



**LOCAL KNOWLEDGE ADAPTATION MEASURES IN AN ERA OF  
CLIMATE CHANGE: A CASE STUDY OF CHIVI DISTRICT IN  
MASVINGO, ZIMBABWE**

**BY**

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## DECLARATION

Student number: M154004

I, Doreen Taurai Tshuma, declare that **LOCAL KNOWLEDGE ADAPTATION MEASURES IN THE ERA OF CLIMATE CHANGE: A CASE STUDY OF CHIVI DISTRICT, IN MASVINGO ZIMBABWE** is my own effort and that the sources that were used or quoted have been indicated and acknowledged by way of complete references.

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Date:

## ABSTRACT

The study sought to explore possibilities of local knowledge adaptation measures used by the people of Chivi in the era of climate change. The interpretivist paradigm was employed to investigate various ways used by the participants to adapt to climate change. Purposive sampling was utilised to select the main respondents who met the age criterion of fifty (50) years and above, and who were born and bred in Chivi district. This procedure was to ensure that the participants had witnessed climatic changes occurring in Chivi. The age was taken to authenticate lived experience of climate change by the participants. Data was gathered through focus group discussions, in-depth interviews, observations and transect walks. Information collected through these methods and their associated tools was presented in tables, figures as well as qualitatively in words. Photographs were taken and presented to substantiate information gathered from observations and transect walks. The study was guided by indigenous knowledge held by the respondents. This community based approach was chosen over the top-down approach which is usually imposed on people by stakeholders.

Research findings revealed that climate in the area has changed as evidenced by accounts given by people who have stayed in the area in the last fifty (50) years or more. Extreme weather events such as droughts, high temperatures and sometimes floods were cited. The numbers of rain days have reduced whilst there is an increase in the occurrence of dry spells during the rain season. Some of the evidence in the area to support the changing climate was that of the drying of rivers which used to flow right through the year, the extinction of some species and the reduction in biodiversity. Although quite a number of local knowledge adaptation measures were known in the area, a small percentage of people were using them. These measures included dug out water infiltration trenches, temporary migration of livestock, the *zunde raMambo* concept

and crop diversification and rearing of drought resistant animals. A number of barriers were found to be hindering the widespread and effective use of local knowledge adaptation measures. The study concluded that the importance of using indigenous knowledge systems as adaptation measures has been relegated for top-down scientific measures. It is recommended that indigenous knowledge systems be documented so that present and future generations benefit by enhancing their adaptive capacity to climate change. Education platforms should be established to teach and empower young generations on the importance of using and respect for indigenous knowledge systems. Growing of drought resistant crops and keeping drought resistant animals should be embraced by every household in the area to eradicate poverty brought by increased climate variability and climate change being experienced in Chivi District. A framework for pathway to intergrating indigenous knowledge systems in climate change adaptation was developed as a pathway to sustainable climate change adaptation for communities.

#### **KEY TERMS**

Climate change, climate variability, vulnerability, exposure, adaptation, mitigation, local knowledge, risks, extreme weather events, impacts, barriers

## **DEDICATION**

The thesis is dedicated to my mother Mrs L. Magorimbo and my late daughter Sakhile Lyn Tshuma.

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## **LIST OF ABBREVIATIONS**

|          |  |
|----------|--|
| AGRITEX: | Department of Agricultural Technical & Extension Services        |
| CBA:     | Community Based Approach   |
| CBD:     | Convention on Biological Diversity                               |
| FAO:     | Food and Agricultural Organisation                               |
| GDP:     | Gross Domestic Product   |
| GHG:     | Greenhouse Gas   |
| HDI:     | Human Development Index  |
| ICRISAT: | International Crops Research Institute for the Semi-Arid Tropics |
| IPCC:    | Intergovernmental Panel on Climate Change                        |
| IKS:     | Indigenous Knowledge Systems                                     |
| NGO:     | Non-governmental organisation                                    |
| TERI:    | The Energy and Resources Institute                               |
| UNEP:    | United Nations Environmental Program                             |
| UNFCC:   | United Nations Framework on Climate Change                       |
| UNFCCC:  | United Nations Framework Convention on Climate Change            |
| WMO:     | World Meteorological Organisation                                |
| ZIMSTAT: | Zimbabwe National Statistics Agency                              |

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# **CHAPTER ONE: INTRODUCTION**

## **1.1 Introduction**

The biophysical systems in any environment have thresholds and potentials to the activities man may engage in when striving to sustain a living. Systems like forestry, agriculture, soil and energy resources are all affected by climate (Lin & Petersen, 2013). Particularly important are the effective rainfall and temperatures of an area which have significant effects on ecosystem thresholds, such as species composition and distribution over space (Williams & Jackson, 2007). These drivers easily affect ecosystems which are fragile and therefore less resilient to changes. Climate change has been occurring in the World, affecting settlements, agricultural patterns and ecosystems at large. Evidence of climate change was noticed around the 1840s when scientists gathered proof of former Ice Ages (Barry & Chorley, 2009). Ice Ages and interglacial periods are said to have occurred in the past two million years being caused by movements of plate tectonics and natural oscillation of the earth (Christopherson, 2012). Climate change therefore has been occurring since time immemorial. However, over the last one hundred (100) years, climate change has been attributed to anthropogenic causes, where man has led to increases in carbon dioxide and other greenhouse gases (Stigson, 2010; Christopherson, 2012; Gupta, 2012; Malachin, 2013). This has led to various effects on individuals, population species, communities, ecosystems and biomes on a large scale (IPCC, 2007; Dillon, Wang & Huey, 2010; Beaumont, Pitman, Poulsen & Huey, 2011; McMahon et. al, 2011). It is important to note that changing climate is alleged to be threatening the existence of species on earth, including mankind.

In order to avert the dangers posed by climate change, two approaches have been agreed upon by scientists to deal with the challenges and benefits brought by climate change (IPCC, 2007).

These approaches are mitigation and adaptation. Mitigation is meant to reduce greenhouse gas emissions into the atmosphere whilst adaptation is a coping strategy that is meant to reduce the challenges and maximize the benefits brought by climate change. Impacts of climate change are unavoidable, hence the importance of responses that are aimed at reducing their impact. In this chapter, the background to the study is delineated. The scope of the study is also outlined.

## **1.2 Background to the study**

### **1.2.1 Overview of the changing climate**

There is growing support that the world climate is changing at a great pace (Bergkamp, Orlando & Burton, 2013; Malachin, 2013; and Singh, Byjesh & Bantilan, 2015). This has been worsened by increases in greenhouse gas concentrations, especially carbon dioxide, leading to global warming (IPCC, 2007). Climate does not only vary from place to place, but it naturally varies over time (Barry & Chorley, 2009; Holden, 2008; Hess, 2011; Christopherson, 2012). It is important to note that climate differs from place to place due to a variety of reasons such as latitude, altitude, ocean currents, surface cover and human activities. Scientists worldwide agree that greenhouse gases are beneficial to the earth because without them temperatures would fall to below 0°C. Greenhouse gases (GHG) help in that they have a blanket effect of trapping outgoing infra-red radiation. The function of GHG is to trap heat thereby keeping the earth warm and sustaining life (Barry & Chorley, 2009). However, the GHG have increased beyond unprecedented levels since the 1960s (IPCC, 2007; Vellinga & Verseveld, 2000; Miller & Spoolman, 2012).

The Intergovernmental Panel on Climate Change (IPCC) published a report in 2007 which predicted that global warming will result in, among other things, a decline in water availability resulting in billions of people facing water shortages, disruptive seasonal rainfall patterns leading to droughts and floods, reduced crop yields, and increased food insecurity as well as a reduction in forest resources. Global air temperatures have risen in the range of 0.55 to 0.67°C (IPCC, 2013). This is threatening the sustainability of human livelihoods and security and sustainable development as well. This increase has been attributed to high levels of greenhouse gases mainly through industrialization, clearing of forests, agriculture and burning of fossil fuels. Therefore, there is need, for adaptation and mitigation measures worldwide to deal with climate change.

### **1.2.2 Global concerns on climate change**

The United Nations Environmental Program (UNEP) together with the World Meteorological Organization (WMO) set up the IPCC in 1988 to formulate strategic responses to all aspects of climate change. This was after agreement among scientists was reached that indeed climate change was real and there was need for global co-operation to deal with its associated challenges (IPCC, 2007). The first IPCC Assessment Report was then written in 1990 and it led to the formation of an international treaty, the United Nations Framework on Climate Change (UNFCCC), and as of the year 2017, five (5) Assessment Reports had been written. This shows that the world is concerned about climate change because it is a major risk to sustainable development.

According to the IPCC (2014) there, is scientific agreement that global impact of changing climate will have huge consequences on agriculture-based livelihoods especially in sub-Saharan

Africa. The dire impacts will have differing effects and extent depending on the area and sector. Projections indicate that the unfavorable impact of the changing and increasingly varying climate will be felt strongly in Southern Africa, where Zimbabwe is situated (Rekacewicz, 2005; Lobel, Banziger, Magorokosho & Vivek, 2008; Knox et al, 2012). Southern Africa's temperatures have risen by between 1-4° C between mid 60s and mid 90s and precipitation changes range from plus or minus ten to fifteen percent (10 -15%) on average during the rainy season (Unganai, 1996).

Climate change and climate variability are likely to affect more the poor and the vulnerable who are concentrated in many parts of Africa and this will increase the gap between the world's rich and poor (Masika, 2002). Although developing countries are the least contributors to greenhouse gas emissions, they are the most susceptible to the impact of climate change. Brazier (2017: 45) gives the example of Zimbabwe that its;

contribution to the climate change problem is very small. Its emissions per capita are- a quarter of the global average and electricity consumption per capita is about twenty percent (20%) of the global average.

However due to a high dependence on rainfall and water resources, the impacts of climate change are felt more. There is evidence already that crop yields in Africa are declining due to a reduction in rainfall and an increase in temperatures (Zinyengere et al., 2013). This has a major impact as the region mainly has an agrarian economy which is rain-fed. Agriculture as the life-form of livelihoods of many people in Africa, any unfavorable effect on it result in increase in poverty levels and reduction in food security (Singh, Byjesh & Bantilan, 2015). In addition to the problems brought by climate change, countries in Africa are faced with other challenges such as land degradation, unstable economies and poor governance (Vermeulen, Aggarwal, Ainslie et al;

2012). As a result of the region's susceptibility to climate change, it is imperative for communities to find ways of minimizing its impact on their livelihoods.

Global concerns have also been expressed regarding the uncertainties brought by climate change. The uncertainties are in terms of future climate predictions and security threats. Bergkamp et.al, (2013) propose that it is no longer reliable to use present and past climate patterns to forecast weather variability and extremes in the future because there are a lot of uncertainties. Scientists are no longer sure of what the future holds regarding the climate. Predictions of future climate scenarios are therefore made but not with absolute certainty on what the impacts of the shifting climate will be on the socio-economy, culture and the environment (Hulshoff, 2014). Therefore, this is making developmental planning very difficult, especially in Africa, where the economy is mainly agrarian and rain-fed; and its GDP (Gross Domestic Product) very low. Hulshoff (2014) adds that some government leaders have even gone further to recognize the complexity of climate change/security nexus as they play a blame game on climate change issues. Developing nations blame developed countries for being the major polluters, arguing that they should take charge of addressing the problem (Hulshoff, 2014). On the other hand, developed countries see climate change as a national risk as they anticipate an increase in the immigration of people from developing nations seeking better livelihoods. In addition developed countries argue that they cannot pay for the mistakes done by their 'ancestors' during industrial revolution (Zhang; 2011) Therefore, to avoid a global catastrophe due to climate change, it is of the essence that nations reach an agreement and find ways of dealing with changing climate.

### **1.2.3 Approaches to climate change**

Mitigation and adaptation are two approaches which have been advocated by the IPCC (2007) to reduce the effects of climate change. These two approaches are complimentary when it comes to climate change as they both contribute to sustainable development. Whereas mitigation is global in nature and aims at minimizing greenhouse gases in the atmosphere, adaptation is specific to an area depending on the effects experienced there. However, the IPCC report (2001: 2) observes that “adaptation has the potential to reduce adverse effects of climate change and can often produce immediate ancillary benefits, but will not prevent all damages”. This observation is significant to note particularly in Africa and other developing countries as most livelihoods are agrarian based, hence the importance of the adaptation processes to climate change as many people in sub-Saharan Africa are mainly concerned about ‘hanging in there’ (Dorward, 2009). On the other hand, regarding mitigation of climate change, policies have been put in place at different conferences such as the United Nations Framework Convention on Climate Change (UNFCCC of 1992) and the Kyoto Protocol enacted in 1997. These have been ratified and adopted by different governments but not all. For mitigation to be successful in combating climate change, all countries have to agree on ways of implementing the suggested policies (Stigson, 2010; Parker, Christer, Mattias & Bjorn-Ola, 2012; IPCC, 2013). Without agreement by all nations, greenhouse gases will continue being emitted to dangerous levels which will worsen climate change. Increases in greenhouse gas emissions greatly impact on livelihoods and the future environments, even if mitigation approaches are implemented. The impact of climate change is unavoidable; hence the need and importance of shifting the focus to adaptation processes which are meant to alleviate problems brought about by the changing climate.

Ordinary people are mainly concerned about efforts which have immediate benefits compared to futuristic benefits which they might not experience. Scientists agree that adaptation strategies are realized immediately by the concerned community as opposed to mitigation (Arbuckle et.al, 2007; IPCC, 2008, Rurinda, 2014; Singh, Byjesh & Bantilan, 2015). Mitigation efforts may be felt in the future, as these are global in nature and meant to lessen greenhouse gas concentration in the atmosphere. However, decisions made today to reduce greenhouse gas emission(s) might have beneficial effects to future generations as they may help in combating climate change. According to Parry et.al (2005) since the Third Assessment Report by the IPCC in 2001, adaptation has emerged as an important tool in climate change, worldwide.

Adaptation can either be a top-down or grassroots based approach. This approach seems to be failing as it targets disaster prevention without considering or consulting the affected community in the decision making-process (Brazier, 2015). Grassroots based adaptation takes into cognizance the local people, their experiences with climate change and severe weather events, thereby empowering them in the decision making-process. However, the approach requires communities who are pro-active for them to fully benefit. Adaptation measures therefore, differ from place to place depending on the extreme weather events experienced, the community, technology, bio-physical characteristics, and institutional arrangements at play (Bryan and Behrman, 2013).

#### **1.2.4 Importance of local knowledge in adaptation**

This study acknowledges the importance of Indigenous Knowledge Systems (IKS) in the livelihoods and sustainable development of communities. In this study local knowledge means

the same as indigenous knowledge systems and these terms are used interchangeably in the write-up. Conversely, IKS has been criticized and condemned by Western countries as they believe that it is backward in terms of development. For instance, Mawere (2014) argues that the colonial government despised and relegated indigenous knowledge as unscientific, instead of having it integrated into modern ways of knowledge generation. This condemnation and lack of documentation of local knowledge has led to its poor usage by the indigenous people (Mapara, 2009). Tanyanyiwa and Chikwanha (2011:1) note that “the oral and rural nature of traditional knowledge has made it largely invisible in the development of communities and modern science”. In this regard, local knowledge has been relegated due to its oral nature and lack of documentation while ‘scientific knowledge’ has taken the upper hand. However, since 1992, IKS has been getting worldwide recognition in many aspects of life. The Convention on Biological Diversity (CBD) signed in 1992 in Rio De Janeiro by different countries recognized the importance and development of measures to protect IKS (Kaya & Seleti, 2013).

A number of scientists worldwide agree that IKS has an advantage over science because it relies on locally accessible skills and resources, thus it can be cost-effective if used in combating climate change (Tanyanyiwa & Chikwanha, 2011; Mawere, 2014). Chikaire and Nnandi (2011; 33) concur by adding that, “climate experts are looking up to indigenous African Knowledge as a probable salvation to the devastating effects of climate change”. This shows that local knowledge is well adapted to the culture and environment where it is applied, unlike, modern technology which is foreign and might not work for the concerned people. In adaptation, affected communities use local knowledge strategies which have been tested and tried as well as passed on from generation to generation.

The indigenous people of Africa have immense local knowledge which helps them in sustaining their livelihoods. According to Chikaire and Nnandi (2011), farmers in Africa for example, are able to make predictions and interpretations of the climate using their local knowledge thereby making appropriate decisions concerning cropping seasons and other vulnerabilities that might befall them. Chikaire and Nnandi's observations are useful for this current study as they lay bare the importance of IKS in managing climate change. This study focused on assessing the use of local knowledge adaptation measures, by the indigenous people of Chivi District in Masvingo, in trying to reduce the harmful impact of climate change at the same time maximizing the positive effects arising there from.

#### **1.2.5 Zimbabwe's changing climate**

As a nation, Zimbabwe has not been spared from the phenomenon of global warming. Its situation is even worsened by the economic meltdown in the country which started around 2000. In addition, recurrent droughts in recent years have devastated the agricultural section, the backbone of the country's economy. As weather patterns become more uncertain due to climate change, agrarian communities are facing considerable economic and environmental risks (Fraser, 2007; McMichael 2009). Research in Zimbabwe shows a trend towards higher temperatures and declining annual rainfall (Unganai, 1996; Zambuko, 2012). Brazier (2017) points out that the average temperature in Zimbabwe has amplified by 2° C during the past one hundred years and that the highest increase was observed over the preceding forty years.

Inconsistent rainfall patterns have become markedly wide. The onset of the rain season has been changing with rains coming in late most of the time. In most parts of Zimbabwe, for instance,

five decades ago, the rain season would commence at the end of October but of late for example in the past ten years (10) it is starting in December and sometimes in January (Chikodzi, Murwendo & Simba, 2013). Dry spells are increasing and this is worsened by lack of water harvesting strategies. This is having a profound impact on the crop production rhythm across the country. The cessation of rainfall is also unpredictable (Rurinda, et al., 2014) with rainfall periods extending into June and July and at times ending in early March (Chikodzi, et al, 2013).

Chivi District, in Masvingo Province is among some of the most arid areas in the country. It largely falls in agro-ecological regions IV and V with a total annual rainfall of below 500mm per annum. The researcher had always been curious about how people in the district experienced their day to day livelihoods with such climatic conditions and the poor soils found there. Now with the onset of extreme weather events brought by climate change, the researcher was interested in investigating their coping strategies. A number of studies have been carried out in Zimbabwe on climate change but these have concentrated on the evidence of this phenomenon and modern adaptation strategies (Bergkamp, et.al, 2003; Mutekwa 2009; Chikodzi, *et al*, 2013; Rurinda *et al*, 2014). However, none focused on the use of local knowledge as an adaptation strategy to climate change in Chivi District. Using IKS as an adaptation strategy makes it socio-culturally situated and thereby more meaningful to the people concerned. It is thus important to fill this knowledge gap by exploring the use of local knowledge adaptation measures by people of Chivi District, in this environment of climate change.

### **1.3 Statement of the problem**

Zimbabwe is mainly an agrarian based economy and climate change is a main risk to the livelihoods of the people. Chivi District receives little rainfall while relying mainly on rain-fed farming. With the onset of climate change, new challenges such as droughts, decrease in water availability and decrease in crop productivity are being faced. These require people to find ways which are effective and manageable in achieving food security and the use of natural wealth for sustainable progress.

Suggested modern adaptation measures seem to be failing to solve problems of climate change (Mutekwa, 2009; Kpadonou, Adegbola, & Tovignon, 2012; Nkoana, Verbrugyen & Huge, 2018)). Indigenous knowledge systems have been in use for generations by various communities but due to modern technology, there has been an erosion of their potential use. According to Robinson and Herbert (2001), the IPCC (2007), and Nyong, Adesina and Elisha (2007), mainstreaming IKS into climate change may result in the development of cost effective adaptation processes that are participatory and sustainable. There was need, therefore, to assess the use of local knowledge by people in Chivi in adapting to climate change. The conceptual framework used in the study used a community based approach. This was appropriate as the framework uses the concept of local knowledge which is location specific. It is also based on norms, values and perceptions of the people in the area under study. As such knowledge obtained from the study, which as explained earlier has been and is still being eroded, will thus be preserved, and benefit generations to come.

#### **1.4 General objective**

The research aim was to assess local knowledge adaptation measures by people of Chivi district in Masvingo in an era of climate change.

#### **1.5 Specific objectives**

The general objective of the study was broken into the following specific objectives, to:

- examine the experiences of the people of Chivi District in times of climate change.
- explore local knowledge adaptation measures which people of Chivi District use in fighting climate change.
- analyze the effectiveness of local knowledge adaptation measures to climate change by the people of Chivi District, and
- suggest and recommend local knowledge adaptation measures which are community based and can be effectively used to fight with climate change.

#### **1.6 Research questions**

- What are the experiences of the people of Chivi District in Masvingo in the era of climate change?
- What are the local knowledge adaptation measures which the people of Chivi use in responding to climate change?
- How effective are the local knowledge adaptation measures used by the people in Chivi in dealing with climate change?
- How can local knowledge adaption measures be improved to sustain livelihoods in this era of climate change?

## **1.7 Justification of the study**

Adaptation as a process is one of the two approaches which are important in minimizing challenges brought by climate change to the livelihoods of people and the environment (IPCC, 2007). It was crucial for the researcher to examine the use of local knowledge within adaptation measures. IKS had been sidelined in favour of scientific options, hence the need for further investigation. The shared perceptions and beliefs among people in a community go a lengthy way in the sustainable development of such communities (Chikaire & Nnandi, 2011). Previous researchers have acknowledged scientific adaptation processes in ensuring improved livelihoods during climate change. However, scientific adaptation approaches require sound capital economies which are not within reach of most developing countries. This enquiry sought to contribute to the importance of indigenous knowledge in adaptation processes. IKS is important as an adaptation approach because it is derived from past and current generations' observations and experiences of the changing climate in a specific community. Mawere (2014: 89) states that, "IKS is not transferable but provides relationships that connect people to their environments and the changes that occur within it". This citation shows that communities are able to benefit from their IKS in adapting to changes that take place in their respective environments. All aspects of a community are thus intertwined in their IKS. Research on local knowledge adaptation processes is therefore crucial as it gives insights into the indigenous ways used by residents of Chivi District in combating climate change and to assess whether or not these are successful and to what extent. The study is therefore important in influencing local people in providing practical ways that help in fighting climate change. The impact of climate change varies from one area to another, therefore, Chivi residents will get empowered with local knowledge adaptation measures specific to their area. It is documented that local knowledge has value and is

developed, tested and tried over an extensive time as it is accepted and moved from generation to generation (Mawere, 2013; Gwakwa, 2017). Through reading and participatory engagement, the young generation is empowered with this knowledge so that they are able to adapt to the changing climate and for the preservation and continuation of IKS. The various local knowledge adaptation strategies should be documented so that future generations are able to access it.

Various Governmental and Non-Governmental institutions which deal with climate change such as ICRISAT may also benefit from the understanding of IKS as an adaptation option. Documentation of this knowledge specific to people of Chivi is essential so that organizations such as ICRISAT are able produce seed varieties and other inputs that benefit the community. Projects which are also aligned to this local knowledge may be implemented to help vulnerable people of the area to improve their livelihoods and wellbeing. The Government may capture and document people's views on IKS and adaptation and develop a policy on climate change that mainstreams local knowledge adaptation processes. IKS funding may be done to help in the encouragement in using IKS in combating climate change.

People of Zimbabwe in general may benefit from knowing the significance of local knowledge in dealing with climate change in different areas such as farming, power, forestry, and mining. This is important as all these areas are susceptible to climate. The study may lead to the, appreciation, promotion and protection of local knowledge by the people of Zimbabwe. Each geographical area experiences extreme weather events different from other areas and people there might possess different IKS which is specific to that area. Acknowledgement of the significance of IKS in responding to climate change may make a contribution to a shift in acceptance and use of IKS for the betterment of their livelihoods by different communities.

Other researchers may benefit from the new knowledge base on local knowledge and climate change that might be used in future studies. Climate change is a topical issue, so many researchers might benefit from the addition of literature from the findings of this research.

### **1.8 Limitations**

Although some limits were met during this study, these were not major hurdles for the researcher to not achieve the set study objectives. The researcher found ways of overcoming the limitations and as such they did not have a bearing on the results of the study. The limitations were identifying key participants with the required attributes for the research, time, finance and negative perceptions of participants who may consider the study an intrusion in their day to day lives. Identifying elders born and bred in Chivi, who are aged fifty (50) years and above proved a cumbersome task especially for the researcher who was an outsider. People migrated in and out of the area over time. However to overcome this limitation, help of Chiefs in the district was sought and they purposively identified the participants who matched the required attributes. This helped in putting the research findings in context.

The researcher is a full-time Lecturer at Great Zimbabwe University with a full-time teaching load and certain days were granted by the Department to go and carry out field studies. Thus the study was restricted to Chivi District in Masvingo Province of Zimbabwe because of limited time and the results of the study would only apply to the area under study. In addition local knowledge adaptation measures may vary from place to place, and cannot be generalized to other areas except where other researchers see them applicable.

The study was longitudinal in nature. Repeated visits were made to the study area to collect data from the same participants. This proved to be cumbersome and expensive as constant visits to the field were required for data collection. Participants' farming activities were assessed from the period of field preparation to harvesting of outputs and the researcher triangulated with prior given information. However, to mitigate this limitation, later movements during data collection were limited to few purposively chosen participants. The researcher purposively selected users as well as none users of IKS during later visits to assess how they were responding to climate change for the purposes of making a comparison of how they are coping with climate change.

### **1.10 Thesis outline**

The focus of this thesis is on local knowledge adaptation measures in the era of climate change. Although climate change affects the whole of Zimbabwe and the world at large, this study only focuses on Chivi District in Masvingo Province of Zimbabwe. The study is divided into six chapters.

**Chapter one** is the introduction to the thesis. It giveses the background of the study, the statement of the problem, the research aim, objectives and research questions. The chapter also justifies the research by showing the research gap in addition to providing a delimitation of the study and an explanation of key terms used in the study.

**Chapter two** presents the conceptual framework used in the study and the related literature representing reliable research on the problem of this present study. The conceptual framework shows the link between adaptation to climate change and local knowledge. The study adopted the framework by Bryan and Berhman (2013) on climate change where local knowledge was incorporated as an adaptation measure. The chapter also links the research problem with other

existing findings, putting the study within a research framework and highlighting the knowledge gap the study seeks to fill.

**Chapter three** focuses on the research methodology. This represents the research design, the sampling procedure and various data collection methods and instruments used to collect data on local knowledge adaptation measures by Chivi residents in combating climate change. The research is qualitative and uses the interpretivist paradigm.

**Chapter four** outlines the presentation and analysis of findings. The chapter includes presentation and interpretation of data which were collected through interviews and focus group discussions.

**Chapter five** discusses the results from chapter 4 in line with the findings of other authors with the aim of ascertaining lines of agreement and contradictions in relation to climate change adaptation in the Zimbabwean scenario, specifically in Chivi area.

**Chapter six** is the conclusion. The conclusion of the study is derived from the data analysis that is based on the findings and discussion presented in chapters 4 and 5. The chapter also outlines recommendations resulting from the research findings.

### **1.11 Definition of terms**

The definitions of the following terms are given because they immensely featured in the thesis.

**Climate change:** any change in the numerical distribution of atmospheric conditions especially if the variance persists over a long period ranging between decades and millions of years (IPCC, 2007). Scientific agreement shows that climate change is mainly a product of changes in atmospheric chemistry caused by anthropogenic activities. Climate change can cause either negative or positive changes in an area. Extreme weather events brought by climate change

usually compound other structural problems such as population increase and the overexploitation of natural resources (Endfield, 2012)

**Climate variability:** the fluctuation of climate above or below a long-term average value in a year (IPCC, 2007). Temporal climate variability operates between months and decades which distinguish it from climate change which operates between decades and millions of years.

**Extreme weather events:** these are unexpected, unusual, unpredictable severe weather events that are out of the norm from the past weather recorded in an area (Vellinga & van Verseveld, 2000). Both the occurrence and strength of such severe events are greater than before globally.

**Exposure:** presence of a climate hazard which might leave people, assets and ecosystems at risk. It is therefore the condition of being affected by a phenomenon, in this case climate change.

**Vulnerability:** the capability or incapability of a person or people to react and deal with any outside pressure placed on their livelihoods and welfare (Kelly & Adger, 2000). This depends on one's experience, sensitivity and adaptive capability to the stress. It is the act of being defenseless in the face of damage various systems (Gbetibouo & Ringler, 2009).

**Adaptation:** they are strategies used to minimize the negative impact of the changing climate and maximize their beneficial effects (UNFCCC, 2007). Adaptations can be 'scientific' or local knowledge based.

**Mitigation:** ways of limiting or controlling anthropogenic greenhouse gas emissions so that their total accumulation is limited by reducing their sources or enhancing their sinks (Gupta, 2012)

**Indigenous/local knowledge:** ways of knowing and living which are developed within communities, over a lengthy period of time. The knowledge is originally indigenous to a specific geographical area (Chikaire & Nnandi, 2011). Indigenous knowledge differs in diverse natural environments and is experienced differently by different people. IKS is part of cosmology where

distinct people have shared beliefs, constructs and feelings. The knowledge is determined by the cultural values of the concerned people in that specific area.

**Adaptive capacity:** the capacity of ecosystems to regulate themselves when faced with atmospheric changes, by taking advantage of opportunities or by coping with the consequences of the changing climate (IPCC, 2007). Adaptive capacity is determined by a variety of factors including institutional arrangements and system resilience.

**Resilience:** it is a positive reaction to the negative changing climate effects where a complex adaptive system is able to self-organize thereby building ability for adaptation (Adger, Hughes, Folke, Carpenter & Rockstrom, 2005).

## **1.12 Conclusion**

The purpose of this study was to assess local knowledge adaptation measures by people of Chivi District in an era of climate change. This chapter gave an introduction to the study by giving the background to the study. Climate change has history and it has become a topical concern due to the impacts it brings. The statement of the problem is clearly explained to show the knowledge gap that this study seeks to fill.

The chapter also outlined the aim and objectives of the research. Justification of the study was also provided. The major research question and the sub-questions were stated. Delimitation of the study in terms of the physical study area attributes of the sample and conceptual framework was explained. The thesis outline was clearly stated and key terms of study defined. The next chapter examines the review of literature linked to climate change and local knowledge adaptation measures by authoritative scholars.

## **CHAPTER TWO: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK**

### **2.0 Introduction**

This chapter examines the connection between the research problem and the existing body of literature thus situating the research and thereby showing the research gap for the study. The chapter provides a brief context to the issue of climate change and adaptation measures which have been researched elsewhere including in other parts of Zimbabwe. Research conducted in Zimbabwe has mainly focused on climate change impacts and few studies focused on adaptation but these were paying particular attention to modern methods of adaptation. The value of local knowledge in livelihoods development projects has taken centre stage since the 1990s, however little has been done in incorporating it into climate change issues (Ajani, Mgbenka & Okeke, 2013). Therefore, there was need for this study to focus on local knowledge adaptation measures in Chivi District, where this has not been researched on. The matter of climate adaptation includes history of changing climate and how it has affected different people. It also concerns various adaptation measures that have been adopted in other countries as a reaction to the changing atmospheric conditions. Climate change, though being a topical issue worldwide (Stigson, 2010; Barry and Chorley, 2013), has a long history (IPCC, 2007). There is wide evidence of extreme weather conditions including continued shifts in average temperature and rainfall globally which are being attributed to climate change (Holden, 2008: Christopherson,

2009; IPCC, 2013). The conceptual framework that guided this study uses a CBA mainly focusing on local knowledge adaptation measures used to fight climate change.

The concepts which guide the study in the conceptual framework include climate signals, actors in the arena, local knowledge, biophysical characteristics and institutional arrangements. The conceptual framework was used to demonstrate linkages with previous work and thereby forming a foundation for the research. A community approach of the conceptual framework is in contrast to the top-down approach used in modern adaptation methods. There is consensus among scholars that the top-down approach in dealing with climate change adaptation is failing (Nyong, Adesina & Elasha, 2011; Chengula & Nyambo, 2016). The top-down approach mainly targets disaster prevention at national levels without involving the community that is directly affected by the phenomenon in decision making processes. Scientific climatic and weather forecasting is also not within the reach of most disadvantaged communities especially those in the rural areas of most developing nations where there is limited access to radio and television. This shortfall on communication about weather information results in the communities not having knowledge on day to day weather reports. Such a scenario hints on the need to use local knowledge as a tool in fighting climate change as opposed to modern adaptation measures. This form of information is easily accessible to communities as long as it is passed from generation to generation to benefit indigenous people in that particular area. Most communities are excluded from wider national developmental processes which are mainly done using the top-down approach.

A number of climate change studies have been conducted in Zimbabwe but these mainly focused on evidence of climate change, impacts and modern adaptation strategies (Bergkamp et al, 2014; Mutekwa, 2009; Chikodzi et al, 2014). However, none have been done on adaptation using local knowledge strategies employed by the local people paying particular attention to Chivi District. It is imperative, therefore, to fill this knowledge gap by exploring the use of local knowledge adaptation measures by people in Chivi district in this climatic change era.

## **2.1 Conceptualizing Local Knowledge and Implications for this study**

Local knowledge has been defined in different terms. Among the terms are ‘local/traditional knowledge’ (Mazzochi, 2006; Nugroho, Carden & Antlov, 2018); ‘indigenous knowledge’ (Mapara, 2009; Chanza & de Wit, 2015); ‘traditional ecological knowledge,’ (Turner, Ignace & Ignace, 2000) and ‘indigenous ways of knowing’ (Mapara & Nyota, 2008). In this research, the terms local knowledge and indigenous knowledge systems were used interchangeably as they mean the same thing. In addition to these definitions, local knowledge is also known as a ‘collective’ pattern of human beliefs; behavior and knowledge of a specific group of people (Khupe, 2014). This definition implies an integration of the sum total of a community’s ways and belief systems. The practices and beliefs by the people use local knowledge to answer the *what, why* and *how* of such actions. In this thesis, local knowledge is defined as the knowledge and practices by a community that is built by generations as they interact with the environment over long time.

A group of people in a given locality has beliefs, ceremonies, taboos, folk stories, customs, rituals, crafts and language which all make up what is considered as its local knowledge.

Nugroho et al. (2018: 3) add that

local knowledge is embedded in practice, action, morality and spirituality; it has a central role in social relations and reciprocity among people, as well as in the unity of people and nature.

Local knowledge therefore goes beyond the spiritual role of a people but shapes their total way of life as well (Ogunniyi, 2007). Hammersmith (2007:2) shows the importance of the relationship between the community and IKS by observing that

Those natural communities are characterized by complex kinship systems of relationships among people, animals, the earth, the cosmos, etc, from which knowing emanates.

It is imperative to note that IKS is not static but changes over time as the custodians of such knowledge change. In addition, the migratory nature of human beings also results in changes of what is termed IKS by a community.

Local knowledge presents itself through the use of different sectors like farming, security, botany, crafts, medicine, zoology and language. Indigenous people have developed local knowledge over an extended time period and this IKS is used in their day to day lives such as reducing vulnerability to disasters, improving health and protecting properties (Mapara, 2009). The value of local knowledge and adaptation is acknowledged by various authors (Robinson & Herbert, 2001; Ajibade & Shokemi, 2003; Nyong et al., 2008). Nyong et al. (2008: 1) explain the importance of local knowledge in Africa by stating that

the local population in this region through their indigenous knowledge systems, have developed and implemented extensive mitigation and adaptation strategies that have enabled them to reduce their vulnerability to past climate variability and climate change, which go beyond those predicted by models of future climate change.

Although the value of IKS is recognized it is rarely taken into consideration in the climate change discourse (Manyani, Chagweda, Muzenda-Mudavanhu & Chanza, 2017). This calls for a shift from just acknowledging the importance of IKS to action where local knowledge is documented and used to improve livelihoods of people in dealing with climate change. It should be stated that climate change has a history and has been occurring over a long period as discussed in the following sections.

## **2.2 History of Climate Change**

Climate change according to the IPCC report (2007) refers to fluctuations in the average state and statistics of climate elements on all spatial and temporal scales beyond those of individual weather events. Climate change therefore is significant in its variability, persisting over decades in a certain place. The World Meteorological Organisation (WMO) together with national meteorological services worldwide have been monitoring and recording weather and climate observations for more than one hundred (100) years (Brazier, 2017). Natural change in climate has been occurring since time immemorial. This phenomenon is caused by natural factors such as the earth's orbit around the sun, variations in solar and volcanic activities (Ahrens, 2008; Pachauri, 2010) and nothing suggests that it will not continue in the future. Authors agree that 18 000 years ago the earth was in the grip of a cold spell with glaciers covering most areas of North

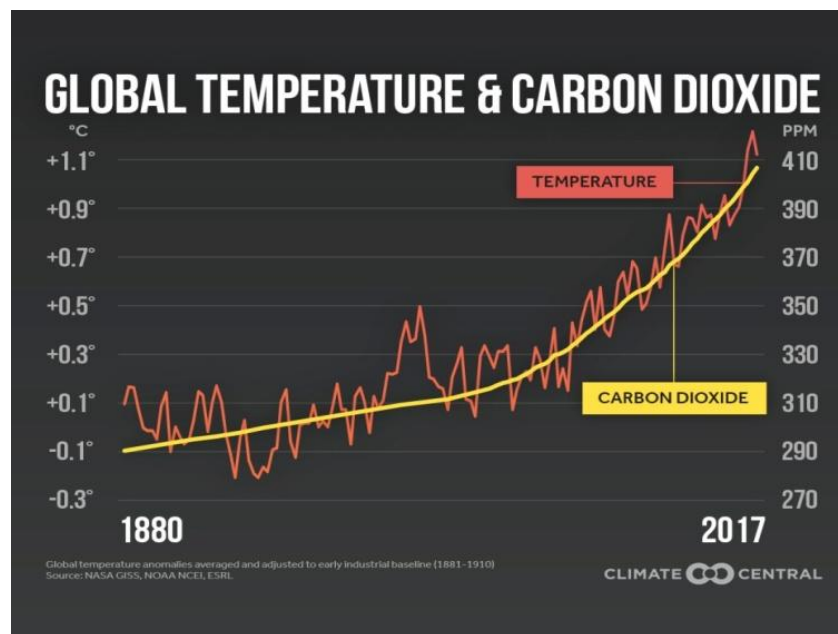
America and Europe (Barry & Chorley, 2009; Christopherson, 2012; Brazier, 2015). Since the 1980s, climate is said to be changing at a rapid pace compared to the last thousand years (Brazier, 2017). This is because; of late climate change is mainly being attributed to anthropogenic factors that are leading to an increase in greenhouse gases.

Carbon dioxide (CO<sub>2</sub>) is the main greenhouse gas that is amplifying climate change. CO<sub>2</sub> has amplified by forty percent (40%) starting pre-industrial period and this is attributed largely from using fossil fuels and modifications in land (Ahrens, 2008; Christopherson & Gupta, 2012). This shows that due to industrialization and an increase in population worldwide, carbon dioxide emission has greatly increased in the atmosphere. Dobbins, et al., (2015) add that climate change is a consequence of economic success globally. They argue that when the World War II ended, the global economy has increased tenfold and this has necessitated an uprise in the usage of fossil fuels. Fuels such as coal produce greenhouse gases mainly carbon dioxide on combustion. Greenhouse gases have a blanketing effect in the atmosphere leading to changes in climate. Increases in both pace and extent of climate change impacts have been noticed. The Geneva World Climate Conference (1978) highlighted the increased problem of greenhouse gases and anthropogenic induced climate change. The gases operate in a similar way to a glass in a greenhouse by allowing short wave rays to get through while restricting the long-wave rays from escaping (Brazier, 2017). This results in the trapping of warmth in the environment thereby resulting in global temperatures to go up.

According to Barry and Chorley (2009), global climate has undergone major shifts on geological timescales including Ice Ages which had continental ice sheets. The first major ice sheet is believed by scientists to have occurred 2,500 million years ago in the Archean period.

Christopherson (2012) adds that seven major Ice Ages have occurred through geological time and these are separated by warm periods. Global surface temperatures from instrumental records have shown an average increase of 0.7°C from 1880 to 2002 (Barry & Chorley, 2009; IPCC, 2013). Figure 2.1 shows relationships between carbon dioxide and temperature. Global average temperatures have generally increased but variably as CO<sub>2</sub> concentrations in the atmosphere have also gone up. Brazier (2017) supports this notion by observing that increased levels in CO<sub>2</sub> strongly mirror the rise in temperatures experienced globally. The strong correlation between carbon dioxide concentration and increase in temperature shown by the graph in figure 2:1 below is widely accepted as the main cause of global warming (IPCC, 2014).

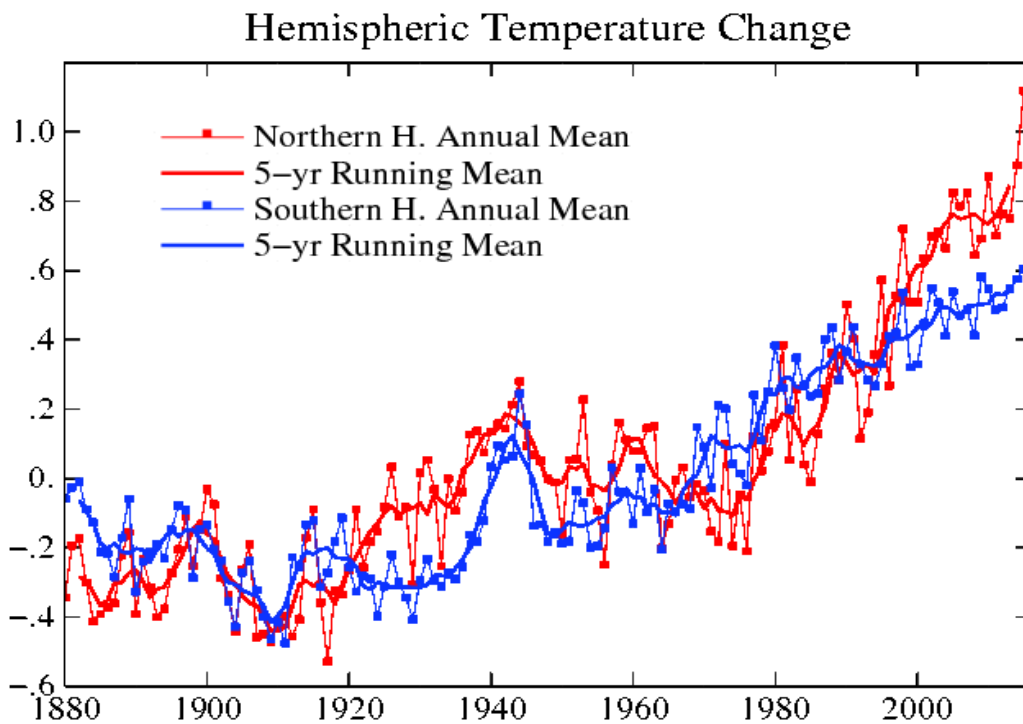
**Figure 2:1 Relationships between global temperatures and carbon dioxide**



Source: Climate Central (<https://www.climatecentral.org>)

Figure 2.2 shows a general trend of a global increase in temperatures shown separately for the northern and southern hemispheres. This warming has been more pronounced in the Northern Hemisphere (Barry & Chorley, 2009; IPCC, 2013). In Canada for example, temperatures have increased, leading to a decline in ice covering the sea, changes in hydrological patterns and other climatic related hazards being credited to the changing climate in the last sixty (60) years (Holden, 2008; Barry & Chorley, 2009; Christopherson, 2012). Globally, precipitation has increased or decreased by ten percent (10%), (IPCC, 2013). Barry and Chorley (2009) suggest that since the period 1900, precipitation has increased north by about 30°N and by contrast, the tropics and sub-tropics have experienced a decrease over much of the region, from north Africa eastward to south-east Asia and Indonesia.

**Figure 2:2 Hemispheric Temperature Changes**



Source: Barry and Chorley, 2009, page 447

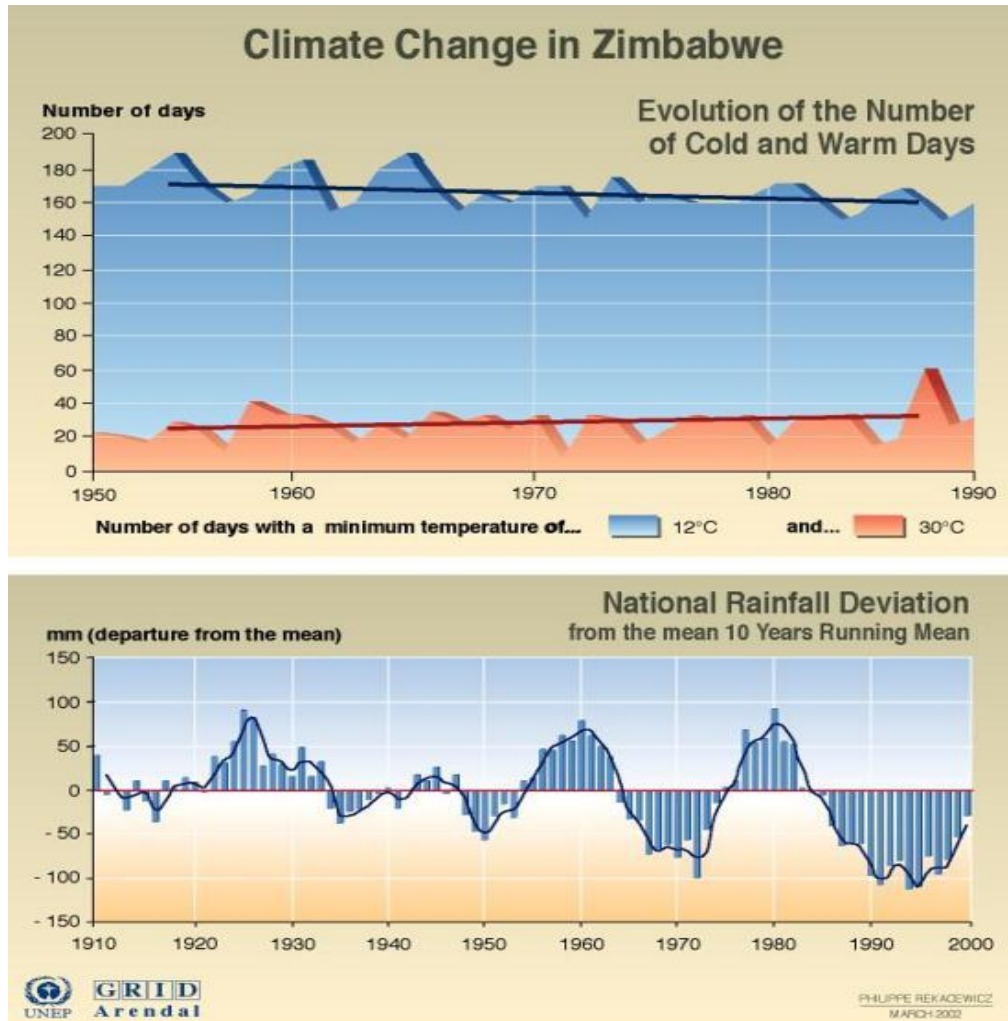
Statistically, in Southern Africa, temperatures have risen by between 1-4°C and precipitation changes range from plus or minus ten to fifteen percent (10-15%) on average throughout the time of the year when rains are expected (Unganai, 1996). In Zimbabwe, research shows a trend towards higher temperatures and a declining total annual rainfall (Unganai, 1996; Zambuko, 2012). Zambuko (2012) further points out that average temperature in Zimbabwe has increased by 2°C during the past one hundred (100) years and that the highest increase was observed over the last forty (40) years. This has largely been caused by industrialization and an increase in population which has increased the emission of greenhouse gases. Since rainfall and temperatures are related, rainfall patterns have thus become inconsistent, coming in late most of the time and leading to an increase in dry spells. Average rainfall in Zimbabwe, according to Zambuko (2014) has decreased because in the 1930-1 season it averaged 665.1mm per annum and in the 2013-4 season averaged 617.6mm per annum. This is a reduction of seven percent (7%) in the eighty four (84) year period. Rainfall seasons have become more unpredictable and sometimes extend into June and July whereas in prior years it used to be between March and May of each year (Zambuko, 2012; Chikodzi, Zinhiva, Simba & Murwendo, 2013).

In Zimbabwe, mean temperatures are projected to rise by three degrees Celsius (3°C) before the end of the century and rainfall is also predicted to decline at a high rate (Brazier, 2015). Figure 2.3 below shows the trends in rainfall and temperatures in Zimbabwe since 1900. Figure 2:3 shows that temperatures are on the increase whilst years with mean rainfall on the negative variation from the mean are also on the increase. There are broad fluctuations in seasonal rainfall

in the last 100 years with a general decrease in rainfall of five percent (5%) since 1900 due to climate change (Brazier, 2015).

Comparatively there is now a rise in hotter days and a decline in colder days than in the past. The Zimbabwe Meteorological Department also adds that the frequency of droughts and floods has increased since 1990 and sometimes these occur back to back, for example the 2001 drought followed the floods of 2000.

**Figure 2:3 Climate Change in Zimbabwe**



Source: Zimbabwe Department of Meteorological Service at <http://weather.utandc.co.zw/climate/climatechange.htm>

### 2.3 Adaptive capacity and susceptibility to climate change

Climate change and variability are two terms which are sometimes used interchangeably despite having different meanings. According to Holden (2008) and Christopherson (2012), climate change refers to deviations from climatologically normal mean statistical measurements over long periods of time, generally thirty (30) years and above. The IPCC Report (2013) points out that change in climate may continue for a long period, usually ten (10) years or more and thus species, including human beings need to either adapt or migrate to new areas in order to avoid

the harsh impacts. On the other hand, climate variability is the deviations in atmospheric conditions over a given short period (IPCC, 2007; Peters et al 2013; Brazier, 2015). It is therefore the way atmospheric conditions vary annually from the mean value. For example, variations from the mean rainfall over temporal and spatial scales may mean drought or flood. Changes in climate are real and shrouded with a lot of uncertainty. Bergkamp, et al., (2013) assert that it is no longer reliable to use past climate to forecast variability and weather extremes.

Vulnerability and adaptation are both important in that they share close relationships with climate change. The adaptive capacities of households or communities depend on their vulnerabilities and resilience to the changing climate. O'Brien et al., (2012) note that adaptive capacity refers to the community's possibilities to endure pressures from climate change and continue functioning normally despite the ravaging effects of the envisaged changes. Studies have shown that such ability to adapt is affected by the community's socio-economic features including access to technological, financial and information resources (Smit & Wandel, 2006; Heltberg et al., 2008). Access to these resources has been found to have either a contributory effect to the community's ability to adapt whilst deprivation of such access may inhibit the community's adaptation potential (Heltberg et al., 2008). High adaptive capacity can thus enhance the adaptation process whilst low ability to adapt capacity maybe a barrier to the process.

The IPCC Report (2001; 4) defines "vulnerability as the level to which a system is susceptible or unable to cope with adverse effects of stresses including climate variability and extreme weather events such as droughts and floods". Vulnerability is therefore a function of how a system is affected by climate change and variation and its capacity to adjust (Bryan & Behram, 2013;

Singh et al., 2015). The way people are susceptible to climate change differs across location and temporal scales and therefore adaptation requires knowledge of various potential options that can be chosen depending on a particular situation (TERI, 2005). For effective adaptation to take place people should be aware of their vulnerabilities and identify factors that strengthen their adaptive ability so as to reduce the vulnerabilities (Brazier, 2017). The IPCC (2007) argues that there is scientific proof that indicates climate change has greater consequences on agricultural based livelihoods in Africa compared to other regions globally. The impacts, however, vary according to the system and area. This shows that the countries in Africa are more susceptible to the changing climate compared to other areas worldwide. The vulnerable communities should therefore, recognize their vulnerabilities and identify ways of strengthening their adaptive capacities when responding to climate change.

Vulnerabilities to climate change therefore depend on a number of factors based upon the region. Ayers and Hug (2010) and Rurinda (2014) argue that climate change vulnerability is based on factors mainly related to the stage of growth of that particular country. The Human Development Report (2008) suggests that developing countries, particularly in Africa, are the poorest, and rank lowest on the human development index (HDI). Peoples' susceptibility to climate change in an area is determined by how they are exposed, their sensitivity and adaptive potential. Areas might have the same physical vulnerabilities, but may be different in terms of resources and potential to fight climate change. Ayers and Hug (2010) claim that, Netherlands and Bangladesh have the same physical vulnerabilities but Bangladesh has a lower adaptive capacity compared to the Netherlands and thus the way they deal with climate change differs greatly.

The low-income groups are mainly susceptible to climate change since they are poorly capital endowed in adapting to extreme weather events. Sivakuman (2006), ADB (2009) and Singh et al (2015) concur that low-income groups are already under pressure with land degradation, price increases and other societal problems. These factors have a bearing on climate change impact as they worsen the vulnerabilities of the affected population. Rurinda (2014) further points out that communal farmers Africa face multiple challenges and are mainly dependent on farming, animal rearing, natural resources and help from the community members. All these four sub-systems are one way or another affected by the changing climate. Some families in the rural areas have ‘urban-connections’ who usually cushion them during periods of climatic shock but these have also become vulnerable due to the economic meltdown affecting the region (Rurinda, 2014). ‘Urban connections’ are relatives or friends who stay in urban areas and help the rural folks during times of helplessness. This shows that within the same community, vulnerabilities vary as some rely on safety nets whilst others have no one to ‘shield’ them from climate change impacts. It is important, therefore, for these low-income countries to benefit from local knowledge adaptation measures which are cost effective (Ajani, Mgbenka & Okeke, 2013) in responding to climate change challenges.

The Human Development Report (2008) states that it is the most susceptible people globally who are directly under threat from climate change because poverty and vulnerability are inter-linked. According to several studies done around the world, climate change will result in decline of crop output particularly in the tropics and this will further put pressure on food security and livelihoods of already vulnerable groups in developing nations (Ajani et al., 2013). Ayers and Hug (2010) agree that it is those countries that are mainly susceptible to the changing climate

that also have the lowest capacity to deal with climate change. Development in these countries is consequently in danger from climate change, making eradication of extreme poverty, hunger and HIV/AIDS difficult. Climate change further compromises efforts to attain the Sustainable Development Goals (SDGs) by the year 2030 especially in Africa (Jaiyesimi, 2016).

Vulnerability is not only context specific but, rather, depends on biophysical, social and economic conditions which according to Cutter (1996) are important indicators of thresholds for vulnerability. Areas with poor biophysical and economic environment are more susceptible to the changing climate than areas with good biophysical, social and economic conditions. Nelson (2011) reiterates that impacts of changing climate will be felt unevenly due to differences in power and social norms. However, the impacts will be overlaid onto already problems of vulnerabilities in both towns and rural environments. This might result in widening the disparities between the wealthy and the underprivileged. Rural communities and developing nations are more susceptible to the changing climate than urban communities and developed nations respectively as a result due of their poor adaptive capacity and available resources. Ayers and Huqr (2010) concluded that without adaptation in developing countries, development under changing climate conditions is not sustainable.

In Southern Africa, many areas are prone to climate risks especially erratic rainfall and drought. Most farmers in these areas, Zimbabwe included, rely on rain fed agriculture. Unganai (1996) and Zinyengere et al. (2013) concur that in addition to rainfall, temperature increase as a result of climate change has an important key function in crop production. They add that there is evidence, in Zimbabwe, that yields from staple food crops like millet, maize as well as sorghum

are declining due to increased temperatures and declining rainfall trends. Farmers in Africa are more susceptible to changing climate impact in that they have no capacity to engage in irrigation schemes.

Vulnerabilities can be characterized from alternate points of view, contingent upon the target group concerned (Adger, 2006; Heltberg et al., 2008). Climate change induced vulnerabilities cannot be explained without due regard to resource utilisation within the broader political economy. Ribot (2010) suggests that actions of humans with selfish interests have been at the fore in determining changes in climate across the world despite numerous calls for people to be environmentally friendly in their pursuit of development.

Several studies have identified two polarized interpretations of vulnerability which inform the policy context in which people fight climate risks and adapt to changes, namely; the social constructivist and the risk-hazard frameworks (Fiissel & Klein 2006; O'Brien et al., 2007). The difference between these two settings is on outcomes of associated events. The social constructivist framework explains numerous causes of a single outcome of climate change while the latter is concerned with numerous outcomes which emanate from a single event (Adger, 2006).

O'Brien et al. (2012) found that risk-hazard approaches regard vulnerabilities to changing climate as a result directly connected to the effects of climate change. Therefore, the risk-hazard approach's major thrust is to integrate external interventions by incorporating technological measures to reduce forecast effects. Thus, this view regards climate change hazards as not only being manageable within a given community; rather it requires coordinated efforts on a broader

scale. However, Eriksen and Kelly (2004) maintain that the social constructivist setting is often preferable as it regards climate change hazards as product of numerous factors and processes which result in changes in the society and associated environments. In relation to IKS, the social constructivist setting is desirable as it places the same burden within the social system compared to risk-hazard approaches that consider the biophysical systems (Ribot, 2010).

Vulnerabilities of communities to changes in atmospheric conditions are influenced by both their exposure and general sensitivity to the associated impacts in addition to the community's adaptive ability (IPCC, 2007). Gallopin (2006) describes community exposure as the extent of stress, perturbation, shock or hazard which may significantly alter the functioning of the community, whether instantly or extending over seasons and seasons. Easterling et al. (2004) describe sensitivity as the degree to which communities' functioning is influenced by changes in climate without consideration of adaptation. This may result in unfavorable or favorable outcomes to the community. Systems or communities that are extremely exposed and more sensitive to the changing climate and less able to adjust to the changes are thus more vulnerable (Brazier, 2017). Therefore, the vulnerability of a community is directly connected to how it is sensitive and exposed to climatic events.

## **2.4 Impact of climate change**

The changing climate result in both negative and positive impacts in various areas of the world with negative impacts being felt more in the more vulnerable communities of developing nations. Climate change poses immense danger to farmers who have fewer resources especially those

residing within the tropics, areas which are agrarian based (Nedumaran, Jyosthnaa, Singh, Bantilan and Byjesh, 2015).

The IPCC Report (2013) demonstrates that increase in temperatures will persist and increase beyond the 3°C projection by year 2100 regardless of reduced GHG emission, thereby impacting negatively on many sectors like water resources, wellness of populations, farming, food security and biodiversity. Among the impacts of an increase in temperature are shortage of water, decline in crop outputs especially in tropical regions, shortage of food and increased threats to health and life. Some of these impacts are already being felt globally and it is predicted that they are going to worsen in the future.

There is uncertainty regarding forecasting future climatic change, particularly future precipitation, surges and dry seasons. On the contrary, temperature forecasts are by and large more solid. Globally scientists predict with confidence that temperatures will continue to rise in decades to come (Dobbins et al., 2015; Hopkins et al., 2015). The rise in temperature will result in a rise in sea levels. The IPCC (2014) forecasts a large increase in temperatures in sub-Saharan Africa compared to the worldwide yearly mean temperature. Some forecasts have envisaged increased rainfall incidents in East Africa (IPCC, 2007; Seitz and Nyangena, 2009; SEI, 2009), while some suggest declining rainfall in southern Africa (Funk et al., 2008). Regardless, climate is changing as of now and future climate is probably going to be different from the prevailing one. This makes it imperative for communities to be prudent in environmental management, lest they may be overwhelmed with associated overheads of the changing climate which are expected to be unprecedented.

Various authors predict that agricultural output will increase in mid-latitudes areas because of temperature increase which will in turn result in increased rainfall and prolonged cropping seasons (Cline, 2007; IPCC, 2013; Nedumaran et al, 2015). However, yields within the tropics are projected to decrease especially from rain-fed crops. It is estimated that agricultural outputs will decrease by between nine to twelve percent (9-12%) in developing countries and six to eight percent (6-8%) in developed countries (Cline, 2007). Severe water shortage and floods are forecast to occur and this already being felt in some parts of the globe, for example floods in Bangladesh, (Ayers and Huq, 2010; Nedumaran et al., 2015), leading to a reduction in available clean sources of water for domestic use.

The UNFCC (2007) summarizes the impact of climate change as mainly disaster- related such as famine, spreading and increase of diseases, economic losses, biodiversity losses, droughts, floods, heat waves and loss of traditional lifestyles. These impacts have serious repercussions on way of life of people, particularly those in sub-Saharan Africa. Book et al. (2007) and Christensen et al. (2007) observe that in Africa, there is already evidence of higher warming of one and half (1.5) times compared with the global mean, a decline in yearly rainfall and an increase in extreme weather events all attributed to the changing climate. A downward trend in precipitation and an upward trend in temperature will result in harmful impacts on agriculture, availability of food, health and ecosystems in Africa where the ability to adapt is very low as a result of widespread poverty, low GDP, low levels of primary health care, already degraded ecosystems and conflicts among others (Vermeulen, Aggrawal, Ainslie, Angelone & Campbell, 2012; Nedumaran et al., 2015; Singh et al., 2015). Agriculture in Africa is severely affected due

to shortages in land brought by the increases in population. This is worsened by climate change impact such as shorter growing seasons and uncertainty as farmers are not sure whether there will be enough rain or floods or even what type of crops to grow. In East Africa, there is expected to be an upward trend in mean annual precipitation leading to increased water-borne diseases for example dengue fever, cholera and meningitis (Boka et al., 2007; Christensen et al., 2007). Scholars agree that impacts of the changing climate are diverse and differ from area to area. In Asia for example, climate change is predicted to lead to result in the occurrence of more summer monsoon precipitation resulting in flooding which will reduce crop output by thirty percent (30%) (Boko et al., 2007). In the same region, the rise in temperatures will result in glaciers melting in the Himalaya Mountains thereby increasing chances of floods, mudslides and erosion in Nepal, Pakistan, Bangladesh and northern India (UNFCCC, 2007).

In Asia for example, the 2006 landslides in the Philippines, the 2004 Indian Ocean Tsunami, heat waves and tropical cyclones led to widespread land degradation and ecosystem destruction (Cruz et al., 2007). Major impacts from these extreme weather events on the life of people will be felt resulting in loss in their sources of income and even their lives. Roy and Venema (2009) observe that in India, extreme weather events for example monsoons, cyclones and drought are having greater impact on the rural poor who are forced to give up their landholdings to moneylenders as a way of sustaining themselves. Heat waves and water-borne diseases further strain the health delivery systems in India which like in most developing countries are already in a poor state.

In Latin America, researchers have observed that climate change has led to widespread negative impacts in the region. These vary from a decline in yearly rainfall in greater part of Central

America to the melting of glaciers in the Andean mountains, an increase in dry spells in Northeast Brazil, heat waves and uncertainties in rainfall patterns (Christensen et al., 2007; Magrin et al., 2007).

Climate change is also affecting major natural forests of the world. Forestry in Canada is very important to the country's economy but climate change has brought an increased incidence and intensity of forest fires by seventy four percent (74%). Pests and diseases have also increased and these adversely affect trees and ecosystems (Williamson et al., 2007). Additionally, climate change is leading to a decline in precipitation and warming in resulting in the low productivity of forests. With time, the species composition, distribution and structure of the Canadian forests will also change. The major problem of forests around the world, for example the Amazon, is that trees are significant as they act as carbon sinks as they remove carbon dioxide and add oxygen from the environment during the course of photosynthesis thereby creating a healthy atmosphere (Singh et al., 2015). Low productivity of forests becomes a cyclic problem as carbon dioxide is not removed from the atmosphere thereby contributing to climate change.

Idowu, Ayoola, Opele and Ikenweiwe (2011) found that climate change resulted in several adverse impacts in Nigeria due to the country's great vulnerability. Coupled with the general rise in temperature, the changing climate has adversely impacted on agricultural production, fisheries, forestry and post-harvest activities in Nigeria (Idowu et al., 2011). This has been attributed to alterations in the rainfall pattern with some areas receiving too little rain compared to previous decades. Some areas had been receiving a lot of rainfall compared to what is necessary, culminating in uncontrolled flooding which devastated some farmlands

(Akpodigaga, 2010). The general health of the people has been vulnerable to the increase in temperature and humidity which provide a favorable environment for propagation of disease carrying pests, which not only damage Nigerians' source of income but also cause harm to life and property.

A study in Zimbabwe by Brazier (2015) concluded that climate change has reduced water for household, farming and industrial use(s). The degradation of natural resources such as soil, water, natural plants, crops, animals is also on the increase. This is leading to increased food insecurity especially among the rural people who mainly rely on farming as source of livelihood. Cases of diseases like cholera, malaria and diarrhoea are now increasing due to upward trend in temperature, flooding and poor quality water for domestic use. The water tables are falling due to an increase in dependence on underground water for both farming and domestic use(s). Flooding has been occurring in Zimbabwe due to climate change. An example is the 2000 Cyclone Eline-induced floods which had devastating effects in the country. A total of 136 deaths were reported, 59 184 houses and huts destroyed and 538 schools destroyed (Zimbabwe Meteorological Services Department). The recent Cyclone Idai of 2019 which had devastating consequences on human lives and property is another case of ravaging effects of the changing climate in Southern Africa.

Evidence is available in Zimbabwe that the natural agro-ecological regions have shifted due to climate change and variability (Chikodzi et al., 2013; Brazier, 2015). These scholars argue that region 1 which receives rainfall in excess of 1000mm per annum with low temperatures is said to be shrinking and part of it now falls under regions 2 and 3. Region V which is arid in Zimbabwe in nature is said to be expanding into areas which were previously semi-arid, making the original

classification of regions by Vincent and Thomas (1960) less useful as a planning tool in agriculture. These authors therefore propose a reclassification of these agro-ecological regions to align with changes being induced by climate change in Zimbabwe.

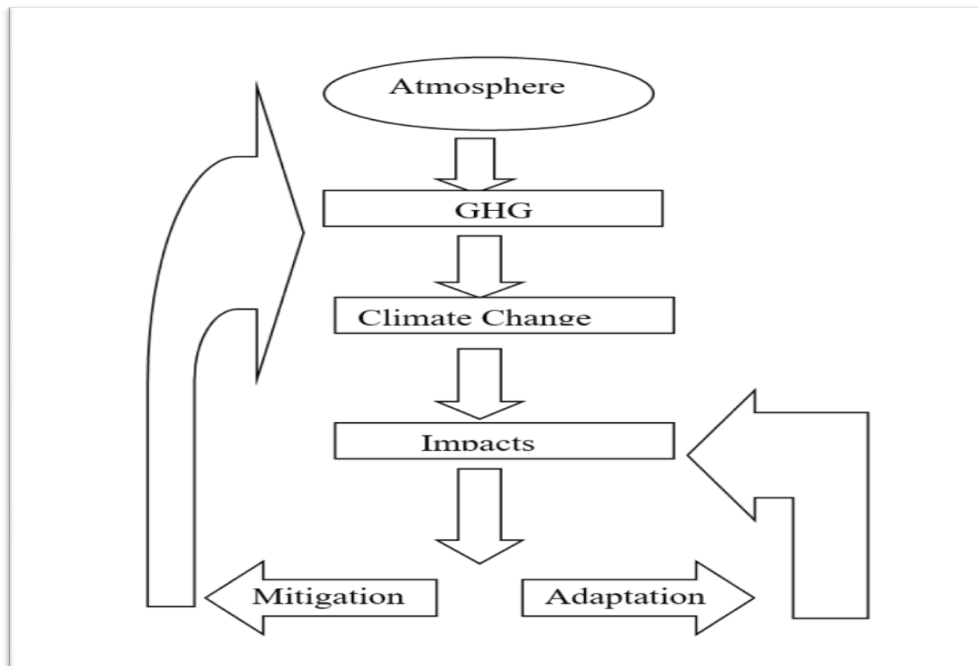
The foregoing discussion has suggested a line of agreement amongst researchers as they concur that despite developed countries being the major contributors to climate change, they are the least affected. Nations which feel the brunt of the changing climate are the poor nations with poor capacity to adapt. This makes it imperative to research on how the vulnerability of communities in developing countries can be minimized to improve their adaptive capacity.

## **2.5 Mitigation and adaptation to climate change**

The changing climate has presented new challenges to societies which therefore need to adjust to this phenomenon. The IPCC (2007), advocates for two main approaches, as ways of dealing with challenges and benefits brought by climate change. These are the two complimentary approaches of mitigation and adaptation.

As shown in Figure 2.6, mitigation is a precautionary measure meant to reduce GHG emissions (CO<sub>2</sub>, CH<sub>4</sub>, NO<sub>2</sub>, O<sub>3</sub>, and chlorofluorocarbons) or enhancing their sinks, for example, through afforestation and reforestation.

### **Figure 2.3 Mitigation and Adaptation Linkages**



Mitigation policies are important in that they reduce GHG emission before they attain levels that may result in permanent consequences on the globe (IPCC, 2003). The impact of reduction of GHG emissions will be felt by generations to come. Mitigation measures are therefore not effective in reversing existing climate change but are meant to stabilize GHG emission to levels that enable ecosystems to adapt naturally, where production of food is not in danger and economic expansion can continue in a sustainable manner (Gupta, 2012). Decisions therefore made today on reducing greenhouse gases have implications for future climate whilst adaptation measures improve the livelihoods of the present.

### **2.5.1 Mitigation measures**

Six key development areas have been identified by the IPCC for nations to decrease their GHG contributions by 2050 so as to attain sustainable development across the globe (Stigson, 2010). These areas are power generation, industry, transport, buildings, consumer choices and land-use changes.

Among the global mitigation policies, is one that seeks to limit global temperature rise to 2°C which is associated with a carbon dioxide equivalent concentration of 400-500ppm (parts per million), by volume (IPCC, 2012). The United Kingdom Climate Change Committee proposed a policy of “act now, and act globally” as a way of limiting temperature increase to 2°C (Committee on Climate Change, 2008). There is scientific consensus that carbon dioxide has a significant impact on global temperatures among other GHG. Scientists argue that the most significant drivers in increasing CO<sub>2</sub> are using fossil energy, growth in the economy and population increase. Barry and Chorley (2009) translate these calculations to suggest that a rise in CO<sub>2</sub> from 320 ppm during the 1960s to 387 ppm in 2008 raised the earth’s mean surface temperature by 0.6°C in the absence of other factors. Anthropogenic causes of GHG emission increase have led to increases of these gases. Human activities are said to be adding GHGs to the atmosphere at a rate much faster than natural processes can remove them. The IPCC Report (2014) states that the sum annual man made GHG emission has continued to rise with a bigger increase between 2000 and 2010 in spite of increasing policies to mitigate against the changing climate employed around the world. Mitigation being global in nature, therefore calls for collective action, a greener approach and climate-friendly lifestyles (Machin, 2013).

Gupta (2012) recommends the use of renewable energy which has less carbon content, use of energy- efficient appliances and vehicles as ways of mitigating GHG emission. The Britannica Guide to Climate Change (2009) advocates that societies should find ways of changing their energy consumption patterns in favour of energy production which uses low-carbon, and sustainable use of forest as well as land-use management. In essence, such ‘green technology’ is

meant to reduce GHG emission thereby reducing environmental damage and promoting sustainable development (Laltaika & Faida, 2013). However, the reduction in GHG emissions calls for a concerted global effort among individuals to make mitigation work. Conferences and summits on climate change have been held as from 1992 Rio Earth Summit. However, these conferences seem to be failing to come up with legally binding agreements on how to manage mitigation. Different causes of problems of binding agreements includes problems of leadership (Parker et al, 2012), domestic constraints (Christopherson, 2010) and problems of enforcement (Barrett, 2008).

The perception of a general divide between benefits and obligations of developing and developed nations is the most contentious issue of the global climate change debate. In relation to equity issues, developing states maintain that developed states ought to act first in the reduction of GHG emissions arguing that they are the basis of the majority historical and present emissions of GHGs. The equity principle was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and was later buttressed by the 1997 Kyoto Protocol. These frameworks outline binding thresholds on gas emissions for developed countries only. However, there is still inconclusive evidence regarding developing countries' obligations in relation to their own emissions (Parker & Blodgett, 2008). Regarding the roles of developing and developed nations in GHG emission reductions, the UNFCCC (1992:4) states that:

The parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country parties

should take the lead in combating climate change and the adverse effects thereof.

The observations by UNFCCC imply that all nations should work in protecting and serving the climate system. Evaluation on GHG per capita emissions by all countries was done and it was concluded that developed countries were top on the list of GHG emitters (Parker & Blodgett, 2008). However, Chandler et al. (2002) demonstrate that developing countries' levels of greenhouse gas emission are more likely to surpass those from developed countries in the near future. In view of this assertion, it becomes imperative that developing countries engage in endeavors targeted at climate change risk reduction. While developing states have been unwilling to agree to obligatory emission targets, asking that richer countries primarily act, a number are implementing measures which are appreciably reducing escalation of their own GHG emission (IPCC, 2013). This shows that disagreement among countries regarding emission targets means that mitigation as an approach may not completely eradicate the problem of climate change. However, countries may not predominantly focus on complete climate mitigation; rather they may seek ways of attaining development driven by concerns from societal problems. For instance, the major focus of some countries' initiatives may encompass the attainment of energy security, overall economic growth, and improved air quality, despite changes in climate conditions. By so doing, the outcome of such measures resonates with the goal of reducing the growth of a country's combined annual GHG emission.

A study by Santos, Garaffa, Lucena and Szklo (2014) in Brazil shows that the country recently engaged in concerted efforts to combat the emissions of gasses as a mitigation measure to reduce climate change. This led to annual GHG emission averaging ninety-one (91) million tonnes,

translating to ten percent (10%) lower than they would be if diversification to energy efficient supplies were not used. Such concerted efforts encompass provision of tax incentives to local citizens who purchase vehicles that have low-powered engines. This has made transportation more affordable for the middle class. Such a move, along with other initiatives such as the use of renewable electricity, co-generation, and energy efficiency have assisted in lowering gas emission with a target of at least forty -five (45) million tonnes a year by 2020 (Cerri et al., 2010). In relation to mitigation measures that are localized to specific communities, Cerri et al. (2009) note that the Brazilian government's policy targeted indirectly encouraging the reduction of emission growth in the forestry sector. Desisting from deforestation and proper land use may reduce carbon dioxide emission by nearly double as much as the energy division.

Xing (2017) established dramatic reduction in gas emission in China following the country's pursuit of mitigation strategies which are targeted at reducing harm to the environment through a reduction of gas emission. This has been attributed to the country's organised activities in managing population growth, reducing deforestation through afforestation, improvement in energy competence and fuel moving from coal to natural gas use (Mohajan, 2013). According to Ohshita, Price, Zhou, Khanna, Fridley and Liu (2015) climate change mitigation strategies since the turn of the millennium have assisted China in reducing its annual gas emission by at least 250 million tonnes of carbon that corresponds to one-third of China's present discharge. Consequently, Vennemo and Aunan (2016) forecast that persistent policies for economic development, efficiency, and ecological protection is likely to lower Chinese gas emissions by a further 500 million tonnes annually by the year 2020.

Climate change mitigation measures have also been recorded in India. Sharma (2006) conducted an assessment which revealed escalating levels of gas emissions revolving around four percent (4%) per annum as the country strove to provide for the national developmental needs. Realizing the potential harm of rising emission levels, the country engaged in organized climate change mitigation strategies, and results have been realized through a reduction in emissions from using power associated CO<sub>2</sub> in the last decade (Shukla & Dhar, 2016). Concerted efforts have been directed on ensuring the restructuring of the economy, enforcing existing clean air laws and a commitment towards embracing renewable energy (Pahuja, Pandey, Mandal & Bandyopadhyay, 2014). Fekete, Roelfsema, Höhne, den Elzen, Forsell and Becerra (2015) also identified later efforts by India to reduce GHG emissions which include an improvement in energy efficiency, afforestation, changing from using coal to gas and improvements in energy transmission. The result has been a significant reduction in carbon dioxide emission.

In South Africa, the post-apartheid government has made strides towards prioritising the development needs of the poor. Despite the concerted effort, Höhne et al. (2012) has established that at least one-third of the South African population's households lack access to a power grid, though GHG emission has been rising since the country experienced industrialization. Realizing the threat of such escalating emission levels on to the environment, the government embarked on a project of phasing out subsidies to the previous carbon-complex coal liquifying industry (Krog, 2015). This was to be replaced by opening the country to natural gas imports. However there is still inconclusive evidence regarding this initiative's impact on the reduction in gas emission and harm to the environment. All these efforts by various governments are meant to reduce greenhouse gas emission, thereby dealing with climate change. However, for mitigation

to be successful, it needs a holistic approach whereby all nations worldwide, not only ratify but take action in reducing GHG gas emission.

The foregoing studies suggested the contribution of climate change mitigation efforts by countries through reduction of gas emission. However, Machin (2013) and the UNFCCC (2015) argue that even if the production of GHG emissions are massively reduced, this might not avert the stoppage of further changing climate because the total accumulation of gases is what determines the phenomenon. This calls for an approach which improves the livelihoods of people, presently. This focuses on approaches that help communities manage and adjust to climate change in the moment. Brazier (2017:102) proposes that “it is crucial that as individuals, communities and as nations we strengthen our ability to withstand potential adversity and to adapt the ways we live and the resources we use.” Such an approach calls for adaptation processes which are tested and proven to reduce vulnerabilities in communities thereby improving their livelihoods.

Several scientists dispute that although the climate change issue is stuck at international level, it is multi-scale, spatial and temporal in nature (Hayward, 2008; Parker, 2012). Therefore, there is need to involve communities themselves as it is the people in the communities that will feel the impact of the changing climate and are better placed to address the challenges and benefits of the changing climate. It is imperative therefore for communities to use adaptation as an approach for combating climate change, especially at local levels throughout the world. Stigson (2010), Machin (2013) and UNFCCC (2015) observe that even if there is a decline in GHG emission, climate change impacts will still be felt because the emissions are already in the atmosphere.

Adaptation is therefore needed in the interim, especially with the incidence of extreme weather events.

### **2.5.2 Adaptation measures**

According to de Perthuis (2010), adapting to the changing climate can be reactive or proactive. Reactive adaptation is when people react after experiencing the effects of the changing climate while proactive is done before the impact has been felt to reduce susceptibility (Kpadonou et al., 2012). Strategies for adaptation differ from place to place dependent on many factors. Bryan and Behrman (2013) observe that the adaptation process is determined by aspects such as biophysical attributes of the area for example physical and ecological systems; user characteristics such as the extent of vulnerability and cognitive ability on readiness to respond to climate change; institutional dispositions like socio and cultural norms that influence how communities adjust to the changing climate. Adaptation is thus contextual and specific in nature as opposed to mitigation which is global. According to the IPCC (2013) adaptation is predominantly significant in sub-Saharan Africa not only for the reason that there is widespread poverty, however in addition to the huge insecurity regarding the effects and the extent of the changing climate as a result of insufficient measured data. Rurinda (2014) concurs with the foregoing discussion claiming that adaptation to changing climate in southern Africa is very important as seventy percent of the rural dwellers are dependent on farming for their livelihoods given that this sector is extremely sensitive to the changing climatic conditions. In developing countries, bulk of the people is dependent on agriculture that rely entirely on rainfall, forestry and fisheries for their day- to -day livelihoods, of which these are largely affected by the changing climate. This

definitely affects the socio-economic lives of people in these countries thereby leading to an increase in poverty and a reduction in food security (Singh, Byjesh & Bantilan, 2015).

Adapting to the changing climate is a necessity that communities cannot afford to overlook given the extensive and mainly negative consequences associated with such changes to the welfare of community members. Several studies, (McCarl et al., 2001; Burton et al., 2006; Adger et al., 2007; Heltberg, 2008), show that throughout mankind's history, social order adjusts to suit conditions in the environment and the atmosphere which have a modifying effect on settlement and agriculture and various features of their economies and ways of life. A study by Burton et al. (2006) indicates that most communities have managed to keep pace with environmental changes, especially gradual changes. This is especially true for natural climate change which occurs over longer periods. Challenges have been experienced in cases where the changing climate is induced by anthropogenic actions as this tends to be more rapid, making it difficult for communities to keep pace with the change.

Climate change adjustment is a subject which is receiving much attention in line with development goals that have been set and modified by nations, especially nations with agro - based economies. The IPCC (2007) claims that greater impacts of the changing climate are experienced amongst developing nations because their economies tend to be sensitive to such changes yet they have less adaptive capacity. This makes it essential for them to develop vigorous ways of adapting to climate change. Smit and Olga (2001) note that adaptation encompasses changes in environmental-social-economic sectors to meet real or anticipated climate change that can harmfully impact human welfare. In this manner, adaptation can reduce

unfavorable effects of environmental change on human wellbeing and prosperity while also increasing their potential to make use of opportunities as they arise. From a human perspective, climate change adaptation requires modification in society's planning towards reducing household vulnerabilities to climate change (Smith, 1997; Smit and Wandel, 2006; Fussel, 2007).

Adapting to climate change is intended to establish community's flexibility in the face of environmental change. According to Adger (2000), community versatility or resilience encompasses the maintenance of normal functions despite being engrossed in stressful conditions. It includes the flexibility to keep equipped and working even in the face of real life stressors. There should be continuity in terms of everyday functioning in a community. Easterling et al. (2004) believe that resilience shows human potential to adjust, without much damage, in light of aggravating situations. They further highlight the need for agility to return to normalcy in the quickest movement once normal activities get interrupted. O'Brien et al. (2012) found that human sustainability in society is correlated to resilient socio-ecological systems, which depends on institutional arrangements and human capital. Human systems have the ability to acclimatize to differences in the environment, in so doing enhancing the sustainability of their activities.

In relation to adapting to changes in the climate, O'Brien et al. (2012) notes that the phrase 'to cope' or 'to adapt' refers to measures taken by a community to maintain their functional operations in order to adjust to changes induced by changes in climate. Phrases 'to cope' or 'to adapt' are related to various time scales and speak to various procedures done by communities in dealing with climate change (Eriksen and Kelly, 2007). Coping with changes in climate is related

to reacting to climate change in the short term while adapting pertains to long-lived measures which may relate to overall change in major beliefs in the community's way of life. According to Anderson et al. (2010), coping measures may be modified and engaged for longer periods of unfavorable circumstances, from one season to another. O'Brien et al. (2012) observes that current coping strategies have a bearing on a community's future coping potential, along with capacity for longer term adaptation.

Forms of adaptation are distinguishable in line-specific features. Smit and Olga (2001) identify the most prevalent attributes of adaptation are purpose and time span. A study by the IPCC (2007) identified three adaptation types including spontaneous adaptation, anticipatory adaptation and planned adaptation. Spontaneous adaptation is self-directed as communities and individuals may unknowingly adapt to a situation as a reaction to climatic change. The response is tailor-made to suit changes to the environment without external intervention from climate change agencies. Anticipatory adaptation is proactive as communities and individuals adapt in expectation of climate change prior to the materialization of the effects brought by the changing climate. In essence such communities have full knowledge of impending climate change and therefore prepare for the onset of the phenomenon.

Planned adaptation follows a defined pattern, often basing on guidelines developed by climate change agencies. This type of adaptation is build on an understanding that the environment has altered or is about to transform and that action is mandatory to sustain, return to, or attain a preferred state. Maddison (2006) observes that because of institutional limitations, the potential for organized adaptation has been moderate in many less developed nations, which increases

vulnerability to disruptions in the environment. Whilst organized adaptation encompasses interventionist measures, spontaneous adaptation happens naturally and does not require external coordinators (Smith et al, 1996).

## **2.6 Local knowledge adaptation measures**

Adaption to changes in climate depends upon the adaptive competence of the local people and varies from one geographic location to another. In sub-Saharan Africa, farmers have been using indigenous knowledge as an approach of reducing vulnerabilities to changes in climate in order to cope with extreme events (Ajani et al., 2013). For example, farmers in sub-Saharan Africa would do intercropping, use short season seed varieties, crop diversification and rear different types of domestic animals. The rationale for using IKS in adapting to changes in climate rests upon the low financial capacity to use modern methods which are expensive especially for people in developing countries. In addition, communities using their indigenous knowledge resources are said to be living an ‘eco-friendly’ lifestyle as they have minimal negative impacts on the environment. The harshness of the effect of climate change on developing indigenous communities requires the use of adaptation approaches which have been time tested by the affected people. Laltika and Faida (2013: 970) note that:

Climate change is a matter of life and death for local and indigenous communities. This is not only because most adaptation techniques prescribed require economic and technological ability, which is lacking among poor and marginalized communities, but also because mitigation strategies currently in place by and large militate against the rights and welfare of indigenous peoples. Through traditional knowledge and

associated genetic resources, local and indigenous communities are able to live an eco-friendly life with very little impact on the environment, let alone production of GHG.

The importance of using IKS in adapting to changes in climate adaptation has been well articulated by Nyong et al. (2007) and Ajani, Mgbenka, & Okeke (2013). They argue that IKS create a moral person who identifies with the important decision making process in the community, a person who connects with his environment and the changes occurring within it thereby having a sense of community belonging and stability. IKS brings in the idea of the participatory approach which makes community members part of the adaptation process. Unlike scientific adaptation processes, IKS is cost-effective, efficiently uses environmental resources and only needs to be passed from one generation to another (Nyong et al., 2007; Nyota & Mapara 2008; Ajani et al, 2013) and benefits generations to come. Community members are thus able to live in the 'new' environment using strategies that have been built upon and tested over time by generations and generations.

Scientific adaption has proved costly to most people principally in developing countries and as such, the necessity to resort to using various local knowledge adaptive strategies as a way to curb challenges and benefits of the changing climate. The discussion which follows shows countries that have benefitted from using local knowledge adaption in this era of climate change.

In Benin, Kpadonou, Adegbola and Tovignan (2012) established the significance of using IKS in adapting to the changes in climate experienced in Oueme Valley. The area they studied is a low flood plain which is characterized by cycles of dry and wet years. People in this area have

developed what are called *whedo* (finger-ponds) as a way of dealing with climate irregularity. Finger-ponds are built in river flood plains to entrap fish in times when there is low water as an adaptation measure to climate change so that people benefit economically from selling fish and as food for their families. Finger-ponds are used to enhance the productivity of areas affected by floods and on wetlands. Ponds are smaller bodies of water and some people make them by lining the ponds with plastics to prevent percolation of water underground. During the dry season, Oueme Valley people grow cow crops on the dyke of the finger-ponds (*kanfli*) thereby extending their growing season (Kpadonou et al., 2012). The water that is trapped by ponds during flood recessions is used for irrigating crops such as vegetables. The agro-finger-ponds also benefit farmers during flooding times as these are raised from the flooded areas thereby making them well-drained and suitable for farming. Peru farmers call the raised field ‘*waru waru*’ and they use them to increase drainage of the poor soils and to provide water from canals during drought stricken times (UNFCC, 2007).

A number of studies have been done in Africa on local knowledge and weather predictions (Mararike, 1999; UNEP, 2002; Nyong, Adesina and Elasha, 2007; Chikaire and Nnandi 2011; Shoko 2012; Risiro, et al., 2012; Shoko and Shoko 2013; Makwara, 2013; Chengula and Nyambo, 2016). These agree that in the absence of weather forecasts and climatic reports from the meteorological department, local knowledge proves to be reliable and gives early warning systems to farmers so that they make appropriate decisions. Chikaire and Nnandi (2011) observe that local knowledge in weather forecasting is very important in the traditional African community as the indicators are able to predict the coming of drought or floods in an area. As an example, the height of bird nests close to rivers predicts the coming of floods, while increase in

records in moth is indicative of drought. Biological, astronomical and mythical indicators are used to forecast different weather patterns and have proved to be significant in local people's prediction of climate change.

Mawere (2014; 14) argues that in “pre-colonial Africa people used a myriad of traditional strategies enshrined in indigenous knowledge systems to conserve the environment.” These strategies included use of *mitupo* (totems), *ngano* (folktales), *zviera* (taboos), *unhu* (ubuntu) and the belief that natural resources are communally owned as opposed to individual private property rights. Tatira (2002) believes that taboos were meant to keep people in check so that they would not destroy the environment. Mawere (2014) gives a number of examples of taboos which were used in pre-colonial Zimbabwe and were quite effective in resource conservation. For example, it was a taboo to cut down a tree with unripe fruits or to harvest such fruits. It was believed that the perpetrator would be chased by a *mhondoro* (ancestral lion) and the perpetrator could even die (Bourdillon, 1987; Mawere, 2014). The understanding in natural resources conservation was passed from generation to generation through *ngano* (folklores) which are usually told by elderly people to children (Duri & Mapara, 2007; Mawere, 2014). Embedded in these stories were taboos and totems that were meant to teach children the importance of conserving forests, water and soils.

Chengula and Nyambo (2016) established that in Tanzania local farmers trust and use traditional practices to predict weather and determine their farming practices under climate change on the slopes of Mount Kilimanjaro. Farmers use bird behavior such as the singing of certain birds as indicative of the onset of rains. As an example, the Malachile sunbird's (*ndelerefa*) singing after

a prolonged January and February drought means that rainfall is about to occur and farmers can start preparing for farming as this is indicative of good rains. Farmers also draw on the behaviour of insects, animals, plant phenology and environmental changes on mountains as tools for weather forecasting thereby affecting their decision making when dealing with climate change. In a study in Mberengwa, Zimbabwe, Shoko and Shoko (2013) established that people of that area rely mainly on local knowledge for weather forecasts instead of meteorological forecast information. Examples of abiotic body indicators documented were; the occurrence of a halo surrounding the sun indicates the onset of heavy rains, a moon with skewed orientation indicating famine and the presence of a prevailing easterly winds which shows an imminent drought (Shoko & Shoko, 2013). Local knowledge and weather forecasting can prove to be beneficial to people as they can use this information to improve their food production especially during times of climate change.

The Pacific Islands are said to be vulnerable to disasters for example an increase in sea level leading to increased and intensified cyclones, droughts, soil and groundwater salinization as well as an increase in both land and sea temperatures (Bettencourt et al, 2003; Mimura et al, 2007; Hall, 2008). However, habitants of the Islands have been successfully using their IKS in adapting to climate change (Lane & McNaught, 2009). These two scholars add that traditional practices have been accepted and used by generations and they include house construction, food preservation and management of their natural resources.

Anderson (2002) discovered that women on Yap Island use their local knowledge about the hydrology of the area to find drinkable water by digging wells that reach freshwater. Lane and

McNaught (2009; 89) point out that “local gender specific knowledge must be recognized; it can contribute much to furthering the existing body of knowledge on climate change, as many communities across the Pacific are already witnessing and adapting to changes that are affecting their livelihoods.” It is important therefore for people to draw from their field experiences and understand the link between their communities, characteristics and their natural resources. This gender specific knowledge is very important as it relates to how households devise coping strategies depending on how the household is genderised.

Agricultural adaptation is a critical response that shapes the future of climate change impacts in agrarian societies. Research has shown that a community’s ability to adapt is a major step towards mitigation against poor yields that may result from the unfavourable impact of the changing climate, as well as to enhance agricultural production in the case of favourable climatic conditions. Smit and Wandel (2006) identified cheap procedures that can be used by agrarian societies such as diversifying crops and varying the time for operations to suit current patterns as crucial in adapting to climate change. These measures require adequate experience attained over the years in farming so that a pattern or trend can be established. Monitoring of such trends may suggest the need for altering the way we operate.

Kandlinkar and Risbey (2000) identified two levels of agricultural adaptation, namely micro and macro-levels. Micro level adaptation is at a small scale, focusing on individual farmer adaptation or adaptation at community level while macro level encompasses nationally coordinated efforts dealing with domestic agriculture and how it relates with local and international policy. Decisions at the micro-level focus on the short term as the community reacts to seasonal climatic

shifts. Such decisions are influenced by individual farmer characteristics, their assets and access to information. Kandlinkar and Risbey (2000) reiterate that in developing countries where there are less of nationally coordinated measures to adaptation, micro level decisions seem to take centre stage in preserving the socio-economic position of communities. This is in line with the conceptual framework used in this study which uses a community-based approach. As such, though being confined to the short run, micro level decisions seem to carry the community for longer periods. As such, IKS in these countries have a bearing on micro- level decisions.

Studies on the selection of adaptation measures suggests a range of the family unit and farmer attributes, organised variables, and domestic climatic and agro-biological circumstances as key causes of the speed of reception (Gbetibouo, 2009). SEI (2009) notes that alternatives available for adaptation in communities do not only encompass the establishment of adaptive capacity and resilience in climate change, rather they also encompass the need for environmental preservation. Characteristics of households are said to have an enormous effect on the choice of adaptation measures adopted. User characteristics include age, instruction stage, sexual orientation of the head of the household unit, size of the household, agricultural experience and household resource endowments. Gbegeh and Akubuilu (2012) found that an individual's age may impact on the choice to receive new innovations. Old age may imply that an individual is seasoned in farming and has accumulated vast amounts of farming experience which enhances their evaluation of current approaches to adaptation. On the contrary, another school of thought proposes that elderly farmers are less tolerant to risk associated with trying new approaches, and they stick to old ways of operations which may retard progress towards adaptation to changes in the climate (Adesina & Forson, 1995). This school of thought shows that elderly farmers have fear of the

unknown and prefer preservation of the existing order. The young generation therefore is seen as more risk prepared as they can deviate from older methods without much difficulty, and this increases their chances to quickly adapt to changes in climatic conditions (Marenya & Barrett, 2007).

Training on ways of adapting to the changing climate has been established to enhance the preservation of wealth and resources. According to Nkonya et al. (2008), training and creation of general awareness may improve a community's understanding of climate change. Training empowers households to get to and construct data appropriate to settle on inventive options (Shiferaw, Okello and Reddy, 2009; Gbegeh and Akubuilu, 2012; Ochieng', Owuor and Bebe, 2012). This is necessary for the creation of locally based measures to become accustomed to the changing climate as education brings improved understanding of the phenomenon and better ways of dealing with effects of the changing climate.

The impact of the gender of the head of the family on the choices is influenced by the region concerned (Gbetibouo, 2009). Nhemachena and Hassan (2007) found that in Africa, climate change adaptation measures were prevalent amongst female-headed family units. The possible explanation behind this observation is that in the majority of small-scale agricultural activities in Africa, a greater number of farmers are women as they constitute most of the rural population. This gives women more rural farming experience and immense knowledge on managing and transforming their agricultural practices in response to changes in environmental conditions and different variables, including market availability and food security (Nhemachena & Hassan, 2007).

The level of wealth within a household has been found to have a bearing on its adoption of IKS. According to Nkonya et al. (2008), wealthier families are at a lower risk and are capable of engaging in technologically based measures of adjusting to the changing climate and mitigating losses associated with changes in environmental conditions. Less privileged families and those with fewer resources are at a greater peril from the impacts of climate change and are more likely to engage in traditional methods for adjusting to changes in climate as they cannot afford technology based measures which may be costly to them (Gbetibouo, 2009). This shows that poor families are more susceptible to the changing climate than the richer ones.

The extent of farming operations is liable to influence the choice to pursue technology-based measures or IKS in a move to adjust to the changing climate. Other related factors also include the soil type and its fertility. The scale of farming operations has a bearing on access to information, thereby impacting on knowledge regarding available alternatives. Small scale indigenous farmers are often limited in knowledge on wide farming operation options (Gbegeh & Akubuilu, 2012). It is imperative for such farmers to depend on local knowledge options for farming operations. Engagement in large scale farming may force interaction with like-minded farmers from across the country and may compel an individual to look for information from government sources and other agricultural agencies (Marenja & Barrett, 2007). The associated costs of seeking information are likely to be an inhibiting factor for small scale farmers to engage in technology-based adaptation; hence the alternative is for them to use traditional approaches that are locally based and familiar to the farmers (Gbegeh & Akubuilu, 2012). This suggests that

IKS are more in use amongst small scale farmers who cannot afford costs associated with planned adaptation at the macro level of adaptation.

Studies have identified institutional variables as being instrumental in the decision to utilise modern adaptation systems compared to the adoption of IKS. As such, institutional factors have adversely impacted on the adoption and use of IKS. In Southern Africa, such factors include access to financial services, other sources of income, relevant information and security of tenure. Opportunities for getting information from the meteorology department and from formal and informal institutions enhance adoption of technology-based adaptation measures. Similarly, where there are robust formal agricultural extensions services and interaction amongst farmers there are high chances of adhering to organised adaptation measures (Nkonya et al., 2008; Gbetibouo, 2009).

Research has shown that deprivation of access to finance and credit facilities is a major factor which drives smallholder farmers to consider alternative preservation practices which have their backing in the IKSs (Reardon & Vosti 1995; Gbetibouo, 2009). Confinement to IKSs is attributable to the requirement for own capital or borrowed finance when one is seeking to adopt modern technology in climate adaptation. Therefore, the inability to borrow money hampers small scale farmers' attempt to integrate adaptation practices that need a lot of capital investment such as, irrigation, extensive fertilizers and terracing.

FAO (2010) identified environmentally friendly agricultural practices that are possible at the micro level by individual farmers and their communities. These encompass farming practices

that embrace mulching, intercropping, conservation agriculture, integrated pest and disease management, agro forestry, crop rotation, consolidated livestock-crop management, aquaculture and enhanced water management. These practices enhance the sustainability of agricultural activities and makes more land arable through the reduction of land degradation through malpractices such as soil erosion, deforestation, overgrazing and repetitive tillage (World Bank, 2012). The ability to practice sustainable agriculture is influenced by local features and the manner of farming. Sustainable agriculture precisely is affected by local climatic conditions, types of livestock and crops, accessible adaptive information and farmers' skills (FAO, 2010). Small-scale farmers take centre stage in sustainable agriculture as they are key to change across the entire agricultural system.

## **2.7 Conceptual Framework**

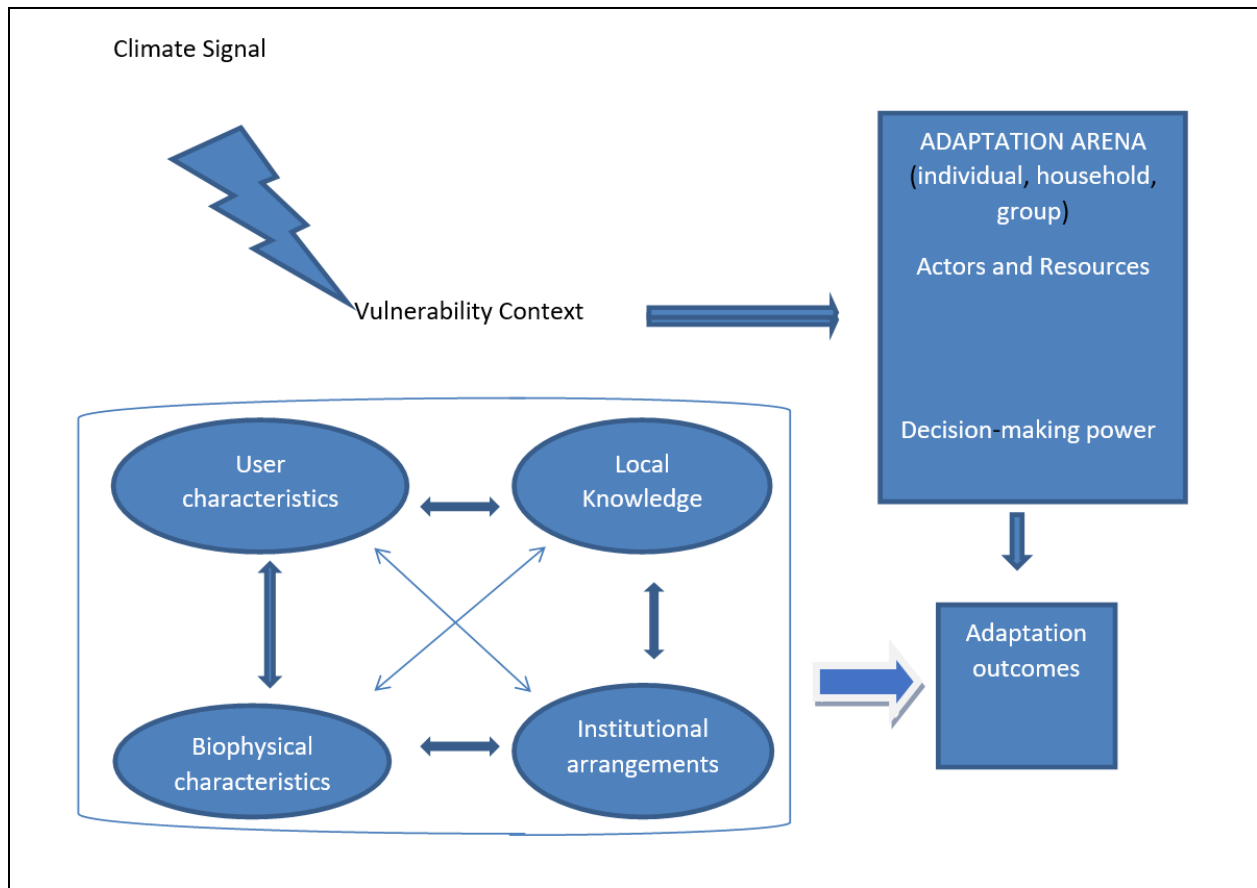
### **2.7.1 Introduction of conceptual framework**

This section discusses the conceptual framework in which this study is grounded. The study adopted a community- based conceptual framework approach suggested by Behram and Bryan (2013) which shows relationships among concepts related to the utilization of IKS in adaptation in the era of the changing climate. The adopted conceptual framework is steered by the research objectives and the problem statement in the study. The study examines experiences of people in Chivi District in times of climate change, how they use their local knowledge adaptation measures and the effectiveness of their adaptation options. Figure 2.7.1 shows the conceptual framework that was adopted and adapted for this study. It shows important concepts which are discussed during climate adaptation. However, it is imperative to acknowledge that the framework is broad and may not work for the area under study. The framework was adapted to

include concepts on local knowledge as an adaptation option. This dimension becomes relevant to this study as no research has been done in Chivi on local knowledge adaptation measures. It is also vital to note that local knowledge is tried and tested for a specific community and therefore more inclined to be more successful grass roots based approaches than top-down approaches which are foreign to the community.

According to Smith (2015), climate change is real and is likely to cause a crisis of human survival and worldwide development, however the extent of its impact depends mainly on human decisions (Brazier, 2017). The decisions made are dependent on people making a balance between mitigation and adaptation (Nkonya et. al, 2008). However, mitigation calls for global consensus to reduce GHG emission whilst adaptation can be very successful in reducing the effects of the changing climate on a local scale in the immediate, depending on how it is done. Mitigation as an approach may be too late as the already emitted GHG in the environment will be felt by generations to come (Huntingford, Lowe, Gohar, Bowerman, Allen, Raper & Smith; 2012, Brazier, 2017).

**Figure 2:4 Conceptual framework**



**Source: Adapted from Bryan and Behrman (2013)**

Furthermore, the IPCC Report (2015) indicates that even if considerable reduction in GHG emissions are done at this moment, changes in climate are already ongoing at a pace that may threaten the capacity of certain organisms and ecological processes to persist in the future. This dimension shows that adaptation is important to improve the livelihoods of people. To accomplish this, a thorough examination of the concepts fundamental to adaptation using local knowledge is necessary to gain insights into the effectiveness of the adaptation options. The study objectives required one to use a culture specific conceptual framework. In addition, adaptations in any area are specific to the values and beliefs of the people under study.

### **2.7.2 Community Based Approach Framework and IKS**

The conceptual framework used for this study was adapted from Bryan and Behrman's (2013) community-based framework which takes a community-based adaptation (CBA) approach. This CBA approach is important and valid as local knowledge differs from area to area. The conceptual framework shows relationships among concepts connected to adapting using local knowledge as adaptation measures in an era of climate change. Bryan and Behrman (2013) point out that most climate change adaptation processes focus mainly on national and international policy responses with very few focusing on communities, individual and household levels. According to Kuriakose et al., (2009), this top-down intervention seems to be failing as it is imposed on communities that are affected by changes in climate. On the other hand, local knowledge (IKS) is a powerful tool which has been used by people of different cultures to conserve resources and in weather forecasting (Nyota & Mapara, 2008; Chikaire & Nnandi, 2011; Risiro, Mashoko, Tshuma & Rurinda, 2012; Shoko & Shoko, 2013; Mawere, 2015; Chengula & Nyambo, 2016). Laltika and Faida (2013) point out that indigenous knowledge system has enabled communities to live in harmony with nature, on the other hand sustaining their livelihoods.

The study focused on local knowledge adaptation measures which are location specific depending on the inhabitants' indigenous knowledge. It highlights the importance of using community-based framework in adjusting to changes in climate. The adapted framework recognises that local knowledge is part of factors affecting adaptation processes during climate change. Linkages in the framework as purported by Bryan and Behrman (2013), suited the focus of this particular study because people's local knowledge, norms, values, their perceptions of the changing climate and available resources affect how they adapt to climate changes. The

conceptual framework goes further to emphasize on local decision-making adaptation processes instead of the top down approaches.

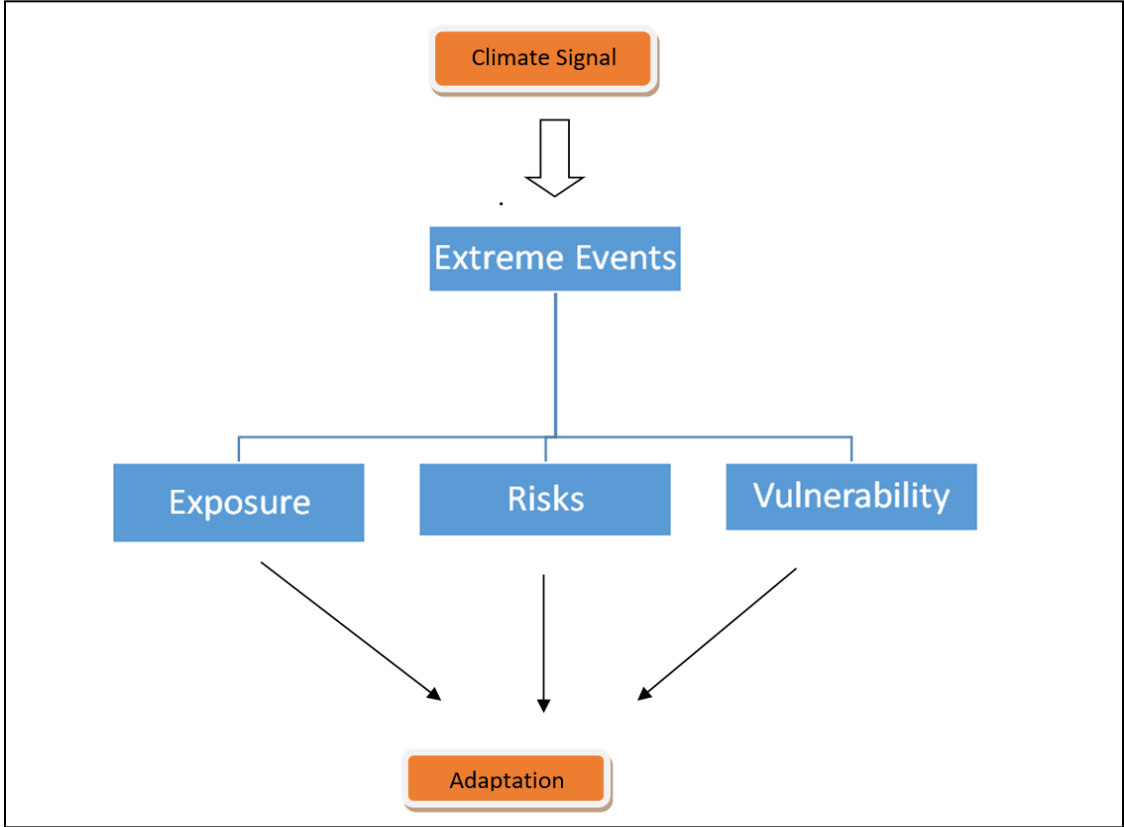
The adaptation approaches should mainly be community based as opposed to autonomous processes which may lead to resource degradation and mounting the load on other community members (Bryan and Behrman, 2013). Collective action in the studied community is important because the collective culture in an area helps in guiding action for community interests. This ethos can be in the form of intergenerational knowledge which is transferred from one generation to another and this is important in adaptation processes (Singh et al, 2015). The dimension on community-based approach becomes relevant to this study which looks at ways used by community members in Chivi to adjust to climate change. These options are specific to the people under study, as opposed to the top-down approaches in scientific adaptation.

### **2.7.3 Climate Signal**

Climate signal refers to changes over a long time in average climate conditions and variations from the mean. These climate conditions which vary from the mean may be extreme weather events such as floods, increase in moisture stress during dry periods resulting in increased drought, heat waves and heavy rainfall (Ayers & Hug, 2010). Although they can be generalized, climatic conditions vary from location to location. This brings out a micro-climate which results in climate change impacts that are different from other areas. This calls for the need to look for adaptation strategies that are location specific, effective and efficient. The conceptual framework becomes relevant to this dimension as it looks at local knowledge adaptation options which are intertwined with the actors' environment and way of life.

Figure 2.5 shows the relationships among climate signal, weather events, exposure, risks, vulnerability and adaptation. Climate signal refers to the changes in expected normal climate resulting in various extreme events. Events such as drought, high temperatures and floods are perceived to be unacceptable in the receiving region. However, some areas experience a combination of adverse and beneficial impacts or opportunities (Ebi & Burton, 2013). The impacts of the extreme events are determined by the exposure of the community to climate change, their perception of risks posed by an event and their vulnerabilities to it.

**Figure 2.5 Relationships among climate signal, exposure and adaptation**



These three drivers of climate change are interrelated and determine how the individual or community adapts to the changing climate. Due to changes in climate, there is an increase in the

occurrence, strength, spatial coverage and duration of various extreme events. Human and natural systems thus need to find coping ways in order to adjust to changes brought by changes in climate. In the final analysis, the way adaptation is done will either result in increasing resilience by decreasing exposure or increasing vulnerabilities of the communities to the changing climate.

#### **2.7.4 Adaptation Arena**

Adaptation arena is the locality or 'field' where the process of adaptation takes place. In the arena are actors (community members) who are involved in the adaptation process. The arena can refer to the environment, household and community at large. As a result of the different actors, the arena is heterogeneous and dynamic overtime (Bryan & Berham, 2013). Actors have different resources, needs and preferences and this results in a non-homogenous 'field' which is not level. However, in this framework which is community based all the actors are united by their local knowledge which is the same. The concept of local knowledge was therefore adopted into the framework to cater for this important tool in the adaptation process. The way the people respond to these extreme events depends on the particular event, its magnitude and the degree of the exposure. The actors can respond to climate change individually or at household and community level. Gardner (2009) and Smith (2015) agree that individuals and communities have to appreciate their individual vulnerabilities so that they are able to make the precise decisions regarding adaptation whether done individually or collectively.

Adger et al., (2009) point out that the impact of changes in climate on people and the way they respond to such change is contingent on the context in which changes in climate occur. Ayers and

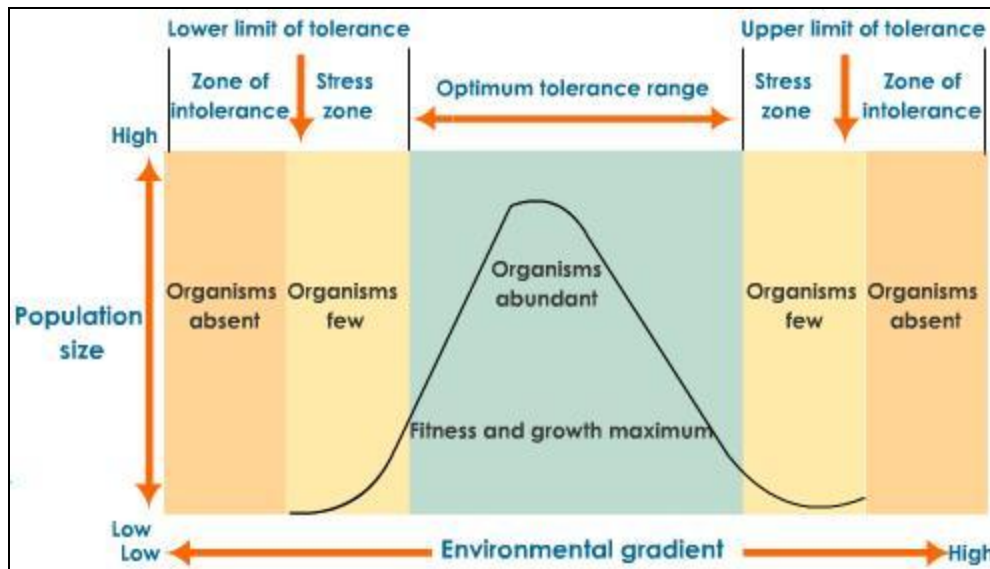
Hurq (2010) argue that people become vulnerable to hazards when they are unable to cope with the impacts if they are socially, economically and physically vulnerable. Players in an area need to understand and accept that climate change is a concern. Risk perception of climate change affects the adaptive process preparedness of a person or community to deal with the phenomenon (Billat & Berkes, 2013). Players in the arena where climate is changing arena have to accept that changes are occurring and that reorientation and sometimes experimentation is inevitable. According to Gardner, Dowd, Mason and Ashworth (2009; 14), “people should develop a sense of responsibility to this vulnerability so that they are willing to adapt”. Willingness to adjust to the changing climate gives people power to implement adaptation. However, Smith (2015) observes that the road to adaptation is sometimes met with barriers. These barriers can be lack of resources, misinformation about climate change, and not believing in the phenomenon.

Vulnerability differs within region, community, households and even individuals. The IPCC (2010) suggests that it is the individuals who are at risk to changes in climate who have the least capacity to adapt to it, in particular those in developing nations. On the conceptual framework, this is the exposure of communities to changes in climate. Some people are highly vulnerable to changes in climate than others depending on their livelihood activities, social characteristics resources, and cognitive factors. Cognitive factors include examples such as the ability to identify the risk caused by climate change or reluctance to acknowledge the necessity to take action in responding to climate risks (Grothman & Putt, 2005; Hamilton & Kasser, 2009). The vulnerability context of the actors is affected by various linkages such as biophysical characteristics, consumer characteristics, institutional arrangements and norms and values in that specific area. These concepts are interlinked and all play a role in the final adaptation process.

### **2.7.4.1 Biophysical Characteristics**

According to Bryan and Behrman (2013), biophysical characteristics imply the sensitivity of environmental and physical systems that is the thresholds further which changes turn out to be permanent and this restricts the ability to adjust (Fishlin et al, 2009). Biological systems thrive under certain temperatures, availability of water and concentration of carbon dioxide. This is in line with Shelford's Law of Tolerance which states that all species exist and reproduce successfully within a defined range of environmental conditions which are biotic and abiotic factors which also differ from area to area depending on the climate experienced there (Lynch & Gabriel, 1987). Abiotic conditions include temperature, light, moisture and nutrients. However, these are not fixed as they can change due to seasonal variations, environmental conditions and life stages of the organism. Extreme weather events are resulting in serious impacts on biodiversity (Hopkins, McKellar, Worboys & Good, 2015). Changes in climate play a vital function in variations of these abiotic conditions and therefore a significant role in the abundance or limited survival of species in a given area (see Figure 2.6 below).

**Figure 2:6 Range of Tolerance**



**After Shelford (1913)**

Species grow and reproduce well within the optimum range, but outside this are zones of physiological stress where growth and reproduction are possible but minimal. The optimal range signifies the most favorable biotic and abiotic conditions under which species thrive and reproduce in high numbers. Outside the zones of physiological stress are zones of intolerance where reproduction is impossible and therefore organisms are absent. The climate of an area is important in defining the ecological niche of organisms. As argued by Hopkins, et al (2015), climate parameters across the globe determine the present distribution of most living organisms except human beings. Human beings are said to be the most adaptable organisms to differences in the environmental gradient. However, of late due to climate change human livelihoods are being threatened. Climate change results in changes in environmental gradients which are seen as hazards. Hazards in the form of floods, drought, and heat waves can be regarded as causes of physiological stress on species leading to reduction in population numbers. Systems that are affected by these abiotic and biotic conditions include forestry, agriculture, water and energy resources. All these can be affected by the changing.

A reduction in rainfall for example affects the growing of certain crops, rearing of certain animals and even the sources of water a community depends on. When climatic parameters shift, organisms are seen to 'move' to more hospitable environments. This can result in certain species becoming extinct in their former habitats. When organisms are stressed beyond intolerance they eventually die. This happens outside the stress zones or intolerance zones where organisms are unable to survive and reproduce, therefore, no organisms are found under these zones. Extreme weather conditions (abiotic conditions) such as high temperatures above 50°C and, drought may cause some intolerant organisms to die. The biophysical characteristic of an area changes due to changes in climate conditions and therefore, it is importance for people in the arena to expect the lasting risks, make the suitable adjustments, build on resilience as well as reduce the negative impacts (Bryan & Behrman, 2013). Scientific climatic predictions are not easily accessible to underdeveloped communities. This is why climate projections and seasonal forecasts can also be successfully done using IKS in order to benefit the local people.

#### **2.7.4.2 Institutional Arrangements**

Adapting to changes in climate also depends on the circumstance of the institutional situation in which it takes place (Jones, Ludi & Levine, 2010). According to Bryan and Behrman (2013), institutions include laws, policies, markets, cultural norms and organizations. These institutions influence how individuals perceive, are affected and react to changes in climate. The researcher was primarily concerned with the organizations in the community (adaptation arena) determining their significance in the adaptation processes. The institutional arrangement in this study is related to the adaptation arena and the actors in the field. Norms and values which affect the

community's local knowledge in determining types of adaptation strategies they can apply in dealing with climate change were also evaluated.

The adaptation arena is the area where the adaptation process is taking place and includes the internal environment (individual to the community) and how these affect adaptation strategies adopted (Storbjork, 2007). Adaptation arenas differ from one area to another owing to the differences in the natural resources found. People have diverse beliefs, wants and choices while their adaptation options may also change over time (Bryan & Behrman, 2013). Within the same environment of the district under study, some people were seen to be more defenseless to changes in climate than others depending on their socio-economic status and the area where they stayed. Their needs and preferences were also different and these affected how they adapted individually and as a community to changes in climate. Actors need to make use of the internal environment to make crucial adaptation strategies which will also impact on the adaptation decisions of future generations.

Adaptation measures which are determined by linkages in the framework may differ from short/long term, form, behavior change/ effect to individuals and communities (Bryan & Behram, 2013; Smit & Skinner, 2002; Agrawal & Perrin, 2008; Heltberg, Siegel & Jorgensen, 2009). The conceptual framework recognizes the importance of women in the community in making the adaptation processes successful. They are an important part of the institutional arrangements in an adaptation arena. Women, although burdened with multiple roles at household and community levels such as fetching water, fuel, fodder, child care and caring for the elderly and the sick, they always prioritize actions which make their tasks lighter (Bryan and

Behrman, 2013). However, norms in an area may change over time depending on the arena and climatic risks being experienced and so do the roles between men and women due to the fact that climatic risks are gendered (Thomas, Twyman, Osbar & Hewitson 2007; Bryan & Behrman, 2013). Patt, Daze and Saurez (2009) in their study on risk taking in Zimbabwe, concluded that females are readily to to look for guidance, take note to guidance and gain knowledge from experience compared to males.

### **2.7.5 Barriers to climate change adaptation**

The concept of barriers is more and more used to illustrate the obstacles that hamper the preparation and accomplishment of adapting to changes in climate. Barnett et al. (2015:2) define barriers to adaptation as “factors that impede adaptation but are surmountable with effort”. Constraints to adapting to changes therefore can be overcome leading to successful adaptation. As argued by Ericksen et al. (2011), for adaptation to be considered successful, it has to lead to environmentally sustainable development routes. However, the constraints to climate adaptation differ from place to place is dependent on the circumstances and the people in that community. Eisenack et al. (2014), posit that barriers are contextual in nature depending on the environment and the actors in the adaptation arena. Challenges to adapting to the changing climate adaptation can be divided into ‘soft’ and ‘hard’ limits (Klein et al., 2014) depending on how easily they can be overcome to make the adaptation process a success.

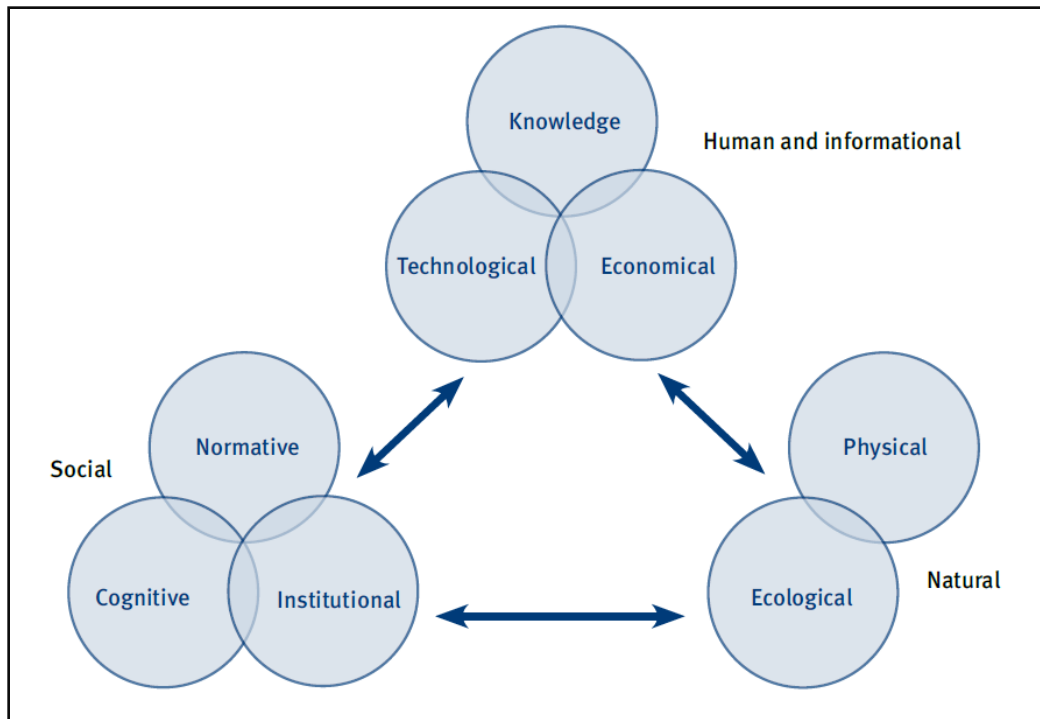
There is an up-and-coming discourse about existing limits (absolute obstacles) and barriers (mutable obstacles) to adapting to changes in climate change (Palutikof et al., 2014). Due to the fact that the topic of changing climate is complex and multifaceted, interdisciplinary approach in

research is the most appropriate method to be perceptive about these barriers. The body of knowledge suggests that efforts to adapt to climate changes, whether planned or non-planned adaptation are hindered by numerous factors.

Despite robustness of adaptation methods, it is difficult to totally avoid damage of global warming and changes in climate to ecological and social systems (Meinshausen et al., 2009, Adger et al., 2009, Stafford-Smith et al., 2011). According to Dow et al. (2013), much is dependent on the sensitivity and resilience of sectors in danger and the severity of the climatic perturbation. Several studies have revealed the importance of efforts to understand how, where and when climate change barriers arise (Stafford-Smith et al., 2011; Palutikof et al., 2014; Islam et al., 2014). The notion of constraints and obstacles to changes in climate sets the basis for studies on the limitations of adaptation due to numerous social and biophysical factors, and how adaptation may fail to circumvent disastrous impacts brought by the changing climate.

Jones (2010) advanced a conceptual framework of barriers to climatic change (Figure 2.7). This conceptualisation of the barriers of changing climate places the basis for the review of related literature on the changing climate barriers, though in relative to the levels of climate change.

**Figure 2.7: Conceptual framework of barriers to the changing climate**



**Source: Jones (2010)**

### **2.7.5.1 Social barriers**

Social barriers are to those barriers within the social environment in which people operate in. They relate to both country related and community level barriers, encompassing the normative, cognitive, and institutional obstacles (Jones & Boyd, 2010). Cognitive obstacles pertain to the belief by people that there is greater improbability that less could be attained by pursuing measures for adaptation now. They relate to the worldview that does not regard climate change as a problem, hence there is inclination to hold back until impacts occur then react. This creates a reactive attitude to adapting to climate change. Therefore, this approach is best aligned to mitigation as a response to climate change more than adaptation as the emphasis pertains to reduction in the impact of imminent effects of the changing climate (Tol, Klein & Robert, 2009).

It is associated with the lack of recognition of dangers connected with implementing adaptation action.

Insufficient knowledge of climatic risks and on how to respond may be obstacles to adaptation (Sally & Wescott, 2011; Barnett et al., 2015). These user characteristics become barriers because they are part and parcel of the actors and if not overcome may hinder adaptation initiatives. When actors are not knowledgeable about climate change and if they have wrong perception of risks involved due to the phenomenon, then adaptation process becomes constrained. As long as individuals or communities believe that climate change is not real, then this belief becomes a barrier to adapting to changes brought by changing climate. To this end, cognitive barriers relates to the individual person's mind-set, the effect of which is felt at the community level.

Normative barriers pertain to the cultural practices that are against change and modernization. They relate to the farmers and their communities' reluctance to adopt new practices in the light of changes in climatic conditions (ICIMOD, 2009). Normative barriers encompass adherence to restrictive traditional and religious norms and practices such that communities and individuals do not envisage the importance of altering their normal way of operations. This is inspite of the realisation that traditional approaches of responding to climate induced shock and stress are no longer be tenable as there exists no cultural memory relative to future changing climate (McGray et al., 2007). For example, communities may rely on old fashioned methods of weather forecasting and planting, thereby restricting economic activity.

Institutional barriers pertain to institutional imbalances and social discrimination that may limit certain groups' access and entitlement to country assets and privileges. According to Agrawal and Perrin (2009), institutions and governance systems enhance local communities' capacity to cope with changes in climatic conditions and may provide ways which assist to nature the social and individual relations in a community. Government institutions may enable the removal of obstacles to adapting to changes in climate (Biesbroek et al., 2013). Jantarasami, Lawler and Thomas (2010) claim that climate change adaptation is more often discussed than pursued by various institutions thereby limiting what can be achieved.

In developing countries, especially in Southern Africa, policies for climate change adaptation are predominantly top-down, as the development of adaptive strategies is vested within central government as they operate through regional and local level governance systems. The top-down approaches usually put forward scientific adaptation approaches which are foreign to a community. This becomes an obstacle to adjusting to changes to climate. However, with IKS, individuals and communities are directly connected to their environments. Hence, the importance therefore of filling this knowledge gap with the use of IKS which actors have experienced and observed in adapting to changes in climate in their locality. Sietz et al (2011) found that in Mozambique, institutional barriers had a greater impact on corporate and individual level adaptation initiatives.

Jones (2010) notes institutional barriers often relate to the structure of governance and management of key institutions within a country. Such institutions provide a framework of governance, distribution and provision of access to national assets and setting the policies and

rules within which a country functions. Institutional inequities occur when a certain segment within the country seem to be preferred compared to others (Barnett & Adger, 2003), for instance, provision of weather forecasts and climate change adaptation empowerment to a certain province in a country, while neglecting others is an institutional barrier. This bias places the preferred province in a better position when it comes to their potential to adapt to climate changes.

In developing countries like Zimbabwe, rural farming communities rely on agricultural extension officers provided by the government's department of agriculture. According to Patt and Gwata (2002), these extension officers link farmers to the scientific community as they provide community level training and education to local farmers on scientific ways of farming and how to adopt innovative ways of farming. While this serves as a noble idea, the extension officers are often inundated by the many farmers they are supposed to support as they can be allocated huge geographical areas. This makes it practically impossible to handle individual farmer queries and situations. This represents weak institutional capacity which is related to problems within the governance systems. This has been the major impediment in the flow of information to the relevant farmers. The result of this information barrier has been that farmers resort to traditional approaches which are often untenable in the modern world (Kolikow et al., 2012).

McGuire (2018) examined the legal and regulatory frameworks which adversely impacted on adaptation endeavours in the coastal zone of the United States. The study adopted the social-institutional approach, wherein the legal-regulatory environment was considered in line with the practices and norms emanating from current policies and laws. Such practices and norms were

contrasted to existing coastal climate adaptation best practices in order to ascertain the lines of divergence or convergence between current norms and practices and the coastal climate adaptation best practices. Thus, legal and regulatory barriers were viewed conforming to planned adaptation. The outcome of the study suggests major policy instruments cumulatively act as obstacles to embracing climate change evaluation proposals in coastal areas. In line with community level adaptation, some legal restrictions were also found to have a contributory effect as they restricted locally earned knowledge which was considered primitive and retarding environmental development.

#### **2.7.5.2 Human and Informational barriers**

Social-cultural obstacles relates to sentiments, principles and patterns which underpin the way of doing things in a community. Studies have shown that socio-cultural factors shape the way communities operate; hence they have a greater impact on the community's climate change adjustments (Stafford-Smith et al. 2011; Jones & Boyd, 2011). According to Stafford-Smith et al. (2011), often communities hold well-established values, norms and beliefs, and cultural practices which impact on their perception of changes in climate and the need for adaptation. In rural communities, they may tend to put off adaptation while proposing that the effects might be delayed. The effects of culture were also found by Rademacher-Schulz and Mahama (2012) as restricting on women's productivity and migration thereby increasing their vulnerability to climate change. Therefore, women led families experienced challenges in mitigating and adapting to climate changes. However contrary to the above notion, Gomba (2017: 74) points out that, "the intersection of patriarchy, hegemonic rural masculinities and climate change is destructive to the environment and if ignored by climate change practitioners, can result in failed

projects". This shows that men in rural societies are often reluctant to adopt to change due to their 'macho culture'. Gomba reveals that men are resistant to climate change adaptation processes because they want to maintain their local hegemonic masculinities. Men opted to continue keeping large herd of cattle which was environmentally unfriendly instead of adapting to cocoa growing. Keeping large herd of cattle in rural Colombia was seen as being masculine. This cultural attitude therefore becomes a barrier to climate change adaptation. However according to Klein et al (2014) they referred these as 'soft' limits as they can be overcome with proper education and knowledge.

Adger et al. (2012) notes that culture is vital to community decisions, including climate change adaptation decisions. It permeates the process of identifying risks as well as the subsequent adaptation strategy implementation. For instance, Moser and Ekstrom (2010) found that in the same geographical region, groups of different cultures react differently to the climate change risks, and such responses may be significantly influenced by the previous mindset, norms and ethics of the group. Similar findings were made by Nielsen and Reenberg, (2010) who focussed on the Northern Burkina Faso and examined the cultural obstacles to adapting to changes in climate. Their study explored strategies for adaptation related to livelihood changes when faced with persistent droughts. Nielsen and Reenberg (2010) found that the *Fulbe*, an ethnic group in northern Burkina Faso, refrained from adaptation measures such as gardening and labour migration, to reduce their vulnerability to drought. Such measures were effectively applied by the *Rimaiibe*, another ethnic group in the same area, and they enhanced their adaptation to climate change to an immense level.

Nielsen and Reenberg (2010) suggest that individual adjustment to changes in climate is a varied practice that is affected by more than technological and economic growth. Rather, at community level, factors such as culture, gender and class played a critical part in the choice of adaptation strategies. As such, the results suggested that culture was a key factor hindering households from embracing key adaptation strategies in Burkina Faso. These cultures caused barriers in terms of labour migration, gardening, working for developmental projects, and the appointment of women in economic activities. The households chose to remain in their no longer productive land despite declining rainfall while also economic productivity of women was restricted.

Financial obstacles have been identified as among the most important barriers impeding efforts to put into practice measures for adaptation. In Ghana, Peterson (2013) found that financial barriers had great impact on households' efforts to engage in climate adaptation. Similar studies within the southern Africa region confirmed lack of financial resources as a hindrance for community level climate change adaptation (AntwiAgyei, 2012), though Bryan et al. (2009) and Kithiia (2011) also established the same for government led climate change adaptation. The UN-HABITAT (2010) found that financial factors pertain to budget deficits which characterise most African countries. Increasing usage of technology related implements makes financial considerations an important force to recognise in any form of adaptation.

Peterson (2013) notes that increasing usage of improved varieties of crops such as groundnuts had notable outcomes for farmers seeking to adapt to climate changes in Ghana. These groundnuts are fast-growing; hence they have enhanced farmers' efforts to remain afloat despite fluctuations in rainfall patterns. However, evidence shows that such improved varieties of

groundnuts are not easily accessible for Ghanaian farmers. This has been largely attributed to the high prices charged which are prohibitive for rural farmers who are left with no other option than to resort to their traditional crops from their own saved seeds which are untenable in the face of climate changes.

A study by Bryan et al. (2009) in Ethiopia also identified financial barriers as a hindrance to climate change adaptation amongst small scale farmers. The financial institutions and companies which support contract farmers refrained from extending credit facilities to these small-scale farmers, which makes it difficult for them to acquire necessary farming implements and inputs. These farmers are poor, hence they were considered more at risk. As such, Dasgupta and Baschieri (2010) confirm that these poor households have a limited amount of capital assets that are necessary to mitigate against the effects of climate changes on their livelihoods. This increases the adverse impacts of climate changes, further worsening their plight as they become more unattractive to financial institutions when it comes to the provision of credit facilities.

The IPCC (2007) suggests provision of access to information relating to the characteristics of climate changes as a crucial weapon necessary for the effective adoption and implementation of climate change adaptation measures at community level in Southern Africa. This is largely attributable to the lack of adequate information relating to climate conditions in Africa, yet a greater proportion of African farming systems are rainfall dependent. Ziervogel et al. (2010) laments the lack of adequate information as climate information in developing countries tends to be more of seasonal forecasts. These do not really aid long-term agricultural plans. Similarly, Patt and Gwata (2002) note that that the usefulness of seasonal forecasts in Zimbabwe were

being constrained by issues relating to credibility, scale, cognitive capacity, legitimacy as well as institutional and procedural barriers. Furthermore, some forecasts often come late, which renders the information less useful to the farmers who would be left with little or no options, save to plunge into a disaster thereby contributing towards food insecurity (Adger et al., 2009).

Archie, Dilling, Milford and Pampel (2014) unpacked the ‘information barrier’ in the interior mountain West in the United States, through a comparison of perspectives on information as a barrier towards climate change adaptation. The study found that information barrier had a profound impact on national managers’ efforts compared to those of local communities. Taking cognisance of planned adaptation and spontaneous adaptations (community level), the results imply that planned adaptation was greatly influenced by the inadequacy of information, whereas it had less impact on community level efforts.

Hélène et al. (2013) focussed on the barriers to adaptation and mitigation amongst livestock farmers across Africa, Europe and South America. The study suggests a bi-directional causality between livestock farming and climate change. While livestock farming contributed towards climate change, it was also in turn influenced by changes in climatic conditions. Hélène et al.’s study assessed farm-scale barriers, using a survey of ten (10) countries. Although the study had a bias towards Africa, the three continents were represented to account for both high and low-input systems. Climate change barriers bedeviling the African continent largely comprised a three-fold; lack of information, education and funds. Adaptation strategies in Africa were largely considered primitive and lacked scientific proof such that while they sought to preserve their

livestock, farmers were also doing more harm to their land and environment. On the contrary, Europe and South American adaptation efforts were hindered by access to labour and land.

Antwi-Agyei, Dougill and Stringer (2013) investigated the climate change adaptation barriers in northeast Ghana. Drawing from the context of a systematic literature review, the study found evidence of inadequate understanding of the barriers impeding the effective implementation of community level adaptation strategies in sub-Saharan Africa, despite the global importance attached to climate change adaptation. In addition, several barriers were identified as having a profound impact on households' efforts to adapt to climate changes, including, *inter alia*, the lack of information on climate change characteristics, socio-cultural barriers and financial barriers. Amongst these factors, socio-cultural barriers had greater impact as households confined themselves to traditional methods which were no longer sustainable in the modern world and which had been significantly impacted by technological advancements. Country level barriers were also identified and these included technological and institutional barriers.

Klostermann, Termeer and Kabat (2013) focused on the nature of barriers to climate change adaptation, utilising a systematic review of literature to assess the current state of knowledge on barriers to adaptation in the peer-reviewed literature. Their study found that though there is lack of convergence on defining barriers to climate change, identification of such barriers is a crucial step towards mitigating their effects to households' livelihoods. The most frequently reported barriers relate to the institutional and social dimensions of adaptation. Developed countries were identified as battling with manpower and land issues. On the other hand, developing countries

were predominantly affected by socially related barriers including the effect of community culture and lack of scientifically derived information.

McNamara, Westoby and Smithers (2017) sought to identify the limits and barriers to climate change adaptation in Australia, in Boigu, a low-lying mud island inundated by the sea during high tides and storm surges. They applied the Sustainable Livelihoods Framework to investigate Australian indigenous communities' experience of climate change impacts in their day to day living. The results suggest that community level adaptation to climate change was mostly hindered by limited access to livelihood assets of the households. Other barriers include household's place based values, which evoke a reluctance to relocate or retreat and difficulties in engaging with government processes to secure external support. As such, the barriers were existent for both spontaneous adaptation and planned adaptation. However, barriers which had greater impact were experienced at the community level where there was more resistance to strategies such as migration and relocation as households were reluctant to leave their long-cherished monuments and lands.

Sirkku (2016) investigated the barriers to the implementation of climate change adaptation in land use planning in Finland. The study focused on institutional and governance systems. The results suggest the existence of climate change adaptation barriers at the local level, emerging from current governance structures. This made it difficult to resolve them by solely focusing on the local level. Current governance structures were noted to have greater impact on shaping the regulatory environment wherein local level players operate. As such, local level adaptation was likely to be influenced by governance and institutional frameworks. This makes it imperative to

recognise the need for coordination across levels of governance to ensure governance structures at higher level set a framework which encourages climate change adaptation at lower levels.

Kolikow et al. (2012) conducted a study on an interdisciplinary framework of limits and barriers to climate change adaptation in agriculture in Australia. The study recognised the importance of undertaking adaptive action by farmers to protect their livelihoods from the impacts of climate change. However, farmers' adaptive actions were adversely affected by the lack of an agreed framework integrating the different understandings of limits and barriers to farming adaptation. This was augmented by technological, biophysical as well as socio-economic factors. Barriers identified were broadly classified in line with the socio-institutional context within which farmers operate and the individual farmers' personal characteristics. The socio-institutional barriers were found to have profound impact as they in turn shaped individual farmers' behaviours whereas the latter had minimal impact on the former.

Studies have also revealed that climate change adaptation can be hindered by technological barriers. Smit and Skinner (2002) identified technological advancements as a major agricultural adaptation pathway. Such improvements in technology include the development of new crop varieties, use of irrigation systems and development of reliable early warning systems. However, Kolikow et al. (2012) note that technological barriers arise as communities are bound to make use of locally applicable adaptation tools and techniques from those developed in other areas. This may affect local farmers in developing countries that have limited technological development, as farmers may not obtain the full range of locally applicable adaptation options. Climate change adaptation measures applicable in developed countries might not be useful in the

case of developing countries due to differing levels of technological developments. As such, Kithiia (2011) found that the lack of advanced technologies in developing countries may hamper household adaptation opportunities and capabilities.

### **2.7.5.3 Natural barriers**

Physical barriers are found in ecosystems thereby impeding adaptation. These barriers arise when species, communities or ecosystems are unable to adjust to new climatic patterns and result in extinction of certain species. Klein et al (2014) referred to these factors as ‘hard’ limits. This suggests that species will now be operating in the ‘zones of intolerance’ (Byran & Behrman, 2013) and will be unable to thrive and reproduce at full capacity. Soil fertility depletion may also be a physical barrier to adaptation (Sanchez, 2002). However, continued addition of fertilizers may improve soil fertility to a certain threshold then after resulting in declining outputs. It is important to note that organic manure is a good source of nutrients and result in improved soil moisture (Rurinda, 2014). Barriers to climate change therefore have to be overcome for successful adaptation to occur. Players in the arena have to find ways to overcome these challenges.

The conceptual framework discussed above is relevant to the study because the process of climate adaptation is contextual. In addition, IKS are specific to an area and the conceptual framework which uses the bottom-up approach is appropriate for the study. The cornerstone of the framework is the experience of people and the local knowledge they use to adapt to the changes in their communities. The grassroots approach of the conceptual framework makes players in the area make crucial decisions based on the local knowledge which they possess. However, the success of the approach is not clear cut and as successful as imagined, as there are

barriers which can be met during adaptation. These obstacles include user characteristics such as adaptive capacity, knowledge on IKS, risk perception, willingness to change and biophysical challenges. Actors in the adaptation arena have to find ways to rise above the barriers. Adaptation and its complexities highlight that challenges must be recognized, managed and overcome. Barriers have to be overcome as they undermine the effectiveness of ways human beings respond to climate change.

## **2.8 Conclusion**

This chapter has discussed literature on the subject of climate change and local knowledge adaptations; its history, impacts, mitigation factors and the conceptual framework used in the study. The literature review has shown that climate has been changing since time immemorial and on account of natural factors. However, present changes are being caused by anthropogenic factors. Although climate change has a long history in climatology, it became a topical issue due to the unprecedented challenges it is bringing to the world at large. The present changes have great negative impacts on humankind and the environment thereby threatening life on earth depending on the vulnerabilities of the species and the environment. Climate change has resulted in rising temperatures, severe and frequent droughts and floods in other areas. Extreme events resulting from climate change such as droughts, floods and increases in temperatures are causing negative biological impacts on species such as reducing reproduction, changes in species morphology and ecosystem processes. However, on a smaller scale, climate change is bringing beneficial impacts resulting in the increase of population species. Mitigation was found to be global in approach though, on its own, it cannot combat climate change. The success of Mitigation as an approach for the reduction of GHG emissions requires consensus by all nations. It was also established that even if GHG emissions are reduced today, the impact of climate

change will still be felt by generations to come. Communities and even individuals are exposed to varying climatic exposure depending of the areas they are situated. In addition, people have different vulnerabilities and adaptive capacities. Adaptation options should thus be tailored to meet the individual differences and not use the one size fits all approach (Brazier, 2017). The need therefore to focus on adaptation which focuses on improving livelihoods of communities depending on the climate change impacts and individuals' vulnerabilities. In addition, adaptation using scientific measures has been met with barriers and has proved inadequate to reduce the negative effects or maximize positive effects of climate change (Gonda, 2017). This has necessitated adaptation measures which are contextual in nature by people in the areas where they are located. Literature has emphasized the usefulness of local knowledge's to the present study because it shows the need for research into indigenous knowledge adaptation measures to climate change. The researcher thus sees the need to fill this knowledge gap.

The conceptual framework adapted showed the importance of using IKS in adapting to climate change. The framework uses a grassroots approach whereby the affected communities and individuals are involved in decision-making processes. The actors, institutional arrangements, the physical environment and local knowledge as key factors in adaptation were discussed. Challenges which can be met during the adaptation process were also explained. Barriers of climate change are divided into 'soft' limits and 'hard' limits. 'Hard' limits are challenges that are difficult to overcome such as biophysical barriers when ecosystems are unable to adjust to new climatic patterns due to threshold levels reached. 'Soft' limits such as cultural beliefs and individual's attitudes on the other hand are easy to overcome. Education and proper knowledge can easily overcome 'soft' barriers. Using scientific adaptation methods was seen as a barrier to

climate change as these may clash with the beliefs and way of life of people in the arena. Local knowledge has been neglected in mitigation and adaptation to climate change in favor of modern methods. The present study therefore explores the use of local knowledge in adapting to various impacts of climate change that as experienced by people in Chivi district in Masvingo, Zimbabwe. The next chapter will discuss the methodology that guided the research.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.0 Introduction**

This chapter explores the ontological and epistemological underpinnings of the study and the research approach as well as methods of data collection and analysis used in the study. Justification of the method and data instrumentation used, is also discussed. The research aims to assess the effectiveness of local knowledge adaptation measures by people of Chivi District in Masvingo in addressing climate change. The main objectives of the study were to examine the experiences of Chivi residents in times of climate change, to explore local knowledge adaptation measures which they use in responding to climate change, to analyze the effectiveness of that knowledge and to suggest local knowledge adaptation measures which people can effectively use to deal with climate change.

### **3.1 Research paradigm**

Researchers' assumptions about social reality (ontological position) and position on knowledge (epistemological position) influence how research is planned and carried out. The ontological and epistemological assumptions used in any research are determined by a set of beliefs that guides the action (Creswell, 2013). There are two main perspectives that have inspired social science research among others and these are positivism and interpretivism (Cohen, Manion & Morrison, 2013; Creswell, 2013). The term positivism was first coined by Comte (Hayat & Muhammad, 2015). Comte views social phenomena as being researched in ways similar to natural and physical phenomena, that is generating laws and theories that could be investigated empirically. Cohen et. al. (2013) view positivists as believing in empiricism, which is the idea

that observation and measurement is the core of research. Positivists use a strict cause and effect approach to research. On the other hand, interpretivists are of the view that human beings think and are rational, therefore, to understand social action, researchers need to explore the reasons and meanings, which affect behavior of people in their setting (Merriam, 2009; Creswell, 2013 & Gray, 2014). Individuals are intricate, complex and different people and therefore the same 'objective reality' may be understood in different ways. As such a multi-case study approach was adopted in order to establish whether the findings of the first case occur in other cases. In addition reality being socially constructed, interpreted and experienced by people in their interactions, the focus of interpretivism is to gain in-depth insight into the lives of the respondents (Creswell, 2013).

This study used the interpretive paradigm whose ontological assumption is that reality is a complex social construction of meanings, values and lived experiences. The epistemological assumption derived from this paradigm is that knowledge is gained by lived experience in situated social context(s) (Miller & Brewer, 2003; Cohen, et. al., 2013). The preferred research methods are thus qualitative in nature which requires close interactions with the respondents thereby gaining empathetic understanding of why they act in the way they do.. This research assesses the effectiveness of the local knowledge of people in Chivi District in Masvingo in adapting to climate change and how they make meaning of their particular actions. Cohen et. al., (2013) suggests that interpretivist researchers begin with individuals and set out to understand their interpretations of the world around them. Procedures are thus inductive, emerging, and are shaped by the researcher's experience in collecting and analyzing the data. Thus, from the interpretivist point of view, knowledge of reality being socially constructed cannot be replicated

by others, in contrast to the assumptions of positivist science. This study focuses on indigenous knowledge which is socially constructed by a community and has ‘evolved’ overtime. The importance, therefore in this study of using the interpretive paradigm in exploring how the participants use their culture, beliefs and experiences to combat climate change. The epistemological stance of qualitative research is that it uses methods such as participant observation, interviews and case studies which result in a narrative descriptive account of a phenomenon. The paradigm is thus said to be emic in nature and the data is regarded as soft. The positivists’ ontological position is that reality is independent of social construction and its epistemological assumption is that people’s perceptions and statements are, true or false, right or wrong (Gray, 2014). Knowledge derived from the positivists is therefore, regarded as hard, real and acquirable. Data is thus collected through control and manipulation of reality.

### **3.2 The research approach**

A qualitative multi-case study approach is employed in this study in order to gain insight on the nature of local knowledge used by Chivi inhabitants in adapting to climate change. The ontological difference between positivism and interpretivism gives the epistemological distinction between qualitative and quantitative approaches. According to Denzin and Lincoln (2005), qualitative researchers study things in their natural setting(s), in an attempt to make sense of phenomena. A qualitative approach was chosen in this case because there was need to study a group of Chivi residents and the nature of their local knowledge used in adaptation, a variable which cannot be measured. Local knowledge is also contextual in nature and so there is need to study people in their natural setting(s). Creswell (2013) points out that qualitative research is also used in cases where researchers need a complex detailed understanding of the issue under study.

The chosen approach made the researcher understand the context in which Chivi inhabitants address the problem of climate change using their local knowledge. The study of human beings, their experiences to climate change, norms and values are best studied in their locality.

A multi-case study approach was chosen for this study because Chivi District is divided into three regions with different distinct soils, temperatures and rainfall patterns. Creswell (2013) and Gray (2013) agree that a case study is qualitative as the researcher explores real life, contemporary bounded system (a case) or multiple bounded systems (cases or collective) over time through detailed, in-depth data collection involving multiple sources of information. Yin (2009) describes multi-cases as empirical inquiry that investigates two or more observations of the same contemporary phenomenon within their real life contexts. This implies that multi-cases set out to unearth meaning from real life contexts and enable replication to confirm emerging constructs and propositions, and extension to reveal aspects of the phenomenon, unlike single case studies. Multi-case studies are more robust (Cohen et al., 2013; Creswell, 2013). Gray (2013) notes that a multiple case study is important because it allows for cross case comparison. Data are collected, analyzed and synthesized into individual case study reports so that the researcher may identify unique patterns within each case (Gray, 2013; Creswell, 2013); however, the findings of each case need to produce converging evidence.

The decision to use qualitative multi-case approach in this study can be justified on the grounds that exploration of the research questions requires a natural setting. This is desirable in the current scenario whereby issues of norms and values in addressing climate change require a qualitative approach and that the district under study is divided into three distinct regions. As

such semi-structured interviews, unstructured interviews in focus group discussions and non-participant observations were used to gather in-depth data on the phenomenon of climate change adaptation.

### **3.3 Population and sampling**

The study population comprised of all the elderly people of Chivi District, aged fifty (50) years and above who were born and spent much of their lives in the district, agricultural technical and extension (Agritex) officers, Environmental Management officials and Meteorological officers. The elderly people aged fifty (50) years and above were chosen because these were considered conversant with the local knowledge of the area. Participants born and bred in the district, are considered cognisant of the changes that have taken place in their environment, some of which may have been caused by climate change. They are also considered to have also experienced climate change in their lives. Climate change is a concept which is regarded to have taken place after an analysis of weather elements over thirty (30) years and above explaining why this group of elderly people was chosen.

According to Creswell (2013), Cohen et al., (2013) & Gray, (2013) the type of sampling done in this study is called criterion purposive sampling. The criteria for selecting who and what to study is geared at gaining some perception on the chronology of the social life of the group, and the contexts that lead to different forms of behavior (Hammersely & Atkinson, 1995). An important advantage of criterion-purposive sampling is that it is valuable when it comes to quality assurance of data collected. A major difference between qualitative and quantitative research is

that the latter uses large samples whilst the former uses small samples or even single case studies, purposefully chosen on the criteria that they are information rich (Gray, 2014).

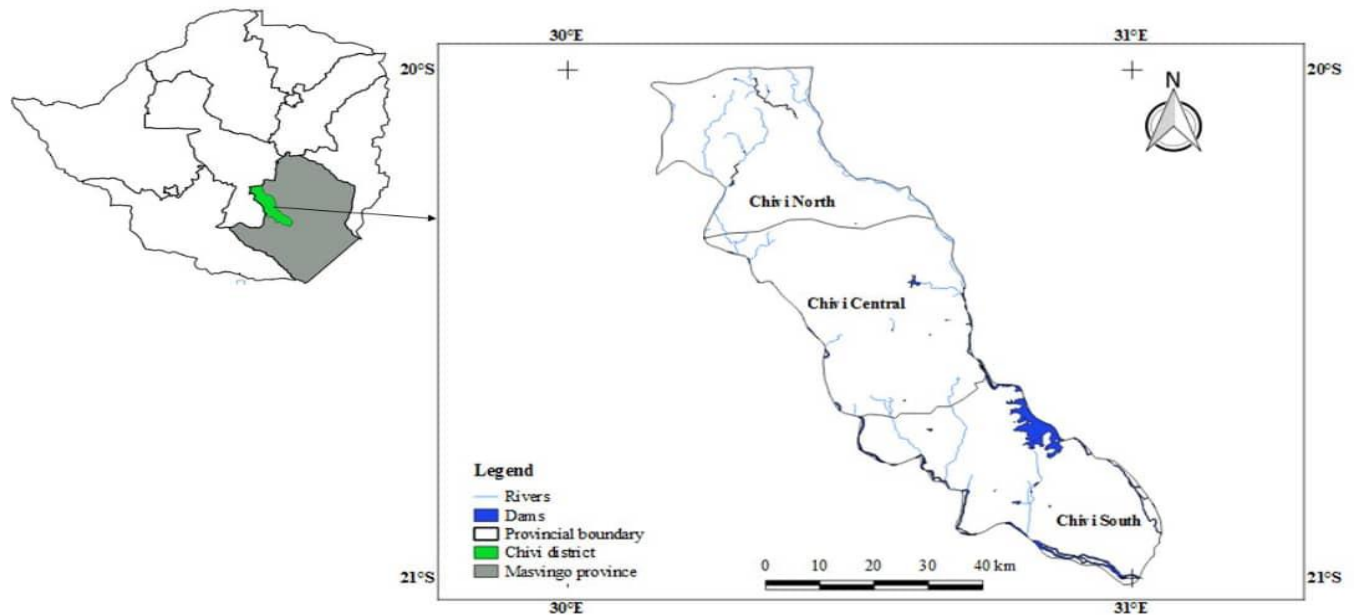
Agritex, Meteorological officers and EMA officials were chosen for their technical knowledge on farming practices and information on climatic data in the area, respectively. Access to the sample was done through Councilors of each region of the district who were also part of the sample. The purpose of the research was explained to the Councilors who in turn helped in identifying the elderly participants for the sample.

### **3.4 Delimitation and sample of the study**

The delimitation of the study is threefold reflecting as it does on: spatial, temporal and conceptual dimensions. Approximately sixty five percent (65%) of the total population in Zimbabwe resides in rural areas where the principal activities are production of food crops, animal husbandry, a few cash crops and employment on commercial farming estates with limited off farm activities (Brazier, 2015). Regarding geographical delimitation, Chivi District is located in low lying areas of natural regions IV and, which are characterized by total yearly rainfall of between 450-500mm and average high temperatures of above 30°C during summer and 15°C during winter. The district has a population of 154 520 and seventy six percent (76%) of the people live in poverty (ZIMSTAT, 2013). Poverty in Chivi is mainly caused by the weak macro-economic environment and high levels of joblessness that result in most people depending on subsistence agriculture. The situation is worsened by people's dependence on a natural resource that is adversely affected by acute weather events like as droughts and floods. Since the district receives low total rainfall in a year, it is climatically marginalized from meaningful agriculture.

Figure 3:1 shows the map of the study area. Time wise, the research was done from 2015 to 2019 in order to have enough time to collect and analyse the data. A community based conceptual framework by Bryan and Behram (2013) was adopted in the study. The framework used highlights the value of local knowledge in responding to climate change. Relationships among concepts such as state of biophysical environment, attributes of the people and the institutional arrangements determine the type of local knowledge used in the community.

**Figure 3:1: Location of Chivi District**



Chivi district is found north of Mwenezi district and west of Masvingo district. The major rivers found in the district are Runde, Tugwe and Mukosi. The map shows the three divisions of the district, Chivi North, Central and South.

Rainfall in this area is generally low and intermittent. Severe droughts occur and sometimes dry spells during the wet period may occur. Therefore, it is perilous to carry out crop production apart from some encouraging areas, where a few drought resistant crops can be grown

(Reynolds, 2004). Animal production is limited to few cattle, donkeys and goats which are mainly for household use. Soils range from poor Kalahari sandy soils to clay soils which do not yield much in terms of crop production and farmers mainly practice dry land farming. Chivi residents, therefore, are vulnerable to climate change and as is argued by Kuriakose, Bizikova & Buchafon (2009), this vulnerability affects the socio-economic development path of a community. The district is separated into three political regions, Chivi North, Central and South which receive varying rainfall totals and also have different soils. Chivi North consists of rocky Kalahari sandy soils, receiving rainfall that is less than 500mm per annum. Chivi Central has loamy soils and rainfall amounts of around 500mm per annum. Chivi South receives less than 450mm of rainfall per year and is mainly made up of sandy soils. A total of forty-four (44) participants made up the sample. The main respondents were aged fifty (50) years and above and were residents who were born and bred in the district and have witnessed climate change(s) in their lifetime. The participants included both genders from the three political regions.

Conceptually, the study looked at adaptation measures using the local knowledge of the study area. Giller, Tittonell, Rufino, van Wijk, Zingore, Mapfumo et al., (2011) point out that agricultural systems in Africa are varied in terms of their agro-ecological and socio-economic environments. Adaptation to climate change, therefore, cannot be a 'one size fits all' approach but has to be tailor made to suit certain conditions. Local knowledge approaches which are specific to an area, depending on people's experiences, may prove to be effective. It is important therefore that this study expounds the experiences of the people of Chivi during the climate change era and how they use their IKS to mitigate the effects of climate change. Indigenous

knowledge systems have been tried and tested for a long time and have proven to work in many situations.

A total of twenty seven (27) people participated in the study. Twenty four (24) were elderly men and women (eight (8) from each region). These were purposively chosen with the help of the councilors and they participated in the Focus Group Discussions (FGD) which does not require large numbers of participants as the main aim is to provide a safe environment which promotes self-disclosure among participants (Creswell, 2013). A group size of about four (4) was ideal and easier to manage as large numbers may divert the discussion from the focus of the exercise (Gray, 2014; Denscombe, 2010). Large groups are also costly and may inhibit contributions from less confident people. The groups were homogenous in terms of age and gender hence two FGDs were held in each spatial area with one group comprising of four (4) people. Inclusion of both genders was necessary so as to have access to different views which were brought by the genders. The research being interpretivist in nature relied on different perceptions and contexts brought by the different genders. In addition, an Agritex officer for Chivi District and two meteorological officers (one from Harare and one from Masvingo) were also chosen for the study. Participants in the study from the three spatial locations were categorized as shown in Table 3.1.

**Table 3.1 Categories of Participants in the Three Spatial Locations**

|                         |                                  |                                |   |
|-------------------------|----------------------------------|--------------------------------|---|
| <b>Spatial Location</b> | <b>Elderly aged 50 and above</b> | <b>Meteorological Officers</b> | <b>Environmental Management Agency Official</b> |
|-------------------------|----------------------------------|--------------------------------|---|

|                      |                  |   |   |
|----------------------|------------------|---|---|
| <b>Chivi North</b>   | 4 men<br>4 women | 2 | 1 |
| <b>Chivi Central</b> | 4 men<br>4 women |   |   |
| <b>Chivi South</b>   | 4 men<br>4 women |   |   |
| <b>Total</b>         | 24               | 2 | 1 |

**3.4 Methods of Data Collection**

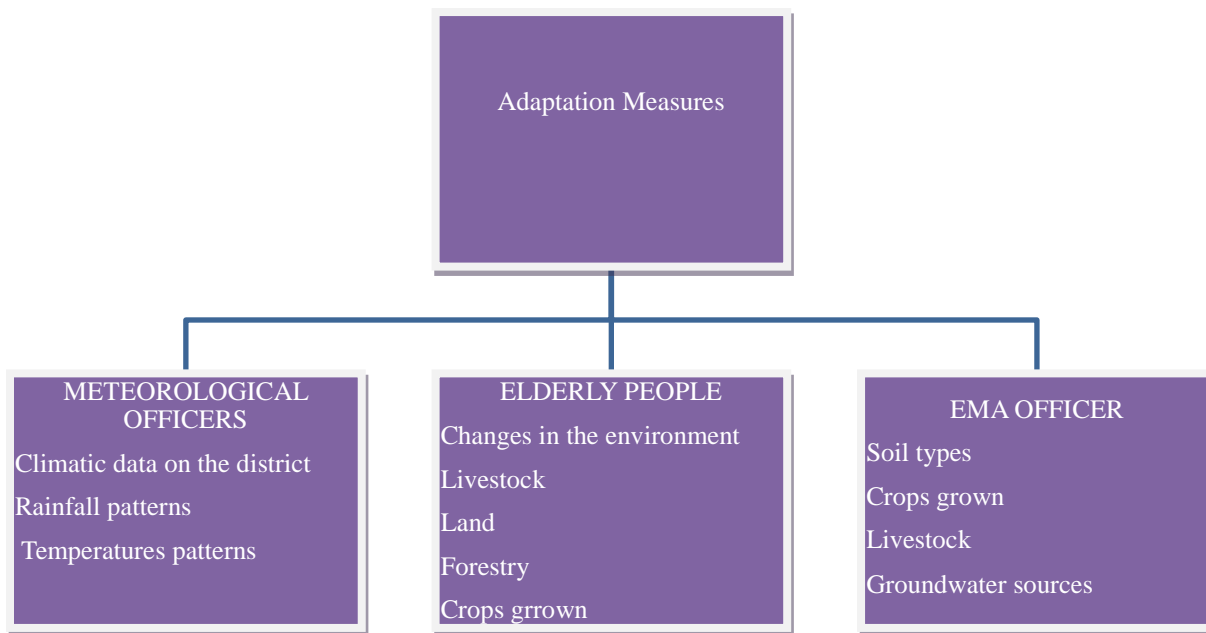
Creswell (2013) proposes that qualitative researchers gather up close data by actually talking to the participants face to face and seeing their behavior and actions within their context. The approach relies heavily on naturalistic data collection tools; therefore, observations and different forms of interviews were the key data collection instruments. According to Gray (2013), interpretivists use meaning-oriented methodologies such as interviews or observation, which rely on personal relationships between the researcher and the researched. Interviews conducted with EMA and Meteorological officers were open-ended and semi-structured. Unstructured interviews were applied in Focus Group Discussions (FGD) for the elderly participants. Unstructured interviews were also used in form of participatory rural appraisals (timelines and transect walks). The strength of these different data collection methods was meant to improve the quality and trustworthiness of data.

Transect walks, interviews and timelines from the elderly people solicited data on their experiences of climate change and the various local knowledge adaptation measures they use in responding to climate change. The elderly provided information such as how climate has

changed in the last thirty (30) years according to their experiences and changes they have noticed in the environment including forestry, water resources and soils. EMA officer provided information on types of agriculture suitable for the area, in terms of crops and animals reared, as well as changes which have occurred due to climate change. Statistics on households affected and declining output(s) in the past years were provided by the EMA officer and FGD participants. Meteorological officers provided statistical data showing trends in temperature and precipitation over the years, its variability and extreme weather events which have occurred.

Figure 3.2 shows the different types of data which were collected from the different participants.

**Figure 3.2 Participants and the data collected**



**3.4.1 Interviews**

Interviews play a central role in data collection in the interpretive paradigm. According to Rubin and Rubin’s (2012) responsive model, interviewing in qualitative research is not fixed but should

allow the researcher to change questions asked, the sites chosen and the situations to be studied. Creswell (2013) detailed nine steps necessary in an interview as a data collection process. These steps guided how the interview process took place as outlined below:

Firstly research questions were developed basing on the research objectives. These were general and open-ended. Secondly interviewees to best answer the questions were purposively identified. The types of interviews used to source the most useful information were then decided. These were semi-structured with both close and open ended questions in order to cater for probes during the interview and FGD processes. Next recording procedures during interviews were decided. with the help of an assistant researcher a recoder was used to capture all the information from the interviews and FGDs and the data was later analysed at a convenient time.

A pilot -testing of the interview questions was then done in order to refine them and assess the degree of observer bias. The pilot testing was done at Mukandapi in Chivi North, an area which was not conducted FGDs in the final data collection procedure. Places where FGDs were conducted where then decided in all the three regions of Chivi district.

Interview schedules were semi-structured for FGDs (Appendix Fi), timelines and transect walks. Probes were used as follow up questions designed to elicit more information on the topic (Legard, Keegan & Ward in Ritchie and Lewis, 2003). The interview schedule was translated into the vernacular language (Appendix Fii) for easier communication with the elderly participants. Structured interviews were used for Meteorological officers (Appendix H) and an EMA official (Appendix G). These schedules were designed differently as these stakeholders provided different data.

Transect walks were used with the elderly participants whereby they walked with the researcher in their environment describing and showing changes which have taken place due to climate change. Photographs of the different landscapes in the environments were taken. In addition, timelines were also used to solicit data on comparisons of landscapes in the present with the past thirty years. Here participants went back in time narrating changes that have occurred in the area. Audio tapes were used to record these unstructured interviews. Transect walks and timelines were done separately for men and women so that they could freely communicate their ideas. Transect walks are forms of unstructured interviews.

### **3.4.2 Focus group discussions**

Focus group discussions (FGDs) are meant to seek data from a selected group of participants about their views on a topic (Cohen et al.; Thomas, 2013; & Gray, 2014). The purpose of FGDs is to gain a range of perspectives on the issue under discussion. The researcher took the role of the facilitator asking questions and being in control of the discussion. The advantages of FGDs are: they allow access to; a wide range of participants instead of using one on one interviews, they collective ideas, culturally diverse groups and can be used as a channel for change both during and after the focus group discussion (Gray, 2014). Focus groups in the study were divided according to gender so that women and men discuss openly and freely about their experiences during climate change. This allowed participants to freely describe the local knowledge adaptation measures they use in addressing climate change. As pointed out by Denscombe (2010), the focus of such a session is for participants to discuss issues based on an item or experience that all participants have similar knowledge about. The interpretivist paradigm focusing on qualitative methodology enabled the respondents to appreciate each other's views, listen and be heard thereby expressing one's thoughts freely and honestly. The other strength of

focus groups is that discussions can trigger new ideas in other participants especially where they share similar experiences. However, a major limitation of focus groups is that the data cannot be generalized to other areas. The results of this study, being a multi-case study, are not meant to be generalized to other areas.

The moderator teamed up with two (2) fellow students in order to help with moderation of FGDs and recording of discussions. Before FGDs began, the date, time and location were noted down. The exercises were carried out in different locations, at different times and on different dates in the three spatial areas. However, FGDs for women and men in the same location were carried out on the same date but at different times. The researcher provided transport for the participants to the chosen locations for the discussions. A diagram of the seating plan in each FGD was drawn with a code for each participant as this helped later during the analysis of data. Participants sat in such a way that they all had a view of the moderator and each other. Figure 3: 3 shows a FGD of female participants in Chivi Central and Figure 3:4 of male participants in Chivi North.

**Figure 3:3 FGD of female participants in Chivi Central**



**Figure 3:4 FGD of male participants in Chivi North**



The moderator introduced herself (Appendix A) and her Assistants and further explained the purpose of the meeting, provided reassurances about confidentiality on the information to be discussed and explained that without diversions, the discussion would take at most two hours. Participants then introduced themselves and codes were applied to each individual to help with the seating plan. Ground rules for each session were stated by the moderator so that the discussion would remain focused. It was explained that there were no right or wrong answers, that they may agree or disagree with each other about certain issues and that probing and encouragement of opinions from everyone was essential so that different opinions would be heard. Flipcharts and recorders were used in order to record the discussions verbatim; however, permission to use the digital recording equipment was requested before the sessions. The moderator captured key ideas on the same issue that were solicited during discussions in form of

field notes and verbatim quotes. Participants were kindly asked to sign consent forms (Appendix D) as an indication that they had agreed to take part in the study.

### **3.4.3 Observation schedules**

According to Creswell (2012), observations schedules are useful tools for collecting qualitative data. Observations are complex and limited to the range detectable by human senses. In this study, observations (Appendix I) were used to visualize and record changes which have taken place in the environment due to climate change using visual media. This presented opportunities to the observer to get data beyond participants' opinions and self-interpretations of changes which have occurred in the environment due to climate change. However, Gray (2014) notes that one drawback of observation is that the interpretation of what is observed may be influenced by the mental constructs of the observer who may see what he or she wants to see and disregard other phenomena that could be an important part of the research. To overcome this possible bias problem, the researcher with the help of the Councilors purposively selected participants who are culturally competent in local knowledge. Observations in Chivi were made in all the three spatial areas noting physical settings, changes, similarities and differences in the regions, activities by participants such as drawing water and looking for energy resources. During the course of field observations, photographs were taken of dry river beds, deforested areas, silted rivers and other phenomena caused by climate change. Walliman (2011) points out that it is important that observations be based on research questions. Observation in this study was overtly naturalistic (non-participant). Gray (2014) notes that, in this type of observation the research is conducted in such a way that participants' behavior is disturbed as little as possible and the researched are fully aware that they are being observed. However, Gray (2014) adds that

field data, has the disadvantage that it is based on the researcher's mental constructs as it is not raw data and some important phenomena might be ignored, hence, the need to base observations on research questions.

### **3.5 Trustworthiness of data**

It is the researchers' view that in any research, whether qualitative or quantitative, researchers are acutely concerned about getting valid and reliable accounts. In qualitative research, many authors have come up with different perspectives regarding the validity and reliability of qualitative data which are parallel to quantitative research. Lincoln, Lynham and Guba (2011) suggest such terms as credibility, transferability, dependability and conformability as opposed to validity, reliability and objectivity in naturalistic research. Whittemore, Chase and Mandle (2001) suggest the use of synthesized perspectives of validity, organized into primary and secondary criteria. The primary criteria are credibility, authenticity, criticality and integrity and secondary criteria are vividness, explicitness, creativity, thoroughness, congruence and sensitivity. These perspectives use qualitative terms that are different from quantitative terms, and employ post-modern as well as interpretive perspectives (Creswell, 2013). For example, instead of using the term validation which is used in quantitative research, Eisner (1991) talks of credibility of qualitative research.

As varied as these perspectives are, Creswell (2013) summarizes them and considers validation in qualitative research to be trying to assess the accuracy of findings, as best described by the researcher and the participants. Strategies are thus used to assess the accuracy of the research findings. Creswell (2013) and Gray (2014) claim that qualitative researchers are worried about

getting the right data, publishing the correct information and getting the right answers to research questions. The following techniques were used to ensure credibility of data; prolonged engagement and persistent observations, repeated visits, use of multiple sources, triangulation and member checking. Triangulation was used to verify accuracy of data by cross-checking information from multiple perspectives used such as FGD, observation schedules, interviews and transect walks. However, controlling all the possible factors that might threaten the trustworthiness of data remained a principal responsibility of the researcher.

Firstly, the nature of the topic which dwelt on local knowledge specific to the community resulted in some participants being initially skeptical about taking part in the study. Consent to carry out research in the area was obtained and a letter was granted by the District Administrator as a way of showing transparency. Informed consent was also obtained in order to deal with the problem of negativity among participants. The objective of the study was clearly explained to the participants and they were given time to leave if they were not comfortable. In the end, all the identified elders took part in the research and were open during discussions. Prolonged engagement and persistent observations in the field was done in order to build the trust of participants. Fetterman (2010) contends that participant observation needs close long-term contact with the people under study. The phenomena of adaptation using local knowledge being contextual in nature cannot be observed in a short period of time and therefore a prolonged engagement was necessary. As such field visits to Chivi were done repeatedly during 2016 and 2017.

The researcher made use of multiple sources as well as methods of data collection in order to provide corroborating evidence thus insuring trustworthiness of data. Triangulation was accomplished through interviews such as participatory rural appraisal and focus group discussions, observations, asking the same research questions to different participants and by collecting data from different sources (elderly people, EMA and meteorological officers). Triangulation in this research was essential as it enabled the researcher to develop all-inclusive understanding of climate change adaptation measures using the local knowledge of the respondents. Member checking was also done by the researcher through asking participants to review both the data collected by the interviewer and the researcher's interpretation of the interview data. Creswell (2013) points out that it is important to take data analysis, interpretation and conclusions back to the participants so that they verify the accuracy and credibility of the research.

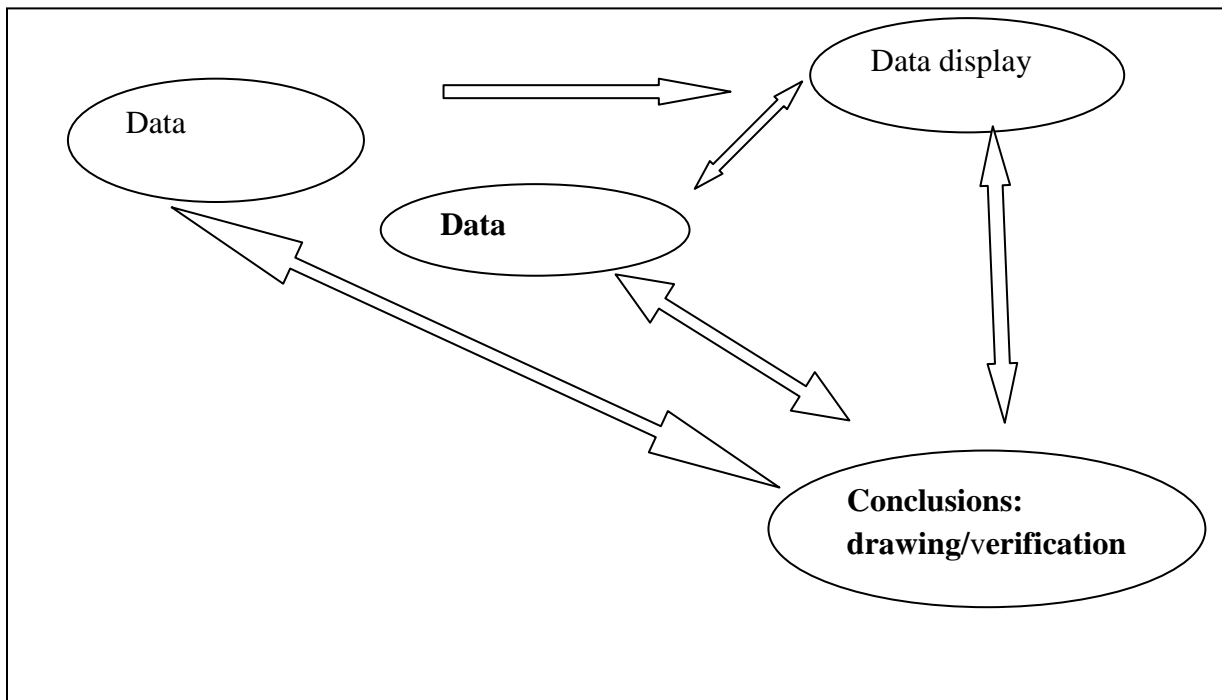
Transferability is the generalization of the study findings to other situations and contexts. Although transferability is important in quantitative research, it is not considered a practical naturalistic research objective (Lincoln & Guba, 2000). The context in which qualitative data collection occurs defines the data and contributes to the interpretation of the data. Generalization therefore, in qualitative data is limited. In this study, the phenomena under study is contextual, therefore, the actual local knowledge adaptation measures are specific to people of Chivi district. Readers of the research however, may make decisions regarding transferability because the researcher describes in detail the participants or settings under study thereby coming up with a rich, thick description. The thick detailed description allows readers to make decisions about transferring findings to other settings because of similar characteristics (Creswell, 2013).

### **3.6 Data Analysis**

After getting sound qualitative data, the data went through content and thematic analysis using the Nvivo software. Stake (2010) and Creswell (2013) agree that there are many different methods of analyzing qualitative data depending on the questions to be addressed and the variety of cases of social reality to be discussed. However, the varied techniques are often interconnected, overlapping, complementary and sometimes mutually exclusive. Qualitative data is often referred to as soft because it is mainly based on intuition and impression and is relative to situation (Creswell, 2013).

The processes of data collection, analysis and report writing are not separate steps in qualitative research. The procedures for analysis were undertaken using the data analysis –interactive model by Miles and Huberman (1994). Data, in this study, was collected using FGD, interviews, transect walks and observations. The various sources of data used makes narrative analysis useful (Kawulich, 2004). In sharing their experiences of climate change and their observations, participants were able to answer the research questions. In this qualitative study, the researcher immersed herself in the data so as to become proverbial with it and self reflect in order to come up with patterns, themes and relationships from the analysis (Creswell, 2013). By immersing in the data, the researcher learns to understand the participants' experiences of climate change, their perceptions and how they are adapting to the changes. While the researcher emerged as the storyteller, the respondents' voices were 'heard' in the direct quotations used in the presentation chapter. This process resulted in the 'thick description' of the the findings and discussion from the research. Miles and Huberman (1994) regard data analysis as having three components,

which are data reduction, display and verifying conclusions which are interactive throughout the process. Figure 3.5 shows the interactive model by Miles and Huberman.



**Figure 3.5: Interactive-Model (Miles and Hubermann, 1994)**

Data reduction during the early stages occurs through editing, segmenting and summarizing of data. In the middle stages, data reduction is through coding and memoing. Memos were used on field notes, interviews and photographs that gave the researcher key concepts that were meaningful. It was important to put tags and labels on data as this gave meaning to pieces of information collected, which was later on put into themes by identifying patterns. In the later stages, data was deduced by writing concepts and explanations based on the research objectives. Qualitative data is usually large and bulky, therefore, the need for data display at all stages of the analysis as this helps in organizing and summarizing the information (Miles & Hubermann,

1994). Data in this study was displayed in graphs, charts and networks. Reduction and displaying of data helped in drawing conclusions. Propositions were drawn early in the analysis thereby giving possible conclusions which could be verified as the analysis occurred.

### **3.7 Ethical considerations**

Ethical issues in qualitative research have to be considered throughout the research process from planning, designing, collecting data, data analysis and writing the report (Creswell, 2013). This is important so that no harm is caused to individuals during the course of the study or in the future. Ethical issues addressed in the study included obtaining an ethics approval letter, informed consent, access into study area, acceptance by participants, building rapport with participants as well as confidentiality and anonymity. It is essential that research is done in a transparent manner so that the researcher builds a good rapport with the participants and that the latter do not feel coerced to take part in the research.

The research proposal was evaluated by the Ethics committee of Great Zimbabwe University and an ethics approval document (Appendix B) was issued before the researcher entered into the field. Informed consent was achieved through seeking permission to study in the area and to interview participants. Permission was granted by the District Administrator (Appendix C). The District Administrator then referred the researcher to three (3) Councilors in the regions of the District who are the community leaders of the participants. The researcher talked to the Councilors in each region and after explaining the purpose of the study was given permission to carry out the study in the area. The Councilors also helped in identifying the main participants in the study. According to Creswell (2013) disclosure of the purpose of the study is very essential.

This was done by informing participants about the general rationale of the study before conducting the research. Honesty is very important and hence informed consent forms were signed by all participants. It was made transparently clear to participants that their involvement in the research was entirely voluntary and that they had the right to withdraw from participation at any time and that they did not have to sign consent forms if they did not wish to. The consent form specified by the Great Zimbabwe University's ethics committee was presented to participants and they were informed about the expectations of the institution. In addition to the consent form, participants were kindly asked to sign consent form for audio recording, in order to take part in the research (Appendix E). Therefore, participation in the study was voluntary and participants were not deceived. The researcher had respected the participants' and informed them that if at any time during the study they felt that they no longer wanted to participate in the research; they were free to opt out.

During data collection, it is important to build trust with participants and disrupt their lifestyles as little as possible (Cohen et.al., 2013: Creswell, 2013: Gray, 2014). This was done through discussions with participants about the extent of anticipated disruption during the course of the study. Discussions with the FGDs participants were done mainly during days when they were not working in their fields so that there was minimal disruption. The site for the study should be respected and participants should not be 'used' to collect data for personal gain (Kawulich, 2005). The FGD participants asked how they will benefit from the research. This researcher explained how it was important that their 'voices' on adaptation was documented so as to benefit future generations and thereby preserving their local knowledge. In addition gifts for all participants were made available so that there was some sense of reciprocity. Giving gifts to

participants was part of building rapport between the researcher and the participants for their 'sharing of their lives' with the researcher (Kawulich, 2005). The researcher built a positive relationship with the participants whereby all the contributions to the research process were valued. A long term relationship grounded in ubuntu/unhuism was built over prolonged engagement with the participants during the course of the research. In addition, the research was carried out 'with' the participants not 'on' the participants (Reason, 1998). This was done through establishing a relationship with the participants where they felt the researcher and assistants were part of them. Building of good relationships was done through active listening, showing empathy and honesty.

Gray (2014) observes that issues of anonymity and confidentiality are also important when it comes to analysis and storage. While analyzing data, confidentiality of participants was achieved through the use of pseudonyms and composite profiles so that individual data of participants could not be accessed by both researchers and non-researchers. Although exact quotes were used where possible in data presentation, pseudonyms were used for anonymity of participants. Information that allows the researcher to link the pseudonym and the participant was kept under lock and key.

Deception occurs when the researcher is not honest in regard to issues such as purpose of study, participant rights and even the time it would take to participate in an interview (Miller, Birch, Mauthner & Jessop; 2012). Denscombe (2010) agrees that researchers should be open and transparent about what they are doing by letting participants know that they are researchers, the intention of data collection and the role of participants in that particular research. To curb the

problem of deception in this particular study, the researcher gave a brief summary of the aim of the research and explained the role of the participants in the investigation.

### **3.8 Conclusion**

This chapter outlined the methodology used in this study. A qualitative multi-case approach was used to gain insight on the nature of the local knowledge adaptation measures used by people of Chivi district in dealing with climate change. The discussion showed that the study engaged various research methods such as FGDs, observations, transect walks and interviews. The rationale of the selection of the research tools preferred and participants sampled was explained. The use of multiple research tools has been justified in that they acted as cross-checks alongside each other seeing as they complemented one another in that, one's limitations was sheltered by the other. Ethical considerations were followed so as to make sure that the study was carried out in an honesty and professional way. The succeeding chapter shows how data gathered were presented and interpreted.

## **CHAPTER 4: DATA PRESENTATION AND ANALYSIS**

### **4.0 Introduction**

In this chapter, the focus is on presentation and analysis of the findings of the research study. The study used phenomenological inquiry which was coined by Edmund Husserl (Padilla-Diaz, 2015). In this study the people of Chivi District explained their experiences and use of local knowledge adaptation measures during climate change and how they interpret these experiences. The study therefore yielded rich narrative descriptions which gave the researcher insights regarding adaptation processes by the people given the climatic changes they experience. Thematic analysis on the research findings was done.

### **4.1 Climate change experiences of the people of Chivi**

This section presents and analyses data on the climate change experiences of the people of Chivi District in Masvingo. The following themes emerged from the data:

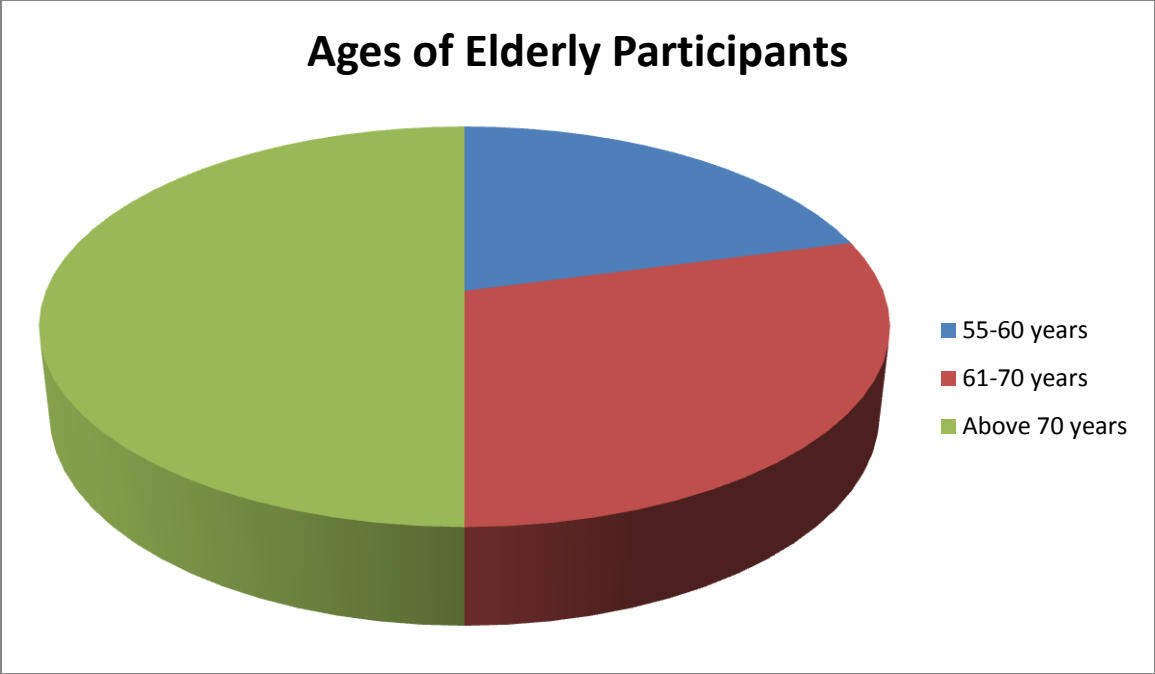
- observed changes in climate
- evidence of climate change in the ecosystem
- challenges brought by climate change.

The focus group discussions were undertaken in Shona, the vernacular language of the people of Chivi. Their responses were then literally translated into English and subsequently analysed. It was noted that some of the responses given from the three areas, Chivi North, Chivi Central and

Chivi South data were similar. In such cases one response was picked. This was to avoid monotonous answers. The themes are discussed in detail next.

#### **4.1.1 Biographical data of participants**

The biographical data of the main participants from Chivi who were involved in FGDs indicated that they were all aged above fifty five (55) years and as indicated in chapter 3 both genders were represented in the study. Figure 4.1 below summarises the ages of the participants who made up the total of twenty four (24). All the participants were born and raised in Chivi. Fifty percent (50%) of the participants were aged above 70 years, 21% aged between fifty five and sixty (55-60) years and twenty nine percent (29%) aged between sixty one and sixty nine (61-69) years. Given the definition of climate change as a change in the statistical distribution of weather patterns when that change lasts for a period of thirty five (35) years and above (Holden, 2008), the ages of the participants therefore showed that these people have witnessed and experienced climate change in Chivi.



**Figure 4.1 Ages of FGD participants**

Included in the study were an Environmental Management officer and two Meteorological officers, who were interviewed. The researcher asked for permission to carry out an interview at the Environmental Management Agency (EMA) in Masvingo and was assigned an officer who is a resident of Chivi. The Officer was chosen on the basis that she was involved in some of the adaptation projects being carried out by the residents of Chivi, was well travelled in the District and was also knowledgeable on climate change. An officer from Masvingo who was knowledgeable on the issues under study and a seasoned Meteorological officer was assigned to the researcher for interviews. The view of the Meteorological officers on climate change was used to source data on the climatic changes in Chivi.

**4.1.2 Observed changes in climate**

The main data collection method in the study was focus group discussion. These were undertaken in the three areas of Chivi, which are North, Central and South. The field data

collection in the three areas was initially done in 2016 and the repeat visits in 2017 as shown in Table 4.1. Therefore, views presented are summaries of the groups' arguments on the issues raised during the discussions. Individual responses from the Meteorological and Environmental Management officers were also given where necessary, as a way of triangulating the data.

**Table 4:1 Dates of visits to the study area for FDGs**

| Region (area)             | Number of FDGs | Dates of 1 <sup>st</sup> visit | Dates of 2 <sup>nd</sup> visit |
|---------------------------|----------------|--------------------------------|--------------------------------|
| Chivi North (Mhandamabwe) | 2              | 28-29 November 2016            | 23-24 April 2017               |
| Chivi Central (Masinire)  | 2              | 30 November-01 December 2016   | 25-26 April 2017               |
| Chivi South (Madzivire)   | 2              | 5-6 December 2016              | 1-2 May 2017                   |

#### **4.1.2.1 Participants' Knowledge on Climate Change**

All focus group discussions participants agreed that the climate in Chivi was not the same as it used to be when they were growing up between 30-40 years ago. Table 4:2 summarises suggested indicators of climate change.

**Table 4:2 Chivi people’s experiences of climate change**

| Broad View  | Chivi North  | Chivi Central  | Chivi South   |
|---|--|--|---|
| <ul style="list-style-type: none"> <li>• Temperatures have increased.</li> <li>• Farming seasons have changed.</li> <li>• Occurrence of extreme weather events e.g floods and droughts</li> <li>• Increase in prolonged dry spells</li> </ul> | <p>The planting season has changed. In the 1970s we used to plant crops in October but now we do so in January because the rains come late</p> | <p>The sun feels as if it is now ‘nearer’ the earth. Rains if they come are very light and sometimes they are very heavy leading to floods</p> | <p>When we were growing up it used to be hot in August, September and October but not like what we experience now. Now it is hotter. Rains used to cool down the temperatures but now there are no rains to cool the temperatures. Sometimes we are not sure whether the rains will come or not</p> |

Focus Group Discussion participants perceived increased temperatures, rainfall variability and increased occurrence of extreme weather events such as droughts and floods as climatic indicators of climate change they have experienced. The temperatures were now higher than they used to be when the participants were growing up. According to the Meteorological officer, due to its geographical location in Zimbabwe, Chivi District being a low-lying area had always experienced high temperatures. However according to records there was a time (30+ years) back when temperatures experienced in the area used to be lower than present day temperatures. The Meteorological officer said;

*“The data we have is for the whole of Masvingo Province. Temperatures vary during the year by 8,3°C with maximum temperatures 29,5°C in October and minimum of 6.2°C in July. However temperatures in Chivi are much higher*

*because the area lies in Natural Regions IV and V. Temperatures in Chivi average 33°C in summer and 10°C in winter. Extremes however are being experienced of late. This year (2017) Chivi experienced temperatures of above 40°C, which is really abnormal.”*

When asked about weather conditions in Chivi, the Environmental Management officer concurred with the Meteorological officer and residents of Chivi in that the rains were now erratic, temperatures had risen and the agricultural season had changed. She also added that there was an increased occurrence of dry spells within a season. The Officer eluded these extreme weather events to climate change. During focus group discussions and interviews with the EMA and Meteorological officers the same sentiments were echoed about floods which occurred in the 2016/17 rain season. Although the rains came late they were very heavy which caused flooding in areas of Chivi district. Regarding rainfall, the officer added that:

*“Dry spells are now very common and temperature variability worsens the already precarious situation. Since 1985 the whole country has experienced the warmest years on record with an increase of 3°C over the past century. Droughts are now on the increase. Farmers can no longer rely on our weather forecasts. Some even argue that we give them wrong information on weather forecasts. We might predict a good rainfall season but the timing and amount of rains prove us wrong. Farmers no longer trust us.”*

There was widespread consensus among the participants that rainfall variability and extreme temperatures impacted negatively on the livelihoods of people in Chivi. The area was found to be vulnerable in terms of exposure and sensitivity to climate change. The meteorological officer added that;

*“Floods although not expected in Chivi, now occur intermittently. During the 1999/2000 rain season we experienced cyclone Eline which killed about 200 people in Zimbabwe besides causing a lot of destruction, Chivi district included. Recently, in the 2016/17 rain season, cyclone Dineo occurred and this killed a lot of people, and destroyed homes, schools and dams. Around 2000 people were left homeless mostly in rural areas of Zimbabwe. Although these figures are for the whole of Zimbabwe, Chivi district was also severely affected.”*

Chivi District residents were now more vulnerable to climate change due to the increase in extreme weather events. These events are attributed to climate change. As noted by the Meteorological officer, the rainfall pattern used to be regular, but since the 1980s they have become unpredictable. It emerged from the findings that the climate of Chivi was changing. It was noted from the study that the severity of the changes differed from one area to another. Comparatively Chivi North and Chivi Central were impacted more by the changing climate as compared to Chivi South. Both the Meteorological and the EMA officers agreed that Chivi South received more rainfall than Chivi North and Central.

#### **4.1.2.2 Extreme Weather Events Experienced in Chivi**

During focus group discussions, the residents made the following observations about their experiences of extreme weather events in the district. The extreme weather events are summarized showing the broad view of the event and the specific experiences in each region as shown in Table 4.3:

**Table 4.3 Extreme weather events experienced in Chivi**

| Broad view  | Chivi North                   | Chivi Central                                   | Chivi South                                      |
|---|-------------------------------|---|--|
| <ul style="list-style-type: none"> <li>• Increase in</li> </ul> | The years 1982, 1983 and 1984 | During the years 1946, 1947 and 1948, there was | Recently we had droughts during 2013-15 seasons. |

|   |  |   |  |
|---|--|---|--|
| <p>extreme weather events such as droughts and floods</p> <ul style="list-style-type: none"> <li>• Droughts occurring back to back</li> </ul> | <p>we experienced severe droughts here in Chivi. During these years most of us harvested nothing from the fields</p> | <p>severe drought throughout the country. We had to rely on Kenya maize meal (Yellow maize) which we got from the Government. Again in 1991-3 and 2001-2 seasons we went back to eating Kenya maize again in order to survive. This maize is tasteless but we had no choice. We had to survive.</p> | <p>Some of us lost the entire herd of cattle. The cattle would just collapse and die because there was no drinking water and fodder. Our situation here in Chivi South was better than in North and South. On the other hand, we have never experienced so much rain as we had in 2000 and 2016/7 seasons. We were told these are cyclones. Imagine harvesting nothing because of too much rainfall.</p> |
|---|--|---|--|

It is evident therefore that in Chivi, drought periods are now on the increase since 1980. These droughts though were interspaced with floods, which was an unusual phenomenon in Chivi as agreed by the Meteorological Officer and residents of the area. These droughts vary from early season drought which is characterized by the delayed onset of the rains to extreme drought where rains failed for two or more consecutive years. Dry spells sometimes persisted throughout the whole rainy season as one participant from Chivi North echoed observed:

*“Mugore ra1987 mvura yainaya iri shoma kusvika mwaka wemvura wapere. Hapana chatakakohwa kubva muminda.”* [During the 1987 rain season, rains were light and patchy throughout. We did not harvest anything from our fields].

The Meteorological officer attributed the increased drought phenomena in Chivi to climate change. Overall, the increase in these extreme weather events increased the vulnerability of Chivi residents. There are a number of uncertainties that have been brought by climate change as highlighted by participants of the FGD's and interviews. Fluctuations in rainfall has led to some farmers to give up on cropping because they were no longer sure weather rains will come or not or whether it will be enough for their crops. Their livelihoods were threatened. One participant from Chivi Central said the following regarding climate variability versus cropping:

*“ Dzimwe nguva mvura inotanga kunaya zvakanaka chaizvo, todyara mbeu dzobuda zvakanaka. Kubva ipapo mvura inobva yaenda kopisa zvikuru kwenguva refu kana mwedzi chaiyo. Apa ndipo panenge poita mbeu maruva. Mbeu dzinofa. Mvura inodzoka apa mari yekutenga dzimwe mbeu hatichina. Saka zvinotiomera chaizvo.”* [Sometimes the rain season starts well with promising rains, we then plant the seeds and they germinate well. After that we then have long dry spells during the critical flowering period and the crops wilt and die. The dry spell can be as long as a month. When the rains come, we no longer have money to buy more seed to plant. So it is a really difficult situation.]

Most of the agriculture in Chivi is rain-fed, therefore the varying precipitation patterns have a negative impact on crop production. The Meteorological officer added that the increasing temperatures worsen the situation as they increase evaporation rates in the area.

The EMA officer added that the biophysical environment in Chivi makes residents more vulnerable to climate change than people from other areas of the same Province (Midlands Province) such as Mwenezi, Chiredzi, Rushinga, and Gutu. Adaptation measures which are

therefore specific to Chivi residents are thus important. When asked to explain the biophysical environment of the area, the EMA officer said:

*“Chivi’s physical environment is made up of poor sodic soils which range from sandy, rocky soils in the northern part, sandy soils in the central part and, loamy/sandy soils in the southern part. These soils require a lot of rainfall for farmers to harvest enough to feed their families. The vegetation is also very poor and is mainly composed of acacia plants. This means therefore that the livelihoods of people in Chivi are worsened by this changing climate. However, adaptation options consistent with the prevailing challenges can be adopted.”*

The biophysical challenges experienced in Chivi, coupled with the changing climate, require residents to adopt a top-down approach to deal with the problems. It is evident from the discussions that the northern part of Chivi was categorized as the most vulnerable area, followed by Chivi Central and Chivi South being least vulnerable.

#### **4.1.3 Evidence of climate change in Chivi**

Through focus group discussions, transect walks and timeline interviews, it emerged that in Chivi the climate was changing. Participants agreed that there were changes in the physical environment, biodiversity, sources of water and outputs from farming.

##### **4.1.3.1 Evidence of climate change in Chivi environment**

Environmental evidence showing that climate was changing was sought from the participants. Table 4.4 shows the summary of the evidence of climate change in Chivi District. The broad view of the evidence in the whole of Chivi is shown first and then specific evidence in the three regions of Chivi District.

**Table 4:4. Evidence of climate change in Chivi**

| Broad View  | Chivi North Views   | Chivi Central Views  | Chivi South views                              |
|---|---|--|--|
| <ul style="list-style-type: none"> <li>• Reduced underground water</li> <li>• Biodiversity loss</li> <li>• Extinction of certain species of vegetation</li> </ul> | <p><i>Mitsamvi</i> (Fig trees) are drying up, <i>misekesa</i> and <i>misvimbwa</i> are no longer found in the area</p> <p>Long back people did not cut down trees for firewood. There is a forest called <i>Rambakutemwa</i> (Refuse to be cut) where people here in Chivi North used to go and pick up dry fallen wood, but now it's no longer a thick forest. People have been cutting down trees for firewood.</p> | <p>Certain type of trees that were found in the forest are now very scarce eg <i>miroro</i> (<i>Annona squamosa</i>), <i>mikute</i> (<i>Syzygium guineense</i>) and <i>mitondo</i> (<i>Julbernardia paniculata</i>)</p> <p>Fruit trees such as <i>mitohwe</i> (<i>Azanza</i>), <i>mitamba</i> (<i>Strychnos spinosa</i>), <i>mikwakwa</i> (<i>Strychnos madagascariensis</i>), <i>nhengeni</i> (<i>Ximenia caffra</i>), <i>tsubvu</i> (<i>vitez mombassae</i>) and <i>nhunguru</i> (<i>Flacourtia indica</i>) are now scarce</p> |  |
| <ul style="list-style-type: none"> <li>• Loss of wetlands</li> </ul>  | <p>Long back in the 1970s and early 1980s there</p>   | <p>Banga and Masinire areas in Chivi</p>   | <p>Wetlands can still be found in isolated</p> |

|  |  |  |                             |
|--|--|--|-----------------------------|
|  | <p>used to be grass called <i>jekachecheka</i> (<i>Phragmites communis</i>) but not anymore</p> <p>The areas called Mashindi, here in Chivi North used to be wetlands but these are now dry lands.</p> | <p>Central used to be wetlands but the areas are now a dryland. There were many of these wetlands in Chivi and we used to grow rice but that is no longer the case</p> | <p>areas in Chivi South</p> |
|--|--|--|-----------------------------|

The above responses from FGDs indicate that there has been great biodiversity loss in terms of vegetation, reduction in underground water and disappearance of wetlands in Chivi. The disappearance of certain trees like Fig trees (*Ficus Carica*) was attributed to the lowering of the water table which the participants attributed to climate change. The EMA official added that:

*“The quality and quantity of water in Chivi District has been compromised due to climate change. This is worse in Chivi North and Central. There is massive siltation of rivers in the area. Certain trees like misekesa (Bauhinia thonningii), Mopane (Colophospermum mopane), mubhondo (Combretum apiculatum) and musasa (Brachstegia spiciforms), which used to be widely found in Chivi, are now becoming extinct in Chivi North and Central. In Chivi South, Mopani and musasa trees are still there, although they are becoming endangered”.*

The EMA Officer attributed these changes to the role of deforestation in this debacle. Some indigenous species for example *Brachystegia*, *mopane*, *wild custard apple*, and *phragmites communis* have become extinct in Chivi North and Central. Tree species like *Syzygium guineense* are usually found close to water sources. Reduction in the species reflects a reduction in the watertable levels in Chivi North and Central. The Meteorological officer suggested that “*the*

*changes in biodiversity being seen today in general are being caused by both climate change and the increasing population. However, the extinction of certain species of flora is mainly attributed to the fact that these are unable to adapt to changes in climate.*” Although both the Meteorological and EMA officers concurred with the sentiments expressed by FGD participants on climate change’s effects on biodiversity, they both proffered that population increase in the area was also contributing to biodiversity changes.

It is worth noting that although an increase in population in Chivi has an impact on biodiversity loss, there was consensus that climate change played a role in both the reduction and extinction of certain species. Through observations during transect walks with residents of Chivi, it was noticed that there were no wetlands in the North. However, in Chivi South wetlands were observed and these were dense with *Phragmites communis* reed (Figure 4:2). *Jekacheka* (*Phragmites communis*) is a sharp blade grass which is found in perennial wetland areas and in rivers. This type of grass used to be found in Chivi North indicating that there used to be enough water to sustain the species. However due to the disappearance of wetlands, this type of grass had become extinct in the northern area. As indicated earlier, Chivi South presently receives higher rainfall than Chivi North and Chivi Central. Chivi South is found in Natural region IV. The EMA officer added that Chivi North was hard hit by climate change and hence the disappearance of wetlands in this area. Patches of wetlands were still found in Chivi Central and South. The Officer gave examples of areas such as Banga and Masinire in Chivi Central which used to be wetlands but were now dry. The FGD participants also cited a reduction in water-berry (*Syzygium guineense*) and fig trees (*Ficus carica*) and a type of grass called *Shengezhu*

(*Hyparrhenia rufa*) in the area. When asked about the significance of these types of trees and grass, the EMA Officer said these were found in areas with a higher water table.

Vegetation species such as *Jekacheka* (*Phragmites communis*) in Chivi North had become extinct due to its failure to adapt to high temperatures and low rainfall. Vegetation types such as mahogany (*mukamba*) and figtree (*muonde*) were being threatened because of climate change. Wild fruit trees such as *Strychnos spinosa* (*matamba*), *strychnos innocua* (*makwakwa*), *ximenia caffra* (*nhunguru*) and *viyez mombassae* (*tsubvu*) were also threatened as indicated by FGD participants.



**Figure 4.2: A stream with *Phragmites communis* in Chivi South**

The vegetation scenario was very different in the three areas of Chivi (North, Central and South). Observations made in the respective areas show that some parts of Chivi South are still densely

populated with a variety of tree species whilst in North and Central Chivi, forests are sparsely populated. Figures 4.23, 4.4 and 4.5 show the vegetation scenario in Chivi North and Central.



**Figure 4.3: Main type of vegetation found in Chivi North**

The vegetation in Chivi North mainly consists of acacia plants which are drought resistant. These plants grow in areas with full sunlight and do well in any type of soil. It was, however, observed from the discussions with the people in Chivi North that this area used to have a wide variety of trees including Musasa trees (*Brachystegia spiciformis*) which require a lot of water. A participant from Chivi north summed up the state of vegetation stating thus:

*“Iye zvino hakuchina masango. Kare kwaive nemipani, mitondo nemisasa. Miti iyi haichawanikwe kuno. Yave minzwa chete.”* [Dense forests have disappeared in Chivi North. Long back we had Mopani (*Colophospermum mopane*), mitondo (*Julbernardia globiflora*) and msasa (*Brachystegia*

*spiciforms) trees. Now we do not see these types of trees. Forests are now composed of acacia trees].”*

The Meteorological officer attributed the disappearance of such species as *colophospermum* Mopane (mopane), *Brachystegia spiciforms* (*musasa*) and *Julbemardia paniculata* (mutondo) in Chivi North to the changing climate. Chivi District is a rural based community with an increasing population, consequently, there is increased demand for natural resources such as wood-fuel, selective exploitation or destruction of certain species and water pollution. Climate change however has increased the threat and loss of certain tree species.



**Figure 4.4: Chivi Central vegetation**



**Figure 4.5: Chivi South vegetation**

In Chivi District, the Meteorological officer pointed out that temperatures had increased by 5°C in the last thirty (30) years. He added that the high temperatures experienced and the lack of adequate rainfall make the area dry and vulnerable to forest fires. Chivi North vegetation as shown in plate 4.2 shows that it has been affected the most by climate change the most compared to Chivi Central and South. Chivi South has some areas which are still densely forested for example around Bubi in Chivi area where plate 4.4 was taken. Changes in flora have a bearing on animal species found in an area since vegetation provides both food and habitation.

#### **4.1.3.2 Changes in Domestic and Wild Animals in Chivi district**

Regarding fauna in the study area, it emerged that the population of certain species has declined whilst some domestic and wild animal species have gone extinct. The broad views for the whole district and the specific changes in the regions are summarized in Table 4.5

**Table 4.5 Changes in domestic and wild animals**

| Broad view  | Chivi North residents' views   | Chivi Central residents' views  | Chivi South residents' view   |
|---|--|---|---|
| <ul style="list-style-type: none"> <li>• Decline in cattle ownership</li> <li>• Increase in donkey ownership</li> <li>• Decline in goats per household</li> </ul> | <p>In the 1960s we used to have an average of 25/35 cattle per household in Chivi North but now most of us have 4/5 per household</p> <p>When I was growing up my father used to keep cattle numbering around fifty (50) but now we only have three (3).</p> <p>Long back donkeys were comparably few. Nowadays donkeys are many. It is considered to be wealthy now if you have donkeys. Some households do not even own donkeys.</p> | <p>Cattle in Chivi central now average ten (10) per household, although numbers were quite high during the 1960s and 1970s.</p> <p>When I was young in the 1960s our family had around eighty (80) cattle. During the last drought (2014/15 rain season) cattle were just dying. People were coming from other areas to buy cattle at a give-away price of even \$50 each. A cow usually fetches \$700 but we had no choice. I have no cattle at present I now only have five (5) donkeys</p> | <p>Since the 1980s, most households have not had a cattle herd above twenty (20). At the moment the average household cattle herd fifteen (15).</p> |
| <ul style="list-style-type: none"> <li>• Decline in</li> </ul>  | <ul style="list-style-type: none"> <li>• In the good old days</li> </ul>   | <p>Generally the numbers of goats</p>   |   |

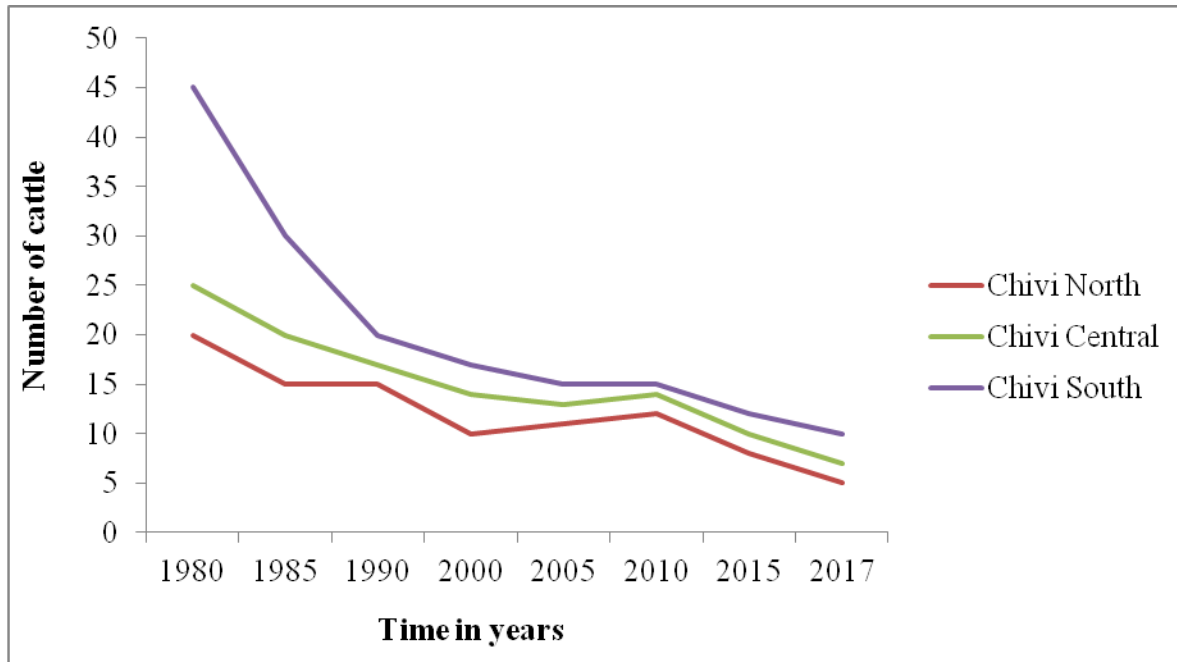
|   |   |  |  |
|---|---|--|--|
| <p>type of animal species</p> <ul style="list-style-type: none"> <li>• Extinct of certain animal species</li> </ul> | <p>there were turo (hare), mbira (rock rabbit), (antelope), mhembwe (duiker) and nhoro (kudus) in the forests. Now we only see makudo (baboons).</p> <ul style="list-style-type: none"> <li>• Wild animals were plenty because their food was readily available.</li> <li>• We used to have goats numbering around fifty (50) but now we do not have even one.</li> </ul> | <p>per household have declined. Hiding places for wild animals were readily available because of the dense vegetation, but not anymore. So wild animals have disappeared</p> |  |
|---|---|--|--|

There are manifest differences in numbers and types of animals kept by the participants in Chivi Central, North and South. Cattle require a lot of fodder and water compared to drought resistant animals such as donkeys and goats. Comparable differences existed among the three regions of Chivi district. As an example, a typical household in Chivi South had eighteen (18) herd of cattle whilst a corresponding household in Chivi North had none. The trend shows a decline in cattle ownership among the participants over a period of thirty seven (37) years. Table 4.6 shows the average household cattle herd size between 1980 and 2017 while figure 4.6 shows the decline in cattle herd in form of a graph.

**Table 4.6 Average cattle herd size per household in Chivi District**

| Year | Chivi North | Chivi Central | Chivi South |
|------|-------------|---------------|-------------|
| 1980 | 20          | 25            | 45          |
| 1985 | 15          | 20            | 30          |
| 1990 | 15          | 17            | 20          |
| 1995 | 10          | 14            | 17          |
| 2000 | 11          | 13            | 15          |
| 2005 | 12          | 14            | 13          |
| 2010 | 8           | 10            | 12          |
| 2015 | 6           | 5             | 12          |
| 2017 | 5           | 7             | 14          |

On average cattle ownership in Chivi District has declined by seventy five percent (75%) between 1980 and 2017. In Chivi Central and South, average household cattle ownership has fallen by seventy two (72%) and by sixty seven percent (67%) respectively over the same period. The EMA officer added that “*about 5000 livestock deaths were recorded just three months in the previous drought of the 2015/16 farming season.*” Due to extreme weather such as droughts (1981/2 and 1991/2) and floods (2002), fluctuation in cattle ownership trends were experienced as indicated in Figure 4.6. Spatial and temporal variations in rainfall regions of Chivi potentially explain the above noted differences. After a good season, some of the participants said they would buy one or two cattle to add to their existing herd. Climate change and increased variability have been identified as the main drivers of the diminishing number in domestic animals. In this study one participant indicated that he sold his cattle at fifty dollars (\$50) each because of the 2014/5 drought. This was a massive loss from the usual cost of one beast which he pegged at \$700 during a normal season.



**Figure 4.6 Decline of herd of cattle over time**

Concerning the deminishing number of goats in the area, (compared to the previous years), one participant summed up the situation stating that:

*“ Mbudzi dzaveshoma nekuti tinouraya tichiita husavi uye kutengesa kuti tiwane mari yekuendesa vazukuru kuchikoro. Kare taivhima musango tichiwana nyama asi iyezvino mhuka dzemusango hakuchina”* [Numbers of goats are now low because we slaughter them and use them for relish and selling them in order to get money for school fees for our grandchildren. Long back we used to rely a lot on wild animals for meat but these are now scarce.]

According to the participants, there was also a shift from cattle rearing to donkey rearing. This was because donkeys were able to survive well in adverse climatic conditions. They opined that donkeys are drought resistant and they are used for various domestic uses such as fetching firewood, draught power during farming and fetching water.

Most of the wild animals in Chivi have become extinct. The EMA officer attributed this to climate change and the increase in the human population which have led to the destruction of forests and therefore disappearance of habitats for animals. Increased human population and deforestation have increased potential and real threats on animal species. During focus group discussions in the three areas of Chivi the following observations were expressed in relation to wild animals:

*“Kare kwaive nemhuka dzakasiyana setsuro, nhoru, mbire nemhembwe. Iye zvino hadzichawanikwe.”* [Long back there were a lot of wild animals such as hare, kudus, rock rabbit and duikers. Today these have all disappeared”] (Chivi North)

*“Mhuka dzesango dzaveshoma nekuti vanhu vanovhima, uye mvura yekunwa nebundo zvave zvisvoma”* [Wild animals are now scarce due to hunting by people, lack of water and vegetation.” (Chivi South)

*“Mhuka dzinogara munzvimbo inemiti yakawanda. Saka kana miti pasisina, mhuka dzinotiza.”* [Animals stay in bushy areas and once the vegetation disappears, they migrate]” (Chivi Central)

*“Makudo achirikuwanikwa nekuti kudya kwawo kuzere.”* [Baboons are still readily found because their food is readily available.]” (Chivi Central)

As enunciated in the above excerpts, some wild animals have gone extinct and some were being threatened by climate change. Baboons however were still found in large numbers in Chivi because they survive on wild varieties of wild fruits, crops and certain tree roots. Habitats for baboons are mountains and they many hiding places. On the other hand, animal species like hare, kudus and duiker feed on grass, therefore the disappearance of these animal species in Chivi

especially the northern and central part. The EMA officer was asked why there was a decline in animal species and he explained that:

*“Animals whether domestic or wild, need a lot of pasture and drinking water to survive and reproduce. The reduction in rainfall and increased temperatures have resulted in less fodder and therefore a reduction in the number of animal species”*

#### 4.1.2.3 Changes in Sources of Water in Chivi District

Table 4.7 shows the different views by FGD participants on the changes in sources of water such as rivers and dams in Chivi District. Wide views for the whole of Chivi District are shown first and thereafter the specifics for each region of the district.

**Table 4.7 Views on changes in sources of water**

| Broad View   | Chivi North  | Chivi Central  | Chivi South   |
|--|--|--|---|
| <ul style="list-style-type: none"> <li>• Rivers heavily silted</li> <li>• Most rivers which used to flow perennially now flow seasonally</li> <li>• Major rivers (Runde and Tokwe) still flow perennially but they are heavily silted</li> </ul> | <p>Musavezi, Ngezi, Nyageti and Nyunotedzi rivers used to be perennial but are now heavily silted and only have water during the rainy season.</p> | <p>Most rivers have become dry except during the rainy season. Rivers such as Nyageti, Tugwane and Nyungecheni used to flow throughout the year but now only flow during the rainy season.</p> | <p>Long back rivers such as Banga and Mandamwane used to have water all year round. Nowadays they only have water during the rainy season. The only rivers that have water throughout the year are Runde and Tokwe.</p> |

Focus Group Discussions revealed that most rivers in Chivi used to be perennial but they have become seasonal due to heavy siltation and low rainfall. The major rivers, Runde and Tokwe had water throughout the year but were also heavily silted (Figure 4.6). The EMA Officer concurred by adding that due to climate change, especially low rainfall, all the rivers in Chivi district were heavily silted. Ninety percent (90%) of the fields surrounding the rivers did not have contour ridges and this led to soils being washed away from the fields into the rivers. This has exacerbated river siltation like part of Runde river in Figure 4.6.



**Figure 4.6 Silted Runde river**

## **4.2 Adaptation Measures by People of Chivi District**

This section of the chapter answers two research objectives. The first one is to explore the local knowledge adaptation measures which the indigenous people of Chivi district in Masvingo use in responding to climate change. The second one was to analyze the effectiveness of local

knowledge adaptation measures to climate change of Chivi. The following themes emerged from the presentation and analysis of the data collected:

- Farming adaptation measures;
- Water and vegetation adaptation options.

Summary of adaptation measures employed in all the areas of Chivi is shown in Table. 4.8, in addition to showing the climatic exposure characteristics, systems affected and the advantages of the adaptation options. The table highlights the climatic exposure characteristic experienced, the system that is affected, the adaptation option chosen and the reason for the choice of the adaptation option.

**Table 4.8 Summary of adaptation options by people of Chivi District**

| Climatic Exposure Characteristic   | System Affected | Adaptation Options Adopted   | Reason for Adaptation Options  |
|--|-----------------|--|--|
| Increased droughts<br>Rainfall variability<br>Floods<br>Extreme temperatures | Crop farming    | 1.In-field water harvesting (infiltration pits)<br>2.Mulching<br>3.Staggering of crop planting dates<br>4.Increase in growing small grain crops<br>5.Intensive farming within the homesteads<br>6.Use of organic manure<br>7.Use of IKS in weather | 1.Water retention in the fields<br>2.Reduces water loss by evapo-transpiration<br>3.To counter risks associated with rainfall variability<br>4.Nutritious, low rainfall needed, low storage loss<br>5. To ensure productivity on smaller areas<br>6.To allow water retention and fertility in the soil<br>7.Tried and tested |

|  |                 |  |   |
|--|-----------------|--|---|
|  |                 | <p>forecasting</p> <p>8.Winter ploughing</p> <p>9.Collective farming (<i>humwe</i>)</p> <p>10.Rain making ceremonies</p> <p>11.Social safety nets (<i>zunde raMambo</i>)</p> <p>12.Establishment of nutrition gardens</p> <p>13.Keeping drought resistant animals (small ruminants)</p> <p>14.Relocating animals to areas with better pastures</p> <p>15.Feeding animals with maize stalks and <i>misekesa</i> (<i>Piliostigma thonningii</i>) tree pods</p> | <p>method of weather forecasting</p> <p>8. Weed control and moisture retention</p> <p>9.colloborative work to reduce labor costs</p> <p>10.To ask for rains from ‘Mwari’</p> <p>11.To provide food to households with poor yields</p> <p>12.To improve nutritional value of household diet</p> <p>13.Donkeys and goats need less water compared to cattle</p> <p>14. Areas like Chivi South have better pastures.</p> <p>15Maize stalks and <i>misekesa</i> (<i>Piliostigma thonningii</i>) pods are nutritious</p> |
|  | Water resources | <p>16.Construction of storm bridges</p> <p>17.Digging out wells in dry river to get potable water</p>  | <p>16.To protect rivers from siltation</p> <p>17.Available ‘clean’ source of water for some households</p>  |
|  | Tree            | 18.Establishing woodlots   | 18.Reduces  |

|  |             |  |   |
|--|-------------|--|---|
|  | resources   | 19.Growing indigenous trees<br>20.Use of <i>tsotso</i> stoves<br>21.Harvesting and selling wild fruits                             | runoff19.Improves micro-climate<br>20.Uses less woodfuel and reduces massive deforestation<br>21.To sustain livelihoods                       |
|  | Livelihoods | 22.Food diversification<br>23..Reversal of gender roles<br>24.Relocation of families to areas near rivers<br>25.Community projects | 22.To improve sources of food<br>23.Women have become bread winners<br>24.Some areas have better rainfall<br>25.Improve livelihood sustenance |

#### 4.2.1 Crop Farming Adaptations

Participants in FGD noted that crop production was greatly affected by rainfall variability and high temperatures leading to crop failure and low output. All FGD participants agreed that in-field water harvesting was a crop farming adaptation technique used by their forefathers. However, of the FGD twenty four (24) participants, only four (4) farmers (17%) were using this adaptation option. Farmers indicated that although the adaptation procedure was effective in water retention and increased crop yield during poor rainfall seasons, it was labor intensive. One farmer indicated that:

*“Makandiwa anobatsira chaizvo kuti mvura igare pasi nekuti tiite gohwo ririnani. Dambudziko racho nderekuti makandiwa anorwadza kuita. Isu tachembera, misana haichada. Vana vechidiki vakatizira kumadhorobha. Makandiwa kuti ashande anofanira kudzika two (2)*

*metres nekufara 2.4 metres akatevedza minda. Zvino zvinoda vechidiki vachine simba, saka tongorega kuaita.*” [Water infiltration pits are very effective in water retention in the fields and they result in better harvests. However, they are labour intensive and only able bodied people can dig the trenches. The infiltration pits should be 2 metres deep, 2,4 metres wide and should be done along the whole field. We have since stopped making them because they need a lot of labour].

An examination of the fields revealed that infiltration pits were 1-2 metres deep within trenches along the fields, and they were spaced at five (5) metre intervals. Comparing two adjacent farmers, one who was using infiltration pits had better yields than the other farmer who was not using the infiltration pits. The farmer who used infiltration pits harvested two (2) tonnes of sorghum over a two (2) hectare piece of land whilst the other farmer harvested one (1) tonne of sorghum over a similar sized piece of land. This showed a fifty percent (50%) difference in harvest. Similar comparable differences in yields were found in the farmers from Chivi Central. Figure 4.7 shows a water infiltration pit and plate 4.7 the field of the farmer who adopted this adaptation technique.



**Figure 4.7 Infiltration pit in a field with organic manure**



**Figure 4.8 Field of sorghum grown using infiltration pits**

When probed further about the effectiveness of this water harvesting technology, one of the farmers who utilized the technique (adaptation option) said:

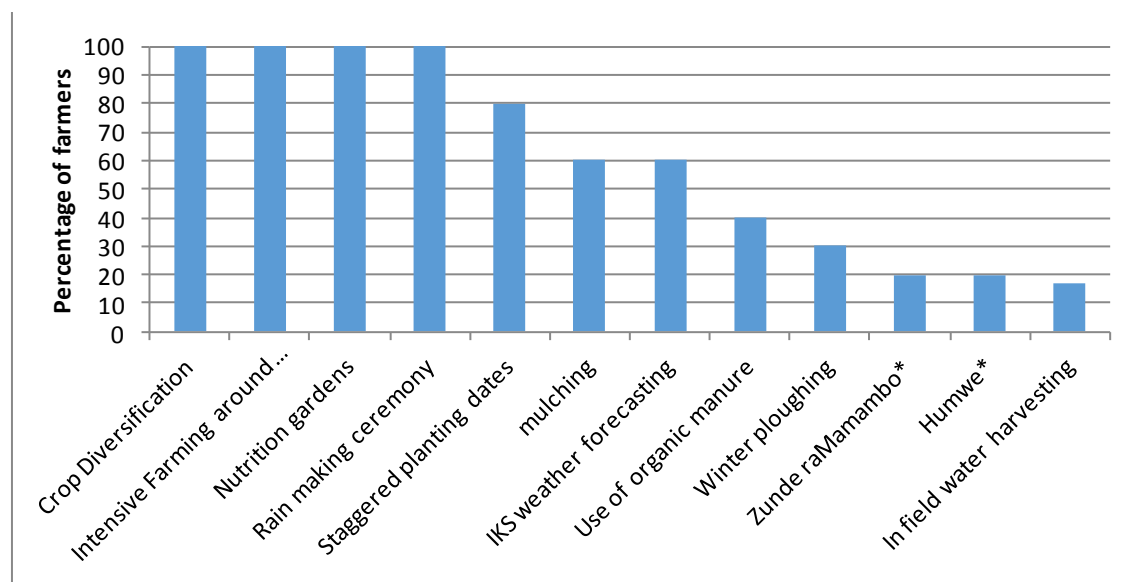
*“Ini ndakadzidziswa nababa vangu kuita makandiwa muna 1958. Ivo vakadzidziswa nevarungu. Handisati mdamboita zhara pamba pangu, uye panogara pakaitwa field day nekuti tinoita gohwo rakanaka gore negore. Chero mvura ikaita shoma, makandiwa anochengetedza hunyoro”.* [I was taught to do infiltration pits by my father in 1958 and my father was taught by whites. My family has never gone hungry even when rains are erratic. Infiltration pits retain moisture in the fields so that we always have good harvests.]

A field adjacent to the farm, belonging to a farmer who did not use infiltration pits harvested nothing from the field. The field is shown in Figure 4.9. The land was later abandoned by the farmer during that farming season (2016/7) due to lack of adequate rains.



**Figure 4.9 An abandoned field due to lack of rains**

Crop diversification, intensive farming around homesteads, nutrition gardens and rain making ceremonies were the major crop farming adaptation measures implemented in Chivi to combat climate change. Figure 4.10 shows the percentage crop farming adaptation options identified by the farmers during FGDs.



**Figure 4.10 Percentage usage of crop adaptation options**

**Note:**

\**Zunde raMambo*- A traditional social safety net concept whereby traditional leaders keep grain reserves to distribute to the needy during distress calls

\**Humwe*- collective farming where farmers provide labour and inputs to a fellow farmer. Food and refreshments during work are provided by the farmer being helped.

Farmers noted that although small grain output (finger millet and sorghum) is good in Chivi, it was not palatable compared to maize, especially to the young generation. They also perceive production of small grains to be labour intensive. All the farmers agreed that there is a general increase in the growing of small grain crops since the 1980s. Historically though, they added that small grains were the main types of crops grown in the area. Maize growing challenges that were highlighted include low drought tolerance and less storage time (8-9 months) whilst small grains

can be stored for many years. Staggering of planting dates for crops was done so that farmers would be assured of harvesting something from the fields. Without staggering of planting dates, farmers agreed that the entire crop could be destroyed by prolonged dry spells. In addition, the farmers recognized the importance of mulching in the fields as they said it moderated temperatures and retained moisture in the soils. They emphasized that this required mulch in form of leaves which had become scarce in the area. This adaptation strategy was being done on small field areas.

Regarding IKS weather forecasting, the sixty percent (60%) of those who used this adaptation technique agreed that weather forecasting by the meteorological office was unreliable and farmers rely on indigenous ways of forecasting weather. Table 4.9 shows the IKS and weather forecasting measures used by the people of Chivi.

**Table 4.9 IKS and weather forecasting**

| <b>IKS Indicator Description</b>   | <b>Indicator meaning</b>  |
|--|---|
| <ul style="list-style-type: none"> <li>• Singing of <i>hwaya</i> (rain cuckoo bird)</li> <li>• Extreme high temperatures between August and October</li> <li>• Occurrence of a whirlwind</li> <li>• Abundance of wild fruits such as <i>chakata</i> (<i>Purinari caratellifolia</i>) and <i>misekesa</i> (<i>Bauhinia thonningii</i>)</li> <li>• Presence of <i>shuramurove</i> (stock birds)</li> <li>• Singing of <i>nyenze</i> (cicada) insects</li> <li>• Presence of full moon</li> </ul> | <ul style="list-style-type: none"> <li>• Rains are near</li> <li>• Signals the coming of a good rain season</li> <li>• Onset of rains</li> <li>• Imminent drought</li> <li>• Onset of rains</li> <li>• Onset of rains</li> <li>• No rainfall</li> </ul> |

The Meteorological officer added that weather forecasting by the meteorological office usually covers a wide spatial area which was general in nature and differences occurred in some areas contrary to the given forecast. IKS, as noted by the participants, is specific to an area and therefore reliable. They also cited lack of access to weather forecast information as another hindrance. Notably, farmers who used IKS in weather forecasting agreed that they used it to be informed for field preparation and crop planting.

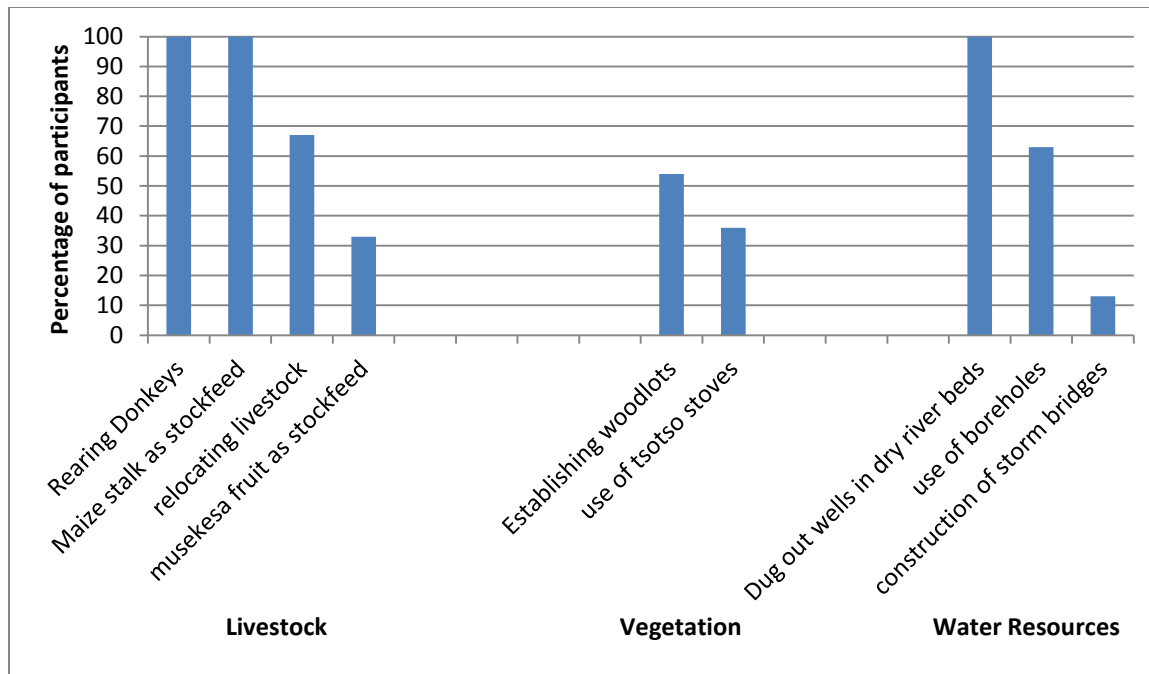
FGD participants were asked to explain further how rain making ceremonies (*mukwerera*, *kukumbira mbura* or *mitoro*) were done and how effective they were. They agreed that although they still carried out rain making ceremonies, they used to be more effective long back in the 1950s up to the 1970s. They argued that people then used to follow proper procedures when carrying out *mukwerera*. Beer for the ceremony was brewed by unmarried elderly widowed women who were no longer sexually active with the help of young virgin girls who were deemed pure. The ceremony was done under certain trees such as *muchakata* (*Parinari curatellifolia*) which the participants believed were associated with water. In addition to brewing and drinking beer, the ceremony involved singing, dancing and eating roasted meat. A gourd containing beer was left under the tree for the ancestors. Elderly men were sent to sacred places in Matobo Hills near Bulawayo called *Matonjeni* to perform sacred ceremonies there and upon their return, rains would fall. The aim of rainmaking ceremonies was to ask for rains from *Mwari* (God) through *Vadzimu* (ancestors). The participants were asked further why droughts were on the increase despite the communities observing rainmaking ceremonies. They advanced an argument that indigenous people no longer follow proper traditions when carrying out *mukwerera*, resulting in

ancestors getting angry and rains not falling. One participant proffered the reasons for rains not falling after performing ceremonies thus:

*“Chembere dzinofanira kubika doro dzave shoma uye dzave kubatabata zvakawanda. Chechi dzechipostori dzawandisa dzinonamatira munzvimbo dzinoera. Pakubika doro vanhu vavekuisa sugar. Saka midzimu yakatsamwa., pasirakatsamwa. Tichikura isu,vakuru vaiti vakaita mukwerera taitoziva kuti mvura inotonaya”* [Old women who are supposed to brew the beer are now few and these engage in different taboos. Apostolic churches hold their ceremonies in sacred areas. When brewing beer, people now add sugar. All these activities have angered ancestors. The land is angry. During the time when we young, rains definitely used to fall after the adults observed rainmaking ceremonies.]

#### **4.2.2 Livestock, Water and Vegetation Resource Adaptations**

FDGs participants were asked to discuss how they have responded to climate change in regard to livestock, vegetation and water resources. The responses from Chivi North, Central and South differed significantly as shown in Figure 4.11.



**Figure 4.11 Livestock, vegetation and water adaptation options**

#### 4.2.2.1 Livestock adaptation options

All of the participants from Chivi North and Central revealed that they relocated their cattle to Chivi South when pastures were affected by long dry spells. Cattle were given to relatives in Chivi South for safekeeping and in wards 24 and 31 (in Chivi South) where herdsmen camped until pastures in their areas had recovered. The EMA officer supported this claiming that wards 29 and 31 in Chivi South were left vacant after people were relocated to other areas during the construction of Tokwe-Mukosi dam. The area was being used as a pastureland by farmers from Chivi North and Central. Notably, all the farmers from the three areas kept maize stalk after harvesting which they fed to livestock during the dry season. However a few of the participants (33%), added that they also fed their livestock with *musekesa* (*Bauhinia thonningii*) pods during the dry season so that the animals survive. Some of the households in Chivi kept donkeys in their

homesteads. These were used as draught power during farming, for transporting wood and for fetching water for household use from distant areas.

#### **4.2.3.2 Vegetation resources adaptations**

Some participants (54%) were involved in the establishment of woodlots at individual and collective levels. Collective woodlots were being established in partnership with EMA. The EMA officer explained that the establishment of woodlots was meant to improve the declining woodlands in Chivi District. Both indigenous and exotic trees are being grown. Woodlots have been established in Chivi North (Nyevedzanai in Ward 8) with mango plantations; Chivi Central (Mavhundusi and Gwatiringa villages and in Wards 11 and 15) with gum plantations and indigenous trees respectively. In Chivi South, woodlots have been established in Sungai Village (gum trees), Ward 17 (indigenous trees), Mbeva village (gum plantations) and Nyimai village (gum plantations). In comparison, there were more woodlots established in Chivi South than in North and Central.

In addition thirty three percent (33%) of the participants from FGDs were trained in the construction and use of *tsotso* stoves [twig stove] by CARE International. The EMA officer indicated that:

*“CARE International in partnership with EMA trained and equipped the community with skills on how to construct tsotso stoves. CARE International provided materials for the stoves’ construction and this has gone a long way in conserving forests and reducing the amount firewood used in the areas where this has been adopted.*

*Additionally the participants sell the stoves thereby getting some money to improve their livelihoods.”*

Although *tsotso* stoves are said to be effective in dealing with climate change as proposed by the EMA officer, the percentage usage in Chivi District is very low (33%). Participants who were trained in *tsotso* stoves skills production were all from Chivi North District.

#### **4.2.2.3 Household water resource adaptations**

All the FGDs participants agreed that they used dug out sand abstraction wells (*mifuku*) in dry river beds to source household water (Figure 4.12). They pointed out that water from such wells is clean and palatable compared to borehole water which is salty. One participant summed up the sentiments by claiming that:

*“Mvura yemumifuku haipere nekuti inocherwa murwizi. Maboreholes anopera mvura. Mvura yemuchibhorani inotoda surf pakugeza nekuwacha nekuti ine munyu wakawanda. Yemutsime inonaka uye pakugeza tinongoshandisa sipo dzisingadhure.”* [Sand abstraction wells do not dry up like boreholes. The water from boreholes is hard and taste salty. When using it for laundry and bathing one has to use surf which is expensive]

Sand abstraction wells are dug in dry sandy river beds. The wells were protected with tree branches when not in use and were used by all the community members. The participants agreed that the sand abstraction wells do not belong to individuals but the whole community. Another participant added that it was important that these wells belonged to the community not to an individual in order to safeguard the water from poisoning if it was an individual property.



**Figure 4.12: A woman collecting water for household use from a *mufuku* (unprotected well)**

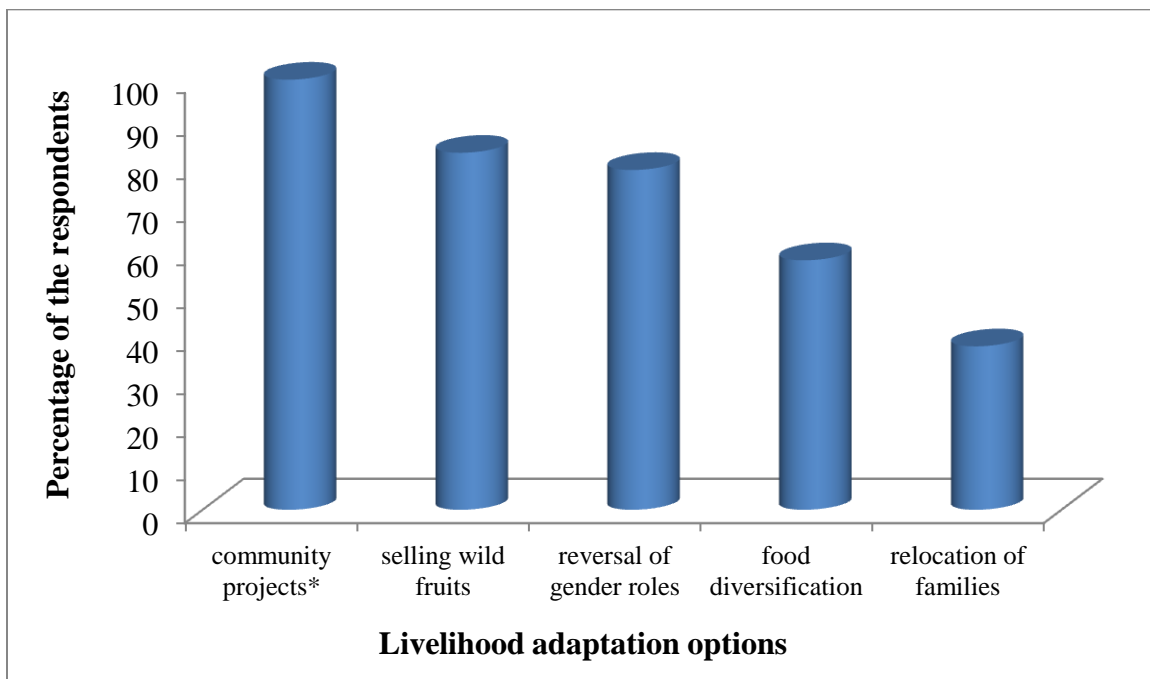
Sixty three percent (63%) of the participants use borehole water in addition to water drawn from the wells for various household uses. A small number of the participants (13%) stated that they constructed storm ridges around their fields to protect rivers from siltation. The bulk of the farmers (87%) argued that they did not have spare time to construct storm ridges as they spent most of their time doing other activities to improve their livelihoods. The EMA officer added that:

*“In Chivi 9 out of 10 fields have no storm ridges and this has led to severe river siltation. Local residents do not comprehend the importance of these ridges in the community. They always argue that construction of ridges is labour intensive and some say their fields are far away from rivers, therefore storm ridges are not necessary in such cases.”*

It can be inferred from the above excerpt that some of the community members regard the construction of storm bridges as a waste of time as they do not appreciate the benefits of constructing the storm ridges.

### 4.3 Other Livelihoods Adaptations

Chivi residents also identified other adaptation techniques that are meant to improve their livelihoods in the face of climate change. A variety of community projects were ranked top, followed by the selling of wild fruits as options for improving livelihoods of the participants (Figure 4.13).



**Figure 4.13 Other livelihood adaptation options**

#### Notes

\*Projects communities were involved in:

- Brewing ‘*mukumbi*’, an alcoholic drink made from *marula* (*Sclerocarya birrea*) fruits for selling
- Using ‘*chakata*’ fruit (from *Parinari curatellifolia* tree) to make biscuits
- Exporting *chifandichimuka* herbal tea (*Myrothamnus flabellifolius*)

- Roasting ‘*hwaka*’ (black monkey orange) fruit seeds
- Making butter and soda from marula fruits

All the FGD participants agreed that they were involved in various community projects to improve their livelihoods in the era of climate change. A company called Marula Zimbabwe which specializes in marula products, partnered with people from Chivi South by empowering them with skills to make butter, soda, nuts and brewing *mukumbi* (beer). These products are either consumed by the participants or sold locally. Among other community projects were baking biscuits from *chakata* (*Parinari curatellifolia*) fruits, roasting *hwaka* (black monkey) seeds and harvesting *mufandichimuka* (resurrection plant (*myrothamnus flabellifolius*)) for herbal tea which is exported. Women are the ones who are mainly involved in these community projects and one participant added that:

“*Pane murungu anouya muno maChivi tichimutengesera chifandichimuka iye achiendesa mhiri kwemakungwa kwachinoitwa tea. Tinowana \$30 pasaga rakazara. Izvi zvinotibatsira kuwana mari yekubhadhara fees dzevana nekuwana mari yekutenga zvinodiwa.*” [There is a white lady who buys resurrection plant from us at \$30 a bag. She sells the plant overseas which is made into herbal tea. This has helped us get money for school fees and buying other household items]

Eighty percent (80%) of the participants pointed out that some of their family members especially children and women gather wild fruits and sell them to passers-by along roads in order to support their families (Figure 4.14). They cited fruits such as *nyii* (*Berchanmia discolor*), *matohwe* (*Anzania garckena*), *matamba* (*strychnos spinosa*), *hwaka* (*strychnos madagascariensis*) and *tsubvu* (*smelly-berry finger*). They agreed that the money they got from selling fruits went a long way in payment of school fees and buying food for the families.



**Figure 4.14 People selling wild fruits along the road**

**4.4 Barriers to climate change adaptation options in Chivi**

FGD participants were asked to discuss some of the factors that are hindering their adherence to the identified forms of adaptation to climate change. The responses obtained are presented in Table 4.10.

**Table 4.10: Barriers to climate change adaptation options in Chivi**

| Adaptation option      | Reason for less usage in Chivi District   |
|------------------------|---|
| Infiltration pits      | Labour intensive<br>Lack of labour for digging<br>General laziness<br>Dependency syndrome |
| Rain making ceremonies | Absence of older women who can properly prepare for the                                   |

|                              |   |
|------------------------------|---|
| (mitoro)                     | ceremonies<br>Improper procedures being done<br>Diversion from proper procedures<br>Elimination of ‘holy areas’<br>Rise of Christianity eroded the usefulness of spirit mediums<br>Doing rain making ceremonies locally |
| Growing small grains         | They are labour intensive<br>Changing tastes and preferences  |
| Mulching for water retention | Labour intensive<br>Difficult to do at on a large scale<br>Lack of tree leaves for mulching   |
| Zunde raMambo                | Low yields per household<br>Corruption by Chiefs<br>Partisan distribution of food<br>Chiefs now keep the yield for themselves.  |
| Collective farming (Humwe)   | Lack of food to provide many people   |
| IKS                          | Lack of elderly people<br>Modernization of culture<br>General corruption  |

#### 4.4.1 Infiltration pits

Participants acknowledged that infiltration pits are useful in improving yields. Farmers engaging in the use of infiltration pits were found to have higher yields than those who did not. However, there was less usage of infiltration pits across the entire Chivi District. Typical responses obtained regarding low usage of infiltration pits included that:

“...makandiwa ane basa saka vazhinji hatichere”. [Contours are labour intensive so we do not bother engaging in them]

“Makandiwa anoda ane labour force yakawanda. Tinoona kuti dzimwe nguva tinofira mahara mvura ikarega kunaya”. [Contours are labour intensive. We labour in vain if we do not receive adequate rains]

“Misha mizhinji yasara chembere dzechikadzi. Varume vemuno isimbe vanongoswera kudoro, zvekurima havadi” [Most households are now women headed. Most men are lazy as they spend most of their time drinking beer]

“Vamwe vanhu vajaira kupihwa chikafu neCARE. Saka kuti varime vachiita makandiwa havadi, chero vachiziva kuti makandiwa anobatsira. Simbe idzodzi dzikaona ndaita gowo rakanaka nekuda kwemakandiwa vanototsamwa. Hanzi unotinyimisa chikafu neCARE”. [Some people are now depended on donor agencies such as CARE International. They do not like the idea of infiltration pits though they are fully aware of their benefits. Such lazy people become angry if some engaged in infiltration pits obtain good harvests. They say such good harvests repel donor agencies].

The low usage of infiltration pits was largely attributed to their being labour intensive as manpower is required to dig the contours. The responses obtained from FGDs suggested that community members were conscious about expending their labour in vain. As such, they viewed the idea of infiltration pits with scepticism, though such a scenario was said to be driven by laziness. In some cases, it was noted that some households lacked manpower to dig trenches. Men were engaged in alcoholism which seemed to take much of their time. In some households, Men were said to have migrated to towns in search of employment as agricultural activities has proved to be inadequate in catering for family needs. As such, farmers sought to supplement agricultural activities with income from their jobs. Households were thus manned by the elderly, the young and women who found it difficult to dig in infiltration pits.

Cases of dependency syndrome were noted as community members were used to receiving food items from donor agencies. Thus, they became accustomed to being given such food items for their daily living. Community members were used to poverty which made them a target of donor agencies who are concerned with providing for communities that are in hunger infested areas. By so doing, the idea of infiltration pits has not been welcome.

#### **4.4.2 Rain making ceremonies (mitoro)**

Discussions with the participants revealed that the Chivi community embraces the idea of rain making ceremonies (*mitoro*). Their sacredness was said to have been eroded over time, thus they were no longer as effective as they used to be some decades ago. Typical responses regarding the less effectiveness of rain making ceremonies included the following:

“Mitoro haichaitwe nemazvo. Chembere dzinofanira kubika doro dzave nhubu. Dzinogona kuti hadzichasangane nevarume idzo dzine zvidhara zvavo zvavanosangana nazvo. Vasikanawo vadiki vosati votevera vanokwanisa kubika doro vave kuziva varume. [Proper procedures for rain making ceremonies are no longer followed. Elderly women who are supposed to brew the requisite beer are no longer honest. They purport to have forsaken intimate relations, yet they engage in such activities under the cover of darkness. Also, girls who could also brew the requisite beer are no longer honest as they now engage in sexual activities at tender ages.]

“Vanhu havachatevedzere kubikwa kwemitoro nemazvo. Mapostori vawandisa maChivi vachienda panzvimbo dzinoera vachisungirira tumachira twavo twutsvuku netwuchena. Midzimu yese yakabatwa nevanhu venguwo chena”. [People are no longer following proper procedures for rain making ceremonies. Apostolic churches have sprouted

in Chivi area. They congregate at sacred places in a manner which makes the ancestral spirits powerless].

“Midzimu yakatifuratira, saka zvinotidzosea shure. Chero tikabika doro mvura haichanaye. Kare vanhu vaisarudzwa voenda Zame (Matonjeni) kunochema kumidzimu kuti mvura inaye, iyezvino havachaende, mitoro yongoitirwa muno maChivi. Naizvozvo midzimu yakatsamwa. [We are no longer in favour with the ancestral spirits. This is quite discouraging as even if we conduct the ceremonies, no rain comes. Traditionally, people would go to sacred areas (Matonjeni) and petition the ancestors for rain. This has since been abandoned as all the processes are now done locally. This must have angered the ancestral spirits]

The results suggest that though community members believe in rain making ceremonies, they are no longer as effective as they used to be long ago. This was attributed to a deviation from the proper procedures that should be followed. Rain making ceremonies were attached to some spiritual manifestations which required strict procedures to be followed for the ancestral spirits to answer the community’s petitions. Some requirements included beer that is brewed by elderly women or virgin girls, without whom the beer is deemed inappropriate for the occasion, hence the petition would not be granted. Given the declining morality and rampant dishonesty amongst community members, most of the elderly women and young girls were no longer fit for the rain making ceremonies’ service. Despite that, such ladies continue to participate in the preparation of the beer for the ceremonies, a move which compromises the chances of rain petitions being granted.

Another impediment to the effectiveness of rain making ceremonies is the increasing Christianisation of the Chivi community. Conversion into Christianity of the community members means an abandonment of some of the long-cherished beliefs. Some areas that were

highly esteemed for their sacredness are no longer regarded as such. These areas have now been converted into shrines where religious sects meet for their activities. Consequently, the ancestral spirits which used to reside and manifest in these areas have abandoned the areas. Therefore, petitioning such ancestral spirits is now difficult as they have since deserted the area to pave way for the religious sects.

Participants also noted community members disregard of sacrosanct procedures. It was notable that rain making ceremonies would be successful if some appointed spirit mediums visit sacrosanct areas, *Matonjeni*, for instance. At such an area, they would be able to communicate with the ancestors as to the manner of the procedure and would receive specific instructions on the relevant conditions for adequate rains. However, as the communities have disregarded this procedure, arguing that the spirit mediums can communicate regardless of location, it is now doubtful whether the current rain making procedures would ever be effective.

#### **4.4.3 Growing small grains**

The practice of growing small grains was identified as crucial in averting hunger caused by low rainfall. While community members concurred that small grains may withstand the strain induced by low rainfall, their cultivation is practiced by a few households. Some of the participants indicated that:

“Vakadzi vemazuva ano havachagone kutswa *mhunga nemapfunde*, saka vanotoda kuti tirime chibage, manje chibage chinoda mvura yakawanda”.

[Present day women cannot effectively prepare millet and sorghum for human consumption. Hence they prefer maize, yet maize growing requires more rainfall]

“Mhunga inoda kupepetwa, yokangwa, yotswiwa, saka vanhu vanoti ine basa guru, vamwe ndosaka vasingairime”. [Millet is labour intensive to prepare for food, thus it is not preferred by most households].

“Vana vanoti sadza remhunga nemapfunde harinake. Iye zvino vanhu vanofunga kuti mhunga ndeye huku chete. Nyamba bodo, handizvo”. [Children do not find millet made sadza tasteful. In their ignorance, they regard it as food for chickens.]

The participants in FGDs indicated that the community members in Chivi were so used to the maize crop that women, who were traditionally expected to prepare the small grains for meals, lack the necessary skills to pound millet. It was noted that unlike maize which can be easily processed by the grinding mills, small grains such as sorghum needs *winnowing*, a process which women find quite difficult. Such a skill was said to be learnt from childhood as elderly women and mothers train their girl-children for marriage. However, because of a laxity in imparting such skills by mothers and elderly women, the younger generation lacks this crucial skill, hence the young generation is not prepared to embrace the idea of small grains. It was observed that, very few households have the necessary resources for preparing small grains to make them ready for cooking such as, *duri* (mortar and pestle) and *rusero* (winnowing basket), amongst others.

Changing tastes and preferences were also identified as another factor that has resulted in the low preference of small grains. The small grains were found to be palatable by the elderly who were once exposed to them in their childhood. The younger generation regarded crops such as sorghum and millet as best suited for consumption by chickens. Even amongst the elderly, some regarded small grains as useful only in preparation for traditionally brewed beer rather than for preparing *sadza*. Only a few households realised the nutritional value obtainable from the

consumption of small grains. This was confirmed by observations made in some fields as small grains were only allocated small portions of land when compared to other crops.

#### **4.4.4 Mulching for water retention**

Mulching of fields was also cited as another adaptation measure in the fields by FGD participants. This was done to moderate temperatures and retains moisture in the soils. The practice was said to be possible on a smaller scale. Some of the reasons suggested for this included that:

“chonetsa haugoni kuzviita mumunda wese, zvine basa guru”. [One cannot mulch entire field, it is labour intensive].

“Two mashizha ekuisa mumunda hatichaawane nekuti miti mikuru yakapera mumasango”. [Tree leaves for mulching are now scarce as there are no longer large trees with leaves in the forests].

It was noted that mulching requires paying attention to each and every portion of the field, which increases work to the farmer. The process requires collection of tree leaves, mostly gathered in sacks which the farmers would carry to their fields. Thus, farmers would have to move around in the forests near their fields in search of tree leaves. Given that most households were manned by elderly, women and the young people, the process was quite difficult for them. Consequently, they could only do mulching for selected portions of their fields, on a small scale.

Mulching was also found to be less used due to the scarcity of tree leaves. This was also owing to increasing deforestation from an increasing population in the community. Households that used to have larger pieces of arable land are now compelled to apportion the land so that they can accommodate the growing number of families. As such, land previously reserved for farming

and cattle grazing is being cleared to pave way for the establishment of dwellings. By so doing, trees are cleared and these are not being replaced due to low rainfall in the area. This significantly limits the potential of having more tree leaves for mulching. This adaptation option is being done on small field areas.

#### **4.4.5 Zunde raMambo**

*Zunde raMambo* is a traditional social safety net concept whereby traditional leaders keep grain reserves to distribute to the needy during distress calls. The chiefs would reserve a portion of land in which community members would be called upon to till and plant crops which would be harvested by community members. The chief would provide storage facilities and distribute food to those in need and during droughts. However, the practice is no longer as effective owing to factors such as:

“Kuti munhu aendese gowo kwaMambo ndokunge akaguta. Zvoreva kuti Zunde raMambo racho harichina gowo rakawanda.” [Working in the chief’s field is possible when one has enough food. Hence, the chief’s field does not produce much as fewer people are available and willing to work in the chief’s field].

“Pave netsika yekuti vanhu vanogona kurega kuenda kuzunde ramambo vongobhadhara kamari. Nokudaro hakuna chicharimwa mumunda” [There is now an option to pay a small fee in return for not going to work in the chief’s field. Therefore, there is no longer productive work in the chief’s field]

“Uye anaMambo vacho vave nehuhori pakupa vanotambura chikafu. Vanongopa hama dzavo.” [The chiefs are now corrupt in the distribution of food to the needy. They now distribute food to their relatives only]

“Vana mambo vava kuzvichengetera goho remumunda vachitotengesa ku GMB pane kuti vape vanhu vemudunhu ravo”. [The chiefs now retain the

yields and sell to the Grain marketing Board and to community members for their own benefit rather than distribute the food to community members].

The participants suggested the lack of effectiveness of the *zunde ramambo* concept. This was attributed to unavailability of people to work in the chief's field. Community members found it worthwhile to work in their fields first before they can work in the collective field controlled by the chief. Despite the provision of labour in the field being compulsory, fewer people indicated their willingness to provide their labour. As such, they would opt to pay a small fee in return for not availing their labour. As a result, less production is realised from the chief's field, hence no food becomes available for those in need.

Furthermore, community members were not content with the manner in which food was distributed. It was alleged that chiefs give priority to their relatives disregarding the criteria of being in need. Underprivileged community members who are not related to the chief are left on their own. By so doing, fewer and fewer people become available to work in the chief's field, opting to work in their own fields. Coupled with this idea was the partisan distribution of the food. In some cases, people were required to belong to a certain political party in order to gain access to food aid. This has a tendency of discouraging people of a different political affiliation from participating in the provision of labour.

Selfish tendencies amongst chiefs were also noted as they would at times retain the yield for their own use. Rather than distributing food to needy community members, the yield may be sold to the Grain Marketing Board or to some community members. Thus, the *zunde ramambo* idea is now considered to be used to enrich the chief at the expense of community members who toil in

the field. Similarly, the amounts realised from the small fees paid by community members who would not avail their labour in the chief's field were not used for the purpose of improving yields. Rather, they were said to be used for the chiefs' private use. Rather than being a social safety net, *zunde ramambo* has become an income generating project for the chief. Such tendencies limit the potential of the chiefs' fields to yield meaningful harvests.

#### **4.4.6. Collective farming (Humwe)**

The participants highlighted the importance of collective farming in Chivi area, where farmers provide labour and inputs to a fellow farmer. The farmer being helped provides food and refreshments in return for assistance. This idea is useful as it helps the underprivileged farmers with manpower to till their fields. However, the idea is no longer as effective as it used to be.

Typical causes for its lack of effectiveness include:

“kare vanhu vaibika maheu, nechikafu chaive chakawanda chokuitisa humwe. Zvino chikafu chekupa vanoshanda mumunda hatichina. Uye sugar yekuisa mumahu hakuchina. Humwe inoda kudya nekunwa. Zvino tinovapei? Hapana.” [Traditionally people would brew maheu and beer and provide food in abundance for the *humwe*. Nowadays it is difficult to provide food in abundance. We do not have sugar for brewing *maheu*.

*Humwe* requires food in abundance, yet we do not have such food.]

Collective farming was becoming less effective due to the lack of food to provide many people.

People were attracted to *humwe* by food and drink; hence failure to provide the requisite food and drink means that fewer people would turn up for the occasion. Such a scenario makes it difficult for the poor to meet the requirements for collective farming. Instead, those households with food in abundance are able to call for collective farming. Due to the need for food, the poor

would then be attracted to work in the fields of households that already have more than enough food. By so doing, the whole idea of collective farming to assist the poor gets defeated.

#### **4.4.7. General IKS usage**

The general use of indigenous knowledge systems although useful as an adaptation measure, has been found to be compromised by factors such as:

“chembere dzinoziva chinyakare dzave shoma munzvimbo ino. Vechidiki ava hapana chavanoziva nezvechinyakare. Ukada kuvadzidzisa vanokuudza kuti nguva dzasiyana. Chave chimanje manje. Zvino chimanje manje chacho zvachisingashande”. [The elderly who understood tradition are no longer available. The younger generation knows little about tradition. They do not want to learn tradition.]

“Zviera hazvichakosheswi. Vanhu havachakoshisi chisi. Ukabatwa uchirima nechisi unofanira kubhadhara mbudzi, zvino huhori hwanyanya. Munhu anogona kubhadhara \$2 chaiyo, mhosva yotorova.” [Nowadays sacred things are no longer held as such. There is no longer regard for *chisi*, rest days. Ploughing fields on a *chisi* used to attract fine of a goat. Due to corruption, an offender can pay as little as \$2 (2017) to cover for an offence for tilling fields on a rest day].

The participants highlighted the less usage of IKS as an adaptation measure in Chivi. This was attributed to the declining number of elderly people who were capable of applying traditional methods for climate change adaptation. Ingrained in tradition, the methods were said to be effective as they would apply to the local area. The modernisation of the community’s culture was blamed for the younger generation’s diminished regard for tradition.

It was also noted that sacred things which laid the basis for IKS were no longer held as such by community members. Traditionally, it was held that resting on an appointed day by chiefs would help preserve the environment and general health of the people and their beasts. Such appointed days include *chisi* and *kugara kwemwedzi*, (half moon) days when no farming activities would be done. *Chisi* days differ from locality to locality and in the study area, Thursday is reserved as a resting day. Chiefs also had rules which prohibited the cutting of trees or establishment of homes in grazing lands. These were meant to preserve the environment. Violation of such rules attracted a fine of a goat. Such a high fine would discourage the violation of the rules. However, corruption amongst community members and the chiefs' Headmen resulted in greater violation of the rules. Upon being caught, an individual may be required to pay a small fee to enrich the Headmen while nothing is remitted to the chief. This has increased chances of violating traditional regulations resulting in more damage to the environment.

#### **4.5 Conclusion**

This chapter has presented and interpreted the data collected. Chivi people's experiences and adaptations to climate change have been presented and analysed. It was observed that the people of Chivi have experienced extreme weather events in the area such as droughts, floods, prolonged dry spells, and an increase in temperature. They attributed all these to climate change. Evidence observed in Chivi such as biodiversity loss, extinction of some species, drying of rivers and decreased yields were all attributed to climate change. The participants gave a wide range of adaptation techniques which they use in dealing with climate change. These were based on past climates that they experienced. They emphasized on using indigenous knowledge systems adaptation strategies which they agreed were contextual, tried and tested over a long period of

time. The adaptation options included in-field water harvesting, use of organic manure, rain making ceremonies, use of indigenous weather forecasting systems and various individual and community projects. Although the participants found the adaptation options to be useful in dealing with climate change, a few utilized them. They cited a number of barriers which were hampering them from using the adaptation options. Among these were changing preferences for maize instead of small grain, modernization of culture, not following the proper procedures when conducting rain making ceremonies and a decline in the older generation which is supposed to teach the younger generation about the importance of using IKS. The following chapter discusses the research's results.

## **CHAPTER 5: DISCUSSION OF RESEARCH FINDINGS**

### **5.0 Introduction**

This chapter discusses the research findings in Chapter 4. The study explored the use of local knowledge adaptation measures by people of Chivi District in Masvingo Province, Zimbabwe in the era of climate change. Discussions are made from the findings of focus group discussions, interviews, observations and transect walks which are guided by themes in Chapter four (4). The themes captured are discussed in light of existing knowledge from other research studies.

### **5.1 Climate change experiences**

#### **5.1.1 Observed Changes in Climate**

Participants cited experiencing increases in extreme weather events such as drought, floods increases in temperature, a decline in precipitation, prolonged dry spells and changes in farming seasons. These findings are consistent with studies which have shown that climate is changing and leading to climate variability. This is evidenced by changes in timing, intensity and duration of precipitation and an increase of extreme weather events (Marengo, Pabon, Diaz, Rosas, Avolas, Montealegne, Villacis, Solman & Rojas, 2011; Bryan & Behrman, 2013; IPCC, 2013). In addition, other studies have indicated that although droughts are globally on the increase, Southern Africa shows the largest actual and projected increases (Unganai, 1996; Christensen, Hewitson, Busuioc, Chen, Gao, Held Jones, Kolli, Kwon & Laprise, 2007; Fraser, 2013; Byjesh & Bantilan, 2015). Participants stated that the period after 1980 has been the warmest they have experienced. This resonates with Brazier's (2015) observation that in Zimbabwe, the same period has been the warmest recorded. Mugandani, Wuta, Makarau and Chipinda (2012) echo the same

ans state natural climatic regions in Zimbabwe have shifted due to climate change. On the contrary, some of the respondents argued that droughts and high temperatures experienced were being caused by people's lack of *unhuism/ubuntu* when it comes to the use of natural resources. This perception is premised on the belief that the Ancestral Spirits were angered by communities' and individuals' relegation of IKS in favour of 'modern' ways of life. This observation is consistent with findings by Mawere (2013) that abandonment of the *ubuntu* philosophy in resource conservation practices has negatively impacted on the environment thus resulting in the occurrence of such phenomena as droughts.

The global increase in extreme weather events is attributed to climate change. The IPCC (2013) points out that changes in climate are being caused by the increase in greenhouse gases especially carbon dioxide and methane. Among the direct effects of climate change are changes in mean climate and increased climate variability and extremes. Globally, temperatures are projected to increase by between 1.4°C and 3.1°C by the end of the century (IPCC, 2013). Chikodzi, Zinhiva, Simba and Murwendo (2013) state that in Zimbabwe, since the 1980s, rainfall has been decreasing and while temperatures have been increasing. They attribute the changes to the changing climate and concur with Mugandani et. al., (2012) that there is evidence of the need for reclassification of agro-ecological zones in Zimbabwe. This will help farmers "to adjust farming systems for sustainable agriculture" (Chikodzi et al, 2013; 3).

The data from interviews revealed that the area under study was made up of poor sordic soils. These soils require a lot of rainfall for farmers to have meaningful harvests. Increased droughts and temperatures have resulted in the reduction in soil water and high evapotranspiration.

Climate change experiences by people in the study area coupled with the biophysical challenges in the area made the Community Based Approach (CBA) conceptual framework suggested by Bryan and Behram (2013) more appropriate in the study area. Local people are in a better position to implement adaptation measures based on their experiences. Agrawal and Perrin (2008) argue that top-down approaches like the National Adaptation Plans of Action (NAPA), may fail to include local communities in their policy-making processes. The CBA approach however uses the bottom-up approach which looks at experiences and vulnerabilities of the affected people. Decisions therefore made by individuals, households and communities regarding risk perception are very important in climate change adaptation (Bryan & Berham, 2013; Singh, Byjesh, Bantilan, Rao, Venkateswarulu, Nirajan, Jayatilika, Deb, Ha & Suddiyamet, 2015). There is consensus worldwide that climate change is inevitable. Communities therefore have to identify adaptation measures that are suitable for their areas and households depending on economic and biophysical problems. Therefore, vulnerabilities of the people will determine the capacity and type of adaptations explored.

### **5.1.2 Evidence of Climate Change**

All the participants argued that there were changes in the physical environment, biodiversity, water and output from farming. This part of the chapter discusses these changes in detail.

#### **5.1.2.1 Biodiversity Changes**

Research findings show evidence of a pronounced reduction in underground water and biodiversity and extinction of certain species in the area under study (See, Table 4.3). These findings are consistent with studies by Kelly and Adger (2000) and the IPCC (2013) who reported that climate change, particularly reduced precipitation and temperature increase are

leading to changes in biodiversity. Climate change is leading to changes in the timing of animal production, length of growing season(s), distribution of species, an increase in pests and diseases, migration of animals and even extinction of species.

Wetlands are said to have disappeared in Chivi North and were threatened in Chivi Central. Climatic data shows that Chivi North is more vulnerable to climate change than Chivi Central and South. These findings are similar to Erwin's (2008), Llorens's (2009) and IPCC's (2015) views that climate change is a major threat to the survival of wetlands worldwide. Climate change affects temperatures and water regimes yet these two variables are important for species survival in wetlands. The reduction in water and an increase in temperature have an effect on the composition and overall wetlands' productivity (IPCC, 2013). Despite wetlands being regarded as resilient to inter-annual temperature and water variations (McCarthy & Rolston 2016), climate change is rapid and resulting in changes that exceed the resilience thresholds of wetlands (Llorens, 2008). As result, there is massive biodiversity loss whose habitat are wetlands.

Participants recalled that during the 1960s, there was diversity of flora and fauna in the study area. Similarly, from discussions with the EMA officer it emerged that there has been a massive reduction in both plant and animal species. Similar changes worldwide have been attributed to climate change (IPCC, 2014). Species have different ranges of tolerance to temperature and water. Any changes in temperature and hydrological regimes may result in shifts in reproduction and thus species composition. Although species have an ability to adapt to changes in climate, it is the unprecedented rate at which changes are occurring which makes adaptation a problem (Hopkins, McKellar, Worboys & Good; 2015). Organisms which are unable to adapt to these

changes may become extinct. Participants mainly attribute changes in species composition to rainfall variability and temperature increases. This is consistent with other studies in Uganda and Botswana (Muhumuza & Byarugaba, 2009; Kgosikoma, Mojeremane & Harvie; 2012). Water stress in species brought about by extreme weather events such as drought and high temperatures result in changes in the morphology, reproduction and composition of species (Hopkins et al; 2015). The extinction and threatening of *phragmites communis* species in Chivi North and South respectively indicates that the water table is now very low. The species is common in wetland areas where the water table is high. The differences in the composition could be attributed to the land heterogeneity which is a result of variability in rainfall (Sankaran et al, 2005; Kgosikoma et al, 2012) and soil fertility (Tefera, Dlamini & Dlamini, 2008). In addition, changes in the spatial distribution of species could be a result of the inability of the species to adapt to the changing climate. Species such as Fig trees (*Ficus carica*), *Bauhinia thonningi*, *Julbernardia* and *ximenia caffra* are threatened with extinction in the study area.

Biodiversity loss in the area can also be credited to non-climatic drivers such as the increase in population in the area. Increased population has resulted in massive deforestation as households and farming areas increased. Wood fuel is the main source of energy; therefore there is selective harvesting of certain species of trees such as *Mopani* (*Colophospermum mopane*), *Mitondo* (*Julbernardia globiflora*) and *Msasa* (*Brachystegia spiciformis*). These types of trees are mainly used as a source of energy for cooking. In Chivi South, selective harvesting of *mahogany*, *brachestegia spiciforms* and *colophospermum mopane* is on the rise because these species are used to make artifacts for selling to improve livelihoods.

### **5.1.2.2 Agricultural Production**

Farmers' views indicate that there has been a great decline in crop and animal production over the years especially 1980 in the study area (Figure 4.5 and Table 4.5). Climate data provided by the meteorological officer shows increased temperature, rainfall variability, the late onset of the rain season, prolonged dry spells and early cessation of rains. These climate characteristics have resulted in massive crop failure in the area under study. Rurinda (2014) reports an increase in within season dry spells coupled with temperature increase leading to severe soil moisture deficit and crop failure.

Although the vulnerability of farmers differs among households, the analysis of crop failure and decline in animal production over the years shows that Chivi North is the most affected part of the district. Chivi district as a whole is characterized by a high degree of temporal and spatial variability in rainfall. Chivi South receives better rains therefore crop and animal production is much better than in Chivi North and Central. The variability in soil characteristics in the region is also a contributing factor to differences in yields. The northern part of the area has rocky soils whilst soil characteristics improved as one moved southwards. There is a close relationship between crop and animal production (Mutami, 2015; Ruppen, Wolfgramm, Schedegger & Bader, 2016). During the 1991/2 drought, there was massive crop failure and a serious decline in animal population. Both crops and animals are sensitive to drought and crops might be more sensitive to climate change than animals (Mertz, Mbow, Nielen, Maiga, Diallo, Reenberg, Diouf, Barbier, Moussa, Zorom, Outtara & Dabi; 2010). Most farmers lost their herd of cattle to drought and some sold to people outside the region at very low prices. In a related research in Makoni and Hwedza districts in Zimbabwe, Rurinda (2014; 31) concluded that "if poor rainfall events occur

frequently for consecutive seasons, farmers would not only experience food shortages for longer periods, but would be forced to sell the few cattle they have, which would lead to long term negative impacts on their livelihoods.”

Studies have shown that animal production is greatly affected by extreme events such as heat waves and droughts (Hulme, 2003; Gaughan, Lacetera, Valtorta & Mader, 2009; Rurinda, 2014). They agree that livestock, especially cattle are particularly sensitive to drought and heat waves. These extreme events have negative impacts on pastures. Climate change coupled with population increase in the area has led to the reduction in grazing land and an increase of low quality pastures. During such times of drought, domestic animals just collapse and die due to lack of forage and drinking water. In the end, farmers usually sell their livestock at ridiculously low prices due to the poor condition of the cattle (Rurinda, Mapfumo, van Wijk, Mtambanengwe, Rufino, Chikowo & Giller, 2014).

The decline in crop production in the study area is consistent with projections by Cline (2007) that climate change, especially increase in temperature, results in a nine to twenty one percent (9-21%) decline in crop productivity in developing countries. Extreme events such as high temperatures and prolonged dry spells result in severe moisture deficit in soils. The same results in low output and in some cases complete crop failure. Furthermore, that crop production in Chivi District is mainly rain-fed which aggravates the situation. The Millennium Ecosystem Assessment (2005) states that globally forty percent (40%) of the land area is dryland consisting of semi-arid and dry sub-humid climates where 2,5 billion people live. These dryland areas although vulnerable to various challenges, are being forced to exceed their biophysical

thresholds due to climate change (Jourbert, Rothauge & Smit, 2008; Sallu, 2010; Fraser, Dougill, Hubacek, Quinn, Sendzimir & Termansen, 2011). Sallu et. al., (2010) and Rockstrom et. al. (2009) add that population increase in an area exacerbates vulnerabilities of a population to climate change by adding pressure on the biophysical systems. Due to population increase in Chivi District, forests have been converted to tilled agricultural land in order to sustain the families' livelihoods. Vegetation is used as source of fuel worsening the biophysical situation. Overtime, land has been degraded and in addition to the effects of climate change, productivity has massively decreased. The decline in productivity may also be attributed to non-climatic factors such as the decrease in labour to work in the fields, land degradation and even an increase in household members resulting in more mouths to feed. Poor methods of farming such as stream bank cultivation and overgrazing are regarded as also contributing to low productivity. Rockstrom et. al. (2009) argue that human induced pressures on the earth are leading to low agricultural production. Production in most cases of such populated and degraded areas has surpassed their threshold boundaries for sustainable development. Anthropogenic- induced climate change and other land degrading factors have thus resulted in the deterioration of agricultural systems.

Farmers indicated that most of their crops fail during flowering periods if there is a drought spell. Rainfall availability is very important during crucial periods such as germination and flowering of crops (Mertz et al, 2010; Rurinda et al, 2014). These periods are very crucial in the development of crops. Prolonged in-season dry spells together with high temperatures during these crucial periods result in crop failure. When crops wither after germination and rains resume, most farmers are not capital resource-endowed to buy more seed for replanting.

Observations during the years of study in Chivi District showed that rainfall was the most limiting factor in rain-fed agricultural production. In the same area, when farmers received favorable rainfall, their crop productivity increased. Although soils in the area are not very fertile, the favourable rains played a significant role in increasing productivity.

In a study done in West Africa, Mertz et al., (2010) found out that climatic factors, especially the decrease in rainfall and temperature increase are the main drivers of decreasing rain-fed crop production. This in contrast to a study done in Hwedza and Makoni Districts in Zimbabwe by Rurinda et.al, (2013) who concluded that soil fertility was the most limiting factor for maize production when early planting is done. It is important to note that no matter how fertile soils may be, water is very crucial in the uptake and translocation of nutrients in the plant.

### **5.1.2.3 Changes in Water Sources**

People in the study area mainly depend on water from rivers and streams for household use(s) and drinking water for domestic animals. Participants agreed that all river beds were dry most of the time(s) except during the wet season. The only rivers that had water throughout the year are Tokwe and Runde although they are heavily silted. The increased frequency of droughts and high temperatures, especially after 1980, were said to be the cause of reduced water levels in rivers. High temperatures increase evaporation (rates) from rivers leading to declining water flow in rivers. FGD participants attributed the disappearance of certain trees such as Fig trees (*ficus carica*) to the decline in the water-table on account of climate change. The IPCC (2014) argues that in addition to climate change, the decrease in underground water globally is attributed to groundwater pumping exceeding groundwater recharge rates. Rainfall variability due to climate

change is leading to low recharge of the underground water. At the same time, drying of water sources is leading to high rates of groundwater pumping.

The numbers of boreholes drilled in the area under study were insignificant given the rate at which species were drying up. Therefore, decreased rainfall and increased temperatures are leading to the lowering of the water table and drying up of the fig trees. Groundwater is mainly recharged from surface water flow regimes. Furthermore, surface water is affected by climate change. The reduction in flowing water and an increase in river siltation and evapotranspiration affect both the quality and quantity of water in rivers and underground (Bates, Kundzewicz, Wu & Palutokof, 2009; IPCC, 2008). Temperatures in the study area are said to have increased by 3°C in the last fifty (50) years and this has increased evaporation rates from water sources including rivers.

Reliance on river water for household use shows that people in the study area are more vulnerable to climate change than areas which use tap water. Their vulnerability is further worsened by their low adaptive capacity to the changing climate. Consequently, the reduction in the amount of water in rivers leads to deteriorating water quality (Pittock, 2011). Indirectly, climate change can also drive the degradation of water resources. Most farmers in the study area have resorted to growing crops along river banks. This degradation has resulted in massive erosion and consequent massive siltation of rivers. Stream bank cultivation coupled with the absence of contour ridges in ninety percent (90%) of the fields surrounding rivers had exacerbated the problem of water sources degradation. Farahani, Fard and Asadoor, (2016) confirm that contour ridges are important in farming as they reduce runoff and soil erosion. It is

clear therefore that the absence of contour ridges in fields near rivers contributes to increased siltation.

## **5.2 Adaptation Measures**

This section of the chapter discusses adaptation measures adopted by the people of Chivi in combating climate change. People use varied coping mechanisms and these are used to enhance livelihood resilience to climate change. The belief that climate change is really occurring and that perceived risks are real, may lead communities to either undertake adaptation measures or not (Howden et al, 2007; Dunlap, 2010). As highlighted earlier, people of Chivi through their experiences, believe that climate change is a reality. Their beliefs, attitudes and perceptions of climate change risks lead them to adopt different adaptation strategies as discussed in this section. This is consistent with observations by Arbuckle, Morton, and Hobbs, (2015: 227) who aver that “farmers who believe in climate change and perceive it as a problem” activate their willingness to take action. Local knowledge and farmers’ perceptions of climate change should therefore be considered when it comes to adaptation options (Xu & Brumbie, 2014).

Like in most rural settlements in Africa, livelihoods in the study area are highly dependent on the nature of the biodiversity and environment that exist in the area (Sallu, Twyman & Thomas, 2009). The biodiversity and the environment therefore create opportunities and threats for adaptation options for people of Chivi district. The differences in environmental dynamics discussed in 5.1.2 gives rise to slight differences in the adaptation options in Chivi North, Central and South. As such, the environment in Chivi South offers more natural-based livelihood options compared to Chivi North and Central.

### **5.2.1. Farming Adaptation Measures**

Climate factors, mainly decreased rainfall and increased temperatures, were perceived by farmers to be the main causes of the decrease in rain fed crop production. However other factors such as declining labour and increased family sizes could have led to the perceived low productivity (Mertz et al, 2010).

The participants cited the establishment of nutrition gardens, use of social safety nets, reliance on rainmaking ceremonies, collective farming, winter ploughing, use of IKS weather forecasting, use of organic manure, intensive farming around homesteads, increase in growing small grain crops, staggering of crops planting dates, mulching and infield water harvesting among the adaptation options in crop farming. All the participants indicated that they had used at least three of the above adaptation options. These options include growing crops around homesteads, use of nutrition gardens and reliance on IKS for weather forecasting.

#### **5.2.1.1 Farming around homesteads**

All the respondents agreed that, in response to the changing climate, they had shifted to intensive crop growing within the homesteads instead of the fields which are further away from their homes. The farmers argued that due to the unreliable rainfall patterns, they now opted for maximizing the growing of crops around their homesteads. These fields are smaller compared to the fields far from their homes. This is to ensure productivity on smaller areas. This development is consistent with Tom's (2014) findings that subsistence farmers have reduced their planting areas due to crop failure caused by climate change. Growing of crops on large areas, given the unreliable rainfall received in the study area, brings with it problems such as loss of money used

to buy seed and other inputs. Lack of able bodied members of the households to provide labour in the large fields could also have contributed to the shift towards growing crops at a smaller scale around homesteads.

The socio-economic and biophysical problems have led to farmers concentrating their farming activities on a smaller scale around the homesteads. In doing so, respondents also argued that they would spend most of their time doing off-farm activities such as fishing and growing vegetables in nutrition gardens where they are assured of sustaining their livelihoods.

#### **5.2.1.2 Crop diversification**

Crop diversification as an adaptation strategy is very crucial because the rainfall patterns determine the choice of rain-fed crops (Mertz et al, 2010). However due to climate change, crop yield in most countries is said to have reached its limit and is now lowering in most regions of the World (Ray, Mueller, West & Foley, 2013). As a result of rainfall variability, farmers are diversifying crops grown to suit the changing climate. In southern Africa, it is recommended to substitute maize growing with less climate sensitive crops such as small grains (Lobell et al, 2008). All the farmers in the study area have adopted this strategy and agree that there has been a general increase in small grain growing since the 1990s. Historically, farmers used to grow small grain crops and then there was an increase in maize growing after colonisation. The adoption of hybrid maize seed varieties saw a displacement of small grains farming.

Furthermore, maize is being sold at competitive prices on the market leading to most farmers opting to grow maize even in the rural areas. However, the reduction in rainfall and the increase

in temperatures have led farmers to revert back to their old ways of growing small grain crops. Contradictions however emerged where some participants argued that the study area used to receive high rainfall during the 1950s and maize growing was common.

Comparable yields of farmers who grew small grain crops were higher than for farmers who concentrated on maize growing. These findings are contrary to findings by Rurinda (2014) in Wedza, Zimbabwe, where maize yields were greater than those for rapoko, also known as finger millet, and sorghum. The results demonstrate that the increase in small grain production over maize is contextual depending on the climatic conditions prevailing in an area. Although there has been an increase in small grain farming, participants express reservation(s) with the unpalatable nature of these crops. The younger generation prefers maize meal as opposed to finger millet or sorghum meal. Small grain production is also labour intensive especially when it comes to harvesting and processing of the grain. The advantages of small grains' adaptation in the area are that small grains are drought tolerant and can be stored for longer periods of time, even up to five (5) years. In addition, small grains have more nutritional value than maize (Taylor, Schober and Bean, 2006). In light of rainfall being an important limiting factor in crop production, sorghum and millet are increasingly being regarded as crucial crops for food security especially in sub Saharan countries.

### **5.2.1.3 Indigenous knowledge systems and weather forecasting**

Indigenous knowledge system (IKS) is an important resource which can be used to improve the adaptive capacity of individuals or groups (Mawere, 2013; Boillat & Berkes, 2013). IKSs are contextual as different indicators may mean different things to people in different settings.

Research has shown that IKS is important in local decision-making processes especially in rural areas (Chikaire & Nnandi, 2011; Shoko, 2012; Manyanhaire & Chitura; Chengula & Nyambo, 2016). Respondents indicated that they rely on the use of IKS when weather forecasting for their seasonal and daily planning. They cited indicators such as the occurrence of a whirlwind, abundance of wild fruits and singing of certain birds and insects as some of the ways of confirming different weather patterns. The chirping of crickets was interpreted as marking the onset of the rain season. Such fauna are said to be more active during very high temperatures just before rains fall (Risiro, Mashoko, Tshuma & Rurinda, 2012). Farmers can then start preparing their fields and buying inputs as chirping of crickets is indicative of a good rainy season.

The unpredictable changing climate has left participants relying more on their indigenous knowledge systems. Furthermore, they argued that the Meteorological Office is unreliable in its prediction of weather. The extensive use of IKS in weather forecasting could also be attributed to other factors such as lack of media (televisions and radios) for transmission of scientific weather forecasts. Modern weather forecasts are general and prediction of weather for a small geographical area might not be precise (Aguado & Burt, 2010; Lutgen & Tarbuck, 2010). Studies have shown that IKS application in weather forecasting has been used successfully to predict impending weather for smaller geographical areas (Chang'a, Yanda, & Ngana, 2010; Risiro et al, 2012; Shoko, 2013). It is therefore clear that IKS is important in weather forecasting as it caters for varied micro-climates in large areas such as Chivi.

The effectiveness of using IKS in weather forecasting in the study area lies in the transmission of such knowledge from one generation to the other through documentation and oral tradition.

Respondents highlighted that, in their areas, IKS was successfully used in predicting the onset of the 2016/17 rainy season. In that regard, most farmers prepared their fields in advance and they had bumper harvests. In addition, that climate change knowledge is difficult to understand among the rural folk, personal experiences and solutions are more reliable among such communities.

The abundance of fruits, such as *Parinari caratellifolia* (*muhacha*) and *bauhinia thonningii* (*musekesa*), indicates an imminent drought (Shoko, 2013). The belief is that God (*Mwari*) provides food in form of fruits to his people so that they do not go hungry in times of drought (Mawere, 2013). Wild fruits are mostly consumed by rural communities in Africa in times of drought to sustain their livelihoods (Shumsky, Hickey, Palletier & Johns, 2014). Fruits are a good source of nutrients; however instead of being eaten for their palatial fun and source of vitamins, they are largely consumed for food (Maroyi, 2011). Contrary to the '*Mwari*' belief of a community being provided an abundance of fruits during drought, Shumsky et al., (2014) argue that water deficit results in an increase in both the quantity and quality of fruits. Shumsky et al., (2014) argue that drought stimulates secondary metabolism in fruits thereby bringing positive effects. Communities' vulnerabilities due to losses in terms of food, livestock and sources of income during droughts makes them rely on wild fruits for food. The consumption of wild fruits is based on the traditional ecological knowledge of a specific area (Arenas & Scarpa, 2007). The consumption of fruits is therefore dependant on the local knowledge of the people.

#### 5.2.1.4 Rain making ceremonies

All the participants agreed that rainmaking ceremonies are very important in their livelihoods. The rainmaking ceremony is called “*bira rekukumbira mvura kubva kuvadzimu*” (ceremony to ask for rains from spirit mediums). The perception among the participants was that droughts were occurring because Ancestral Spirits were angry because of ‘sins’ committed by the communities. Such ‘sins’ include cutting down of sacred trees such as figtrees, breaking of taboos and not following traditional social structures, customs and values (Machoko, 2013; Mawere, 2013).

As part of the ceremony, chosen elders go to Matonjeni (Stone of pools) to appease the angry spirits and pray for the rains. There is a belief that there are perennial pools at *Matonjeni* where ‘*Mwari*’ resides. ‘*Mwari*’ is believed to be powerful in making rains fall (Machoko, 2013). This shows that as long as people appease and pray for rains, their *Mwari* would hear them and avert problems of droughts. These ceremonies are carried out every year in September in preparation for the farming season. However, participants believe that although rainmaking ceremonies are still being carried out, they are not being done according to the cultural customs resulting in their ineffectiveness.

Long back, rainmaking ceremonies used to be conducted at *Matonjeni* (Matopos near Bulawayo) which is about 350km from the study area. However, of late, the ceremonies are conducted in Chivi at designated places. Participants cited the lack of funds to travel to *Matonjeni* to carry out rainmaking ceremonies. They also conceded that in earlier days people used to walk to and from *Matonjenjeni*. In addition, there is a perception that colonialism and modernity brought the

breakdown of cultural customs. Machoko (2013) argues that chiefs stopped sending emissaries to *Matonjeni* with gifts to give to water spirits thereby neglecting the spirits. This breakdown in customs could have led to the rainmaking ceremonies being less effective than they used to be. Participants in the study area could still be carrying out the rainmaking ceremonies because it is a requirement by the chiefs for them to participate and they also fear the wrath from their ancestors. The over fifty (50) years of age participants still regard their belief systems and customs highly.

#### **5.2.1.5 Staggered planting dates**

An analysis of the research study data revealed that most of the farmers staggered their planting dates. Farmers argued that the traditionally known dates for the onset of the rainy season had greatly shifted. This was compounded by the unreliable weather forecasts from the Meteorological office. The farmers argued that, using indicators from their IKS to predict the weather, they are able to stagger their planting dates. Varying of planting dates is an adaptation strategy meant to ensure some measure of successful crop production where farmers are faced with uncertainties regarding the onset of rains. The prediction of planting dates is now complex in these times of climate change (Sacks, Deryn, Foley & Ramankutty, 2010). Staggering of planting dates therefore is done as a result of shifting rainfall patterns and distribution caused by climate change. Farmers are faced with uncertainties of rainfall patterns and as an adaptation option; they stagger dates within a farming season in order to avoid complete crop failure (Lemos & Dilling, 2007).

Staggering of planting dates is consistent with a study done in South Africa by Tom (2014) who concluded that poor planting dates could significantly impact on the growth and yield of crop as plants are subjected to heat stress during dry spells at critical growth stages. In such situations, staggering of planting dates may ensure production of some crops. However according to Rurinda (2014), if the rains start very late especially in December, staggering dates as an option becomes unbeneficial. This is particularly true because the growing season becomes shorter. Staggering of planting dates, therefore, becomes ineffective in such cases. Nevertheless, staggering of planting dates is not limited to stress brought by climate change. Other factors such as limited labour and lack of capital to buy inputs may lead farmers to stagger their planting dates as and when inputs become available. Planting is therefore done in phases when inputs and labour permit and not necessarily because of the unreliable onset of rains.

Farmers practice winter ploughing as yet another adaptation option. Winter ploughing is important because it helps retain moisture in the soils. This adaptation option has been on the decrease due to perceived climate risk by farmers (Rurinda, 2014). Winter ploughing is done after harvesting and helps in moisture conservation and reduction of weeds. This is very important to those farmers who do early planting of crops. Few participants acknowledged doing winter ploughing as an adaptation option. The reduction in the use of this option could be related to the uncertainty of the onset of rains and whether the season will have normal rains or not. Furthermore, lack of labor and resources to do winter ploughing and promotion of conservation agriculture by the Agritex department may have contributed to the decline in the usage of winter ploughing. Participants agreed that the Agritex department discourages them from to doing winter ploughing as this may result in loss of soil.

#### **5.2.1.6 Use of organic manure and mulching**

Rainfall variability and high temperatures experienced in the study area result in high evapotranspiration rates. This has detrimental effects on crops grown such as wilting. Mulching is undertaken to conserve moisture in soils, control weeds and soil erosion. It is a preventative measure against soil loss, evapotranspiration and growth of weeds (Bhardwaj, 2013). Therefore, weed seeds are curtailed from germinating and the coverage of mulch on soils reduces soil erosion by wind and water. Although the participants were aware of the benefits of mulching, the analysis of results showed that this is done on a small scale. Few farmers used mulch in their gardens and fields around homesteads. They use tree branches, straw and crop residue as mulch (biomass). However, according to Bardwaj (2011), this type of mulch requires a lot of labour and materials that are not easy to spread in the fields. In addition, the availability of mulch in the study area is very limited due to severe deforestation. The types of mulch used decompose with time to form manure.

Related to mulching, farmers in the area use organic manure as an adaptation option. Due to high temperatures experienced (above 30°C) and low and unreliable rainfall (below 450mm p.a), participants agreed that they did not use artificial fertilizers in their fields. Instead, they use organic manure from animal dung to increase soil fertility in their fields. Soil fertility is important in buffering crop output against climate shocks (Rurinda, 2014). The addition of organic manure is important in the provision of nutrients needed by plants, improving the texture and structure of soils thereby increasing the moisture retention capacity of the soil. Springate and Kover (2014) argue that with time, yields from maize will continue to decline even with the addition of fertilizers. They add that the impact of climate change, especially high temperatures,

will be great that the addition of fertilizers in the fields will not help in improving yields. The importance of using organic manure therefore has more advantages than just making soils fertile.

The low usage of organic manure in the study area as an adaptation strategy may stem from lack of domestic animals among participants. Most households highlighted that they have very few domestic animals and some participants added that they did not own cattle in their households. Domestic animals according to the participants had greatly declined due to climate change.

#### **5.2.1.7 Zunde ramambo (Chief's granary) and humwe (collective farming concept)**

*Zunde raMambo* is a traditional social safety net concept whereby traditional leaders keep grain reserves to distribute to the needy during distress calls (Gwaka, 2017; Mararike 2001). Due to differences in agricultural production and therefore food insecurity, traditional leaders (Chiefs) source grain to give to the needy. Historically, chiefs reserve a piece of land for growing crops specifically for the needy in the communities. Labor in the designated land would be volunteered by the community members (Mararike, 2001). The Chief's role is to coordinate cultivation, harvesting of crops and the distribution of the food to the needy in the community. In addition, the chief has to identify the needy households in his community before distributing the grain. However due to the breakdown in the traditional system as cited by the participants, chiefs have resorted to sourcing grain from donors and they also encourage villagers to contribute towards the chiefs' granaries. In addition community members are not forced to work in the designated fields. Lack of able-bodied persons in the communities to provide labour has resulted in the abandonment of growing crops in the fields provided by chiefs.

Participants revealed that the *zunde raMambo* concept was under threat due to corruption by chiefs, drought relief from donors and climate change. The criterion used by chiefs in distributing food aid is questionable. Rurinda (2014) reports that social safety nets were under threat as a result of poor recognition of chiefs' roles. The chiefs' roles are undermined by the perceived corrupt tendencies cited by the participants. According to the participants, for community members to benefit from *zunde raMambo*, they had to be related or well known to the chiefs. This is an indication that the perceived corruption meant that the farmers were not willing to contribute to the chief's granary. In this regard, as long as farmers considered Chiefs to be corrupt, they would not contribute any grain because they believed there was no fairness when it came to its distribution.

Climate change impacts, such as rising temperature and the reduction in rainfall, have also led to the reduction in the usage of the *zunde raMambo* concept. Farmers in the study area strongly agreed that due to climate change, farm output had declined greatly and they therefore mainly concentrated on growing crops for their families in their individual fields instead of providing grain to the chiefs. In the end, the *zunde raMambo* concept as a coping strategy had become less dependabale as very few households were using it. The effectiveness of this coping strategy therefore called for the formation of community organizations which were fair in their distribution of grain (Gwaka, 2017).

Related to the *zunde raMambo* concept is the strategy of '*humwe*' (community participation and collaboration during labour intensive times). *Humwe* entails that members of the community provide collective labour to a fellow member who is in need (Rurinda, 2014). This is a traditional

custom where farmers help each other during times of high labour demand in the fields. The host farmer provides food and traditional brews to participating members as a sign of appreciation and to keep the morale of the participants high. Participating members provide free labour to the host. This strategy in addition to helping each other in the communities results in building strong ties and *unhuism/ ubuntu* among members. Climate change has resulted in the able-bodied people who should work in the fields moving to urban centres in search of employment. The importance of using this social harmonizing strategy when farming during the era of climate change is found to be important as it provides ‘free’ labour and ‘*ubuntu*’ in the communities.

Despite the usefulness of the *humwe* concept, participants revealed that there was a decline in the use of this collaborative strategy in the study area. Lack of capital to buy food and beverages to feed fellow farmers was cited as the main reason for low level use of the strategy. Lack of active population to provide labour during *humwe* has also led farmers to concentrate on using household labour in their individual fields. Farmers who use this coping strategy were perceived to have enough resources to feed fellow farmers. These few individual farmers argued though that the *humwe* concept is a very noble strategy and it eased labour shortage among the farmers.

#### **5.2.1.8 Infield water harvesting (makandiwa/ chibatamvura)**

Alongside climate variability and climate change, farmers in the area under study are also faced with poor soils and lack of resources. Increased temperatures have led to increased evaporation from the little rainfall received in the area. What aggravates the situation is that farmers mainly rely on rain fed crop production. In-field water harvesting techniques are adopted as coping strategies by few farmers

in the area to improve on their outputs. These are known as *makandiwa* (contour ridges) or *chibatamvura* (that which holds water) in the local language.

Although all the participants have the knowledge on using infiltration pits, very few are using them as an adoption strategy. Participants agreed that this strategy had been in use in the area since they were young. In this study only eighteen (18%) of the participants used infiltration pits to increase moisture retention in the fields. This was a huge reduction from the survey done by Mutekwa and Kusangaya (2006) in Ngundu ward of Chivi who recorded a sixty one percent (61%) infiltration pit use by farmers. The farmers attributed the low use of infiltration pits to the high labour needed to dig the deep trenches needed to hold the water. Due to the high labour needed when using infiltration pits, local people call them '*dhiga ufe*' which literally translates to 'dig and die'. A lot of labour is needed when digging the trenches that hold water which have channel depths of sixty centimetres (60cm) with cross ties at ten metre (10m) intervals. Therefore locals use the expression 'dig and die' to reflect on the nature of the hardwork involved when using this adaptation strategy. In addition, they argue that you might adopt the strategy to no avail since rainfall received in the area is no longer reliable.

Infiltration pits are important in areas like Chivi where rainfall is low, erratic due to climate change and variability. When rain falls, the pits hold the rain and trap runoff thereby concentrating water in the fields where it is needed most (Nyamadzawo, Wuta, Nyamangara & Gumbo; 2013). The water so trapped would help sustain crops during prolonged dry spells thus raising prospects of salvaging some harvest even in times when rainfall ceases early. Farmers who used this adaptation option argued that people in the study area are used to getting food handouts

from NGOs and the government. The reluctance by some farmers to adopt a labour intensive strategy which however potentially produces significant increases in their yields should be understood against this background. Another challenge faced by farmers in using this strategy is that they are not sure whether rains will fall or not, bearing in mind that meteorological drought occurs once in nine or ten years in southern Africa (Rockstrom, 2004). As a result of meteorological drought and the changing climate, farmers may put a lot of labor in digging infiltration pits yet produce very little or nothing in the end.

There was twenty percent (20%) increase in production among farmers who used this strategy compared to their production in years when they did not use infiltration pits. This general increase in production was similar to findings by Nyamadzawo et al., (2013) who reported that there was an increase of 1.6 tonne per hectare where farmers used infiltration pits in Marange, Manicaland, Zimbabwe. Water conservation practices have been in use in many parts of Africa such as Niger, Benin, Mali and Kenya (Olakeye, Barry, Adeoti & Fatondji, 2006; Ibraimo & Munguambe, 2007; Kpadonou, Adegbola & Tovignom, 2012). High rainfall variability in the study area compounded by challenges in using irrigation makes in-field water harvesting an important adaptation measure. The adoption of *in situ* water harvesting pits has resulted in reducing land degradation especially by surface runoff (Mati, 2005). Despite the farmers having witnessed the success stories of those who adopted this strategy, very few of them are using infiltration pits in farming.

### **5.2.2. Livestock, water and vegetation resource adaptations**

An analysis of the adaptation options used for livestock, water and vegetation showed that they were varied from the three (3) regions of the Chivi District. Some adaptations were adopted by everyone and some by few participants. Vulnerabilities differed between households of the same community and from Chivi North, Central and South. This was mainly as a result of climatic differences in the three areas of Chivi hence differences in vegetation, water and resultant livestock in the area. Livestock production is directly related to the amount of water and vegetation found in an area (Tessema, De Boer, Baars & Prins, 2011).

#### **5.2.2.1 Livestock adaptation**

Exposure to climate change and variability by livestock resulted in various adaptations being adapted by farmers to save their livestock herds. Among these are rearing donkeys and goats, relocating animals to areas with better pastures and using maize stalk and certain wild fruits as stock feed. Livestock is affected directly and indirectly by climate change (McCarthy, Canziani, Leary, Dokken and White, 2001). Rainfall and temperature variability affect animals' reproduction and the growth and quality of pastures.

All the participants agreed that in the 1950s, households in Chivi kept cattle averaging fifty (50) per family. They argued that due to climate change and variability, they lost most of their cattle. Climate change has resulted in extreme events such as drought and high temperatures which reduce both the quantity and quality of pastures. Participants have seen an increase in rearing of donkeys and goats in the communities. The observations are similar to findings by Taruvinga,

Muchenje and Muchenje, (2013) who noticed similar trends in livestock production in the Eastern Cape Province of South Africa.

Cattle rearing in Zimbabwe is very important as it is multifunctional especially in a rural set up. Cattle supply milk, manure (Tavirimirwa, Mwembe, Ngulube, Banana, Nyamushamba, Ncube, Nkoboni, 2013), meat, hide, draught power, lobola payment. They also serve as symbol of wealth (Tessema et. al., 2011) and as a form of saving (Taruvunga et al, 2013). These uses of cattle make them the backbone of the livelihoods of rural people in Zimbabwe. On the contrary, the rise in temperatures due to climate change has resulted in the reduction of cattle herd (Rurinda, 2014). Livestock production, just like crops, is affected by temperature and rainfall variability. Although indigenous cattle are usually more resistant to climate change, temperatures above 30°C result in cattle reducing their intake of feed (Rowlinson, 2008; Masama, 2016). In addition, rainfall variability has resulted in poor quality fodder for cattle. These challenges have led to poor quality and reduction in households' cattle herdsizes and an increase in donkeys and goats rearing. Donkeys and goats are heat tolerant animals (Seoand Mendelhson, 2008; Taruvunga et al, 2013). Donkeys in the study area are used for draught power whilst goats are used for milk and meat production. This change of species and breed of livestock from cattle to small ruminants such as goats is proving to be a valuable livestock based adaptation strategy (Masama, 2016).

Donkey rearing as an adaptation option however does not improve food security in the study area because these are only used for draught power. In addition, all the participants agreed that donkey ownership, like cattle ownership, was now regarded as a sign of wealth in the study area.

This is because donkeys are used during farming as draught power and for firewood and water collection. Lack of firewood and water means people have to travel long distances looking for such resources.

Another livestock adaptation method that was adopted by the participants in the study area was feeding crop remains to their livestock. This was consistent with findings by Mertz et al., (2010) and Tavirimirwa et al., (2013) that after harvesting crops, cattle were left to feed on agricultural residues in the fields. Crop remains were from crops such as maize and small grains (finger millet and sorghum) which are left in the fields upon harvesting of crops. In addition, farmers removed crop stalks from their fields; these were stacked at home for feeding livestock during needy times. Crop residues are rich in nutrients and help in improving vulnerable livestock during times when fodder is unavailable. All the participants used this strategy although they reported that increased crop failure resulted in low agricultural residue to feed the livestock.

Increased frequency and intensity of droughts due to climate change have also led to participants selling their livestock to avoid total loss. During unfavourable seasons, livestock is usually sold at prices well below market value. Livestock is mainly bought by people from outside their areas. This is consistent with findings by Wang, Wang, Li and Qin, (2016) in Tibet that livestock is sold in large numbers during weather disasters such as droughts. In contrast, all the farmers in Chivi said they sold their cattle when they realize that they were about to die, whilst in Tibet fifty six percent (56%) of the farmers sold their livestock after a disaster and forty one percent (41%) sold them before a disaster. Participants held on to their cattle in the hope that rains will

fall and pastures would improve. As a result, most people lost a lot of cattle when extreme weather events occurred for example during the 1982/3, 1991/2 and 2007/8 droughts.

Another key element in livestock adaptation in the area is the availability of pasture in one area of the district. As such participants in Chivi North and Central agreed that they temporarily relocated their livestock to Chivi South during critical times. With pasture degradation in these two areas due to low rainfall and high temperatures, herders relocated their cattle to Chivi South where there would be better pastures. Most herders in the study area carried out collective herding when they relocated their livestock to relatives or friends in Chivi South where pasture availability is better. This migration is usually done before rains fall (October-November) when there are no pastures in Chivi North and Central. However due to an increase in dry spells, livestock get relocated for longer periods than before. When forage improves in their areas after rains fall, farmers or herders take their livestock back to their areas.

About thirty three percent (33%) of the participants reported that they gave their cattle *masekesa* (*Bauhinia thonningii* fruit) as stock feed. The fruits are fed to cattle so that they survive during dry seasons. Djuma (2003), reports that these fruits are given to cattle as fodder during the dry winter season. Jimoh and Oladiji, (2005) argue that the fruit is rich in carbohydrates, crude protein and mineral elements and it is therefore a cheap source of food for both livestock and humans. This adaptation option was being hindered by the destruction of vegetation in the area which resulted in low fruit production in the ecosystem.

### **5.2.2.2 Vegetation resource adaptations**

Vegetation resources, especially trees, are very valuable in a rural set up. Halofsky, Warziniack, Peterson and Ho, (2017), state that vegetation provides a number of important services to a community. The services include ecological (soil, water and health protection), social (recreation), biospheric (climate regulation and biodiversity), amenities (spiritual, cultural, historical) and in supplying resources (woodfuel and forage). A number of indigenous trees in the study area are multipurpose. Trees provide wood for fuel, medicines, fruits, forage for livestock and other cultural roles. However, in recent years the vegetation has greatly changed due to climate change and increased population. Indigenous vegetation is on the decline and observation showed an increase in invasive species such as *lantarna camara* and eucalyptus trees (gum trees) in the area. These species could be spreading due to climatic change in the area. Historically, the species were not found in Chivi area. Climate change was projected to be a direct driver of ecosystem change thereby negatively affecting the services (IPCC, 2007). This meant that due to low rainfall and increased temperatures, vegetation was unable to re-grow and provide the services it used to. With the degradation of ecosystems in the study area, participants tended to resort to two main adaptations, that is establishment of woodlots and use of tsootso stoves to curb the problem of forest degradation.

About fifty five percent (55%) of the participants engaged in the establishment of woodlots at individual and collective levels. The Environmental Management Agency (EMA) was collaborating with communities in growing both indigenous and exotic trees in the area. Participants were taught the importance of growing trees in their areas. Trees are important for soil conservation, improving climate, increasing wood fuel resources, reducing siltation in rivers

and providing habitats for a variety of species. It is important to note that vegetation is very important in carbon sequestration and therefore in countering climate change (Goh, 2017). In the long term, this would help improve services provided by the ecosystem. Exotic trees grown in Chivi are gum trees (eucalyptus) which have an advantage of maturing at a fast rate thereby providing the much needed resources to the communities. However, this exotic tree has a disadvantage of reducing the level of the water table (Forsyth, Richardson, Brown & van Wilgen, 2004). This becomes problematic because underground water is a much-needed resource in Chivi. Low underground water was worsened by the fact that the area received very low rainfall (below 450mm p.a).

The woodlots which are collectively grown become the property of the whole community and are managed by EMA. However, some individuals who have their own woodlots were worried that due to lack of forests in Chivi, trees from their woodlots were sometimes felled by unknown persons. The collectively grown woodlots are fenced with the help of EMA whilst individually owned woodlots were not fenced. Individuals with woodlots which were not fenced got worried that any person could access the woodlots.

Climate change and massive deforestation in the area has led to low availability of wood fuel. Wood however is the main source of energy in the area. About thirty three percent (33%) of the participants in FGDs were trained in the construction and use *tsotso* (twig) stove by CARE International. These participants were all from Chivi North, an area that is heavily deforested and there is a huge shortage of firewood. Compared to the traditional open fire which uses large wood logs, a *tsotso* stove is fuel-efficient and uses twigs instead of logs. Chivi North

communities have benefitted from this technology as they are able to use twigs when cooking in the absence of wood logs. In addition, participants echoed that they sold *tsotso* stoves to supplement their incomes. Each *tsotso* stove was selling at \$50 in 2017 and this went a long way in improving the livelihoods of the people. Although the stove is efficient in reducing wood use, participants who used them argued that the stoves are small and can only accommodate a single pot at a time. It therefore takes longer to cook for a large a family.

### **5.2.2.3 Household water resource adaptation**

Chivi has a problem of water availability for domestic use. According to Chidya, Matamula, Nakoma and Chawinga, (2016) a large proportion of the population in the sub-Saharan region use groundwater for domestic uses and has been proven to be the most reliable source for meeting demand in rural areas in this region (Macdonald & Davies, 2002). Water abstraction is mainly from underground through boreholes, shallow wells near rivers and from flowing rivers. Climate variability and heavy river siltation have led to low water being stored in rivers.

As an adaptation option, all participants agreed that they use dry river bed abstraction wells (*mifuku*) to fetch water for household use. A well is dug by scooping out sand from a dry river bed until water is reached. The water is regarded as ‘clean’ and is used for all household chores. However, the theory that the water was clean needs to be verified because no water quality tests were done. The wells are temporary, shallow and are only dug out during the dry season. This is consistent with findings by Namara, Horowitz, Nyamadi and Barry, (2011) who report that farmers in Ghana dig out wells during the dry seasons to abstract water for vegetable farming. Unlike in Chivi where the water from dug out wells was used for all household chores, in Ghana

it is only used for vegetable farming. All the participants agreed that they preferred water from *mifuku* (well) as opposed to borehole water which they said was salty and ‘hard’. Of these participants sixty three percent (63%) also used borehole water in their areas.

Thirteen percent (13%) of the participants acknowledged that they had constructed storm ridges around their fields in order to protect the rivers from siltation. The EMA officer added that only ten percent (10%) of the fields were protected by storm ridges. Farmers regarded the construction of storm bridges as time-wasting and labor intensive. They added that they would rather spend time attending to their nutritional gardens or fishing during the rainy season in order to sustain their livelihoods. Fishing and nutritional gardens were done in and along the major rivers where water was still available. Storm ridging around rivers is a sustainable farming practice that minimizes soils from being washed away from the fields into rivers (Van de Sand, Mwangi & Namirembe, 2014). Farming practices such as tilling loosen the soil and when heavy rains fall; the soil is washed away into rivers causing siltation. Major rivers such as Runde and Tugwe, which run across Chivi, have an extensive catchment area. Storm ridging around these rivers is therefore important in order to reduce siltation in the rivers.

However, the major challenge with this option is the lack of knowledge about the importance of ridging among communities. As long as communities are not aware of the benefits that accrue from ridging, storm ridges will be adopted by very few people as an adaptation. People’s perceptions need to be changed so that they interact with the environment in a sustainable manner. Water management strategies which include storm ridging and discouraging streambank cultivation are meant to improve the services provided by rivers. Without proper watershed

management, rivers in Chivi might get irreparably damaged, worsening the effects of climate change in the area.

### **5.2.3. Other livelihood adaptations options**

In order to improve their livelihoods, participants in the study area identified other adaptation options such as community projects, selling wild fruits and relocation of families. Due to limited opportunities and adaptive capacity in the farming sector in the area, people were switching to other alternatives in order to improve their livelihoods. These adaptation options acted as safety nets during needy times such as droughts.

The low individual adaptive capacities of rural communities in Africa mean that they have to rely on approaches that are collaborative and involve community engagement. The success of these practices involves the knowledge of the local cultural dos and don'ts (Nyong et al, 2007; Nkoana, Verbruggen & Hugel, 2018). Local knowledge of customs, beliefs and traditions are important in using the adaptation options. Simply put, people should be aware of the natural resources to use and to avoid depending on the cultural norms, values and taboos in the area. People in southern Africa are faced with many biophysical and socio-economic constraints to implement modern practices that can improve their adaptive capacities to the impact of climate change (Rurinda, 2014). As such, most people especially in rural communities have turned to natural resources in order to improve their livelihoods (Woittiez, Rufino, Giller, & Mapfumo; 2013).

Despite natural resources being already affected by climate change, Osbahr, Twyman, Adger and Thomas, (2010) argue that individuals prioritize between elements of production, consumption and ecological systems when faced with risks. In such cases, risk perceptions of hunger outweigh the risk perceptions of environmental degradation. Natural resources therefore are being depleted as people prioritize improving their food security over the environment.

In Chivi South, people partnered with a company which empowered them with skills to make different products from marula fruits (*mapfura*) to improve their livelihoods. Products such as butter, soda, nuts and beer (*mukumbi*) are either consumed or sold to other people locally. In addition, herbal tea leaves made from the ‘resurrection’ plant (*selaginella lepidophylla*) (*mufandichimuka* in the local language) were being sold at \$30 a 50kg bag in 2017 and then exported to Germany. Although the money earned is very little compared to the 200g of resurrection tea which the researcher saw in one of the retail shops (2019) which was being sold at \$32, participants acknowledged that the money goes a long way in improving their livelihoods especially during times of crop failure.

These community projects were done collectively by women in the form of clubs. Women in the areas of study have learnt to use natural resources to sustain their livelihoods in the face of climate change. Biscuits were made using *chakata* (*Parinari curatellifolia* fruits) and these proved to be important as a food substitute especially among school children.

Research demonstrates that rural communities are increasingly relying on wild fruits for food security and income (Osbahr et al, 2010; Woitteiz et al, 2013; Rurinda, 2014). Many households

in Chivi rely on wild fruits to supplement their food and income. Fruits such as *Berchemia discolor* (*munyii*), *Azara garckena* (*matohwe*), *Strychnos spinosa* (*matamba*), *Strychnos madagascariensis* (*hwakwa*) and *Vitex mombassae* (*tsubvu*) are consumed not because they were palatable and nutritious but as the only food available. In addition to providing household food, fruits were also sold along roads to passersby to supplement income. A variety of fruits are found at different times all year round and communities are able to harvest and improve on their food sources. Thus, communities are able to supplement food and income during needy times when droughts result in crop failure.

Most of these projects were being done by women who have emerged as the bread winners in most households. This has resulted in the reversal of gender roles in some households. Women and men play different roles in communities and their perceptions to risk are also genderized (Su et al, 2017). As impacts of climate change, such as drought and temperature variability increase, most men relocate to urban areas in search of employment. This leaves women being bread winners in most rural households (Mu & Van de Walle, 2011). Women who remain in the rural areas have to shoulder the responsibilities which are traditionally regarded as masculine. In the past, all decisions on what type of crops to grow and other farming arrangements were done by men. However due to the reversal of gender roles, women are becoming more actively involved in making such decisions.

Due to rainfall variability, water and firewood are being sourced further away from homesteads. Although this used to be a woman's role, men are now fetching water and firewood using donkey drawn scotch carts because of the long distances that are travelled. Despite cultural

attitudes and practices that still exist excluding women from decision making processes, some women are becoming more empowered and in way self reliant through these adaptation processes. The major challenge however that remains is to strike a balance between gender roles and livelihoods sustainability. Contemporary scholars like Su et al (2017:9) argue that “...gender differentiated perceptions and impacts of climate change are context- specific and depend on the involvement of men and women in agricultural production, socio-economic status, location, and gendered differences in access to and control of key assets...” In most African societies men are seen as the provider, the stronger gender and an ‘indispensable tool’ where even in the face of climate change hunger does not occur (Angula, 2010). On the contrary however, this research has shown that climate change knows no gender. Households which are male headed were affected the same as households which are female headed. Although women are regarded as the ‘clay pot’ and weak in the African traditional society, in Chivi District women proved to be responsible for the main livelihoods and have become the pillar of their families as they make sure food, water and energy is provided for. Women have become empowered, easily diversify and are engaged in fishing, nutritious gardens, cultivating in the fields among other household chores in order to provide for their families.

### **5.3 Conclusion**

This chapter discussed research findings in chapter 4. It considered the local knowledge adaptation measures employed by the people of Chivi District to manage climate change. Climate change impacts are varied and differ from household to household and from community to community. As a result, a one size fits all adaptation strategy does not work for all people.

Climate change adaptation is location specific, unlike mitigation which is global in nature. The contextual nature of adaptation makes local knowledge, norms, and values more appropriate when considering options to reduce impacts of climate change. Within the same district, climate change impacts were found to be varied because of the differences in the spatial nature of climate. As such the northern part of the district was found to be more vulnerable and the southern part of the district less vulnerable. Geographic location is thus important as it determines the amount of rainfall received, soil types and, therefore, vulnerability and adaptive capacities of households.

## **CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 Introduction**

This study explored the use of local knowledge adaptation measures by residents of Chivi District, Masvingo Province, Zimbabwe in an era of climate change. This chapter concludes the thesis by summarizing key findings of the study and it makes recommendations based on the research findings. It provides a summative discussion on local knowledge adaptation measures that are adopted by residents of the study area. The chapter is divided into three sections namely summary of the main research findings, recommendations for various stakeholders and suggestions of directions for further research.

### **6.2 Summary**

The study sought to investigate the various local knowledge adaptation measures used by residents of Chivi District in an era of changing climate. The study's research findings revealed that there is evidence in the study area that climate has changed. Past and present experiences of focus group discussions participants' points at changing climate. Chivi residents indicated that they have experienced extreme weather events such as increasingly frequent and severe droughts, rising temperatures and even floods. These extreme events were shown to vary within Chivi, with the northern area being more affected, followed by the central part and lastly the southern part which is the least affected. Although the participants from FGDs were not clear about what climate change is, they have an understanding that the weather and climate patterns have changed in the last thirty to forty years. The impacts of extreme events were highly differentiated within both the district and individual households. The disparities in the areas are due to differences in the microclimate experienced in the respective areas. The differences in the

extreme events therefore show that a single adaptation measure does not work. The study underscores the importance of using varied strategies which are dependent upon experiences of individual households and areas where extreme events occur. However, there was general an increase in temperatures and a decline in rainfall across the district. Weather patterns in the area have become unpredictable since the 1980s.

Increased rainfall variability and temperatures have resulted in changes in flora and fauna in the area. Some animal and plant species have become extinct especially in the northern part of the district. As such, there is a direct relationship between the occurrence of extreme weather events and the reduction and extinction of some species in the study area. The disappearance of some species however has also been attributed to the increase in population in the area. Households had increased thereby necessitating the clearance of land for farming and building of homes. Changes in sources of water were noticed in all the rivers in the districts. Major rivers although still flowing perennially have become heavily silted in most parts. Most rivers in the area now only flow seasonally if the area receives good rains that season. Underground water levels were very low as indicated by the drying of certain tree species that rely on underground water.

The impact of increased temperatures and rainfall variability among households differed even in the same sub-area of the district. This depends on resource ownership of individual households. As a result, vulnerability to climate change therefore varied across households and from the northern to the southern part. In addition, vulnerabilities differed because they were linked to the risk perception of climatic hazards by households and individuals. Participants who were able to distinguish between climate change and variability were in a better position to adapt to climate

change. These were more resilient as they were in a position to buffer themselves against the changing climate.

To buffer themselves against impacts of climate change, participants adopted a number of strategies depending on the climatic exposure characteristic, the participants risk perception and the system affected. In order for the participants to take part in the adaptation process, they have to perceive climate change as real. The systems that are affected by climate change include crop and animal farming, water resources, vegetation resources and other livelihood activities. Climatic characteristics brought by climate change and identified to affect the residents of Chivi were increased droughts, rainfall variability, increased incidence of floods and increased temperatures.

Whereas most adaptations are top down approach in nature, the study highlighted that participants use the bottom-up approach which proved to be more useful to them. This approach uses experiences and vulnerabilities of the affected people to make better informed decisions. Adaptation options explored were determined by the households' capacities, vulnerabilities and knowledge on the exposed climatic risks. Farmers therefore have to use varied adaptation options in order to ensure some productivity in the face of climate change.

On the question of farming adaptation measures, this study established that farmers adopted a number of measures based on perception, local knowledge and risk perception. The findings of this research and other existing research on climate adaptation elsewhere indicated that farmers resorted to intensive growing of crops on a smaller scale. Unreliable rainfall means that farmers are no longer sure about adequate rains falling and as such they concentrated on smaller areas for

farming. The fact that they are not abandoning farming completely showed that they did not want to miss out in case normal rains fall. In addition, indigenous knowledge systems were used in weather forecasting and rainmaking ceremonies. Weather forecasting using local knowledge indicators varied and findings showed that IKSs were more reliable in showing impending weather as compared to modern weather forecasting methods. The study established that there was a strong belief that rainmaking ceremonies were effective in making rains fall. However, the biggest challenge with this option is that it was not being done according to custom. As such although rain making ceremonies are still being performed, the belief among the residents was that the Gods were angry about the way they were being conducted thereby resulting in droughts. The study concluded that although rainmaking ceremonies are still being conducted in the belief that rains would fall, droughts are on the increase due to climate change. Perceptions among participants were that continued appeasement of the Gods would eventually lead to normal rains occurring in the area. The study therefore underscores the importance of indigenous knowledge being passed on from one generation to another and for its preservation and promotion.

Use of organic manure to manage soil fertility in the study area is very essential as opposed to use of artificial fertilizers. Due to the high temperatures experienced in the area, mineral fertilizers are not suitable as an option for increasing soil fertility. The study however concluded that although organic manure is highly recommended to improve soil fertility, very few households have access to this resource. This results in soil degradation over time as the fertility most fields is not well managed. Staggering of planting dates becomes important when timing for rains is right. Otherwise when done early or late planting of crops might not coincide with the unpredictable rainfall resulting in low or no production at all. Farmers therefore have to assess

climate in their areas and capitalize on windows of opportunities in order for them to produce meaningful harvest.

The study has also shown that the in-field water harvesting technique as an option improved moisture in the fields thereby greatly increasing output for farmers who adopted the strategy. However due to the labour intensive nature of the strategy, most farmers were reluctant to use the option. There is need for educating communities on the importance of water harvesting techniques in order to curb challenges of unreliable rainfall due to climate change.

Varied adaptation strategies were identified to cater for fauna and flora. These included relocation of animals during severe water stresses, feeding animals with wild fruits, establishing woodlots, use of dug out wells and reliance on wild fruits to supplement food and income.

The adoption of these strategies was not uniform across the district. A number of barriers which contributed to the low usage of some adaptation options were identified. Among these were, resistance to change among individuals and households, perception of non-known benefits of the options, cultural beliefs, environmental thresholds being reached, low households and environmental resilience. Lack of knowledge and uncertainty of climate change impacts were also major contributors to low adaptation measures being taken up in the district. The success of adaptation measures to curb climate change impact(s) therefore largely depended on people's attitudes towards understanding the climate change phenomenon.

The study established that all residents whether poor or rich, male or female, are vulnerable to the impact of climate change. However, adopted adaptation strategies differed due to the varied resource endowment among the participants. Resources can be financial or labour. Farmers with low labour force were not able to relocate their livestock herds to areas with better pastures thereby leaving them specify to succumb to climate change or selling them at below market value. These farmers were also not able to restock due to financial difficulties. Women were found to adapt quickly and diversify in activities in order to look after their families. In the face of climate change and risks women were found to engage in more income generating projects than men. Vulnerability therefore is a complex phenomenon which is worsened by people's poor perception of risks brought about by climate change and poor preparedness on their part.

### **6.3 Conclusion**

The experiences by of Extreme weather events such as prolonged and the increased occurrence of droughts, increased temperatures and floods experienced by people in Chivi indicate that climate change is real. Such extreme events are leading to a decrease in agricultural production and a loss in biodiversity. Climate change experiences by people in a particular geographical area show that local people are better positioned to implement adaptation measures.. Vulnerabilities experienced by a community determine the capacity and type of adaptations explored.

The problem of climate change is real and calls for concerted effort by communities and governments to choose among contemporary and local knowledge options in dealing with the changing climate. This study documented local knowledge used in adapting to climate change as

encountered by people in Chivi district. The people of Chivi still uphold the ideals and values of IKS. The study concludes that resilience to climate change is built upon resonance between the local knowledge and the affected people in that community. What is clear from the data presented is that adaptation activities and processes are informed by peoples' experiences of the changing climate, their culture and the importance of learning from others. IKS is dynamic and such practices are therefore a process which requires actors to accept change which occurs in the knowledge systems thereby building better resilience. Although commonalities are present among different indigenous groups, each community has its own distinctive set of knowledge that may be restricted to certain areas (Aikenhead & Michell, 2011). As such the knowledge found in this environment may not be applicable to other communities. It emerged from the study that there is no clear divide among some of the adaptation options used by the respondents and whether these were contemporary or local-knowledge based. Integration of adaptation options was found to be the basis for building more resilient communities and reducing vulnerabilities to climate change. Changing a person's mindset is a difficult proposition. However, participants who continued to use IKS and integrating them with contemporary adaptation measures have managed to build resilience against the changing climate. Food security and improving livelihoods was at the heart of respondents in FGDs. The thesis views the use of local knowledge as part of practices that can be used by communities in adapting to the changing climate.

The effectiveness of adaptation measures adopted by the participants was dependent on overcoming barriers met during the process. Participants had to navigate around hybridity of barriers in order to effectively use IKS as adaptation measures in building resilience to climate

change. Although the use of IKS in adapting to changing climate proved effective in improving agricultural production thereby improving livelihoods of individuals and the community in general, it is discouraging to note that IKS usage is not being adopted uniformly across Chivi District. Some participants were affected by ‘donor syndrome’ to fully utilize IKS in building robust climate change adaptation options. Chivi District communities are always supplied with food by donors and this militates against the communities being self-reliant. In addition, the active population which provides labour in the district is mainly affected by emigration to neighbouring South Africa.

#### **6.4 Recommendations**

Climate change impact is on the rise and the uncertainty it brings about is huge. Therefore, it is important for government to adopt a bottom-up approach when it comes to climate change adaptation. The affected people have the best experiences of the changing climate so they are best positioned to propose ways of dealing with climate-change related challenges. The top-down approach has the disadvantage that it may use knowledge which does not work for the specific group. Community based approaches empower people to be more accountable for their environmental systems. Communities identify measures that are suitable for their areas and households, depending on their economic and biophysical problems. The dynamism of IKS means that individuals and communities should be open to learning and accepting ‘new knowledge’ in pursuit of improving their livelihoods.

Indigenous Knowledge Systems should be prioritised and integrated with modern adaptation measures when dealing with climate change. Local knowledge and contemporary methods were

found to be complementary in adapting to climate change. IKS have been used effectively since time immemorial to combat climate change. It is important therefore for the custodians of IKS to pass the information to new generations in order for them to benefit from them.

Knowledge about climate change impact and adaptation options is very important for all generations. Therefore, there is need to mainstream climate change content in the school curriculum from an early stage. Learners should be taught how to identify potential climatic risks and ways of increasing adaptive capacity thereby reducing their vulnerabilities to climate change. A more comprehensive approach which infuses indigenous knowledge and modern methods of adaptation should be explored in detail.

Community education which shows the importance of environmental protection should be through environmental awareness campaigns and clubs. Environmental protection should be a social responsibility for every citizen and this may go a long way in mitigating effects of greenhouse gases thereby combating climate change. Community environmental clubs and awareness campaigns should also be a platform for educating communities about the importance of IKS in environmental protection and sustainable development.

There is need to promote and educate people on the importance of growing more drought tolerant crops. Small grains such as finger millet, sorghum and chickpeas are drought tolerant, and if grown on a large scale, may go a long way in improving people's livelihoods and food security in this era of climate change. Community members hold the view that small grain crops are more nutritious than large grain crops such as maize.

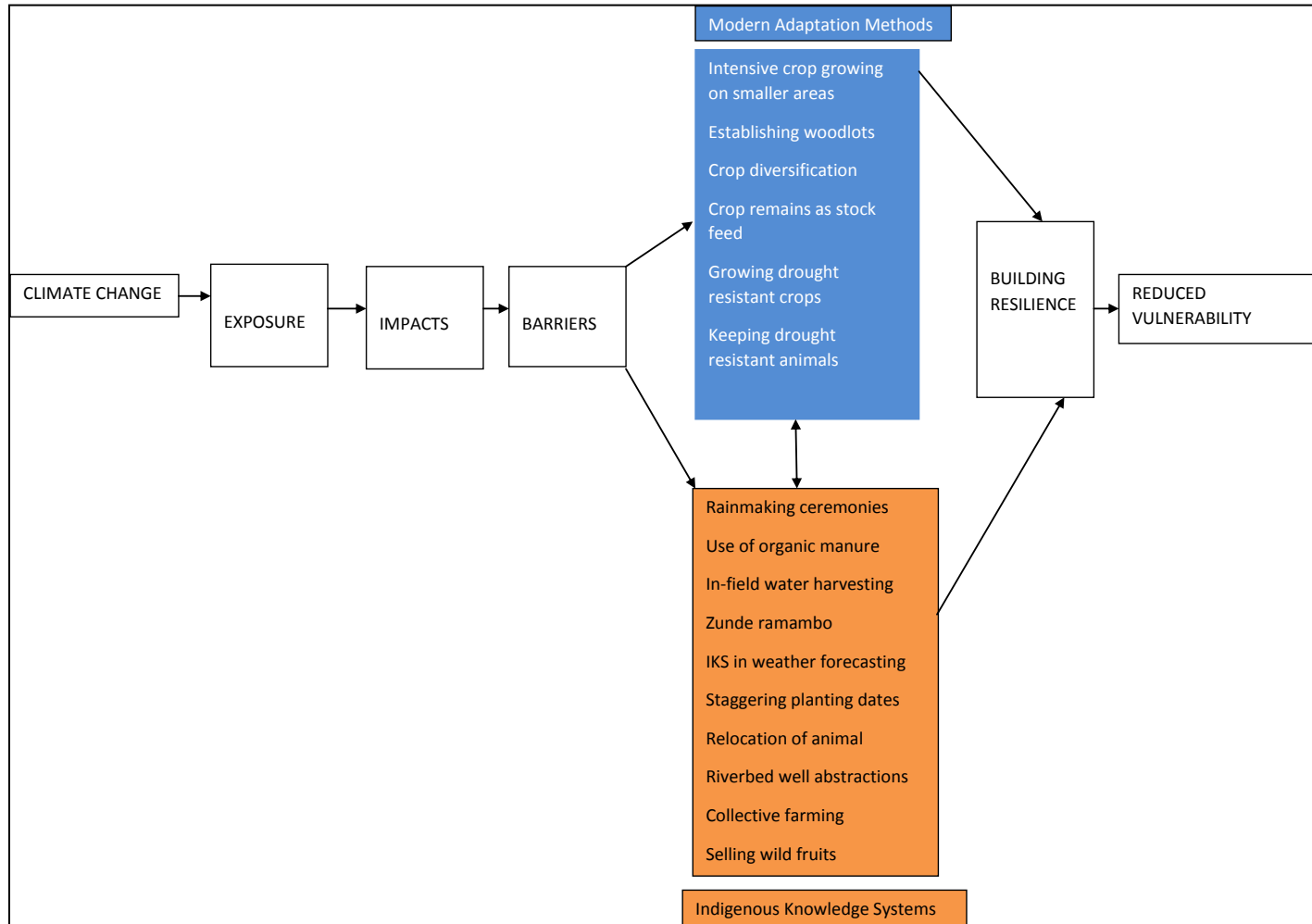
It is important that communities are taught benefits of using in-field water harvesting technologies. Although they are labour intensive, benefits of in-field water harvesting far outweigh the disadvantages. In-field water harvesting technologies, help conserve the limited

rainfall thereby increasing moisture in the field. It also helps to reduce soil erosion through the reduction of runoff. In-field rainwater harvesting helps to increase production by farmers who apply this technology compared to those who do not.

Use of alternative sources of energy should be encouraged in order to reduce deforestation. Deforestation is a direct driver of climate change which needs to be addressed. Zimbabwe is a sunny country where solar energy can be trapped and used efficiently. In addition, there should be promotion of afforestation as a way of improving the environment. Greening the environment goes a long way in combating climate change by creating carbon sinks.

There is need to empower women on issues to do with climate change adaptation. Most rural households are female headed and women take up roles which are traditionally masculine in order to provide for their families. A change of attitude from a patriarchal society is needed so that women are included in decision making processes. This would go a long way in improving livelihoods of people in the rural areas. Climate change impacts being contextual in nature, women are in a better position to make informed adaptation options. It is largely women who make sure that there is food on the table.

Lastly, a framework for pathways to integrating IKS and contemporary methods of adaptation is presented in Figure 6:1 below. The framework is guided by the way respondents experience climate change, the obstacles they encounter in the adaptation process and the choices made leading to reduced vulnerabilities.



**Figure 6:1** Pathway to integrating IKS and contemporary methods in climate change adaptation

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## APPENDIX A: INTRODUCTORY LETTER



21 June 2016

To Whom It May Concern

### CONFIRMATION OF EMPLOYMENT AND PROOF OF STUDENTSHIP

This serves to confirm that Mrs Doreen Taurai Tshuma ID. No. 24-076314F32, EC No. 0622 is a Permanent Full-Time employee of Great Zimbabwe University in the Robert Mugabe School of Education.

She is a registered doctoral (PhD) student with Great Zimbabwe University. Student No. M154004. She is currently doing her research entitled **Exploring Local Knowledge Adaptation Measures in an era of Climate Change: A Case of Chivi District in Masvingo, Zimbabwe**

Could you please kindly assist her in any way possible.

Thank you,

**Dr. K. Mapetere** (*Chairperson- Department of Curriculum Studies*)

A handwritten signature in black ink, appearing to read 'K. Mapetere', written in a cursive style.

**APPENDIX B : ETHICAL CLEARANCE**

**GREAT ZIMBABWE UNIVERSITY**

**ROBERT MUGABE SCHOOL OF EDUCATION**

NAME OF APPLICANT: DOREEN. T. TSHUMA

DEPARTMENT: CURRICULUM STUDIES

PROJECT TITLE: LOCAL KNOWLEDGE ADAPTATION MEASURES IN AN ERA  
OF CLIMATE CHANGE, A CASE OF CHIVI DISTRICT,  
MASVINGO, ZIMBABWE

GREAT ZIMBABWE UNIVERSITY  
FACULTY OF EDUCATION  
22 AUG 2016  
P. O. BOX 1235, MASVINGO  
ZIMBABWE  
TEL: (039) 253504 / 266688

APPROVAL No: 2016/02

COMMENCEMENT DATE: FEBRUARY 2015

APPROVAL VALID TO: FEBRUARY 2020

**COMMENTS:**

MEETS THE CRITERIA, therefore  
RECOMMENDED

The researchers must report immediately to the School Ethics Review Committee anything that might affect ethical acceptance of the protocol. This includes adverse reactions of the participants, proposed changes in the protocol, and any other unforeseen events that might affect the continued ethical acceptability of the project.

In issuing this approval number, it is required that all data and consent forms are stored in a secure location for a minimum period of five years. These documents may be required for compliance audit processes during that time. If the location at which data and documentation are retained is changed within that five year period, the School Ethics Review Committee should be advised of the new location.

**SIGNATURES:**

  
.....

Chairperson, School Ethics Review Committee

253

22/8/16  
.....  
Date

  
.....  
Director, Research and Postgraduate Studies

24/08/2016  
.....  
Date

# GREAT ZIMBABWE UNIVERSITY

SCHOOL: ROBERT MUGABE SCHOOL OF EDUCATION

## RESEARCH ETHICS APPROVAL APPLICATION

TO BE COMPLETED BY THE RESEARCHER

*Please complete only the sections applicable to you*

Name of applicant: TSHUMA DOREEN TAYRAI

Student Number: M154004

Year: 2016

### 1. TITLE OF RESEARCH:

LOCAL KNOWLEDGE ADAPTATION MEASURES IN  
AN ERA OF CLIMATE CHANGE: A CASE OF  
CHIVI DISTRICT, MASVINGO, ZIMBABWE

### 2. MAIN SUPERVISOR

| Name            | Rank      | Contact Number   | e-mail address                   | Contact Address                        | Institution           |
|-----------------|-----------|------------------|----------------------------------|--|-----------------------|
| PROF M<br>KAINO | PROFESSOR | +27124294<br>814 | muganyizi<br>kaino@<br>gmail.com | DAR ES<br>SALAAM<br>CAMPUS<br>TANZANIA | KAMPALA<br>UNIVERSITY |

### 3. CO-SUPERVISOR

| Name                     | Rank   | Contact Number | e-mail address      | Contact Address               | Institution                      |
|--------------------------|--------|----------------|---------------------|-------------------------------|----------------------------------|
| <del>DR</del> S<br>JERIE | DOCTOR | 0172815684     | jerie@<br>msu.ac.zw | SENGA RD<br>GWERU<br>ZIMBABWE | MILWAUKEE<br>STATE<br>UNIVERSITY |

4. RESEARCH FIELD(S) (PLEASE MARK WITH AN X)

|  | YES | NO |
|--|-----|----|
| The research project involves animals                                |     | X  |
| The research project involves plants                                 |     | X  |
| The research project includes work on Genetically Modified Organisms |     | X  |
| The research project involves human participants (subjects)          | X   |    |

5. PHOTOGRAPHY AND/OR AUDIOVISUAL RECORDING

5.1 Will be applied during any stage of the research procedure: YES

5.2 If yes, elaborate Audio recording will be done during focus

6. RESEARCH OBJECTIVE(S) the environment will be taken to show state of the environment and these will be kept under lock and key.  
 i) To examine the experiences of the people of Chivi District in Masvingo in times of climate change.

ii) To explore local knowledge adaptation measures which the indigenous people of Chivi district use in responding to climate change.

iii) To suggest local knowledge adaptation measures which people can effectively use to deal with climate change.

7. SCIENTIFIC JUSTIFICATION/BENEFIT OF THE RESEARCH

The study will benefit local people of Chivi district who may be empowered with local knowledge adaptation measures specific to their area, various Governmental and NGOs that deal with climate change. The people of Zimbabwe will benefit in acknowledging the importance of local knowledge in dealing with climate change.

8. ANIMALS: MATERIALS AND METHODS

8.1 Full description of animals to be used N/A

| Species | Strain/Breed | Gender | Age/ body mass | Number required |
|---------|--------------|--------|----------------|-----------------|
| N/A     | N/A          | N/A    | N/A            | N/A             |

If any of the above cannot be provided, state reason: N/A

8.2 Origin of animals ..... N/A  
 Indicate, if special permission or CITES documents are necessary for the use of the animals. If so, attach required documentation.

8.3 Husbandry **N/A**

Details of person(s) responsible for the husbandry and general care of the animals:

| Name | Qualification | Contact number | Emergency contact number | Contact address |
|------|---------------|----------------|--------------------------|-----------------|
| N/A  | N/A           | N/A            | N/A                      | N/A             |

8.4 Experimental procedures **N/A**

Please indicate in the relevant category (Mark with an X)

|  |     |
|--|-----|
| Experiments involving use of bacteria, protozoa, viruses, fungi or animals species.  | N/A |
| Experiments on animal species that are expected to produce little or no discomfort or minor stress.                                | N/A |
| Experiments that involve significant but unavoidable stress or pain to animal species.   | N/A |
| Procedures that involve inflicting sever pain near, at or above the pain tolerance threshold or unanaesthetised, conscious animals | N/A |

Please include the following:

- Number of animals in experiemental and in control groups
- Initial handling of animals
- Duration of experiment
- Samples to be collected (type, site and volume), frequency per animal?
- Place(s) where the experimental procedures will be performed.

9. PLANTS : MATERIALS AND METHODS

9.1 Full description of plants to be used **N/A**

| Species | Strain | Indigenous/exotic | Protected | Number required |
|---------|--------|-------------------|-----------|-----------------|
| N/A     | N/A    | N/A               | N/A       | N/A             |

9.2 Origin of plants **N/A**

Indicate, if special permission or CITES documents are necessary for the plants. If so, attach required documentation.

Please include the following:

- Number of plants in experimental and in control groups
- Describe experimental procedures in detail
- Place(s) where the experimental procedures will be performed

## 10. GENETICALLY MODIFIED ORGANISMS (GMO'S): MATERIALS AND METHODS

### 10.1 Description of GMO's used in the research project

N/A

| Type | Species | Strain | Number required |
|------|---------|--------|-----------------|
| N/A  | N/A     | N/A    | N/A             |

### 10.2 Origin of GMO's used

### 10.3 Experimental procedure

- In detail, describe the experimental procedures intended.
- Include the number of GMO's per experimental group and the number of groups

N/A

### 10.4 Risk assessment

Include a detailed risk assessment in terms of a possible impact on humans, animals and/or the environment.

N/A

#### a. Liability

Describe how you will address the liability for any possible damage caused by the use or release of GMO's.

N/A

#### b. Notification of the public

Please indicate how the public will be informed about a trial release or release of GMO's if this forms part of the study.

N/A

#### c. Waste management

Describe the procedures that will be used to dispose waste resulting from the use of GMO's must be described in the proposal.

N/A

## 11. HUMANS

11.1 Which characteristics of the study group are relevant to the research?

|   | YES | NO |
|---|-----|----|
| Physical/medical condition                                |     | X  |
| Injections, blood samples, swabs and similar interference |     | X  |
| Use of drugs/medicines                                    |     | X  |
| Use of toxic or dangerous substances                      |     | X  |
| Use of food, fluids or nutrients                          |     | X  |
| Psychometric measuring instruments                        |     | X  |
| Questionnaires  | X   |    |
| Interviews  | X   |    |
| Other   |     |    |

Elaborate Interviews in form of Focus Group Discussions will be used on elderly people aged 50 years and above who are knowledgeable in local knowledge.

11.2 Target population

Where are the research subjects drawn from?

|                          | YES | NO |
|--------------------------|-----|----|
| Hospitals/clinics        |     | X  |
| Local communities        | X   |    |
| Educational institutions |     | X  |
| Other                    |     |    |

METEOROLOGICAL OFFICE (HARARE) (MET)  
ENVIRONMENTAL MANAGEMENT OFFICE (MASHINGO) (EMA)

11.3 Are there any possible impacts that may result from the study to the research subjects and/or the environment? NO

11.4 Which precautions will be undertaken to ensure the safety/protection of the research subjects and/or the environment and/or researchers?

11.5 INFORMED CONSENT

11.5.1 Is it necessary to receive consent from research subjects? YES

Please explain This is done so that the research is done in a transparent manner so that participants do not feel coerced

11.5.2 In order to conduct the research would institutional consent be required? Please explain. YES. Consent from the MET and EMA offices will be required so that they are freely to take part and that

11.5.3 How will the subjects be made aware of their right to withdraw at any stage of the project, even after consent had been given? arrangements are made.

11.5.4 How will the potential risk involved be communicated to research subjects? The potential risks will be discussed with them before doing the Focus Group Discussions, through consent forms which they will sign and through good research methods.

## 11.6 Confidentiality and anonymity

- 11.6.1 What measures will be taken to ensure the rights of the subject to anonymity and confidentiality? *Use of pseudonyms and composite profiles will be used. Information will be kept under lock*
- 11.6.2 Is feedback to research subject(s) necessary? If yes, elaborate. *and key*  
*It is necessary so that they benefit from the research on ways of adaptation to climate change, for member checking and validation of results.*

## 12. UNDERTAKING

The researcher undertakes to:

- Give due respect to all research subjects
- Conduct the research in accordance with the approved protocol, relevant legislation and the policies and procedures of Great Zimbabwe University.
- Notify the School Ethics Committee if changes to the aforementioned protocol are effected.

DORGEN TAURAI TSITUMA

Name (Names & Surname)

Signed: \_\_\_\_\_

*Dsen.*

Date: \_\_\_\_\_

*5/08/16*

**APPENDIX C: DISTRICT ADMINISTRATOR**

Telephone: (037) 277  
Fax : 037328  
District Administration Office  
CHIVI



**ZIMBABWE**

MINISTRY OF RURAL DEVELOPMENT  
PROMOTION AND PRESERVATION OF  
NATIONAL CULTURE AND HERITAGE  
District Administration Complex  
Private Bag 506  
CHIVI

01 December 2016

TO WHOM IT MAY CONERN

**RE: PERMISSION TO CARRYOUT RESEARCH ON ADAPTATION MEASURES IN AN ERA OF CLIMATE CHANGE – CHIVI DISTRICT**

The above matter refers.

Permission is granted to Doreen T Tshuma to carry out the above mentioned research in Chivi District. She is a student of PHD at Great Zimbabwe University, Masvingo.

In advance I thank you for the support.

*Tafireyi C*  
Tafireyi C



**For: ACTING DISTRICT ADMINISTRATOR - CHIVI**

**APPENDIX:D ORAL INTERVIEW CONSENT FORM**

I grant ..... permission to conduct an oral interview with ..... I understand that the data gathered from this interview is for educational purposes only and will not be disclosed to any person other than the Supervisory authority and designated school at Great Zimbabwe University. My participation is voluntary and that I am free to withdraw from the study at any time, and this will not prejudice me in any way.

I therefore agree/disagree (delete inapplicable) that I take part in the research.

.....

(Signature of Interviewee)

.....

(Signature of Interviewer)

.....

(Date)

**APPENDIX E: AUDIO TAPE INTERVIEW CONSENT FORM**

I grant ..... Permission to audiotape an interview with  
..... I understand that the data gathered from this  
interview is for educational purposes only and will not be disclosed to any person other than the  
Supervisory authority and designated School at Great Zimbabwe University. I understand that  
participation is voluntary and that I am free to withdraw from the study at any time, and this will  
not prejudice me in any way.

I therefore agree/disagree (delete inapplicable) that I take part in the research.

.....

(Signature of Interviewee)

(Signature of Interviewer)

.....

(Date)

## **APPENDIX F (i): FOCUS GROUP DISCUSSIONS (ENGLISH)**

### **SELF-INTRODUCTION**

My name is Doreen T Tshuma (Student Number M154004) studying for a Doctorate at Great Zimbabwe University. In partial fulfillment for the Doctor of Philosophy in Curriculum Studies, I am doing a study entitled: Exploring the use of Local Knowledge Adaptation Measures in an era of Climate Change: a case study of Chivi District, Masvingo, Zimbabwe. My cell phone number is 00263773705780 and my email address is [dtshuma@gzu.ac.zw](mailto:dtshuma@gzu.ac.zw). The information derived from this discussion will be helpful in understanding the role of local knowledge in adapting to climate change. I hope you will openly give your views. All the information gathered in this interview is for academic purposes only and will be treated in the strictest confidence. Your identity will remain anonymous. May I ask each of you to sign the consent forms. Those not free to participate may excuse themselves before we start.

1. What do you understand by the term climate change?
2. Think back about 30 years back or more, how has climate changed in Chivi area compared to the present era?
3. How has this affected your lifestyles in terms of crop production, water resources, energy resources and animal resources?
4. How have the outputs per hectare changed over the years?
5. Looking back over all the years you have stayed in Chivi, tell us your fondest memory about this place.
6. What are the disappointments you have experienced during your stay in this area?
7. How has rainfall seasons shifted as compared to the last 30 years?

8. What local knowledge adaptation measures do you use in the different sectors (water, agriculture, forestry, and soil) to alleviate the challenges brought by climate change?
9. What are some of the barriers you meet in using the adaptation measures mentioned above?
10. Do you have any local village institutions which you belong to that help in collective adaptation measures? Let us list them and the aims of these groups.
11. Of all the things we have discussed, what to you is the most important as an adaptation strategy to climate change?

## APPENDIX F (ii): SHONA INTERVIEW GUIDE FOR KEY INFORMANTS

### MIBVUNZO KUVANHU VAKAWANDA VARI PAMWE CHETE

#### Self-introduction.

Zita rangu ndinonzi Doreen Taurai Tshuma (Student Number M154004) ndirikuita zvedzidzo zveDoctor of Philosophy in Curriculum Studies paGreat Zimbabwe University. Mukuzadzikisa zvinodiwa muchidzidzo ichi ndirikuita tsvangurudzo maererano nemusoro wenyaya unoti: **Exploring the use of local knowledge adaptation measures in an era of climate change. A case study of Chivi district, Masvingo, Zimbabwe.** Nhamba dzangu dzerunhare dzinoti 00263773705780 uye munokwanisa knyora tsamba pa dtshuma@gzu.ac.zw. Ndinovimba muchapindura mibvunzo yangu makasununguka. Mukukurukura medu zvatinenge tichitaura zvinenge zvichirekodwa. Zvichabuda munhaurirano iyi zvichabatsira tsvangurudzo yangu muchidzidzo change. Mazita enyu haasi kuzobudiswa pazvinyorwa. Ndinokumbira musigne pamapepa andinawo kuti mabvuma kutaura neni musina kumanikidzwa. Kana pane vasingakwanisi kuita hurukuro iyi neni makasungunuka kusuduruka tisati tatanga.

1. Munonzwisisei nenyaya yekushanduka kwekupisa kana matonhorero enzvimbo dzigere vanhu mumatunhu?
2. Muchitarisa makore makumi matatu apfuura kana kudarika nezvemamiriro ekunze, mune zvamunoona here sezvakashanduka pane mamiriro ekunze mudunhu rekwaChivi kana muchishandisa zvamava kuona iye zvino?

3. Kana zviripo zvakashanduka mune zvemamiriro ekunze, zvii zvamungaone sezvashandukawo zvakare mune zvegarariro enyu pane zvekurima, mawanikirwo emvura, huni nezvekubikisa kana mune zvezvipfuwo?
4. Mungarangerire here kushanduka kwemikoho yenyu mukurima pahekita imwe chete kana kuti pamaeka maviri ane chidimbu mumakore ose aya?
5. Muchitarisa upenyu hwenyu hwese hwekugara muno maChivi, ndechipi chinhu chamunonyanyokurangerira nezvenzvimbo ino?
6. Pangave here nezvinhu zvamunoona sezvinokutsamwisai mumagariro amaita muno?
7. Mungaone sekuti mwaka yenyu yegore muno maChivi yashanduka zvakadii mumakore makumi matatu apfuura kana kudarika?
8. Vanhu vemuno maChivi vanofambirana zvakadii nenguva mune zveruzivo rwunodikanwa mune zvekunaya kwemvura, kurima nekupfuwa zvipfuwo, kuchengetedzwa kwematondo nezvemashandisirwo eivhu kuitira kuti vafambirane nezvavapo mukushanduka kwekunze?
  - a)Zvekunaya kwemvura
  - b)Zvekurima nekupfuwa
  - c)Zvematondo
  - d)Zvemashandisirwo eivhu
  - e)Zvekuchengetwa kwemhuka
9. Ndeapi matambudziko amunosangana nawo pakushandisa chinyakare chenyu mukuedza kufambirana nenguva yekushanduka kwekunze zvamareva pamusoro?

10. Mune boka revanhu vemudunhu rino vanoona nezveshanduko yekunze nezvingaitwe kufambirana nenguva? Kana aripo, tingadome here mapoka aya nezvaanoita sezvinangwa zvawo.
11. Pane zvose zvatataura nekushandisa zviripo nezvekushanduka kwekunze, mungaone sekuti ndezvipi zvinoitwa zvakanyanyokosha zvinoitwa kushanda nezvavapo mudunhu?
12. Umwe neumwe wedu ari mudunhu rino angaiti kukurudzira kushanda nezvavapo maererano nemamiriro ekunze nhasi uno? Ngatidomei zvatingaita, tichitanga nezvakanyanya kukosha zvacho.

## **APPENDIX G: INTERVIEW SCHEDULE - ENVIRONMENTAL**

### **MANAGEMENT OFFICER**

My name is Doreen T Tshuma. I am a Doctoral student (M154004) at Great Zimbabwe University carrying out a study entitled: **Exploring Local Knowledge Adaptation Measures in an era of Climate Change, A Case study of Chivi District, Masvingo, Zimbabwe**. My cell phone number is 00263773705780 and my email address is [dtshuma@gzu.ac.zw](mailto:dtshuma@gzu.ac.zw). The information derived from this interview will be helpful in understanding the role of local knowledge in adapting to climate change. All the information gathered from this interview will be solely for academic purposes only. I hope you will openly give your views. Before we start may I ask you to sign the consent form.

1. May you briefly explain what your department is concerned with?
2. What do you understand by the term climate change?
3. What is the role of your department in awareness of climate change?
4. How has climate change impacted on the environment in Chivi district of Masvingo?
5. How vulnerable are the people in Chivi to climate change?
6. Is this vulnerability the same in the same districts of Chivi?
7. How are the people in Chivi district using the environment to cope with climate change?
8. What important ecological, economic, social and aesthetic values provided by the forests are being disrupted by climate change?
9. What measures have you put in place to protect the environment?
10. What local knowledge adaptation practices may be undertaken to alleviate the problems caused by climate change to the environment in Chivi district?

11. What do you think are some of the barriers which are met by the people of Chivi in adapting to climate change?
12. May you explain the importance of collective adaptation measures in curbing problems of climate change?
13. How sustainable are these practices in dealing with climate change?
14. Do you think people in Chivi have the adaptive capacity to deal with climate change?

## **APPENDIX H: STRUCTURED INTERVIEW (METEOREOLOGICAL OFFICERS)**

1. How long have you been working as a meteorological officer?
2. What evidence is there to show that climate change is occurring?
3. Statistically what evidence is there to show that climate change is occurring in Chivi District?
4. How has climate change affected the rainfall patterns in Chivi district?
5. How has climate change affected the temperature patterns in the area?
6. What other evidence is there to show that climate change is occurring?
7. What extreme weather events which have occurred in Chivi District are associated with climate change?

## APPENDIX I: OBSERVATION GUIDE

### Participatory Rural Appraisal Schedule (Timelines, Transect walks & Observations)

1. Types of sources of water .....  
Distance from homestead.....
2. Fields (i) Location.....  
(ii) Crops grown .....  
(iii) State of crops .....
3. Sources of fuel (home-use).....  
Distance from homestead.....
4. Wild animals.....
5. Soil resources.....
6. State of rivers.....  
.....  
.....
7. **Vegetation** .....  
.....  
.....
8. **Any additional comments** .....  
.....  
.....  
.....