity to climate change related challenges?

12. What are their respective contributions?

13. Evaluate the level of success of the following in building climate change adaptive capacity in the district:

- The community
- The Government
- The Local authority
- NGOs
- Others

14. What would you suggest towards sustained climate change adaptive capacity for the Makonde district?

Appendix 10: Interview Guide for the Local Elders

Interview Guide Questions for the Local Elder/s

1. Age of respondent
2. Duration of stay in the village/ area
3. The understanding of climate change
4. Observed elements of climate change in the region
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
5. Observed climate change – related environmental changes on:
 - Forests/ natural vegetation cover
 - Wild life (animals, fish, birds, other)
 - Water resources
 - Soil resources
6. Elder's practical experience evidencing climate change in the village/ area in terms of:
 - access to and use of forest resources (hunting, fruits, wood harvesting, etc)
 - access to and use of water resources (springs, rivers, wetlands, etc)
7. Major climatic events (and their years) that have caused community suffering over the years
8. How much effect has the climate and related environmental changes had on the local peasant livelihoods (to provide figures where possible) with regards to:
 - Cropping yields and varieties?
 - Livestock productivity and variety?
 - Food security?
 - Household income?
 - Household health?
 - Overall household welfare?
9. How are households coping with the following climate change – related challenges?
 - Increasing water scarcity
 - Crop failure
 - Food shortages

- Livestock losses
- Reduced household income
- Household health challenges

10. What are the social and economic implications of the community/ households' coping strategies to climate change – related challenges?

11. Any assistance that the affected households/ communities receive in times of climate - related crisis

12. Judgment of the level of success of the following in building climate change adaptive capacity in the district:

- The community
- The Government
- The Local authority
- NGOs
- Others

13. Suggestion towards sustained climate change adaptive capacity for the village and Makonde district?

Appendix 11: Interview Guide for the Local School Heads

Interview Guide Questions for

Local School Head

1. The Head's understanding of the concept of climate change
2. Whether there is any climate change taking place in Local area
3. If there is any climate change occurring in the district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
4. Other environmental (biophysical changes) taking place in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
5. How much effect has the climate and related environmental changes had on the local peasant livelihoods (to provide statistics where possible) with regards to:
 - Local Food security?
 - Household income?
 - The running and well being of the school
 - School enrolment and attendance
 - School children's health
6. How has the school been coping with the following climate change – related challenges?
 - Increasing water scarcity
 - Community food shortages

- Reduced household income in the community
- School fees constraints among parents,
- Reduced school enrolment and class attendance

7. What are Implications of the school's coping strategies to the above challenges?

8. How is the school contributing towards enhanced climate change adaptation by the community?

9. What other partners are there in the district to help enhance the school and its Community's adaptive capacity to climate change related challenges?

10. What are their respective contributions?

11. Evaluate the level of success of the following in building climate change adaptive capacity in the district:

- The community
- The School
- The Government
- The Local authority
- NGOs
- Others

12. What would you suggest towards sustained climate change adaptive capacity for the local community?

Appendix 12: Interview Guide for the Local Health Centers

Interview Guide Questions for

Local Health Centre

1. The Head's understanding of the concept of climate change
2. Whether there is any climate change taking place in the local area
3. If there is any climate change occurring in the district, are there any indications or records of change in terms of:
 - Rainfall amounts
 - Rainfall distribution (annual and seasonal)
 - Rainfall variability (annual and seasonal)
 - Mean annual temperatures
 - Annual and seasonal Temperature distribution
4. Other environmental (biophysical changes) taking place in response to climate change, particularly on:
 - Forests/ natural vegetation cover
 - Water resources
 - Animal resources (fish, birds, other beneficial animals)
 - Soil resources
5. How is climate change affecting the running and well being of the Healthy Centre?
6. What health – related challenges are emerging as a result of climate change in the local area?
6. How has the health centre been coping with the following climate change – related challenges?
 - Increasing water scarcity
 - Community food shortages and malnutrition
 - Reduced household income in the community
7. What are Implications of the health centre's coping strategies to the above challenges?
8. How is the health centre contributing towards enhanced climate change adaptation by the community?

9. What other partners are there in the district to help enhance the health centre and its Community's adaptive capacity to climate change related challenges?
10. What are their respective contributions?
11. Evaluate the level of success of the following in building climate change adaptive capacity in the district:
- The community
 - The Health centre
 - The Government
 - The Local authority
 - NGOs
 - Others
12. What would you suggest towards sustained climate change adaptive capacity for the local community?

Appendix 13: Observation Checklist

Village	Site/ Feature	Environmental/ Social Aspect	Level of Climate Change Impact					Remark
			No Impact	Negligible impact	Significant Impact	Severe Impact	N/A	
	Forest	Vegetation age/ height						
		Vegetation density						
		Species diversity						
		Fruit Species						
		Animal species						
		Wood - fiber						
	Water Resource	River/ stream flow						
		River/ stream depth						
		Spring discharge						
		Dam level/ depth						
		Well yield						
		Borehole yield						
	Pasture	Grass height						
		Grass density						
		Grass diversity						
		Livestock variety						
		Livestock numbers						
		Livestock state of health						
	Arable Land	Soil depth						
		Humus content						
		Soil stability						
		Crop variety						
		Crop state of health						
	HH Livelihood and status	Family size						
		Family structure						
		Housing Quality						
		Food stocks						
		Nutrition garden						
		Livestock ownership						
		Family's Nutrition						
Family income								
Health status								
HH Coping Strategies	Land and crop husbandry							
	Food & income							
HH Coping Capacity	Success levels							