RURAL LIVELIHOODS AND ADAPTATION TO CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1 IN MUZARABANI RURAL DISTRICT, ZIMBABWE

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SUBMITTED IN FULFILMENT OF THE REQUIRMENTS FOR THE DOCTOR OF PHILOSOPHY (PHD) DEGREE IN GEOGRAPHY THE SCHOOL OF AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES, UNIVERSITY OF KWAZULU-NATAL, DURBAN, SOUTH AFRICA

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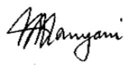
March 2017

DECLARATION

I**, Albert Manyani, Registration Number 213573232,** hereby declare that this thesis entitled:

"RURAL LIVELIHOODS AND ADAPTATION TO CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1 IN MUZARABANI RURAL DISTRICT, ZIMBABWE"

is my own original unaided work. All citations, references and borrowed ideas have been duly acknowledged. I confirm that an external editor was not used. It is being submitted for the degree of PhD in Geography in the College of Agriculture, Engineering and Sciences, University of KwaZulu-Natal, Durban, South Africa. None of the present work has been submitted previously for any degree or examination in any other university.



24 March 2017

Albert Manyani (candidate) | Date

DEDICATION

TO

My wife **Essie** and children **(Molie, Vimbie, Widee, Bidoo and Valee)**

and

All the **participants** in the quest for sustainable livelihoods.

‘Transpire to inspire before you expire’

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Abstract

Climate variability and change has become a major concern locally and globally that has negative impacts on the sustainability of livelihoods as well as socio-economic and environmental well-being. There is also widespread consensus that developing contexts, especially in sub-Saharan Africa, will be most impact by climate variability and change given low coping and adaptive capacities as well as persistent inequalities, poverty, governance challenges and environmental scarcities and degradation which make communities highly vulnerable. In the quest for data generation, which is still scanty and lacking in Zimbabwe, this research sought to assess the sustainability of the rural livelihoods and adaptation strategies to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District, Zimbabwe. In this endeavor, policies governing the execution of the livelihoods were examined and awareness levels of the households determined. Being informed by relevant literature and primary data collection, the research further explored the impacts of climate variability and change on biophysical and socio-economic conditions before examining the adaptation strategies to the climatic phenomena. Challenges faced by household respondents in adapting to climate variability and change were established. Finally, an evaluation of stakeholder roles in promoting sustainable rural livelihood adaptation to climate variability and change was undertaken. As a purposively sampled case study, a mixed approach research design was followed in gathering data from Chadereka Ward 1. The data was collected from 310 household respondents and 10 key informants. This was augmented by 3 focus group discussions and direct observations. Descriptive statistics, using SPSS version 21, regression analysis and content analysis were useful in data presentation and analysis. Farming, gathering and service provision emerged as the dominant current livelihood practices in the study area. Some household socio-demographic characteristics were found to significantly influence the uptake of both livelihoods and their adaptation to climate variability and change. A combination of adaptation strategies pursued in the Ward, such as agroforestry, conservation farming, irrigation, drought tolerant crop and animal variety, livelihood diversification and flood recession cultivation were hampered by mainly institutional forces such as the lack of financial support, poor infrastructure, unfavorable marketing conditions and lack of alternative fuel sources. Generally, climate variability and change have had negative impacts on the biophysical and socio-economic conditions in the Ward evidenced by water scarcity and reduced livelihood portfolios. The results further revealed a low level of climate variability and change knowledge at the household level. Properly constituted, enhanced and effectively monitored policies regarding the management of the natural resources are required to ensure their sustainability. Without these, the sustainability of the practices in the Ward remains greatly compromised. This also calls for more capacity building and resource mobilization and intervention.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF IMAGES

LIST OF MAPS

LIST OF APPENDICES

ACRONYMS

AfDB	African Development Bank
AGRA	Alliance for a Green Revolution in Africa
Agritex	Agricultural Technical and Extension Services
AICDD	African Institute for Community-Driven Development
ASEAN	Association of Southeast Asian Nations
CBD	Convention on Biological Diversity
CCCM	Canadian Climate Center Model
CDM	Clean Development Mechanism
CHANS	Coupled Human and Natural Systems
CHES	Coupled Human-Environment Systems
CLRTAP	Convention on Long-Range Transboundary Air Pollution
COMESA	Common Market for East and Southern Africa
COP	Conference of Parties
CPU	Civil Protection Unit
DFID	Department for International Development
EMA	Environment Management Agency
ENSO	El Nino Southern Oscillation
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GFDL3	General Fluid Dynamics Laboratory
HIV/AIDS	Human Immuno Virus / Acquired Immuno Deficiency Syndrome
IET	International Emissions Trading
ICT	Information and Communication Technologies
IKS	Indigenous Knowledge Systems
IMO	International Maritime Organization
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
ITIKI	Information Technology and Indigenous Knowledge with Intelligence

JIP	Joint Implementation Platform
MDGs	Millennium Development Goals
MENRM	Ministry of Environment and Natural Resources Management
MLRM	Multinomial Logit Regression Model
MRDA	Muzarabani Rural District Administrator
NAPA	National Adaptation Programme of Action
NGOs	Non-Governmental Organisations
NPP	Net Primary Production
OECD	Organisation for Economic Cooperation and Development
SARUA	Southern African Regional Universities Association
SDGs	Sustainable Development Goals
SESs	Social-ecological Systems
SPSS	Statistical Package of Social Scientists
SRLF	Sustainable Rural Livelihood Framework
UNCCD	United Nations Convention on Combating Desertification
UNCED	United Nations Conference on Environment and Development.
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
ZimAsset	Zimbabwe Agenda for Sustainable Socio-Economic Transformation
ZimVac	Zimbabwe Vulnerability Assessment Committee
ZMSD	Zimbabwe Meteorological Service Department
ZNEPS	Zimbabwe’s National Environmental Policy and Strategies
ZRP	Zimbabwe Republic Police
ZIMSTAT	Zimbabwe National Statistical Agency

CHAPTER ONE

INTRODUCTION

1.1 RESEARCH PROBLEM

Climate variability and change issues have generated substantial debate both at macro and micro levels. They have become a global concern (Bob and Babugura, 2014; Costantini *et al*., 2016; Intergovernmental Panel on Climate Change [IPCC], 2014; Molnar, 2010; Niang *et al*., 2014; Otieno and Muchapondwa, 2016). Their linkage to all facets of physical, socio-economic and political development has seen the emergence of relatively new vocabulary in the academic world. Phrases like climate sustainable development, climate compatible development and climate resilient development UNFCC (2012), to mention a few, surfaced in a more appealing way to solicit attention of stakeholders behind this natural phenomenon. Thus, daily new lines of thought towards climate variability and change mitigation and adaptation strategies are discussed and published since the emergence of United Nations Framework Convention on Climate Change (UNFCCC) during the Earth Summit of Rio de Janeiro in 1992 at the United Nations Conference on Environment and Development (UNCED) (Madobi, 2014). Bodansky and Rajamani (2015) note that from 1994 the UNFCCC operated as the international constitution on climate change regime. It has become mandatory for nations including Zimbabwe to pledge their positions regarding this issue. While common but differentiated responsibilities towards climate change mitigation and adaptation between the developed and developing countries are embedded in the Kyoto Protocol of 1997 (Boran, 2016), it remains the mandate of each nation to submit its action plans and achievements when called for by the IPCC (Costantini *et al*., 2016; Kiuila *et al*., 2016; UNFCCC, 2012).

Hulme (2016), Metz (2012) and Sango and Godwell (2015a) define climate as average weather conditions (temperature, rainfall, wind direction and speed) mostly calculated over a period of 30 years. Thus, this study also adopts the definition. On the other hand, climate change is defined by the IPCC (2014:5) as “a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/ or the variability of its properties, and that persists for an extended period, typically decades or longer”. The UNFCCC (2012) defines climate change as a phenomenon resulting principally from anthropogenic forces that change the global atmospheric composition and this adds to the natural variations of climate observed in diferent periods of time. Hence, climate change signifies the dynamic shifts of average weather conditions in particular places.

Hansen *et al*. (2007) identify climate variability as time-space temporal changes in weather elements. Climate variability can thus be exemplified by space specific drought, heat waves, storms, floods, cold spell including El Niño and La Niña weather events, that is, it refers to the yearly fluctuation of climate above or below a long-term average value (Gukurume, 2013). Kelman (2015) note that such phenomena (climate variability and change) are induced by natural as well as anthropogenic forces which constantly alter atmospheric composition and land use. Kaushik and Sharma (2015), Metz (2012) and Toole *et al*. (2016) further affirm that climate has changed and a number of issues need to be considered to safeguard the lives of the human race. Ncube *et al*. (2016) even point out that climate change has the potential of destabilizing economies and public finances, thus, it has to be taken seriously. These would call for multidisciplinary approaches in which mainstreaming of climate change into development policies and sectors become critical. In this regard, earlier on Robinson *et al*. (2006) observed that the debate on climate variability and change had moved from an almost exclusive focus on the physical and natural sciences to include the social sciences, with a specific intent to engage various stakeholders.

The exposure of the inevitable climate variability and change scenario through different fora, brings with it obvious shifts in livelihoods for both rural and urban dwellers (Dube and Phiri, 2013). The developing nations in general and marginal areas in particular are the most vulnerable and worst hit by climate change impacts (Alliance for a Green Revolution in Africa [AGRA], 2014). IPCC (2014) reaffirms that climate change is certain and scientifically proven. It is even posing threats to the achievements of the Millennium Development Goals (MDGs) set in 2000, now Sustainable Development Goals (SDGs). Several governments are challenged to visit their budgets taking into account climate change (Niang *et al*., 2014). Agreements (2010) and Berenter (2012) even reported that the Parties to the UNFCCC agreed to provide financial resources for adaptation in developing countries, particularly in Africa which is considered the most vulnerable to climate change impacts (Bob and Babugura, 2014; Costantini *et al*., 2016; Dube *et al*., 2016). The establishment of best adaptive practices for sustainable, compatible and resilient development in marginal areas remains unaccomplished as these experience the worst impacts (Dube *et al*., 2016; Ncube *et al*., 2016; Sango and Godwell, 2015b). As Musarurwa and Lunga (2012:25) assert, "those affected most by climate change are the same people who least understand the phenomenon".

The Kyoto Protocol agreement signed in 1997 commits member nations to reduce the emissions of greenhouse gases by stipulated percentages and periods (IPCC, 2007). It further provided three mechanisms upon which to meet the set targets which are the International Emissions Trading (IET) where parties that have exceeded their emission reduction commitments under the Kyoto Protocol may sell assigned amount units, Clean Development Mechanism (CDM) which allows emission-reduction projects in developing countries to earn certified emission reduction credits and the Joint Implementation Platform (JIP) where Annex 1 countries can invest in an emission reduction project in any other Annex 1 country as an alternative to reducing emissions domestically (UNFCCC, 2012). Country or area specific assessments regarding climate change adaptation and mitigation is indispensible in waging a better war towards sustainable development (Costantini *et al*., 2016; IPCC, 2014). The focus of this study on Chadereka Ward 1 in Muzarabani Rural District in Zimbabwe is therefore a valuable contribution to existing research in this area, especially with the emphasis on locality-specific responses and dynamics.

Rural livelihoods are a combination of all the capabilities and assets or capitals (natural and socio-economic) at the disposal of humankind for survival in the countryside (Khanya-African Institute for Community-Driven Development [AICDD], 1999; Malleson *et al*., 2008; Scoones, 1998; 2009; 2015). Somorin (2010:904) described a livelihood as, "the way people make a living". Chinsinga (2003), Goredema *et al*. (2011) and Scoones (2009; 2015) argue that the livelihoods are the weapons to salvage rural people from the extremes of poverty ensuring their food security and self-sustenance. These livelihoods become sustainable when they are able to cope with and recover from stresses and shocks (induced by climatic hazards in this case) as well as maintain or enhance their capabilities and assets, without undermining the natural resource base (Cramb and Culasero, 2003; Scoones, 1998). Scoones (2009) conceptualizes resilience as the amount of change which rural livelihoods can experience while keeping their core properties. Molnar (2010) described social resilience as the ability to positively adapt despite adversity in a given circumstance. Further, Tian (2012) observes sustainable livelihoods as being resilient. Sustainability and resilience are useful twin terms in adaptation analysis (Taiy *et al*., 2015). Bhatta *et al*. (2015) critically reveal that these livelihoods are generally based on the natural resources endowment in a particular country in general and specific rural locale. It therefore becomes important to understand the natural resource base available in the research area in Chadereka Ward 1 in Muzarabani Rural District.

Bhatta *et al*. (2015) also identify natural resources as the biophysical assets essential for human well-being. Natural resource endowment therefore considers all the available biophysical resources (land, water and vegetation) in a particular area which community members can use for their survival (Belachew and Zuberi, 2015). Climatic variables are critical resources for rural economies hence, the need to identify the current biophysical conditions of the area (Debela *et al.*, 2015; Molnar, 2010). Seasonality which describes the climatic variable in given time and space act as one of the determinants of rural livelihoods diversification in the study area (Ellis, 1998; 1999). Given the over-reliance economically on natural resources in rural communities, Molnar (2010) notes that seasonal variations and changes in climate negatively impacts on these resources, subsequently posing substantial threats to human well-being. IPCC (2014) and Molnar (2010) express that developing countries are more vulnerable to the adverse effects of climate variability and change despite the wholesome priority given to adaptation.

Home grown inventions or adaptive strategies which are sustainable and health enhancing that would conform to the reduction of climate change impacts are called for (Garnett *et al*., 2013). In this study the use of the sustainable rural livelihood framework (SRLF) in the analysis of the sustainability and adaptability to climate variability and change as elaborated by Scoones (1998) becomes indispensable.

According to Adger (2003) and Satu (2007), adaptation is seen as a dynamic social process which calls for collective action or participation by the communities concerned. It therefore depends upon the prevailing environmental and socio-economic conditions at any given time (Arfanuzzaman *et al*., 2016). Ziervogel *et al*. (2008) even include all the stakeholders found with something to do in the area concerned ranging from the government sectors, non-governmental organizations (NGOs), donors and individuals, a stance also adopted in the current research.

Adaptation to climate variability and change which is the focal point in this research is advocated for as a proxy measure to the reduction of risks and vulnerabilities faced by marginalized communities. Below *et al*. (2011) define adaptation as all forms of alterations in the socio-biophysical environmental systems in response to observed or anticipated variations or changes in climatic inducements. Adaptive capacity then spells the ability or potential of a system to respond successfully to climate variability and change (Below *et al*., 2011; Furness and Nelson, 2016). Gentle and Maraseni (2012) further reiterate that adaptive capacity was context specific and varied from place to place. In relation to the concept of adaptation, Shalizi and Lecocq (2010) and Somorin (2010) debate on ‘avoiding’, for example, emissions (mitigation) or ‘coping’ with the impacts (adaptation). They also raise the idea of consciously accepting residual damages to the environment caused by human actions.

Adaptation practices categorized by Below *et al*. (2010) as farm management and technology, farm financial management, diversification on and beyond the farm, government interventions in rural infrastructure, rural health care services, and risk reduction for the rural population and knowledge management, networks, and governance are points of reference in the context in Muzarabani Rural District. Arku (2013) includes trading as another crucial safety net to food security hampered by climate variability and change. Other authors like Somorin (2010), Soussana *et al*. (2010) and Lin (2011) cite changes in the genotype and proper management to curtail effects of climate change in the environment. More adaptive strategies such as mobilization of funds for infrastructural development, diversification, agroforestry, conservation agriculture, communal pooling, storage mechanisms, mobility and market exchange, to mention a few, are identified by the African Development Bank (AfDB, 2010), Belachew and Zuberi (2015), Chagutah (2010), Choudri *et al*. (2013), Furness and Nelson (2016), Gentle and Maraseni (2012), Juana *et al*. (2013), Manatsa and Gadzirai (2010), Musarurwa and Lunga (2012) and Sarker *et al*. (2013). These and more adaptation practices at local level are not well examined and understood in terms of their sustainability as observed by Arfanuzzaman *et al*. (2016). Further, these form the base upon which other coping and adaptive strategies are analyzed.

Zimbabwe, being a member of various international conventions like United Nations Convention on Combating Desertification (UNCCD), Convention on Biological Diversity (CBD) and the Ramsar Convention on Wetlands, to mention a few, has initiated activities to respond to climate change (Government of Zimbabwe, 2012; 2013; 2015). Directly or indirectly, these multilateral agreements point to climate change mitigation and adaptation by enhancing or transforming national livelihoods (Dube *et al*., 2016). The Environment Management Agency (EMA) of the Zimbabwean Government in collaboration with the United Nations Development Program (UNDP) successfully coordinated pilot projects like “Coping with Drought and Climate Change” in Chiredzi District (Manatsa and Gadzirai, 2010:8; UNDP, 2013:1). Discussions with key stakeholders by the Government of Zimbabwe through the Ministry of Environment, Water and Climate have since started. These led to the launch of the National Climate Change Response Strategy for the country during a two day Conference in November 2015. During the same Conference contributions by various stakeholder groups were made towards the draft of the National Climate Policy. Generally, Zimbabwe has commenced positive steps towards promoting research and publicity through media, workshops and conferences locally and internationally.

Understanding vulnerability of human populations to climate variability and change is more and equally desirable in this discourse. Vulnerability signifies the level of susceptibility to risk. Put in other words, Molnar (2010) presents vulnerability as a function of both moral and physical hazards (exposure to risk) and responses taken to reduce risk, that is, abilities to adapt to the effects. The author further notes the interrelatedness of the concepts of adaptation, adaptive capacity, vulnerability, resilience, exposure and sensitivity which have a wide application to the science on global-change. Below *et al*. (2011) present the ideas that the vulnerability of a social system like a rural community in this scenario to climate change is commonly regarded as its degree of inability to cope with adverse climate impacts and as a function of exposure, sensitivity and adaptive capacity. They further affirm that the poor in sub-Saharan Africa, those in Muzarabani Rural District included, are the most vulnerable to climatic variability and change for they rely almost entirely on rain-fed agriculture or pastoralism (Debele *et al*., 2015; Dube *et al*., 2016). Below *et al*. (2011:25) correctly indicate:

> *…enhancing the ability of such rural communities and associated stakeholders to cope better with the constraints and opportunities of present day climatic variability is, in fact, a necessary 'dress rehearsal' for adapting to future climate change.*

Another aspect addressed is the challenges faced by the households in Chadereka Ward 1 in Muzarabani Rural District as they try to adapt to and cope with climate variability and change. Numerous challenges analyzed include water scarcity, poor infrastructure, poor marketing services, natural disasters and inaccessibility of the area. Enete (2013) and Enete and Amusa (2010) deliberated on some of these challenges particularly water scarcity. Ofuoku (2011) and Gentle and Maraseni (2012) also concur with some of the challenges faced in adapting to climate variability and change. The next section focuses on the significance of the study.

1.2 CONTEXTUALIZING CLIMATE VARIABILITY AND CHANGE

Anderson *et al*. (2012) claim that human beings have strongly contributed to the global climate change since the 1950s. This was revealed from their study on 'Testing for the Possible Influence of Unknown Climate Forcings upon Global Temperature Increases from 1950 to 2000'. Chifamba and Mashavira (2011) suggest that the Save River discharge in Zimbabwe has decreased by 43% from 1982 to 2009 owing to climate change. Further evidence to suggest that climate is changing includes the changing rainfall pattern which is decreasing and the increasing air temperature and sunshine intensity causing variations in stream flows (Dube *et al*., 2016; Madobi, 2014; Pinto *et al*., 2016). Other evidence which can be listed incorporates global sea level and temperature rise, warming oceans, shrinking ice sheets, declining Arctic sea ice, glacial retreat like on the summit of Mount Kilimanjaro in Africa, extreme events (especially droughts and floods), ocean acidification, and decreasing snow cover (Goyette, 2016; IPCC, 2007, Lang and Ryder, 2016). The beginning of the rain season has become unpredictable and overall the climate in Zimbabwe is regionally differentiated, generally becoming warmer with more erratic rainfall patterns (Chifamba and Mashavira, 2011; Jiri *et al*., 2015b).

Figures 2.1, 2.2, 2.3 and 2.4 by the Zimbabwe Meteorological Services Department (ZMSD) (2014) portray the scenarios of rainfall and temperature in Zimbabwe in stipulated time periods. Generally, the graphs show a decreasing trend for precipitation (Figure 2.1) and increasing trends for temperatures (Figures 2.2 and 2.3). Figure 2.4 summarizes how annual average rainfall deviated from the normal in the past century with extremes of excessive rainfall recorded in the seasons 1924/25 and that of 1999/00 (characterized by the devastating Cyclone Eline) as observed by Sango and Godwell (2015b). Excessive dryness or drought was recorded in the seasons 1921/22, 1946/47, 1972/73 and 1991/92. All these point to the fact that climate is changing in Zimbabwe, according to the ZMSD (2014).

Unganai (1996) had suggested that as atmospheric CO_2 doubles, average air temperature would be increased by 2 to 4^0C. This was based upon the developed two equilibrium General Circulation Models (General Fluid Dynamics Laboratory [GFDL3] and Canadian Climate Center Model [CCCM]) for Zimbabwe. As for average annual precipitation nationally, Unganai (1996) revealed that a decline of 10% during the season of October to April was recorded from 1900 to 1994. This leaves room for the perception and claim that climate is really changing. The situation has also been confirmed by Rurinda *et al*. (2014). However, Mazvimavi (2010) argues that climate change impacts were not yet statistically significant due to low signal from the high inter-annual variability of rainfall in the country for even a much longer period. Mazvimavi (2010) further states that the reduction in rainfall might probably be a result of multi-decadal variability originating from the bunching of years with above and below average rainfall. For climatic variability and change evidence, climatic trends analysis is essential as also revealed by Challinor *et al*. (2009). There is need to constantly check on livelihoods, especially of rural dwellers who constitute the majority in Zimbabwe (62%) in terms of their sustainability (Brown *et al*., 2012). Adaptation strategies need to be examined and enhanced. Data is critically needed for some countries like Zimbabwe which do not have a climate change policy yet (Government of Zimbabwe, 2013; 2015).

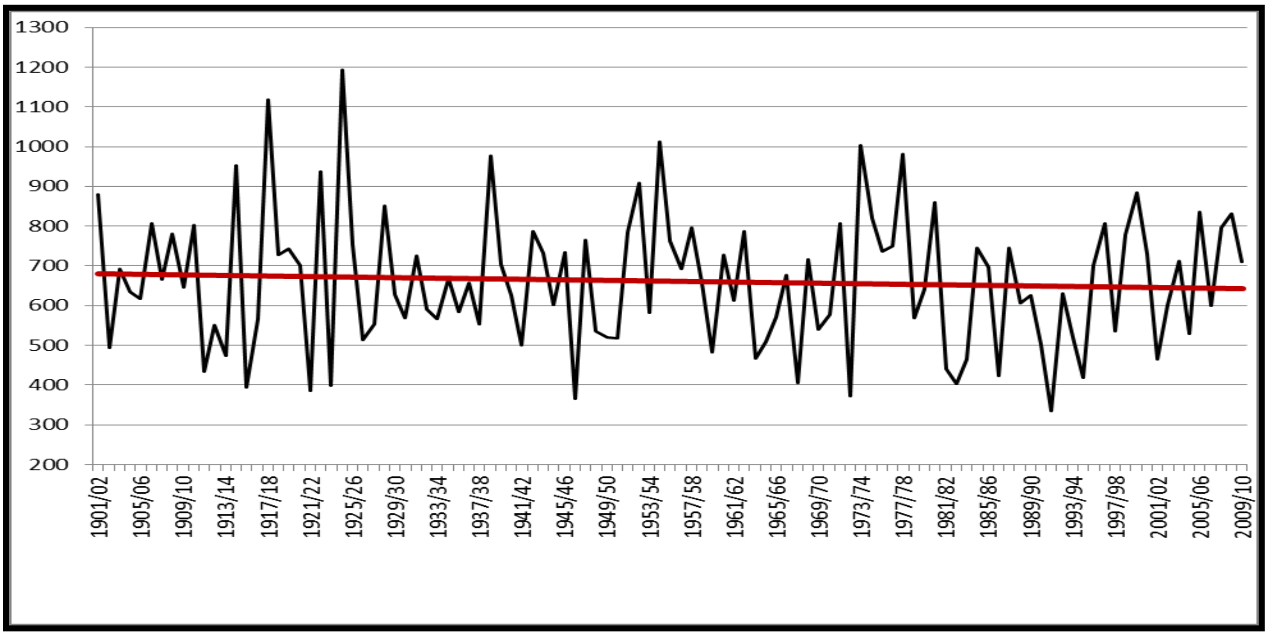


Figure 1.1: Zimbabwe Average Seasonal Rainfall (mm) 1901/02 to 2009/10 (adapted from ZMSD, 2014)

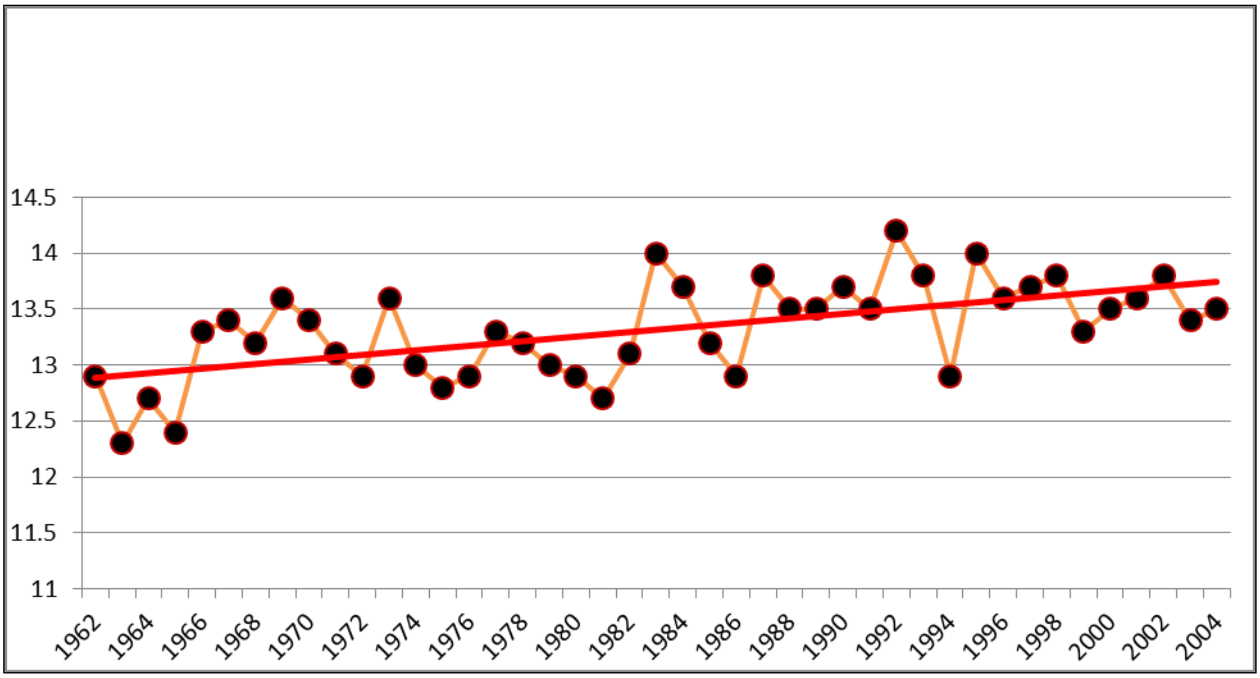


Figure 1.2: Zimbabwe Annual Mean Minimum Temperature ^{0}C (1962 to 2004) (Adapted from ZMSD, 2014)

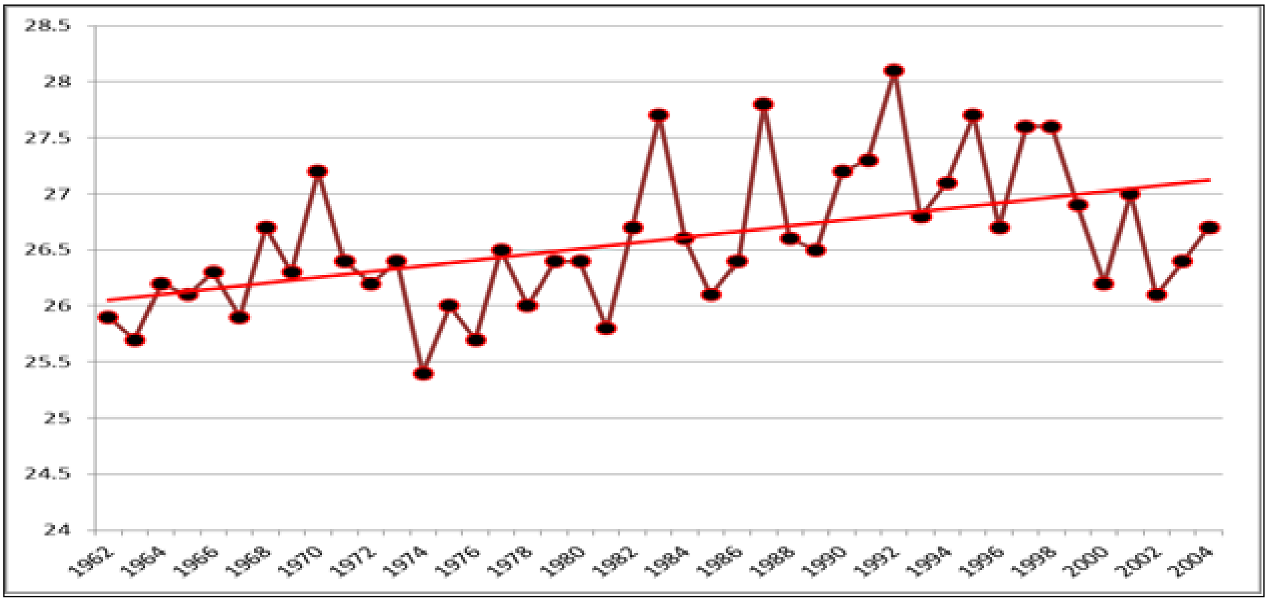


Figure 1.3: Zimbabwe Annual Mean Maximum Temperature ^{0}C (1962 to 2004) (Adapted from ZMSD, 2014)

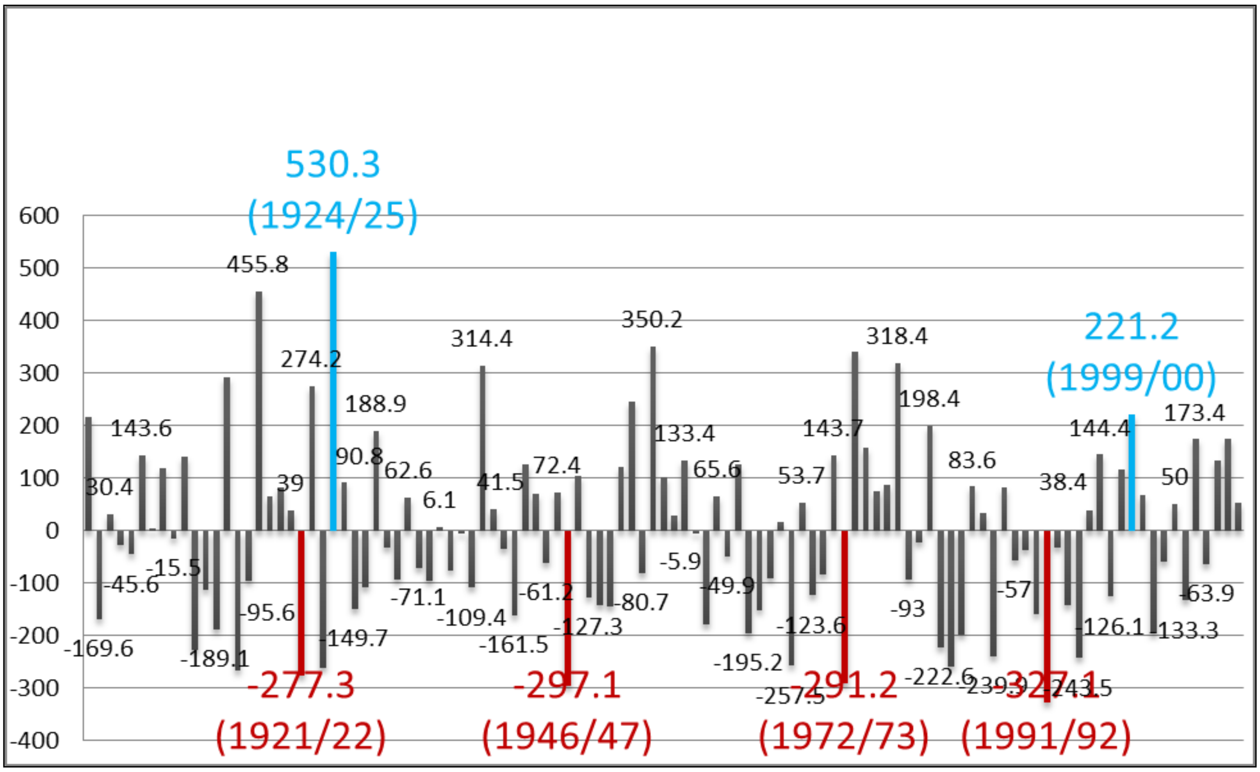


Figure 1.4: Zimbabwe Annual Average Rainfall Deviation from Normal (mm) 1901/02 to 2009/10 Seasons (Adapted from ZMSD, 2014)

Table 1.1: Agro-ecological regions of Zimbabwe in conformity with climate variability and change (adopted from Mugandani *et al*., 2012)

Natural Region	Characteristics	Previous Area Coverage (%)	Current Area Coverage (%)	% Increase or Decrease
1	Specializes in diversified cropping of valuable tea, coffee and other plantations, mean annual temperature ranges of 15-18 ºC.	1.8%	4%	106% increase
2	Intensive crop and livestock production region. Grow maize, tobacco, cotton and wheat and experiences a mean annual temperature range of 16-19 ºC.	15%	7.6%	49% decrease
3	Semi-intensive crop and livestock production. Maize, tobacco, cotton and wheat crops are grown. Has a mean annual temperature range of 18-22 ºC.	18.7%	16.1%	13.9% decrease
4	Semi-extensive livestock production area. Some drought tolerant crops like sorghum, millet and figure millet are grown including short seasoned maize varieties. Has mean annual temperature range of 18-24ºC.	37.8%	39.9%	5.6% increase
5	Extensive production area with a mean annual temperature range of 21-25 ºC. For Game and wild life.	26.7%	32.5%	22.5% increase

Mugandani *et al*. (2012) set to find out if the Agro-ecological Regions of Zimbabwe had changed or varied given the publicized issue of climate variability and change. Using rainfall, length of growing period (LGP) and soil group parameters, the variations in area coverage for the Agro-ecological Regions of Zimbabwe also known as the Natural Farming Regions of Zimbabwe were noted. Table 2.1 summarizes the variations and changes. Table 2.1 shows the Agro-ecological Region 1, with the smallest area coverage (1.8%) and receives the highest amount of rainfall had doubled to 4%. The Natural Farming Region 2 which is considered the bread basket of Zimbabwe, as characterized by the production of the staple food, maize, has tremendously reduced by 49%. The reduction of almost fourteen percent (13.9%) has also been noted for Agro-ecological Region 3. Arid conditions have increased for the two regions and have seen the Agro-ecological Regions 4 and 5 increasing in their extension becoming even more arid. This clearly shows that the country is becoming drier as climate continues to vary and change (Sango and Godwell, 2015b). Thus, this study sets out to establish the biophysical and socio-economic impacts of such a phenomenon and proposes measures to adapt.

1.3 SIGNIFICANCE AND JUSTIFICATION OF THE STUDY

It has become clear that the world is under threat from climate variability and change. Projections on global temperature increases of 2^0C or more by the mid - 21^{st} century, if no action is taken, will make the whole world inhabitable (IPCC, 2007). This presents the essence of exploring adaptive strategies and mitigation measures to climate variability and change. Already climate variability and change impacts are being felt through extended drought periods, unpredictable dry spells, floods and storms leaving no doubt of the scientific projected impacts of the phenomena mainly in developing countries (Kongsager *et al*., 2016; Toole *et al*., 2016; Sango and Godwell, 2015b). The current research seeks to provide insights on some of the deliverables of discussions held by the Government of Zimbabwe and various stakeholders regarding climate change nationally. The Government of Zimbabwe (2013; 2015) points out that climate change awareness levels in Zimbabwe are still low and no meaningful action is done to mitigate or adapt to climate variability and change where such knowledge is found. Thus, extensive communication is needed for public awareness irrespective of age, gender and educational level; among other demographic and socio-economic categories. As such, this research adds data on local level dynamics to the body of knowledge which is considered scant by Musarurwa (2012). Gentle and Maraseni (2012) assert that adaptation strategies by rural communities are normally responsive to short-term shock events thus questioning their planning and sustainability. In fact, climate change needs long-term solutions.

Some climate variability and change related studies have been done in Zimbabwe (Brown *et al*., 2012; Chagutah, 2010; Government of Zimbabwe, 2013; Madobi, 2014; Manatsa and Gadzirai, 2010; Mazvimavi, 2010; Mudavanhu *et al*., 2012; Musarurwa and Lunga, 2012; Muzamhindo *et al*., 2015; UNDP (2013); Nyamwanza and New, 2016; Sango and Godwell, 2015a; 2015b; Unganai, 1996). These have, among other issues, looked at climate projection models and adaptive strategies nationally and locally. The submissions had been more general in some cases involving all the sectors of the economy. Locally research has concentrated more on the southern lowveld with little or limited focus in the northern lowveld in which Muzarabani Rural District lies. It therefore leaves a gap in the field of research to explore the uniqueness of such marginal areas for the provision of informed decisions locally by policy-makers regarding climate change adaptive capacity in Zimbabwe as a whole. Furthermore, as indicated earlier, the research contributes to the body of knowledge on climate change and local adaptive capacity as well as strategies employed. The physiographic locations of places present threats or opportunities in relation to climate change Kaushik and Sharma (2015). Thus, a focus on the case study of Chadereka Ward 1, with extremely rural characteristics in Muzarabani Rural District of Zimbabwe promotes informed and broader choices for climate change mitigation measures and adaptation strategies internationally that ensure that locality specific dynamics are considered.

The main issue is: how sustainable are the livelihood strategies in adapting to climate variability and change? What is being done to adapt to climate variability and change impacts at the local level? What challenges are being encountered as rural communities, especially in developing and vulnerable contexts, try to adapt to climate variability and change? Since climate variability and change is now inevitable, how can societies adapt or become more resilient and less vulnerable to the impacts? Tackling the phenomenon at a local level, especially at the household level, increases grassroots participation and ensures that relevant and effective responses and strategies are understood, encouraged and supported. This also challenges the top-down approaches in the generation, dissemination, and reactionary responses to climate variability and change issues.

The choice to consider Muzarabani Rural District in Zimbabwe for this study is appropriate given its socio-economic and physical conditions. Ziervogel and Calder (2003) reaffirm the need to prioritize and develop adaptive mechanisms and capacities in different setups of the community. This research therefore paves the way for promoting climate variability and change awareness and adaptation within poverty-stricken rural communities in Mashonaland Central Province of Zimbabwe. Kaushik and Sharma (2015) observe that the traditional reliance on faunal indicators and signals for weather variations has since changed with the disappearance of these fauna and their signals distorting rural communities' understanding of weather phenomena. Molnar (2010) points out the emergence of new seasonal rainfall patterns, frequent dry spells or droughts, cyclones and floods which are directly threatening the agricultural systems of a large proportion of the population in the tropics.

The study of contemporary issues like climate variability and change, as Swanborn (2010) states, requires the use of vibrant strategies which are compatible with many kinds of data sources. Thus, the case study research strategy was considered relevant in this research. Arguments in favor of the strategy have been adopted from scholars who include Yin (2013), Gerring (2006) and Rajasekar *et al*. (2013). The idea that the research makes use of varied instruments in one area (interview guides, observation guides, focus group discussion guides and household questionnaire schedules) makes it a case study. The research considered maps of the area which were available in the Map Library (Geography Department), Bindura University of Science Education without going further to the Surveyor General's Office in Harare. Some were even adopted from the literature and some drawn using quantum GIS. The current research also conforms to some of the characteristic features of the case study research which, according to Sarantakos (2013) and Swanborn (2010), include a focus on one or few specific instance(s) of the phenomenon like Chadereka ward 1. Furthermore, as also highlighted by Gerring (2006), a case study is an in-depth study of the phenomenon (the rural livelihoods strategies and their adaptation to climate variability and change in the study area). Sarantakos (2013) and Swanborn (2010) also indicate that a case study permits the use of several stakeholders with varied backgrounds, perceptions, interpretations, reasoning, explanations and prejudices such as the ones identified for the key informant interviews in this research. Furthermore, using a holistic approach in which there is an integrated human-nature study (as provided by the Coupled Human Environmental Systems [CHES] framework) and orienting towards the development of new theories or better ways of solving societal problems thus, challenging the traditional paradigms like in the merging of the two frameworks (SRLF and CHES) (interdisciplinary approach) emerges which is used in this research.

In contrast, the case study strategy may be affected by bias and exaggeration of some responses by the interviewees. In such cases, triangulation (the use of wide varieties of data collection techniques on one issue) validates some wayward affirmations (Bryman, 2008). Thus, this study made use of triangulation by using both quantitative and qualitative methods.

1.4 STUDY AIM AND OBJECTIVES

The research has as the aim to assess the sustainability of rural livelihoods and adaptation to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District. The specific objectives considered are:

- To identify the current rural livelihoods strategies in the face of climate variability and change and the policies or regulatory systems (laws) governing their execution in the study area. This is to establish what rural people in the study area are currently doing to survive in relation to climate variability and change without evaluating whether they are sustainable or effective. Information on the factors that influence which livelihood options are considered is also gathered.
- To determine the degree of awareness of climate variability and change by the inhabitants in Muzarabani Rural District. This calls for an evaluation of the knowledge base on climate variability and change among the people in Muzarabani Rural District. Their knowledge on the issue directly influences their activities and adaptation to climate variability and change.
- To explore the impacts of climate variability and change on biophysical and socio-economic environments in Muzarabani Rural District. Attention shall be given to the biophysical and socio-economic impacts of climate variability and change.
- To critically examine the livelihood adaptation strategies to climate variability and change. The focus is on the capacity of the rural livelihood strategies being practised in Chadereka Ward 1 and their adaptation to climate variability and change.
- To identify the challenges encountered by the households in Muzarabani Rural District in adapting to climate variability and change, and the implications thereof. This objective examines the constraints or problems faced by the community of Chadereka Ward 1 in adapting to climate variability and change. The focus is on socio-economic, political or institutional and physical constraints. The challenges were examined in relation to the SRLF and CHES conceptual approaches that frame the study.
- To evaluate stakeholders' roles in promoting sustainable rural livelihood adaptation to climate variability and change in Muzarabani Rural District. The roles of the Muzarabani Rural District Administrator (MRDA), the Agricultural Technical and Extension Services (Agritex) officers, the Chief, the EMA, Civil Protection Unit (CPU), NGOs, the public sector, kraal head and Ward counselor are examined.

1.5 THESIS ORGANIZATIONAL STRUCTURE

Chapter 1: Orientation of the Study

The introductory Chapter one presents the background to the study problem of rural livelihoods and adaptation to climate variability and change in general and Chadereka Ward 1 in Muzarabani Rural District in Zimbabwe in particular. Contextual meanings of the main concepts guiding the research such as rural livelihoods, adaptation, adaptive capacity, climate variability and change, sustainability, vulnerability, resilience, and natural resource endowment are briefly provided. The Chapter highlights the significance of the study, giving the current position of Zimbabwe with regards to climate change. The aim, objectives, scope and limitations of the research are outlined as well. Generally, the Chapter gives the scope and focus of the research.

Chapter 2: Literature Review

Various research on relevant issues to rural livelihoods and adaptation to climate variability and change are reviewed in this Chapter. These include continental and country specific issues. Details of rural livelihoods, climate variability and change responses and challenges as experienced in different areas are examined. This review provides the knowledge gap to be filled by the present research. The Chapter presents survival and livelihood strategies adopted by the rural populace and how they adapt to climate variability and change. Institutional roles in mitigation measures and adaptive strategies to climate variability and change are discussed. The literature review therefore enriches the aim and objectives of the study.

Chapter 3: Theoretical and Conceptual Framework of the Research

Chapter three focuses on the theoretical and conceptual underpinnings of the research. In this study the frameworks provide distinct insights into the manner in which rural livelihoods are connected to the socio-economic and environmental processes embedded in both the social and natural sciences. The SRLF which works as both a methodological and analytical tool in sustainable livelihoods analysis is discussed. The three-stage process model which positions the objectives under livelihood-vulnerability interaction awareness, the policies or regulation systems and sustainable rural livelihood adaptation strategies is also analyzed. The CHES approach is also considered in this research.

Chapter 4: Research Methodology

It is in this Chapter where the research design, procedure for sampling, data collection and analysis are described in the context of the research problem. Research instruments are clearly presented together with the study site physiographic characteristics. The research questions are also presented. The Chapter specifies the target group sources of data including household representatives and key informants.

Chapter 5: Results Presentation, Analysis and Discussion

The research findings are presented in Chapter five. Some are textual while others are tabulated, mapped or diagrams and graphs are used. The results are then analyzed using qualitative and quantitative techniques depending on the type of data gathered. The analytical tools like Microsoft Excel, SRLF and Statistical Package of Social Scientists (SPSS) version 21 were used.

Chapter 6: Summary, Recommendations and Conclusion

Finally, Chapter six summarizes the important findings of the research in relation to the research objectives presented. This provides an overview of the sustainability status of the livelihoods strategies used in adaptation to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District. The impacts of climate change on rural livelihoods and challenges to sustainable adaptation practices are provided. Lastly, the way forward and recommendations are suggested.

1.6 CONCLUSION

The orientation to the study provided in this Chapter provides the general background and an outline of the international and Zimbabwean position regarding climate variability and change. Globally, the drive is to institutionalize climate variability and change concerns. Through the UNFCCC several countries, both developed and developing, have agreed to collaborate in reducing negative human impacts on climate as well as developing mitigation measures and adaptation strategies to its variation and change. Zimbabwe is no exception though currently there is no clear cut binding policy on climate change per se. As reported in the first draft for Zimbabwe National Climate Change Response Strategy, “there is generally a limited supportive environment to respond to climate change issues at the national level” (Government of Zimbabwe, 2013:64). It is, however, noted that Zimbabwe’s National Environmental Policy and Strategies (ZNEPS) houses climate change issues. The country meanwhile is carrying out consultations and research through government departments, research institutions, civil society and private agencies in an effort to develop and integrate climate change policy into the national economic development sectors (Government of Zimbabwe, 2013). This research comes at a crucial time when the country is considering developing sustainable adaptive strategies to climate variability and change. Thus, by identifying the adaptation livelihoods practices and assessing their sustainability in the study area, legislators or policy-makers have wider options to considerwhen making decisions for climate change adaptation. The community also benefits from the identified practices as these would amplify their traditional and usual activities thereby reducing the negative socio-economic impacts of climate variability and change. Additional literature and publications in the field of climate variability and change at the local level is promoted paving the way for more research on innovations towards solving the problem.

Climate variability and change is instantly and directly felt in marginal rural communities. As recommended by the international conventions, it is imperative for every individual to ‘think globally and act locally’ to avert and reduce the impacts of climate change (Boran, 2016; Chagutah, 2010; IPCC, 2014). Thus, adequate and relevant information on climate change needs to be shared with people in marginal areas. This research, therefore bridges the gap by focusing on understanding and contributing to improving capacities and assisting with appropriate strategy information on climate variability and change. This has been outlined in this Chapter as the significance and scope of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This Chapter focuses on reviewing literature or publications on rural livelihoods and adaptation strategies to climate variability and change being guided by the aim and objectives of the present research. Both worldwide positions and national orientations with regard to rural livelihoods and adaptation to climate variability and change are analyzed revealing the inherent knowledge gaps. Specific thematic subjects are discussed which include rural livelihoods practices, indigenous knowledge systems (IKS) and climate change awareness levels, biophysical and socio-economic impacts, adaptation strategies, challenges and stakeholder participation in adaptation strategies.

2.2 DEFINITION OF CONCEPTS

Definitions of fundamental concepts binding the research are examined in this section. These provide clarity on issues addressed by the study. Despite the complexity of the terms, contextual understanding or meaning is considered essential. The key concepts explained include rural livelihoods, climate change, climate variability and adaptation. Noteworthy is the fact that the definitions provided here are not exhaustive and serve as guides to an understanding of the phenomena under study. The concepts in some instances are further explained to illuminate the issues under discussion.

2.2.1 Rural Livelihoods

This is a two in one concept which clarifies the geographical location of survival assets and processes. Chambers and Conway (1992 cited in Bhatta *et al*., 2015:146) describe “livelihoods as a system comprising of assets, capabilities, and activities for a means of living”. The concept comprises of people and what they are capable of doing for them to survive or live. The critical issue includes food, which comes through the availability of income and different assets (Butt *et al*., 2015; Lienert and Burger, 2015). Resources (both natural and socio-economic) are the sources of any livelihood. A livelihood becomes ‘rural’ if it entirely depends on climate sensitive natural resources (Kaushik and Sharma, 2015). Sango and Godwell (2015b) also note that rural livelihoods are those sustained by forestry resources for a variety of uses like food, fuelwood and medicinal; together with pasture for livestock. Taiy *et al*. (2015) further stress that rural livelihoods are rainfall reliant in terms of agriculture. According to Acharya (2006), a livelihood therefore explains a situation when individuals have enough flows and stocks of food and money to fulfill their basic necessities. Kaushik and Sharma (2015:41) state that “the livelihoods of the rural poor are directly dependent on environmental resources like land, water, forests and are vulnerable to weather and climate variability”. Given these observations and contributions, there is the need to consider efforts towards rural livelihoods adaptation to climate variability and change in Chadereka and discuss their sustainability.

Khanya-AICDD (1999) and Scoones (1998; 2009; 2015) also explain rural livelihoods as a combination of all the capabilities and assets or capitals (natural and socio-economic) at the disposal of humankind for survival in the countryside. Chinsinga (2003), Goredema *et al*. (2011) and Scoones (2009) further argue that livelihoods are the weapons to salvage rural people from the extremes of poverty ensuring their food security and self-sustenance. These livelihoods become sustainable when they are able to cope with and recover from stresses and shocks (induced by climatic hazards in this case) and maintain or enhance their capabilities and assets, without undermining the natural resource base (Butt *et al*., 2015; Cramb and Culasero, 2003; Scoones, 1998). Butt *et al*. (2015) further describe sustainable livelihoods as those activities that enhance the people’s life on a long-term basis without threatening future livelihood possibilities of others. These livelihoods are trans-generational as they resist stress and other natural and anthropogenic shocks (Carney, 1998 cited in Bhatta *et al*., 2015:146).

Acharya (2006) further classified livelihoods into production-based (where individuals till the land and produce on their own), labor-based (where individuals sell their labor to those who have land), exchange or market-based (whereby some households sell their surplus or other non-farm products) and transfer-based entitlements (where households depend on transfers or donations from the government or other social organizations). Contextually, a rural livelihood refers to all the activities or processes and the assets (natural and man-made) that support life for individuals or households. Thus, in this case agricultural activities become critical as the socio-economic base for the rural communities like Chadereka Ward 1 in Muzarabani Rural District. In the area the four classes of livelihoods are examined as contributors to climate variability and change adaptation mechanisms.

In the contemporary period, households and individuals, especially the poor rural farmers are encouraged to intensify efforts to diversify livelihoods portfolios (Dube *et al*., 2016). Given the current scenario of climate variability and change, diversification of rural livelihoods is well supported as safety nets to improve the lives of the rural poor by various authors (Bhatta *et al*., 2015; Kongsager *et al*., 2016; Maninder and Singh, 2015). Dube *et al*. (2016:265) even suggest that "a move away from livelihoods purely dependent on agriculture and local ecological systems would reasonably buffer local communities from the full impact resulting from the projected reduction of precipitation and increase in temperatures". Maninder and Singh (2016) discuss the need for alternative technologies in diversifying livelihoods for the natural dependent farmers. Rural livelihood diversification, according to Aberman *et al*. (2015) and Ellis (1998), improves and supports the living standards of the majority in the countryside of the developing world.

Hanna and Oliva (2016), Huq *et al*. (2015) and Scoones (2009) argue that livelihoods centered on agriculture are the pillar for survival and development in most rural communities in developing countries. Butterfield *et al*. (2008) and Cooper *et al*. (2008) reiterate that these are pivoted directly on the natural environment. The on-farm activities as identified by Gentle and Maraseni (2012) and Molnar (2010) are rain-fed hence principally affected by temperature, rainfall and seasonal variability; the main components of climate variability and change. Currently, there are stakeholder debates at national and global levels as climate variability and change is feared to be upsetting the sustainability of the rural economies. Specifically, the UNFCCC (2012) suggests that climate variability and change scenarios impede the achievement of the MDGs now the SDGs. Adaptation to this calamity which is worrisome and receiving a lot of attention becomes more crucial (Brown *et al*., 2012; Lin, 2011; Shalizi and Lecocq, 2010; Ziervogel and Calder, 2003). This calls for rural livelihoods transformation which enhances survival and reduces vulnerability in marginal areas (Bryan *et al*., 2012; Lienert and Burger, 2015).

Substantial research notes that rural livelihoods have increasingly been threatened by climate variability and change (Dube *et al*., 2016; Kongsager *et al*., 2016; Wang *et al*., 2016). While Below *et al*. (2010; 2011), Bryan *et al*. (2012) and Yegbemey *et al*. (2014) identify climate variability and change amongst the critical threats to sustainable development in Africa, Granderson (2014) considers assessment, communication and response to the risks posed by the phenomena as the fundamental issues regarding climate risk management. This calls for mitigation measures and adaptation strategies to climate variability and change to save the human race from extinction (Thomas *et al*., 2004 cited in Otieno and Muchapondwa, 2016:2).

2.2.2 Climate Change

Climate variability and change phenomenon has developed into a broad subject, cross-cutting into bio-physical (natural), socio-economic (social), political, scientific and cultural disciplines in an attempt to reduce the risks it poses to development facets (Valdivia *et al*., 2010). According to Metz (2012), climate is the average weather conditions (temperature, rainfall, wind direction and speed) mostly calculated over a period of 30 years. Chirala (2013) defines climate change as a long-term shift in weather statistics, which include average temperature and precipitation including wind found at a given place and time. Ross *et al*. (2013) call climate change ‘climate disruption’, ‘climate chaos’ and ‘climate crisis’. In one Zimbabwean media source, climate change has earlier been presented as ‘devastating’, ‘adverse’ and ‘ravaging’ (UNFCCC, 2011). The preceding terms illustrate situations which have unfriendly and unpleasant connotations with respect to weather conditions. Thus, in this context, climate change entails the adverse dynamic shifts or transformation of average daily weather conditions in particular places within stipulated time periods. Bob and Babugura (2014), IPCC (2014) and Kelman (2015) indicate that climate change is a result of direct or indirect human activities which change the global atmospheric components. Climate change spells the unpredictable weather elements with temperatures becoming excessively high and precipitation portraying varied extremes between wet and dry conditions (IPCC, 2007 cited in Rurinda *et al*., 2014:66). Usually wind speed becomes also unbearable (Dube *et al*., 2016). Such variations are impacting negatively on livelihoods of the rural poor in most cases such as Chadereka Ward 1.

According to Buys *et al*. (2011), Chazovachii *et al*. (2013) and Obiora (2014), climate change is believed to be a result of natural variability within the climate system (referring to synergies among the atmospheric, hydrospheric, lithospheric and biospheric components of the earth in addition to solar radiation received by the earth) and anthropogenic activities (mostly the burning of fossil fuels). As years pass by, the global atmospheric composition is continuously altered due to increased greenhouse gases or carbon dioxide which drives excessive increases in temperature and unpredictable rainfall patterns among other changes in weather elements (Bob and Babugura, 2014). Though the causes of climate change are not central to this research, a general understanding of how the phenomenon comes about is essential. Therefore, as the concept of climate change is explained, for the current research, survival or adaptation strategies are examined to ensure sustainability of humanity. An update on climate change in relation to adaptation is informative in relation to the manner in which the phenomenon is evolving. Both natural and social scientists benefit as best practices are sought and revealed.

Smith (2013) seconds a definition of climate change articulated by the National Climate Change Response White Paper as quoted by the Government of the Republic of South Africa as the trend in alterations of the general weather elements due to global warming. UNCED (1992) posits climate change to be the changes in climate influenced by the anthropogenic activity both directly and indirectly. Human action is believed to trigger changes in the global atmospheric composition over a long time period. Thus, these definitions in addition to the description of the outcome of climate change also point to its causes. The IPCC (2007) further observes climate change as persistent variations in the atmospheric properties calculated statistically over many years. Therefore, the current research adopts these definitions as they all point to alterations in the state of the atmosphere on places over extended time periods. Of specific consideration are the changes in temperature and precipitation.

Granderson (2014) points to the opportunities and challenges presented by the phenomenon (climate change) for communities and their livelihoods. Specifically, Muzari *et al*. (2014; 2016) and Granderson (2014) identify tangible impacts on rainfall, temperature, seasonal variations, and the manner in which biodiversity and ecosystem services are spread. Climate change, Granderson (2014) further asserts, creates opportunities for innovations through adaptation mechanisms. Bongo *et al*. (2015) also support the idea by highlighting benefits accrued by destocking as an adaptation strategy to climate change mechanism. Further, more efficient use of natural resources and cultural communication modes for climate change are promoted and developed (Bongo *et al*., 2015). Brown *et al*. (2012) allude to more constraints posed by climate change. Worth noting are snow and ice melts resulting in rising global mean sea level which endanger coastal communities. Somorin (2010), correctly highlights, that in Africa, climate change presents more adverse consequences of extreme events like more drought and floods. Thus, sustainable development for the continent is threatened.

Metz (2012) further affirms that climate has changed and a number of issues need to be considered to safeguard the lives of the human race. These would call for multidisciplinary approaches in which the mainstreaming of climate change into development policies and sectors becomes critical (Adu-Boateng, 2015; Arfanuzzaman *et al*., 2016). In this regard, earlier on Robinson *et al*. (2006) observed that the debate on climate change has moved from an almost exclusive focus on the physical and natural sciences to include the social sciences, with a specific intent to engage various stakeholders. Hence the need to examine climate change issues at a more local level, Chadereka Ward 1.

2.2.3 Climate Variability

Climate variability involves time-space temporal changes in weather elements (Hansen *et al*., 2007). Madobi (2014:1271) defines climate variability as "the way climate fluctuates yearly above or below a long-term average value". Buys *et al*. (2011) point out that Australian farmers consider climate variability to be an extreme natural weather event while climate change is an anthropogenic induced phenomenon. Climate change, according to Cuevas *et al*. (2016), is believed to be the cause for increased climate variability. The definition from the Food and Agriculture Organization (FAO, 2007; 2010) perspective is more elaborate as it considers climate variability to express a climatic parameter of a region or sub-region which varies from the recorded long-term mean. This implies that in any given season or year in a stipulated time period and place, climatic conditions vary. Rainfall and temperature including other parameters are found below or above normal values making it difficult to predict suitable livelihoods options. On climate variability no one is assured of getting adequate rainfall annually (FAO, 2010). It has become a common feature to experience extreme weather condition (droughts and floods) in sub-Saharan Africa (Musiyiwa *et al*., 2014; Muzari *et al*., 2014).

On another note, Thornton *et al*. (2014) examine climate variability as deviations from the mean values or state of climate statistics, which implies records of extreme weather events. These are observed on both temporal and spatial scales. The IPCC (2012) underscores climate variability to be climate anomalies either resulting from internal or external processes depending on the force which triggers the phenomenon which refer to natural processes within the climate system and anthropogenic forces, respectively. Dinse (2011) had prescribed climate variability to reflect the manner in which climate fluctuates annually above or below a long-term mean score. While climate change is designated 'long-term continuous change' with regards to weather elements, Dinse (2011) further calls climate variability 'year-to-year variation' which is short-term. This phenomenon is of great significance in understanding the sustainability of rural livelihoods and adaptation to climate variability and change, the focus of this research.

2.2.4 Adaptation

Adaptation is one of the key concepts in this research. Wheeler *et al*. (2013) and Yegbemey *et al*. (2014) refer to it as any form of adjustment or alteration in ecological, social or economic systems in response to current or projected climatic change and its effects or impacts. Kale (2013) and Kongsager *et al*. (2016) also note adaptation as all kinds of activities focused on a vulnerable system to climate change with the intention to moderate, reduce or eliminate its harmful effects or to exploit opportunities. This calls for creativity in promoting processes, practices and structures which ensure minimum potential damages thus, enhancing maximum benefits from opportunities inherent in climate change. Tompkins *et al*. (2010 cited in Noble *et al*., 2014:839) further allude to adaptation as a practice to reduce risk and vulnerability; to seek opportunities and build the capacity to cope with the impacts of climate variability and change from the macro level (global or national) to micro level (local or individual) including natural systems. The focus is on the mobilization of capacity through harnessing decisions and actions (Furness and Nelson, 2016).

Abel *et al*. (2016) and Park *et al*. (2009) distinguish between incremental and transformational adaptation**.** On the former no major changes are needed. Instead, there is the adoption of the existing solutions or actions. In this case, Noble *et al*. (2014) summarized crop diversification, irrigation, water management, disaster risk management and insurance as long dated societal adaptation strategies to weather and climate impacts. However, for current climate variability and change, novel approaches are needed to capture more adaptation strategies and address new challenges. Thus, transformational adaptation which requires a complete overhaul of the practice or livelihood is called for (Kates *et al*., 2012). This aims at venturing into a new field of adaptation which involves changing the principal characteristics of systems in responding to actual or expected climate variability and change effects. That is, livelihoods change completely like from crop to livestock production, migrating from an area to another with a different lifestyle, changing people's understanding of climate variability and change, and the nature-human relationship (Kates *et al*., 2012; Noble *et al*., 2014). Such categories of adaptation are to be explored in the case of Chadereka Ward 1.

Twomlow *et al*. (2008) on another note differentiated adaptation from mitigation. While adaptation is viewed as changes or alterations in systems' management styles, institutional structures and layout, and infrastructure availability for efficient and effective responses to looming climate variability and changes; mitigation is considered an effort to eradicate or minimize future climate change impacts through a reduction in carbon emissions (Kongsager *et al*., 2016; Noble *et al*., 2014). This is facilitated by creating carbon sink environments for it is difficult to completely eradicate the generation of greenhouse gases given the current level of technological development particularly in the less economically developed countries. Thus, the concept of adaptation in this research focuses on rural community responses to climate variability and change whether passive, reactive or anticipatory.

Below *et al*. (2011) define adaptation as all forms of alterations in the socio-biophysical environmental systems in response to observed or anticipated variations or changes in climatic inducements. It is further seen as a dynamic social process which calls for collective action or participation by the communities concerned (Adger, 2003; Satu, 2007). Adaptation therefore depends upon the prevailing biophysical and socio-economic environmental conditions at any given time.

Adaptation practices in rural settings categorized by Below *et al*. (2010) as farm management and technology, farm financial management, diversification on and beyond the farm, government interventions in rural infrastructure, the rural health care services, risk reduction for the rural population, and knowledge management, networks, and governance; are points of reference in the context of Muzarabani Rural District. Arku (2013) included trading as another crucial safety net to food security hampered by climate variability and change. Other authors like Lin (2011), Somorin (2010) and Soussana *et al*. (2010) cite changes in the genotype and proper management to curtail effects of climate change on the environment. More adaptive strategies were published by the AfDB (2010), Chagutah (2010), Manatsa and Gadzirai (2010), Gentle and Maraseni (2012), Musarurwa and Lunga (2012), Juana *et al*. (2013), Choudri *et al*. (2013) and Sarker *et al*. (2013).

2.2.5 Mitigation

According to Somorin (2010), following presentations during the UNFCCC, mitigation involves the controlling of greenhouse gases to stabilize climate change at an acceptable limit. That is, mitigation aims at reducing emissions or enhancing the sinks of greenhouse gases. Ayers and Huq (2009 cited in Somorin, 2010:909) state that as climate variability and change debate wages on globally, mitigation is considered one of the tasks for the developed countries, who are expected to fund strategies to reduce or eradicate greenhouse gases emissions. Somorin (2010) further point out that adaptation is considered the duty of the developing countries given their low mitigative capacity and high vulnerability. The concept, therefore, is significant given the impacts posed by climate variability and change (Bhatta *et al*., 2015). Thus, its reference in this research should not constitute a misplacement of the term; rather it helps construct meaningful and holistic responses to the phenomena.

2.3 CAUSES OF CLIMATE VARIABILITY AND CHANGE

The World Meteorological Organization identifies greenhouse gases, aerosols and land use changes as the major drivers of climate change. The greenhouse gases are constituted by water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) derived from anthropogenic activities (Toole *et al*., 2016), among other natural sources (Anderson *et al*., 2012). The IPCC (2014) claims that these anthropogenic greenhouse gas emissions kept on increasing since the pre-industrial period thus rendering high concentrations in the atmosphere. Aerosols are particulate substances found in the atmosphere comprising of dust, ash, organic droplets and soot generally resulting from anthropogenic activities. Human activities contribute tremendously to pollutants through the burning of biomass, exhaust emissions from vehicles, agricultural and industrial processes (Bob and Babugura, 2014; Madobi, 2014; Muzari *et al*., 2014; Yanda, 2010). The IPCC (2014) and Egbe *et al*. (2014) further present that anthropogenic main drivers of greenhouse gas emissions are the size of population, economic activity, technology lifestyle, energy use, patterns of land use, and climate policy.

Naturally, modulations of the solar cycles, volcanic eruptions and other geothermal processes contribute to the global phenomenon of climate change or increased emissions of greenhose gases though some consider this as insignificant (Kelman, 2015; Mao *et al*., 2015; Qin *et al*., 2016). Olaniyi *et al*. (2013) and Qin *et al*. (2016) added that global energy balance due to fluctuations in the Earth's orbit, ocean circulation and atmospheric composition are also natural forces contributing towards global warming leading to climate change. Smallholder farmers in Zimbabwe attribute climate change to supernatural powers (Muzari *at al*., 2014). Nature regulates itself but the rate at which human beings interfere with their processes exacerbates and compound global warming leading to climate change (Simatele and Simatele, 2015). Land cover changes due to deforestation and desertification for agricultural and industrial purposes are counted the major causes of climate change. Obiora (2014) suggests that remediating the climate change crisis focuses directly towards human beings to change their behavior as they are the major culprits.

2.4 AWARENESS AND ADAPTATION TO CLIMATE VARIABILITY AND CHANGE

One important aspect when dealing with societal problems like climate variability and change is to understand if the community is really aware of the phenomenon. Thus, some communities spontaneously, unconsciously and haphazardly react to the crisis in their midst out of ignorance or as a normal day to day part of life (Toole *et al*., 2016). This is common in most rural areas of the developing world as opposed to the wealthier and more highly educated countries (Kelman, 2015). The question to be answered is what levels of climate variability and change awareness exist among people in their localities? Madobi (2014) found that some communities have merely general knowledge about the causes, effects and adaptation or mitigation strategies of climate variability and change. Other people like smallholder farmers use their perception in describing the prevalent climatic conditions (Egbe *et al*., 2014; Jiri *et al*., 2015a; 2015b; Kima *et al*., 2015). When a calamity linked to climate variability and change such as flood or drought strikes, communities have various ways, some undocumented, of how they perceive and respond to it through the use of their IKS (Gwenzi *et al*., 2016; Musarurwa and Lunga, 2012). Some compatible solutions to a local problem are found within the local community itself (Chifamba and Mashavira, 2011). Jiri *et al*. (2015b:103) further state, "farmers use tree phenology, animal behavior and atmospheric circulation as sources of local knowledge to predict the onset and 'quality' of the season". It becomes imperative to tap into IKS with regard to rural livelihoods and adaptation to climate variability and change in the study area.

IKS is defined as:

> *Traditional knowledge – the wisdom, knowledge, and practices of the indigenous people gained over time through the experience and orally passed on from one generation to the other – has, over the years, played a significant part in solving problems, including problems related to climate change and variability.*
>
> (Chifamba and Mashavira, 2011:22)

Masinde and Bagura (2012) also defines indigenous knowledge as ‘place-based knowledge’ originating from the local cultures and closely linked to long-established communities which are well-versed with their local natural resources or environments. Thus, the understanding of the natural resource base by the locals cannot be overlooked or underestimated and subdued by the scientific knowledge as it is holistic, getting into the cognitive domain of individuals. Risiro *et al*. (2013:19) view IKS as “a body of knowledge, or bodies of knowledge of the indigenous people of particular geographical areas that they have survived on for a very long time”. Thus, from these definitions, awareness of climate variability and change and the adaptive mechanisms are intertwined with the knowledge posed by the local people with their community.

From Chifamba and Mashavira (2011), Masinde and Bagura (2012) and Risiro *et al*. (2013) the issue of climate variability and change is not new. For antiquity, indigenous people have always been dealing with the issues of climate as their livelihoods had always been hitched on rain-fed agriculture (Adetayo, 2013; Maponya *et al*., 2012; 2013). They have vast experiences of reacting to seasonal anomalies which dovetail into climate change (Musarurwa and Lunga, 2012). As such, the indigenous people in Zimbabwe have been aware of the climate change phenomenon and have developed adaptation strategies which need documentation as the world at large is still struggling to provide a universal solution to the pandemic.

Despite the applausable remarks on IKS by some authors, Briggs and Moyo (2012) described it as disappointing for it failed to impress on development initiatives in general. However, it remains debatable as decisions taken by most smallholder farmers are guided by the local socio-cultural conditions (Briggs and Moyo, 2012). The essence of this research is to establish the awareness level, policies and regulatory systems (including laws) governing the execution of livelihoods options among other issues regarding climate variability and change in the community of Muzarabani. According to the people in Chadereka Ward 1 in Muzarabani, is climate really changing? How do they know and how has it changed?

Maponya *et al*. (2013) view awareness to climate variability and change as being alert of the atmospheric environment in which people operate noting changes and anomalies as they carry out their day to day living. They further regard climate variability and change as an emerging and disturbing phenomenon in developing countries, which already are embedded within issues of poverty eradication, food security, Human Immuno Virus/ Acquired Immuno Deficiency

Syndrome (HIV/ AIDS) pandemic, among others, a situation also confirmed by the IPCC (2012) and Ranger and Fisher (2013). However, Juana *et al*. (2013) reviewed research undertaken by several authors such as Acquah-de Graft (2011) and Nyanga *et al*. (2011). The authors established that the majority of the peasant farmers in sub-Saharan Africa were aware that the annual temperature range had generally increased while precipitation had become varied depending on the region either north or south of the equator. Moyo *et al*. (2012) reported that most of the farmers in Hwange and Masvingo in Zimbabwe strongly believe that climate is changing as rainfall amount; distribution pattern and temperature are unpredictable and varying greatly. However, Adetayo (2013), Betzold (2015) and Ogunleye and Yekinni (2012) revealed that some poor resource farmers in Nigeria have low knowledge on climate change issues. Climate variability and change have had negative impacts on the livelihoods of most farmers thus, the need to establish household level of awareness to climate change issues and adaptive mechanisms in the case of Chadereka Ward 1 in Muzarabani Rural District.

The traditional signal to climate variability and change as noted by Roncoli (2006) and Chifamba and Mashavira (2011) include appearance of unusual birds in the locality, mating of some animals and flowering of some plants. When people observe such activities, they become aware of the time of the year and what to do for their livelihoods. Marrying traditional knowledge and scientific knowledge is a desirable approach currently to achieve the technological innovativeness of the concerned community as well as enriching adaptation strategies to environment problems like climate variability and change (Chirimuuta and Mapolisa, 2011; Nyantakyi-Frimpong, 2013). Normally, local knowledge and experiences assist legislatures in the designing and implementation of acceptable policies. For example, failure to observe traditional norms and beliefs with regard to water resource management result in drying of wells as observed by Muyambo and Maposa (2014). They further pointed out that the sustainability of the use of natural resources also depends on the IKS though Toole *et al*. (2016) argue that lacking environmental knowledge and concern such as climate change issues does not negatively affect sustainable practices. Even Madobi (2014) disregarded lack of knowledge and acknowledged that the dissemination of the information to the local communities is all that matters. Shemdoe *et al*. (2015) note as critical the empowering of decision-makers with knowledge on issues pertaining to climate variability and change. The authors further assert that some local government authorities in Tanzania portray low levels of knowledge and skills of dealing with climate change and vulnerability assessments. Climate change awareness at local level therefore is an issue worth researching.

Various ways of ensuring awareness to climate variability and change phenomenon among people, particularly the marginalized exist (UNFCCC, 2011). These, as UNFCCC (2011) indicate, range from the use of community radio as in Malawi, the media (newspapers) in South Africa and Zimbabwe, the use of the Media-Science-Policy dialogue in the Congo Basin to the internet worldwide. Umunakwe *et al*. (2014) also observed extension agents as other sources of information on climate variability and change. The concern, however, is on accessibility to the climate change information with reference to space allocated for the environmental issues in the media.

Risiro *et al*. (2013) notes the density of spider webs predicts a wet season and a circular halo around the moon known as *dziva* in Shona also predicts a wet season as well. Animal and plant behavior, wild fruit availability and wind direction prior to the rainy season all predict rains. Gwenzi *et al*. (2016) also reveal that there exist positive relationships between IKS and modern science of some indicators of climate variables like wind and precipitation. They confirm that IKS have the potential to be used as seasonal forecasting when properly developed. In marginal rural areas, these traditional ways of predicting climatic conditions are helpful given the inaccessibility of some places.

In Ghana, according to Nyantakyi-Frimpong (2013), small-scale farmers detect the beginning of the rain season through the flowering of the Shea nut tree, the migration patterns of some birds and the position of the constellation Pleiades. Soil moisture content and suitability for some cultivars is detected through the growth of special grasses. As Tanyanyiwa and Chikwanha (2011) argue, the ancient myths and beliefs together with other IKS are indispensable in as far as ensuring sustainable utilization of the varied natural resources, inclusive of climate. They based their affirmation on how water, pastures and other natural resources were considered critical in Bikita of Zimbabwe. In this regard, they called for the engagement of the traditional rules and regulations in ensuring sustainable management of forest resources in the area. The call is for an integrated approach combining technical and IKS to the management of natural resources.

Masinde and Bagula (2012) explore the use of wireless sensor networks and mobile phones in bridging scientific and indigenous knowledge regarding communicating and forecasting weather for local needs in Africa. This novel integration approach was termed Information

Technology and Indigenous Knowledge with Intelligence (ITIKI). What emerges from this is that both indigenous and scientific knowledge are complementary and bring about suitable technologies to the local communities which become easy to apply given diverse demographic and physiographic characteristics. This is supported by Muyambo and Maposa (2014) who also looked at the use of the IKS in water resource management by the Ndau community in Zimbabwe. Thus, blending IKS with scientific knowledge is presented as an effective adaptation strategy to climate variability and change. Masinde and Bagula (2012) uphold the view that the participatory approach which fuses the two types of knowledge promotes a better understanding and development of sustainable strategies to climate variability and change adaptation.

For climate variability and change adaptation strategies to be cost-effective, participatory and sustainable, Nyantakyi-Frimpong (2013) posits the incorporation of IKS as in Ghana. Furthermore, Nyantakyi-Frimpong (2013) reveal that in western Kenya, the Nganyi community are guided in their decisions to prepare land and sow seeds by the behavior portrayed by ants, songs of birds and the flowering of trees. Roncoli (2006) reported that some African farmers use the leaf and fruit quantities in local trees to depict changes in climatic conditions. They are therefore guided as to what livelihoods to practice. Roncoli (2006) confirmed that local climate prediction had been complemented through the use of ethnographic and participatory approaches. This enables the bottom-up scenario of focusing on climate prediction issues rather than from formal institutions like the meteorological departments. When the method is developed further, regional and global climate forecasting could be enhanced (Roncoli, 2006). These climate variability and change awareness systems are explored in the case of Chadereka Ward 1 in Muzarabani Rural District.

2.5 THE IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON THE ENVIRONMENT

Globally, the sustainability of rural livelihoods has come under threat from the impacts of climate variability and change (Matarira *et al*., 2013). This section reviews the impact of climate variability and change on the biophysical and socio-economic environment. Climate variability and change as an issue which has currently received extensive publicity, knowledge and understanding of its impacts pave the way to uncover the adaptive strategies, reduce further negative consequences and promote sustainable livelihoods (Sango and Godwell, 2015a). Thornton *et al*. (2014) and Matarira and Mwamuka (2015) also note that the improved knowledge of climate variability and change impacts on natural and human systems create an essential and initial step towards providing effective solutions to the effects. The reviewed literature is presented in two sections each, critically focusing on the environment and providing the knowledge gap, the underpinning of the present study.

The IPCC (2007) asserts that even though Africa's production of greenhouse gas emissions is minimal, it would be the most affected by climate variability and change. Climatic conditions, specifically rainfall and temperature adversely affect agriculture which is mainly rain-fed in the region (Molnar, 2010; Moyo *et al*., 2012). Internationally, the existence of conventions like the UNFCCC since the early 1990s spells the gravity of the whole climate change issue (IPCC, 2007; Government of Zimbabwe, 2012; 2013). On-farm activities constitute the principal rural livelihoods in Chadereka Ward I, the study site in Muzarabani Rural District of Zimbabwe. Thus, according to Cooper *et al*. (2008) and Butterfield *et al*. (2008), the livelihoods are pivoted directly on the natural environment. The purpose of this study is to assess rural livelihoods in terms of their sustainability in the selected Ward. It further seeks to identify the current practices and challenges faced by households in Chadereka Ward I in an attempt to adapt to climate variability and change. Data on climate variability and change, particularly at the micro scale, is still needed in an endeavor to promote locally-based adaptation strategies.

2.5.1 The Impacts of Climate Variability and Change on the Biophysical Environment

The biophysical environment, according to Aberman *et al*. (2015:4), refers to natural systems which are sensitive to physical and ecological processes and present some limitations to climate variability and change adaptation. This section provides a review of the consequences of climate variability and change on the natural environment, specifically considering biodiversity defined by Brown *et al*. (2012) as variability among living things and the ecosystems that support them and other terrestrial natural features like the atmospheric, hydrospheric and lithospheric systems. Bob and Babugura (2014), Jiri *et al*. (2015a), Thornton *et al*. (2014) and Twomlow *et al*. (2008) projected Africa to be the worst affected continent with regards to climate variability and change. In fact, predictions for southern Africa suggest:

> *…a general decrease in total seasonal rainfall, accompanied by more frequent in-season dry spells that will significantly impact crop and livestock production, and hence economic growth in the region.*
>
> (Twomlow *et al*., 2008:780)

The temperatures will be excessively high with erratic rainfall. Furthermore, Sango and Godwell (2015b), Yanda (2010) and IPCC (2014) predict that the rural poor will suffer the most consequences given the inherent characteristics of their communities, particularly those in the drier areas like the northern lowveld of Zimbabwe in which the study area, Chadereka Ward 1, is located. An assessment of the biophysical impacts of climate variability and change in the predicted area is therefore essential before irreversible damage so as to advise on precautionary measures. Again, the rural community depends on the natural resource base which is the source of their livelihoods (Aberman *et al*., 2015). It is important to note that already the vagaries of climate variability and change are being experienced in the referred region. Muzari *et al*. (2014) and (Ncube *et al*., 2016) acknowledged sub-Saharan Africa to be recording crop and livestock failure and chronic food insecurity due to drought and other associated climate extremes. An adapted summary from the IPCC (2007 cited in Chirala, 2013) on the impacts of climate variability and change for the regions of the world show that the main issues in Africa are rising sea levels (especially in low-lying coastal areas); decreasing length of the growing season in both cropping and rangeland area; variations in temperature and rainfall critically affecting grasslands species important for livestock leading to low production; the frequency, intensity, magnitude and timing of extreme events which will strongly impact on the prevalence and distribution of pests, weeds, and crop and livestock diseases; and increasing vegetation and animal species shifts.

In its fifth report on climate change, the IPCC (2014) points out that the atmospheric and oceanic temperatures have increased, causing a reduction in snow and ice coverage. A rise in sea level is further projected through the use of climate models (mathematical representations of important processes in the climate system of the Earth) (IPCC, 2014). Scientifically, the use of the General Circulation Models (GCMs) is for simulating a number of climatic elements such as temperature, precipitation, winds, clouds, ocean currents and sea-ice aimed at providing future predictions (Pinto *et al*., 2015). The Earth System Models (ESMs) are widely used for simulating the carbon cycle, critical in the greenhouse gases issue. In this regard, the multi-model simulations have been employed (IPCC, 2014). According to Chifamba and Mashavira (2011), rainfall patterns, amplified drought cycles and increased agricultural pests and diseases have been compounded by climate variability and change. Chikodzi and Mutowo (2014) published the drying of Mutubuki wetland in Gutu District of Zimbabwe due to the same phenomenon. Generally, climate variability and change is projected to alter ecological systems, biodiversity, genetic resources and the benefits accruing from ecosystem services (Noble *et al*., 2014). Already ecosystem services under threat from the impacts of climate variability and change include pollination, pest and disease regulation, climate regulation services and potable water supply.

For Africa, it is predicted that the continent is on the verge of having shifts in the distribution of biomes, with more expansion towards savanna climate in the rain forests and towards aridity and desert climate in the savanna (IPCC, 2014). As a result, effects are visible through increased vector and water borne diseases among other direct and indirect consequences (Yanda, 2010). Generally, neither the aquatic and the subaquatic nor the terrestrial and the atmospheric systems can be spared in exploring the issues of climate variability and change given the inefficient adaptive mechanisms in Africa. The IPCC (2014:1204) expressed:

> *Key regional risks relating to shifts in biome distribution, loss of coral reefs, reduced crop productivity, adverse effects on livestock, vector- and water-borne diseases, under nutrition, and migration are assessed as either medium or high for the present under current adaptation, reflecting Africa's existing adaptation deficit.*

The issue is that the adverse biophysical impacts of climate variability and change on sustainable development of rural livelihoods are nowhere near reversal and abatement as the continent is incapacitated physically, socially and economically. Thus, adaptation, though being the common slogan the world over, is reported by the IPCC (2014) as being a challenge on the African continent. However, such critical issues need to be assessed from grassroots or local level so as to provide a clear picture on how to respond to the calamity. It is behind this assertion that the biophysical impacts of climate variability and change are examined at ward level, in this case Chadereka Ward 1 in Muzarabani Rural District being the study area.

IPCC (2014) in its report further affirms changes that are occurring in the distribution and transformations of all types of atmospheric, aquatic and terrestrial ecosystems in Africa. The impacts are compounded by the anthropogenic land use systems already alluded to which include the expansion of agricultural land, livestock pasturing and the extensive use of fuelwood. Yanda (2010) and Bola *et al*. (2014) ascertain the threat of climate variability and change on various species. Their assessment projects the idea of the 'survival of the fittest'. These authors further reveal that various species with higher rates of migration will survive the catastrophe of climate variability and change for some time. Plant species sensitive to reduced precipitation, especially in Southern Africa, will suffer extinction if no timeous corrective measures are taken to reduce the climate variability and change impacts (IPCC, 2014, Phiri *et al*., 2014). There is need to explore the impacts with regard to Muzarabani, a rural marginal areas prone to vulnerability even with the slightest change of climate. Thus, grass and shrubs with their short root development are projected to be more vulnerable as they lack resilience.

A further review on climate variability and change impacts on biophysical environment, with little attempt on adaptation, shows ever deteriorating conditions (Aberman *et al*., 2015). The impact was projected to negatively affect temperature and precipitation which are observed in their extremes (Basak *et al*., 2015; Bola *et al*., 2014). Temperature is projected to have increased by 2^0C from the levels of the late 20^{th} century (Muzamhindo *et al*., 2015). The authors further say that not all impacts are negative. The melting of ice due to increasing temperatures would create further land for agricultural expansion. Initially there would be increased growth rates and food conversion efficiencies which would be stressed as heat increases (IPCC, 2007). IPCC (2014) reports that there is going to be a worldwide marine redistribution of species with some areas experience a reduction in marine biodiversity. As such the sustainability of fisheries provisions and other ecosystems become questionable.

As another impact of climate variability and change on the biophysical environment, a reduction in renewable surface water and groundwater resources is projected particularly in the dry subtropical regions with a high confidence level (Aberman *et al*., 2015; Huq *et al.*, 2015; IPCC, 2014). In fact, drought and desertification are some of the extreme water related events which have been projected to affect the southern parts of the African region (IPCC, 2007; Madobi, 2014). The genetic structures of some animals are also going to be affected by climate variability and change phenomenon. An example is the changing mating periods for dominant and subordinate male elephants which are the wet and the dry seasons, respectively (Yanda, 2010). Increasing aridity therefore affects the production of high breed elephants as the conditions would only be favorable to the subordinate ones.

2.5.2 The Impacts of Climate Variability and Change on the Socio-economic Environment

The impacts of climate variability and change on the biophysical environment in the preceding section are not felt in isolation. Rather they are interrelated to and complimented by those of the socio-economic environment. Gukurume (2013), Muzari *et al*. (2014) and Nyantakyi-

Frimpong (2013) point out that increased drought/ rainfall variability in terms of intensity in sub-Saharan Africa of late has had negative consequences on smallholder farming activities across the continent. Bola *et al*. (2014) and Nkomwa *et al*. (2014) confirm that the frequent occurrence of droughts and floods in lower-lying areas of the African continent is generally a direct result of climate variability and change. These are heavily impacting on the livelihoods of the rural populace besides the natural environment as already reviewed (Phiri *et al*., 2014). The sustainability of such activities in the continent remains questionable and impaired. Huq *et al*. (2015) and the IPCC (2014) second that the impacts of climate variability and change are far reaching, disrupting food production and water supply. Infrastructure and some human and natural habitats are destroyed rendering some places inaccessible and inhabitable (Huq *et al*., 2015). Nhemachena (2014) further reveals that the phenomenon is leading to high rates of human morbidity and mortality as consequences of stress and psychological impairment. The impacts are worsened by lack of preparedness, unplanned and poor responses to such extreme natural events (IPCC, 2014).

Gukurume (2013) concurs with Yanda (2010) that climate variability and change is strongly felt by the rural poor with limited response capacity. In fact, most rural peasant farmers are confronted with food insecurity due to crop failure resulting from recurrent droughts and floods (Sango and Godwell, 2015b). In Bikita District of Zimbabwe, Gurukurume (2013) also reported death of livestock on top of low crop yields as a result of climate variability and change affecting the southern lowveld of the country. This is also affirmed by Debela *et al*. (2015), IPCC (2014) and Jiri *et al*. (2015a). Thus, localized studies provide details of the impacts. The current study on Chadereka Ward 1 facilitates comparison of the impacts given the almost similar geographical conditions. Such studies are correctional to the lack of data and literature on climate variability and change from the developing countries lamented by the Working Groups of the IPCC (2014).

Boko (2007) and Kirchner (2014) report on both positive and negative consequences of climate variability and change on the socio-economic environment. The reports suggest a reduction in cold-water mortalities of many aquatic life including valuable fish and shellfish species. Thus, aquaculture is promoted. Other benefits identified by the authors include reduced cost on icebreaking and opening of new routes for ship vessels, especially in latitudes which would experience ice melting due to increased temperatures. There would be more land for agricultural activities also known as agricultural extensification (Kirchner, 2014). Hobday *et* *al*. (2016) predict that flooding of coastal areas would displace millions of people, some currently occupying the areas in both the developing and the developed countries. Sea-level rise effects are reported to be differentiated according to the level of development (Hobday *et al*., 2016; Weatherdon *et al*., 2016). Thus, the developing countries will suffer the most, given their economic deficiencies (IPCC, 2014). Hobday *et al*. (2016) further suggest that loss of land will cost the Gross Domestic Product (GDP) of most coastal countries. Boko *et al*. (2007) confirm that the consequences of sea-level rise like protection costs will be far greater for developing countries relative to those for developed countries. Tourism, which is a source of revenue for many tropical countries, is hampered compounding further financial crisis in developing countries (Boko *et al*., 2007; Easterling *et al*., 2007).

Dube *et al*. (2016) and IPCC (2014) cited diversification of social networks and agricultural practices as a positive response to climate variability and change. In this regard, climate variability and change promote innovation as people try to craft responses to the perceived impacts. Climate variability and change has had impacts on “wealth and its distribution across society, demographics, migration, access to technology and information, employment patterns, the quality of adaptive responses, societal values, governance structures, and institutions to resolve conflict” (IPCC, 2014:56).

The IPCC (2014) projects that climate variability and change increase and create new risks for both natural and human systems. The severity of the impacts is wealth selective - having the weak and marginalized people suffering the worst consequences (Costantini *et al*., 2016). Other socio-economic impacts are observed on broken down infrastructure network such as roads, bridges, telecommunication and other critical services being experienced in remote and marginal areas (Kongsager *et al*., 2016). Such is to be analyzed in the case of Chadereka Ward 1.

Yanda (2010) observed that inhabitants of coastal, semi-arid and arid areas, especially in developing countries are more vulnerable to a wide range of health effects due to climate variability and change. The health impacts are exacerbated by extremes of climate events like drought and floods (Gerlitz *et al*., 2016). When each of these phenomena occurs, food shortage is experienced leading to undernourishment, kwashiorkor and other food deficiency related diseases. Malaria, vectors, pests and climate related diseases have become ubiquitous and localized due to climate variability and change. The widespread poverty and over-reliance on rain-fed agriculture compound further the impacts of climate variability and change on already stressed people (Gukurume, 2013). Alade and Ademola (2013) note a decrease in poultry production due to pests and diseases resulting from climate variability and change.

The IPCC (2007) asserts that even though Africa's production of greenhouse gas emissions is minimal, it would be the most affected by climate variability and change. Climatic conditions, specifically rainfall and temperature, adversely affect agriculture which is mainly rain-fed in the region (Molnar, 2010; Moyo *et al*., 2012; 2016). Internationally, the existence of conventions like the UNFCCC since the early 1990s spells the gravity of the whole climate change issue (IPCC, 2007; Government of Zimbabwe, 2012; 2013). On-farm activities constitute the principal rural livelihoods in Chadereka Ward I, the study site in Muzarabani Rural District of Zimbabwe. Thus, according to Cooper *et al*. (2008) and Butterfield *et al*. (2008), the livelihoods are pivoted directly on the natural environment. The purpose of this study is to assess the rural livelihoods in terms of their sustainability in the selected Ward. Data on climate variability and change, which is lacking particularly at the micro scale, is still needed in an endeavor to promote locally-based adaptation strategies (Gerlitz *et al*., 2016).

Manyeruke *et al*. (2013) further analyzed the socio-economic impacts of climate variability and change in Zimbabwe. These authors together with Mugi-Ngenga et al. (2016) reaffirm that African agriculture is really sensitive to climate change. Thus, Bob and Babugura (2014), Rurinda *et al*. (2014) and Umunakwe *et al*. (2014) confirm that the socio-economic vulnerability of Africa to climate variability and change is grounded on its reliance on rain-fed agriculture for both domestic and small agricultural export earnings, increased poverty levels, low socio-economic and physical capital, devastated infrastructure and the entire use of traditional technology. A 50% decline is agricultural output is projected for Africa by the year 2020 endangering food security on the continent (Gukurume, 2013; Manyeruke *et al*., 2013). This is due to water scarcity and the alteration of the natural ecosystem by climate variability and change. As Manyeruke *et al*. (2013) point out, in Zimbabwe agriculture contributes 15-20% of the GDP, 40% and 60% of exports and domestic industrial raw materials, respectively. Hence, the impact of climate variability and change on this economic sector is a major setback to sustainable development of the country (Muzamhindo *et al*., 2015; Muzari *et al*., 2014). Gukurume (2013) observed the damage of crops by heat waves at their critical stage of maturation, a situation which compounded food insecurity profiles of farmers in Bikita.

Niang *et al*. (2014) suggest impacts of climate variability and change on human rights in Africa. Endless debates on responsibilities of each block of countries, developed and developing, towards adaptation and mitigation include human rights issues. The insufficient support by the developed world in promoting mitigation and adaptive strategies in the developing countries whose majority are poor exacerbates the impacts. This also hinders the progress and achievements by the MDGs currently the SDGs (Niang *et al*., 2014). Climate variability and change has devastating impacts on the well-being of individuals and communities as the poverty levels continue escalating unabated (Bob and Babugura, 2014; Gukurume, 2013).

Milan and Ho (2014) and Suckall *et al*. (2015) observed that climate variability and change leads to increased migration which in turn causes human suffering like the case of xenophobia in South Africa. Mares and Moffett (2016) further suggest that human rights are violated as climate variability and change refugees are turned away. Political instability and conflict also arise (Gerlitz *et al.,* 2016; Yanda and Bronkhorst, 2011). Climate variability and change do not impact society in isolation. Rather it affects in unison with other forces. Mares and Moffett (2016:297) even suggest that "climate change may acutely increase violence in areas that already are affected by higher levels of homicides and other social dislocations". Gerlitz *et al*. (2016) and Madobi (2014) discussed the ignition of domestic, national and regional conflicts over scarce resources like fresh water and arable land. The global economic crisis limiting the expansion of livelihoods options and widespread poverty skewed generally towards the marginalized people is yet another problem (Niang *et al*., 2014). The ideas by most developing countries to redressing the imbalances of land after independence have left some disgruntled. Some land is no longer productive due to increased aridity (Dube *et al*., 2016).

Demographically, climate variability and change impacts are felt in relation to the excessive increases in population. It is projected that by "2050 the population would have tripled reaching 3 billion from 1 billion on the African continent" (Niang *et al*., 2014:1211). In addition, the vulnerability to the effects of climate variability and change is strongly felt by women and children who are generally responsible for rain-fed smallholder farming in the developing world in general (AfDB *et al*., 2010; Bob and Babugura, 2014; Swain, 2011). AfDB *et al*. (2010) further note the loss of formal employment for able-bodied men and women, and the scramble for the informal sector as the global financial crisis deteriorates further due to climate variability and change. Climate variability and change has even affected the calendar year for most the economic activities done at the local level (Bola *et al*., 2014).

Commodity specific analysis of the impacts of climate variability and change on agriculture, according to Niang *et al*. (2014), depict that tree crops (coffee, tea and cocoa) in Kenya and Uganda portray increased suitability at high latitudes while cotton in Ghana and Côte d'Ivoire is decreasing. This is directly caused by variations in temperature and precipitation, key elements of climate variability and change. In Bangladesh, Basak *et al*. (2015) report the death of many commercial and indigenous trees due to climate-induced floods which rre affected by water-logging. Further, Basak *et al*. (2015) note loss of investment, biodiversity and a drawback on the afforestation program.

The livestock system is reported to be stressed by a multitude of climate variability and change related forces (Wang *et al*., 2016). Niang *et al*. (2014) isolated rangeland degradation, water scarcity, fragmented grazing areas, sedendarization, land reform systems, cropland extensification, lack of opportunities to diversify livelihoods, conflict and political crises, unreliable social safety nets (also highlighted by Hanna and Oliva, 2016), and insecure access to land and markets, among other resources, as livestock stressors. Thus, the underlining projection is a further decrease in livestock globally. Crop and livestock production disturbances due to climate variability and change directly affect food security in Africa (Piya *et al*., 2016; Yanda, 2010).

Urbanization and its associated challenges are also reported to be fuelled by climate variability and change (Suckall *et al*., 2015). This is mainly due to rural-urban migration as people move to towns for better employment opportunities (Gray and Wise, 2016; Milan and Ho, 2014; Niang *et al*., 2014). Given that urban local governments are projected not to have the capacity to cope with rural-urban movement pressure, Niang *et al*. (2014:1225) observe the challenge "to climate-proof infrastructure that is not there". Already there existed urban problems before the issue of climate variability and change. Thus, the situation is compounded by the current phenomenon of climate variability and change. Urban authorities are confronted with a plethora of problems due to inappropriate regulatory structures and mandates; poor or no urban planning; unavailability of data; no planned disaster risk reduction strategies; lack of proper servicing and infrastructure development (particularly waste management and drainage); uncontrolled settlement (slums) on high-risk areas like floodplains, wetlands, and coastlines; ecosystem degradation; competing development priorities and timelines; and lack of coordination among government agencies or sectors (Adu-Boateng, 2015; Gray and Wise, 2016; Kundzewicz *et al*., 2014; Milan and Ho, 2014). All these spell a potential disaster for

African cities with respect to climate variability and change. However, Suckall *et al*. (2015) and Swai *et al*. (2012) also note out-migration of males in search of food to feed families in the period of shortages caused by climate variability and change. They are engaged as casual labor or exchange various family possessions with food. In such scenarios women are left taking care of children, further compounding their burden.

There are more challenges than opportunities regarding climate variability and change impacts (Bongo *et al*., 2015). An overview of these impacts is critical in guiding policy planners to transcend in their activities cautiously thereby avoiding uninformed decisions. The impacts discussed form the basis for further comparison with experiences at the local level like Chadereka Ward 1, the current study area. Being a marginal area, published literature on the outcomes paves the way for critical assessment and monitoring as efforts to reduce the impacts are presented.

Current and possible future socio-economic impacts and vulnerabilities associated with climate variability and change for African Regions based on models were noted by Boko *et al*. (2007). In relation to Southern Africa, the following were highlighted:

- Assessments of water availability, including water stress and water drainage, show that parts of southern Africa are highly vulnerable to climate variability and change. Possible heightened water stress in some river basins.
- Southward expansion of the transmission zone of malaria may likely occur.
- By 2099, dune fields may become highly dynamic, from northern South Africa to Angola and Zambia.
- Some biomes, for example, the Flyboys and Succulent Karoo in southern Africa, are likely to be the most vulnerable ecosystems to projected climate changes, whilst the savanna is argued to be more resilient.

There is need to examine such impacts with reference to Chadereka Ward 1, Muzarabani Rural District in Zimbabwe.

2.6 ADAPTATION STRATEGIES TO CLIMATE VARIABILITY AND CHANGE

Given the momentous and irrevocable effects of climate variability and change on the biophysical and socio-economic environments, a focus on adaptation strategies to assist and advise the global society on sustainable practices to the calamity is increasing (Lacey *et al*., 2015; Klostermann *et al*., 2015; Noble *et al*., 2014). Numerous literature on this issue has been published at different scales: local, national, regional and global (Dannevig and Hovelsrud, 2016; Jiri *et al*., 2015b; Katanha and Chigunwe, 2014; Kayigema and Rugege (2014); Shemdoe *et al.*, 2015; Simatele and Simatele, 2015). Consideration, assessment and analysis of such data is critical in building local and national adaptation strategies as the climate variability and change debate has turned international. This section is set to critically examine adaptation strategies in use at various scales so as to identify the gaps and acknowledge the ones that may be of help to the geographical characteristics of the study area. This review is divided into sub-sections each focusing on the identified scales. Before the subsequent discussion as suggested, a revisiting of the concept of adaptation strategies is paramount.

Noble *et al*. (2014), Sango and Godwell, (2015a) and Tompkins *et al*. (2010) refer to adaptation strategies as a collection of options that are considered helpful and essential in circumventing an environmental problem like climate variability and change. In this case the concept encompasses long-term actions done by societies in a way to eliminate or reduce the climate variability and change negative impacts. Park *et al*. (2009), Wheeler (2013), Kale (2013) and Yegbemey *et al*. (2014) examine this concept as discussed in sub-section 2.2.4. What is of interest is the classification of adaptation into incremental and transformational, and also the noted differences between the concept and mitigation as provided by Twomlow *et al*. (2008). They further typified the concept of adaptation to climate variability and change as passive, reactive or anticipatory. These characteristics form the referral points as livelihood adaptation strategies to climate variability and change impacts in this research are reviewed. Tompkins *et al*. (2010) further define adaptation strategy as a phenomenon involved in risk and vulnerability reduction. Bhatta *et al*. (2015) suggest that adaptation strategy involves planning and is a process which is more continuous. It tries to consider capacity building from local to global and the restoration of natural systems as a way of coping with climate variability and change. Belachew and Zuberi (2015) also stress that local participation is crucial in fostering climate variability and change policy and project designing.

Table 2.1: Categories and examples of adaptation strategies/ options (adapted from Noble *et al*., 2014:845)

Category of Adaptation		Example of Adaptation Strategy or Option
Structural/ physical	Engineered and built environment	Water storage; sewage works; improved drainage; flood and cyclone shelters; building codes; storm and waste water management; transport and road infrastructure adaptation; adjusting power plants and electricity grids.
	Technological	New crop and animal varieties; traditional technologies and methods; efficient irrigation; water saving technologies; conservation agriculture; food storage and preservation facilities; hazard mapping and monitoring; early warning systems; renewable energy technologies.
	Ecosystem based	Ecological restoration; increasing biological diversity; afforestation and reforestation; bushfire reduction and prescribed fire; assisted migration or managed translocation; ecological corridors; ex-situ conservation and seed banks; community-based natural resource management (CBNRM); adaptive land use management.
	Services	Social safety nets and social protection; food banks and distribution of food surplus; municipal services; vaccination programs; essential public health services.
Social	Educational	Awareness raising and education; gender equity; extension services; sharing local and traditional knowledge; participatory action research and social learning; community surveys; knowledge-sharing and learning platforms.
	Informational	Hazard and vulnerability mapping; early warning and response systems; systematic monitoring and remote sensing; climate forecast services; longitudinal data sets; integrating indigenous climate observations and community-based adaptation plans.
	Behavioral	Accommodation; household preparation and evacuation planning; retreat and migration; soil and water conservation; livelihood diversification; changing livestock and aquaculture practices; crop-switching; changing cropping practices, patterns, and planting dates; silvicultural options; reliance on social networks.
Institutional	Economic	Financial incentives; insurance; catastrophe bonds; revolving funds; payments for ecosystem services; water tariffs; savings groups; microfinance; disaster contingency funds; cash transfers.
	Laws and Regulations	Land zoning laws; building standards; easements; water regulations and agreements; laws to support disaster risk reduction; laws to encourage insurance purchasing; defining property rights and land tenure security; protected areas; marine protected areas.
	Government policies and programs	National, sub-national, regional and local adaptation plans; urban upgrading programs; municipal water management programs; disaster planning and preparedness; city-level district-level and sector plans.

The dimension of this research is to reveal tangible livelihood adaptation strategies being implemented in Chadereka Ward 1 in Muzarabani Rural District. Table 2.1 summarizes in general adaptation strategies to climate variability and change given in different categories. The categories and adaptation strategies or options presented in Table 2.1 are not comprehensive. Rather this may be one of the many ways of examining how societies are adapting or responding to climate variability and change impacts. The categories and the adaptation options do not operate in isolation per sector. Some nations have developed National Adaptation Strategies (NASs) like the European Union member countries (Klostermann *et al*., 2015) while others call them National Adaptation Program of Actions (NAPAs) (Kongsager *et al*., 2016). As the European Commission (2009 cited in Noble *et al*., 2014:845) put it, several of these adaptation strategies are referred to as “green infrastructure”. Societies respond to climate variability and change impacts differently given the differences in the manner in which they are affected by the phenomenon. The potential livelihood adaptation strategies to climate variability and change in Muzarabani are examined considering the already published categories and options in this research. The adaptation options give room to further probe challenges and stakeholder roles in executing activities to do with climate variability and change impacts reduction in the case of Chadereka Ward 1. From the presentation, a further classification of adaptation strategies into structural and non-structural dimensions can be deduced.

2.6.1 Global and Regional Adaptation Strategies to Climate Variability and Change

Kupika and Nhamo (2016), Madobi (2014) and Somorin (2010) claimed that the fundamental environmental threat facing the world currently is climate variability and change. Niang *et al*. (2014) further reveal that Africa’s contribution to anthropogenic global emission of greenhouse gases is relatively small. However, the continent remains the most vulnerable to the impacts of climate variability and change (Madobi, 2014; Mandryk *et al*., 2015; Molnar, 2010). Mandryk *et al*. (2015) have attributed the vulnerability to Africa’s low human adaptive capacity coupled with a heavy reliance on rain-fed agriculture. Africa’s consequent rising widespread poverty, lack of economic and technological resources, insufficient safety nets and educational progress as cited by the IPCC (2014) further compound the situation of vulnerability and maladaptation to climate variability and change.

Globally, conferences like the UNFCCC and Conference of Parties (COP), and treaties such as the Kyoto Protocol deliberate on how society should respond to climate variability and change

(Kyoto Protocol, 2012; UNFCCC, 2011). The main agenda on these international summits is to map ways towards climate change mitigation and adaptation. Thus, the Kyoto Protocol called for the reduction of greenhouse gas emissions the principal driver for climate change (Kiuila *et al*., 2016; Kyoto Protocol, 2012). Surminski *et al*. (2016) made reference to COP21 of Paris where climate risk insurance adaptation strategy was debated. On one occasion, the Southern African Development Community (SADC) member nations were summoned to support the Regional Action Plans for adaptation to climate change as a way of promoting agriculture in the region since it is our only way of withstanding food insecurity (Manyeruke *et al*., 2013). IPCC (2014) and Manyeruke *et al*. (2013) elaborate on adopting proactive practices in a way to reduce climate variability and change impacts. With the current development in technology to forecast and monitor weather events, adaptation initiatives such as improved crop varieties, water management systems or infrastructure like irrigation canals and coastal dykes are enhanced (Kongsager *et al*., 2016). The uses of remote sensing devices improve climate monitoring and early warnings on climate-related hazards (Klostermann *et al*., 2015). In Central and Southern America, particularly Mexico and Argentina, adaptation initiatives have gone further to include the creation of commodity stocks as economic reserve, the spatial separation plots for cropping and grazing, diversification of income through livestock disposal, provision of crop insurance and creation of local financial pools (micro-finance) as an alternative to commercial crop insurance (IPCC, 2014).

Asian countries like the Philippines are encouraging drought resistant crops, use of shallow tube wells, rotational irrigation method in times of water scarcity, construction of water harvesting basins, construction of fire guards and monitored burning. In other countries affected by flooding, early flood warning systems, the strengthening of dikes and evacuation of victims are adaptive mechanisms encouraged (Bhatta *et al*., 2015; Kundzewicz *et al*., 2014). Lin *et al*. (2016) observe China's adaptation actions to include the construction of agricultural infrastructure and farmland water conservation technologies, the renovation of supporting facilities, the promotion of dry farming and the upgrading of irrigation zones, among other actions. In the case of sub-Saharan Africa, small-scale irrigation has been confirmed to increase crop productivity (Kamwamba-Mtethiwa *et al*., 2016). The adoption of soil and water management systems for upland farming, rainwater harvesting, leakage reduction and hydroponic farming contribute greatly to climate variability and change adaptation in the region (Bhatta *et al*., 2015). Lyle (2015) posits that in order to maintain agricultural regions facing climate change viable, there is the need to adopt technological innovations or new practices that reinforce the present system and/ or to consider the long-term transformational change with the idea of introducing strictly new land use practices to replace those overtaken by the climate variability and change events. Lyle (2015) again affirms that since the impacts from climate variability and change are scale specific (farm or region), so should be the adaptation strategies currently and in future. Thus, the author supports the use of the case study approach in dealing with these adaptation strategies to climate variability and change issues. Each specific area is embedded in its own unique opportunities and challenges as well as farm and farmer management differences.

Gerlitz *et al*. (2016), Kashaigili *et al*. (2014) and Mishra *et al*. (2012) identify the different adaptation strategies in the Himalayan region such as mobility, diversification, depending on natural resources, market exchange and reducing consumption and other social obligations. Earlier on, Gukurume (2013) noted that policy responses to climate variability and change should promote innovative ideas from individuals and communities and retain the principles of equity and social justice. Bob and Babugura (2014) add that gender as an important aspect of development should also be integrated in this adaptation debate. By so doing the longevity or sustainability of the adaptation strategies would be enhanced.

Mishra *et al*. (2012) further ascertain that the practical adaptive capacity to climate variability and change is dependent upon socio-economic facets like wealth, technology, education, traditional knowledge, information, skills, infrastructure, access to resources and management capabilities, which are the capitals or assets (economic, social, human, physical and natural) as promulgated by Scoones (2009). Furness and Nelson (2016) and Niles *et al*. (2016) further added attitudes, values and belief as other important determinants of adaptive capacity. The adaptation strategies can also follow the bottom-up or top-down, reactive or predictive, autonomous or planned principles. Furthermore, critically examining adaptation strategies to climate variability and change, Mishra *et al*. (2012) observe that the generation and dissemination of climate information and the execution of informed action are the indispensible ingredients to the success of the whole activity.

Molnar (2010) and Toole *et al*. (2016) note the ever increasing vulnerability to climate variability and change of developing countries due to high levels of degradation of natural resources and the use of inappropriate technologies. Aberman *et al*. (2015) further suggest that vulnerability to climate change impacts is exacerbated by over-reliance on natural resources for livelihoods. Capacity to adaptation is worsened by the limited and insecure asset base for individual households (Aberman *et al*., 2015). As such, Molnar (2010) reiterates that adaptation to climate variability and change remains a challenge within the tropics and subtropics where the majority of developing countries are located. Molnar (2010:8) declares, "capacity building must be integrated into adaptation measures for sustainable agricultural development". The summative call here is for human skills development.

According to Juana *et al*. (2013), acknowledging various authors in sub-Saharan Africa, arable farmers are adapting to climate variability and change through various mechanisms. These include the planting of low water-requirement crops and those of short duration in flood prone areas. The planting and harvesting time are changing (Niles *et al*., 2016). Musiyiwa *et al*. (2014) propose intensification of agriculture and the use of stress tolerant crops as adaptation strategies in some Zimbabwean agricultural regions. Below *et al*. (2012) categorized adaptation strategies into those linked to agricultural water management, of farm and crop management adjustment and the diversification on and beyond the farm. Some farmers in Southern Africa and parts of East Africa are developing water conservation methods such as water harvesting, waste water re-use in agriculture and crop irrigation (Gandure *et al*., 2013). The authors further point out that in southern and some parts of East Africa the farmers are switching from arable crop farming to livestock farming. More boreholes in drier regions of sub-Saharan Africa are being sunk (Gandure *et al*., 2013; Granderson, 2014). Further, off-farm income generating activities and destocking through selling or slaughtering during prolonged drought periods and restocking afterwards are other adaptation mechanisms being employed in the sub-region (Gandure *et al*., 2013; Granderson; 2014). Such adaptation strategies were also discussed by Muzamhindo *et al*. (2014).

These practices are not exhaustive as vast literature exists on this issue of adaptation to climate variability and change Brown *et al*. (2016). Somorin (2010), for instance, identified farmer informed resource management practices like the growing of short seasoned crop varieties, selective livestock rearing and introduction of new technologies conversant with the current climatic conditions. Some ongoing projects in support of the adaptation strategies have been identified by Somorin (2010) which include building adaptive capacity to cope with increasing vulnerability due to climatic change being done in Zambia and Zimbabwe and is still in progress. Wang *et al*. (2016) classify adaptation strategies into mobility, storage, livelihood diversification, communal pooling, and market exchange. These and others are assessed in the case of Chadereka Ward 1.

2.6.2 Selected Countries' Adaptation Strategies to Climate Variability and Change

Country specific adaptation strategies to climate variability and change provide details for comparison, simulation and engagement by countries in similar peril. Wheeler *et al*. (2013) focused on incremental adaptation as they considered adaptation to climate variability and change in Australia. This kind of adaptation, as Wheeler *et al*. (2013) rightly indicates, involves the adoption of actions free from major decisions or information. In the Murray-Darling Basin (also called the Basin) in Australia, Wheeler *et al*. (2013) established that incremental adaptation to climate variability and change is done considering the expansive strategy (a focus on increasing efforts and production), the accommodating strategy (the one that tolerate change through engaging in more efficient infrastructure and changing crop mix) and the contractive strategy (which spells effort and resource ownership reduction). In all the adaptation strategies, Wheeler *et al*. (2013) emphasized the role of planning. It can be understood from these strategies that adaptation to climate variability and change is not all about expanding or contracting hectrage but to also use natural and socio-economic resources effectively and efficiently, thereby diversifying activities. Thus, irrigation is an effective adaptation strategy in Australia.

Berkhout *et al*. (2015) note that for the European Union, mainstreaming climate adaptation into its policy is possible when members develop a shared concern about the risks posed by climate. They also indicate that members should have have a high-level of political will to respond to the risks and agree on 'hard' instruments (like mandates). Furthermore, they state that members need to embrace 'win–win' prospects (meeting today's needs at the same time maintaining sustainability for the future) for infusing or linking climate with other policy goals. The authors further observe variability and lack of seriousness in the implementation and decision-making on these issues by member states. However, best efforts have been put towards fostering a low carbon economy (mitigation) though there is still a need to take radical steps to achieve climate resilience in major key domains like agriculture, biodiversity and infrastructure (Berkhout *et al*., 2015; Hanger *et al*., 2015). The incremental and technocratic or transformative approaches to adaptation in the European Union still need to be considered critically to allow global commitment towards climate resilience.

In Tanzania, Below *et al.* (2012) identify the need to invest in rural infrastructure, the need for unveiling and efficiently using inputs and the need for a good education system which mainstreams gender in adaptation strategies as discussed by Bob and Babugura (2014). This implies that social and human capitals are strengthened. Saha and Bahal (2010) presented several adaptations to climate change in West Bengal. Furthermore, in sub-Saharan Africa a number of researchers have also focused on climate variability and change. Juana *et al*. (2013) review climate variability and change adaptation strategies practiced in selected countries in sub-Saharan Africa. The main adaptation strategies identified in Zimbabwe were using different crop varieties, crop diversification, and changing planting dates; switching from farm to non-farm activities; and increasing the use of irrigation, water and soil conservation techniques. These techniques were also identified by Chanza and De Wit (2016). Additional strategies identified which were also noted by the Government of Zimbabwe (2012; 2013) were rearing goats and sheep as opposed to beef cattle and chicken as well as using forest products. Of late, regional migration of both animals and people as a consequence of climate variability and change has increased facilitating trade in the process as cited by Gray and Wise (2016) and Suckall *et al*. (2015).

2.6.3 Adaptation Strategies to Climate Variability and Change in Zimbabwe

Adaptation strategies to climate variability and change in Zimbabwe can be reviewed considering selected sectors which are the agricultural, biodiversity, water resources, health, human settlement and tourism sectors as discussed in the Zimbabwe's National Climate Change Response Strategy (Government of Zimbabwe, 2015). These guide further discussions on the issues in the study area.

2.6.3.1 Agricultural Sector

Agriculture is a fundamental rural livelihood in all the developing countries of the world constituting over 50% of the GDP (Katanha and Chigunwe, 2014; Mugi-Ngenga *et al*., 2016, Sango and Godwell, 2015b; Suckall *et al*., 2015). It is the most vulnerable to climate variability and change as the activity is reliant mainly on natural rainfall (Government of Zimbabwe, 2015). Jiri *et al*. (2015a) and Muzamhindo *et al*. (2015) reaffirm the eminent need of developing moisture conservation technologies as one of the adaptation strategies in Zimbabwe. Engaging in the growing of short seasoned varieties of maize, moisture deficit tolerant crops like the small grains (pearl millet, finger millet and sorghum) and proper farm management are key strategies to agricultural development (Katanha and Chigunwe, 2014; Rippke *et al*., 2016).

Zimbabwe is encouraging dam construction so as to promote irrigation, particularly in most dry regions (Government of Zimbabwe, 2015). Traditionally, mixed crop and livestock farming had been doing well and should be promoted as revealed by Ncube *et al*. (2016).

2.6.3.2 Biodiversity Sector

As most negative impacts of climate variability and change on the biophysical sector are likely to be felt in the southern, western and extreme northern parts of Zimbabwe, the call for biodiversity management strategies to maintain and restore the ecosystem is widespread (Government of Zimbabwe, 2015; Mafongoya *et al*., 2016). Such strategies include a reduction in the rampant human extraction of resources like land, vegetation and water coupled with controlled veld fires. Most of these marginal areas are the ones which had been reserved for wildlife and that is where the game parks, sanctuaries and safaris are located (Madobi, 2014; Musiyiwa *et al*., 2014). However, some of these have been slowly turned into habitable places for people due to ever increasing population in the country (Muzari *et al*., 2014; Rurinda *et al*., 2014). The protection and reservation of areas for biodiversity need reinforcement or strengthening of rules and regulations as observed by Bhatta *et al*. (2015) and Kupika and Nhamo (2016). Actually, where this is properly done, there is increased carbon sequestration process which reduces and mitigates climate variability and change impacts (Dube *et al*., 2016).

Net Primary Production (NPP) (total organic matter found at a place and time) indicates rangeland health (Government of Zimbabwe, 2015) which supports livestock and wildlife systems. As climate variability and change impacts continue unabated, NPP is dwindling reducing the carrying capacity of rangelands (Dube *et al*., 2016). The adaptation strategy as it stands is to shift to small livestock like goats (Dube and Phiri, 2013), the reduction in the heads of livestock and the provision of supplementary feeds as well as mixing livestock with wildlife in the range land (Otieno and Muchapondwa, 2016). Climate variability and change comes accompanied by diseases, thus the Oxfarm (2015) and Government of Zimbabwe (2015) suggests improved disease surveillance mechanisms. Above all mainstreaming of adaptation into sectoral planning is of paramount importance as an adaptive strategy (Niang *et al*., 2014).

In another source, the IPCC (2014) suggests that options for ecosystems adaptation to climate variability and change are scant, coupled with uncertainty in terms of their effectiveness. For biodiversity therefore available strategies include erection of migration corridors for ecosystems, land use management (Juana *et al*., 2013), and rehabilitation of degraded areas (biologically planting vegetation and mechanically restoring gullies and sand scooping from silted rivers) (Kupika and Nhamo, 2016).

2.6.3.3 Water Sector

Zimbabwe as a land locked country relies directly on water that comes as rainfall which then sinks into the ground and some flows in the natural river systems (Government of Zimbabwe, 2015). During the off rain season, Phiri *et al*. (2014) note that the only sources of water are the underground reservoirs in wells and boreholes and the few dams constructed throughout the country. As adaptation measures to water scarcity, in Zimbabwe the construction of more dams and efficient use of water in the irrigation sector are being encouraged (Muzari *et al*., 2014). Mugi-Ngenga *et al*. (2016) also observed similar water management practices in Kenya.

2.7.3.4 Health Sector

Climate variability and change impacts are also assessed by incidences of some human and livestock diseases (Filho *et al*., 2016; Mellor *et al*., 2016; Rurinda *et al*., 2014). Singh *et al*. (2016) observe that usually inhabitants of developing countries rely on government responses for adaptation since they lack financial capital and the political power to initiate individual strategies. As such most programs rests on the resources of the state. For instance, the Government of Zimbabwe (2015) and Muzari *et al*. (2016) indicate that the geographical distribution and transmission of disease vectors like malaria significantly correlate with temperature and rainfall. Therefore, malaria is more concentrated in the southern and northern lowveld with high temperatures in which the study area is located (Dodman and Mitlin, 2015). As such, the government promotes and supports disease control programs done in collaboration with the NGOs

Wu *et al*. (2016) discuss disease prevention and control programs to be done effectively in African countries. They further suggest that better drainage, reforestation, desalinization and infrastructure development can help minimize the impacts of climate variability and change. Spraying programs and malaria campaigns are some of the adaptation strategies done by the Ministry of Health and Child Welfare in Zimbabwe being supported by the World Health Organization (WHO) (Brown *et al*., 2012; Chagutah, 2010). Other diseases such as cholera, typhoid, bilharzia and diarrhea are water borne and increase during flood periods which are being addressed through integrating sustainable water development and management into national strategies (Government of Zimbabwe, 2015; Muzari *et al*., 2016). Increasing infrastructure in terms of clinics and roads to health service centers are other critical strategies to pursue (Government of Zimbabwe, 2015).

2.6.3.5 Human Settlement and Tourism Sector

As an agro-based country, Zimbabwe experiences a decline in agricultural production due to climate variability and change impacts (Muzari *et al*., 2016; Government of Zimbabwe, 2015). A decrease in agricultural yields propels outmigration from the rural areas towards urban areas (Dodman and Mitlin, 2015) compounding the situation as in Peru (Milan and Ho, 2016). Thus, the receiving urban centers like Harare and Bulawayo run short of water, accommodation and other services (Adger *et al*., 2015; Angula and Kaundjua, 2016; Suckall *et al*., 2015). In the human settlements discussion critical issues include the rural communities and their livelihood options (Kongsager *et al*., 2016; Martin *et al*., 2016; Muzari *et al*., 2016; Sango and Godwell, 2015b) and health aspects (Singh *et al*., 2016; Umunakwe *et al*., 2014; Wu *et al*., 2016) in respect to climate variability and change. In Zimbabwe malaria is prevalent in the rural settlements of the low veld as already highlighted in the preceding section. The concern for this section is to consider the adaptation measures in such rural settlements known to have low adaptive capacity (Government of Zimbabwe, 2015).

Dam construction to aid irrigation schemes and the growing of drought tolerant crop varieties are fundamental intervention strategies to climate variability and change impacts in rural settlements (Chagutah, 2010). Dube *et al*. (2016) and Muzari *et al*. (2016) suggest natural resource use in building settlements and trade in wild products as important adaptation measures in drought and flood prone areas. The Government of Zimbabwe (2015) further alludes to the development of early drought and flood warning systems in addition to water recycling. Solar energy usage is considered critical in reducing fuelwood usage and the over-reliance on non-renewable energy sources like diesel for powering irrigation engines (Kaya and Chinsamy, 2016; Nyamadzawo *et al*., 2015). A close assessment of these and other adaptive measures is paramount is the case of Chadereka Ward 1. Of interest is also to explore the policies and regulations regarding the location of settlements, their design, codes and standard of the buildings (Government of Zimbabwe, 2015).

Common adaptation strategies pursued in Zimbabwe include crop and livestock management, water management, and diversification of livelihood activities (Chikodzi and Mutowo, 2014; Gukurume, 2013; Jiri *et al.*, 2015a; Muzamhindo *et al.*, 2015; Rurinda *et al*., 2014; UNDP, 2013). Agroforestry, conservation farming, hiring labor, donations and local weather forecasting systems are also important strategies practised in most parts of the country. The major constraints identified include shortage of resources, overuse of common pool resources, natural hazards like diseases and pests, inadequate access to credit facilities, tenure insecurity and lack of knowledge and extension services (Chatutah, 2010; Chikodzi and Mutowo, 2014; Gukurume, 2013; Jiri *et al.*, 2015a; Rurinda *et al*., 2014; UNDP, 2013). These adaptation strategies and challenges are examined in the case of Chadereka Ward 1.

2.7 CONSTRAINTS IN ADAPTATION TO CLIMATE VARIABILITY AND CHANGE

Generally, adaptation to climate variability and change in developing countries is greatly constrained for it involves action on shorter time scales rather than longer ones giving rise to numerous immediate development challenges (Hansen *et al*., 2007; Katanha and Chigunwe, 2014; Kaushik and Sharma, 2015). The capitals or assets (natural, social, financial, human and physical) which form part of the livelihood framework present some constraints as communities engage in adaptation strategies (Rurinda *et al*., 2014).

Klein *et al*. (2014) define a constraint as a factor or a process which makes it difficult to execute any activity as expected. Contextually, this refers to all the barriers, obstacles or challenges to climate variability and change adaptation planning and implementation. These can be classified as those that reduce adaptation options, those that increase cost of adaptation and those that reduce the efficacy of selected options in terms of meeting the adaptation goals (Klein *et al*., 2014). Further, the authors exemplify the constraints as lack of resources (financial, technology or knowledge), lack of institutional commitment and support or poor environmental management of ecosystems. Adaptation capacity to climate variability and change is dependent upon different stakeholders' willingness, sectors and geographical regions (Adger *et al*., 2003; Alfieri *et al*., 2016; IPCC, 2014; Kneil *et al*., 2014; Kaushik and Sharma, 2015). This poses varied constraints resulting from the distinction. This also implies that the constraints can be socio-economic, political as well as biophysical. For this research the biophysical, socio-economic and political/ institutional challenges are presented in the subsequent sub-sections.

Worth noting is that while the various constraints are debated independently as factors affecting the adaptive capacity at different places, these do not act in isolation (Chitende, 2013; Kneil *et al*., 2014). Thus, in this review, the identification of the constraints in different environments is discussed.

2.7.1 Biophysical Constraints in Adaptation to Climate Variability and Change

Nature has a tendency of restoring itself with minimal disturbance from anthropogenic activities (Muzari *et al*., 2016). Currently, the natural environment, with little or no interference from human activities rarely exists unless it is extremely inaccessible (Ashley and Hussein, 2000; Bhatta *et al*., 2015; Muzari *et al*., 2016). Technology has since made almost all places and every resource accessible. Thus, human-induced constraints are dominant in the biophysical systems. Conway and Schipper (2010), Rurinda *et al*. (2014) and Niles *et al*. (2016) identified increased incidences of pests and diseases as a constraint affecting livestock production which is an adaptation strategy in most places where crops are affected by drought.

Natural systems, being critical in household adaptation to climate variability and change in developing countries, are often constrained by non-climatic physical factors. For instance, the migration of some animal and plant species as climate change intensifies is barred by the geographical physical features like rivers or coastlines and lack of enough height to migrate upwards (Kneil *et al*., 2014). Mafongoya *et al*. (2016) further establish soil properties as hindering adaptation as well. The factor of soils (Rurinda *et al*., 2014) is compounded by the deplorable quantity and quality of water due to climate variability and change. Agricultural adaptation strategies to climate variability and change are thus turned theoretical as most communities particularly in developing countries lack the capacity to manage and address soil and water issues properly.

Some biological properties affect adaptation, acclimation and behavior of some organisms to climate variability and change (Otieno and Muchapondwa, 2016). Migration among non-human species as an adaptive strategy is associated with some biological properties like fecundity, phenotypic and genotypic variations, rates of dispersal, and interspecific interactions (Kneil *et al*., 2014). These therefore inhibit the movement and the species succumb to climate variability and change.

The other biophysical constraint comes with the rate at which the physical environment is being degraded. While natural capital is considered a pillar for sustainable livelihoods, Brown *et al*. (2012) and Goulden *et al*. (2013) suggest that the ecological systems are feared to be reducing its resilience to climate variability and change. There is substantial evidence which reveal the rates at which coral reefs, marine ecosystems, tropical forests, coastal wetlands and underground water are being depleted (Hobday *et al*., 2016, Huq *et al*., 2015; Liu *et al*., 2015; Phiri *et al*. 2014). All this is being influenced by anthropogenic activities (Alfieri *et al*., 2016). The influence of non-native species is seen as yet another challenge to adaptation capacity (Goulden *et al*., 2013). Thus, the biophysical constraints cannot be under-rated as their impacts are far reaching as such they need to be analyzed in the case of Chadereka Ward 1.

2.7.2 Socio-Economic Constraints in Adaptation to Climate Variability and Change

Climate change is occurring within a background of plethora of global challenges such as population growth, urbanization, land and water use, rural-urban migration, and biodiversity depletion (Onyekuru and Marchant, 2016; Rurinda *et al*., 2014). Linked to these challenges are water scarcity, poor infrastructure, poor marketing services, natural disasters and inaccessibility of the area (Enete and Amusa, 2010; Enete, 2013). Ofuoku (2011) and Gentle and Maraseni (2012) also concur on some of the challenges faced in adapting to climate variability and change. Thus, efforts to adapt to the impact of climate change should do so in a manner that is consistent with these broader development issues (Qin *et al*., 2016). Qin *et al*. (2016) together with Mugi-Ngenga *et al*. (2015) and Muzari *et al*. (2016) suggest that sustainable land management is crucial to minimize land degradation, rehabilitate degraded areas, and ensure the optimal use of land resources for the benefit of the present and future generations. Some farmers have small pieces of land and lack the necessary inputs like seeds and fertilizers (Diiro *et al*., 2016; Dube *et al*., 2016; Shisanya and Mafongoya, 2016).

Some of the social constraints inhibiting adaptation to climate variability and change include knowledge deficits or gaps (Anandhi *et al*., 2016; Shemdoe *et al*., 2015). Both traditional and scientific knowledge systems are critical in the pursuit of adaptation to climate variability and change (Chanza, 2014; Gerlitz *et al*., 2016; Kneil *et al*., 2014). The risk perceptions on climate change impacts are directly dependent upon education and knowledge on the phenomenon (Muzari *et al*., 2016). Therefore, the capacity to develop and use technologies (biotechnology, hard technologies, soft technologies and organizational technologies) given in Muzari *et al*. (2016) to achieve adaptation goals rests upon the knowledge base of an individual, the institution and the society at large. Kamwamba-Mtethiwa *et al*. (2016), Kneil *et al*. (2014) and Sonwa *et al*. (2016) further point out that the temporal heterogeneity in adaptive capacity by different societies lies in their level of technological development. Technology as a constraint to adaptation capacity by different countries depends on its availability, its accessibility (the capacity to finance, operate, maintain and transport), its acceptability to users and affected stakeholders, and finally, its effectiveness in managing climate risk (Akhtar, 2016; Iglesias and Garrote, 2015; Jones *et al*., 2010). Hanna and Oliva (2016) and Rurinda *et al*. (2014) noted the deterioration of societal ‘safety nets’ due to extreme poverty as yet another social constraint. Human resource through community involvement remediates the adaptation capacity crisis (Furness and Nelson, 2016).

The capacity to adapt to climate variability and change is strongly influenced again by what Klein *et al*. (2014:914) call “entitlements of actors to economic resources” coupled with economic development and trends in globalization (Amjath-Babu *et al*., 2016). Stakeholders or actors find themselves confronted by climate change and the global financial crisis as revealed by authors such as Arfanuzzaman *et al*. (2016) and Hanna and Oliva (2016). This has also been observed by Madobi (2014) in their study of how Australian farmers were coping with drought.

Kongsager *et al*. (2016) and Weatherdon *et al*. (2016) stress that climate-sensitive sectors like agriculture, forestry and fisheries are more vulnerable to the impacts of climate change, thus rendering greater difficulties on their adaptive capacity. Economic development and human occupation of hazardous landscapes through urbanization are viewed to threaten human life by exposing them to climate variability and change (Hanna and Oliva, 2016; Kneil *et al*., 2014). Financial capital which is known to take various forms like credit, insurance, tax revenues as well as earnings of individual households or private entities, is also a major constraint particularly in the developing country (Shisanya and Mafongoya, 2016). This widens the adaptive capacity gap between the two groups of countries, the developed and the developing (Nguyen *et al*., 2016). Kneil *et al*. (2014:914) reviewed that most recent research estimated the cost of adaptation to be in the range of US$75 to US$100 billion per year by 2050. The Least Developed Country Fund has been set up to help countries of the group to come up with their NAPA. The Adaptation Fund set up through the UNFCCC is accessed through the sale of carbon credits which are the certified emissions reductions credits which comes under the CDM (Banerjee, 2015; Kneil *et al*., 2014). At the moment the demand surpasses the funds available and funding remains a constraint hindering adaptation capacity (Arfanuzzaman *et al*., 2016; Dietz *et al*., 2016; Nguyen *et al*., 2016).

Various researches have noted funding as a critical component affecting adaptation to climate variability and change world over (Dietz *et al*., 2016; Donner *et al*., 2016; Shisanya and Mafongoya, 2016). For instance, Dasgupta *et al*. (2016) and Islam *et al*. (2016) reveal that fishing communities in Bangladesh are facing challenges in accessing financial assistance from banks as well as increased aquatic salinity. Similarly, this was also noted in South Africa, Canada and Australia only to mention a few. Insurance as a measure to reduce climate risks and meet financial challenges to adaptation is considered an expensive option and has no takers particularly in the developing countries (Ng'ang'a *et al*., 2016).

As Kneil *et al*. (2014:915) note, "the effectiveness of societal efforts to adapt to climate change is dependent on humans who are the primary agents of change". Cuevas *et al*. (2016) and Nelson *et al*. (2016) suggest that inhabitants of a place who can be regarded as human resources become a constraint in adaptation to climate variability and change if they lack intelligence for the uptake and use of technology, in addition to decision-making on which adaptation strategy to consider in their order of priority. Human resources are a critical asset in the planning and implementation of adaptation strategies (Brown *et al*., 2016). In line with human resources are the social and cultural factors that can be constraints to adaptation capacity (Bongo *et al*., 2015). The present research therefore seeks to further explore the socio-economic constraints which strain adaptation mechanisms in Chadereka Ward 1.

2.7.3 Political/ Institutional Constraints in Adaptation to Climate Variability and Change

A proper understanding of the impact of political or institutional constraints to climate variability and change adaptation paves way for sound decision-making regarding the phenomenon (Milder *et al*., 2011). According to Shackleton *et al*. (2015), political, among other socio-psychological or religious constraints to climate variability and change adaptation have been underpublicized. The current research therefore included this identified gap for a discussion with reference to Chadereka Ward 1. Political constraints encompass failure by government institutions to provide full commitment to issues pertaining to climate change adaptation (Milder *et al*., 2011). Further, adaptation in some regions of Africa, according to Sonwa *et al*. (2016:12), is hindered by "conflict or post-conflict situations, which inhibit communications, learning, and innovation". Furness and Nelson (2016) further mentioned lack of physical capital such as infrastructure as a hindrance to climate change adaptation. Since adaptation to climate variability and change requires the mobilization of resources, decision-making, planning and implementation of specific policies by societal institutions like religious sectors as given by Murphy *et al*. (2016) and Watson and Kochore (2012), the political will is of fundamental importance (de Leon and Pittock, 2016; Keskitalo *et al*., 2016; Milder *et al*., 2011). Kneil *et al*. (2014) acknowledge that institutional capacity is directly linked to the level of priority assigned to adaptation. Despitehis issues, Keskitalo *et al*. (2016) indicate that there is no full coverage or integration of climate change adaptation into the state regulatory structure of legislation and policy-making thus, funding schemes for adaptation present further challenges (de Leon and Pittock, 2016). Abid *et al*. (2016) note the role of local government in the provision of infrastructure as weak and limited in dealing with climate change adaptation issues. However, the political or governance role is critical in considering, among other aspects, the proper allocation of resources, legal and regulatory responsibilities and authorities (Keskitalo *et al*., 2016).

Due to the complexities of governance networks comprising of many actors who include government agencies, market actors, NGOs, community-based organisations and social networks, different perceptions for the need for adaptation as well as the factors that constrain or enable adaptation are indispensible (Matthew *et al*., 2015). Perry (2015:1) observed, "action is constrained by institutional mandates focused on preserving existing conditions rather than recognizing a dynamic future". The greatest political hindrance to climate variability and change adaptation generally is the resistance to change. Adaptation processes should be mainstreamed into both formal and informal sectors with a supportive political sphere (Nhemachena, 2014). Without the political good will, the response to climate change issues at any scale is obscured (Government of Zimbabwe, 2013; 2015). Thus the issue requires further debate in the case of the present study of Chadereka Ward 1. For Zimbabwe, climate change issues are broadly included in the country's National Environmental Policy and Strategies and there is no stand alone policy on the phenomenon.

2.8 STAKEHOLDER PARTICIPATION IN RURAL LIVELIHOOD PRACTICES IN THE FACE OF CLIMATE VARIABILITY AND CHANGE

Stakeholder participation in climate variability and change adaptation and mitigation is critical the world over (Aldunce *et al*., 2016; Lawson, 2016; Tompkins and Eakin, 2012). The authors further note that active participation generally builds resilience and sustainability of rural livelihoods given the adverse climatic conditions being experienced globally. Stakeholders intervene in different capacities to examine and provide support towards community problem reduction or alleviation (Bohensky *et al*., 2016; Wise *et al*., 2015). Lawson (2016), for example, discusses the worthiness of stakeholders in the National Climate Change Policy-making processes in Ghana. Thaker *et al*. (2016) observe that beliefs, norms and networks which are shared socially regarding climate variability and change are fundamental in raising and promoting the adaptive capacity of individuals and communities. The review of literature on stakeholder participation in issues of rural livelihoods and climate variability and change is significant for comparisons and advancement of best practices with regard to the current research.

Few *et al*. (2007:56) assert that "stakeholders must have a genuine opportunity to construct, discuss and promote alternative options". This supports their earlier observation of Article 6 of the UNFCCC of 1992 which called for all Parties to enhance public participation in responding to climate change and its effects. Sango and Godwell (2015b) conclude that climate change is a multi-stakeholder and multi-dimensional agenda whose address lies in multi-sectoral approaches. Thus, the determination of stakeholders' roles and their effectiveness in climate variability and change adaptation is of great concern in the present research. Who are the stakeholders? What are their roles in rural livelihood and adaptation to climate variability and change? These are the questions answered by this review and further probed in this research.

Dilling and Berggren (2015), Haque *et al*. (2016), Mafongoya *et al*. (2016) and Prokopy *et al*. (2015) identify NGOs, scientists or researchers like climatologists, media, professionals, the general public (consumers and suppliers), agricultural advisors or extension educators as some of the stakeholders concerned with climate variability and change issues. A stakeholder, as defined by Freeman (2010), is a group of people or an individual with an influence in the accomplishment of the objectives of an organization or society. Stakeholders were also labeled as planners, managers, supporters, or makers of climate-sensitive decisions (Dilling and Berggren, 2015). The literature on the stakeholder subject concurs in that the individual or the group has vested interest in the organization's goals. On this note, numerous stakeholders are involved in climate variability and change adaptation issues to ensure the feasibility, sustainability, legitimacy and acceptability of the generated solutions (Gramberger *et al*., 2015). As Muchanga (2012:81) observed:

> *...planning for climate changewould require a diversity of views from multiple stakeholders such as educationists, traditional leaders, the government, affected people, government statutory bodies, clergies, NGOs, among others.*

Collins and Ison (2009) and Gramberger *et al*. (2015) also affirm that polycentric stakeholder engagement is considered a critical component in coming up with research results which are acceptable and conclusive to political and societal decision-making. Thus, the results could have a practical application. In Chadereka Ward 1, the roles of such stakeholders are evaluated as a way of fostering and enhancing effective participation thus, promoting sustainable rural livelihoods as people adapt to climate variability and change. Climate variability and change is part of the global Agenda 21, among other issues which call for global partnership for sustainable development as revealed by the UNCED (1992). The UNCED (1992) further identifies individual countries, international organizations together with various organs and organizations of the United Nations system, and NGOs as critical stakeholders which is also affirmed by Muchanga (2012).

Abid *et al*. (2016) suggest the provision of infrastructure as part of the role of local government in climate change adaptation. Thaker *et al*. (2016) also note the promotion of public awareness campaigns as a crucial task for the NGOs in fostering a high level of community collective efficacy in adaptive capacity to climate variability and change. Niang *et al*. (2014) observe that local and traditional knowledge is being used by communities in fostering resilience and adaptive capacity to climatic variability and change response in Africa. Taiy *et al*. (2015) add that some governments and other stakeholders normally distribute climate smart technologies and they create a supportive environment through policy and institutional framework. In some particular instances university specialists and researchers train extension educators in climate variability and change adaptation matters who in turn also educate the smallholder farmers (Prokopy *et al*., 2015). Abel *et al*. (2016) suggest that the success of adaptation strategies to climate variability and change is based on the collective action processes in which leadership, lobbying, research, innovation, negotiation, conflict resolution, facilitation and managerial abilities are brought together. The authors further note the value of engaging stakeholders with diverse experiences and abilities. Such situations are assessed in the case of the present research.

Few *et al*. (2006 cited in Muchanga, 2012) reviewed four categories of stakeholder or public participation which are passive, consultative, self-mobilization and interactive. The first two approaches have weaknesses as they are not inclusive. On the last two, even Muchanga (2012) acknowledged that they are the most appropriate as they allow active public engagement in the planning of climate variability and change adaptation.

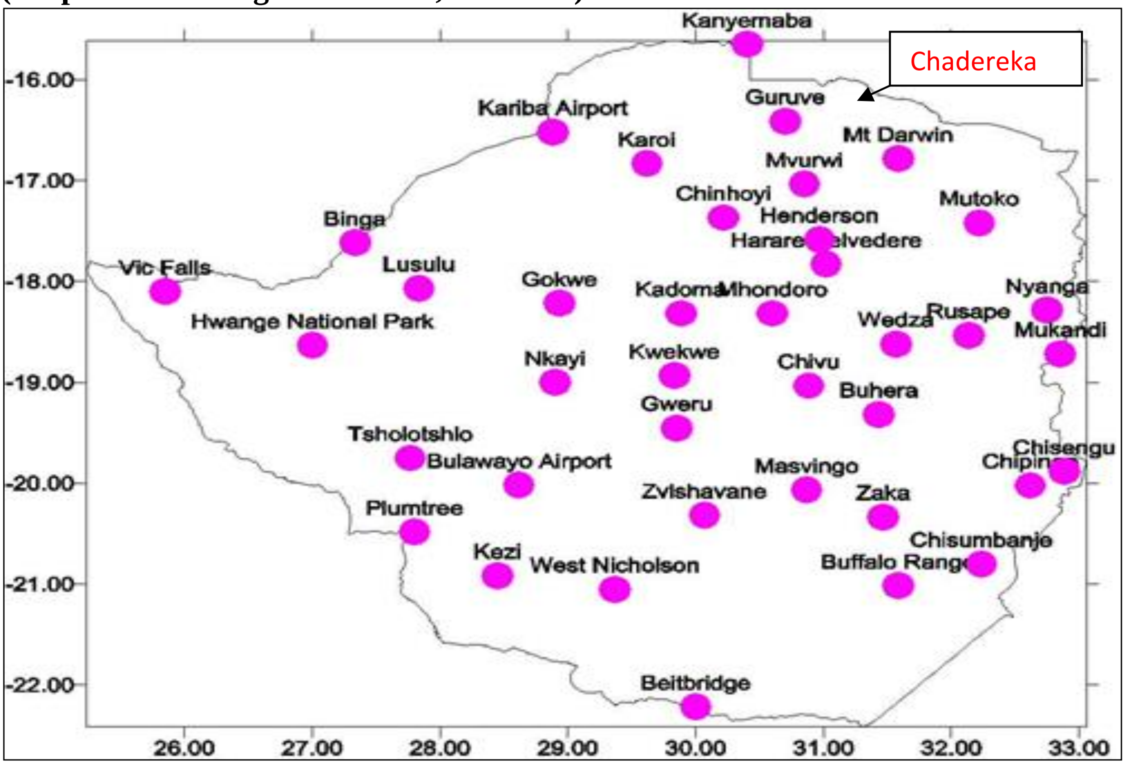
In developing countries there is still the need to explore strategies for adaptation to climate change as the livelihoods are still mainly based on agriculture which is rain-fed (Chifamba and Mashavira, 2011; Gentle *et al*., 2012; Molnar, 2010; Ngondjeb, 2013). Currently, technological innovations to adapt to and mitigate climatic disaster still need more action and publication for their uptake by farmers (Nyasimi *et al*., 2016). Thus, the role of stakeholders in climate change adaptation and mitigation generally is essential. The marginal areas are the ones hardest hit by climate change as the livelihoods in such areas are crippled by adverse climatic conditions (Gukurume, 2013). Institutional roles in responding to climate variability and change have increased in the recent past (Cadman, 2013). The Government of Zimbabwe (2015) identifies some of the stakeholders and their roles in climate variability and change adaptation in Zimbabwe:

- ZMSD: Provides climate monitoring and prediction, and disseminates probabilistic seasonal climate forecasts to provinces, districts and wards as well as maintains a network of meteorological observatories, meteorological stations and rainfall stations throughout the country.
- Department of Civil Protection: Coordinates all disaster management activities including all weather related catastrophes and facilitates capacity building programs at national and provincial levels especially in emergency preparedness and response.
- NGOs like the UNDP, United Nations Educational, Scientific and Cultural Organisation (UNESCO), Practical Action, Zimbabwe Regional Environment Organizations (ZERO), Zimbabwe Environmental Law Association (ZELA), Business Council for Sustainable Development in Zimbabwe (BCSDZ), World Vision and RED CROSS: Funding programs and projects such as the Five-year coping with Drought and Climate Change project, developing and piloting a range of long-term agricultural adaptation measures as well as national policy frameworks on climate change adaptation, and mainstreaming sustainable natural resources management in agricultural education.

- Rural District Councils: They have limited capacity to reduce exposure and to cope with consequences of extreme weather conditions such as flooding, storms, droughts, heat waves and cold spells and their impacts on local communities. They are, however, expected to enforce by-laws on siting, designing, quality and building standards.

The Government of Zimbabwe (2015) does not sufficiently consider the role played by the local people in climate change adaptation yet they matter the most when it comes to the implementation of strategies. The government and its subsidiary bodies like the Agriculture Technical and Extension Officers have a role to play in this issue of climate change adaptation. The stakeholders' roles and those by the local community are discussed with respect to Chadereka Ward 1 in this research. Non-state organizations like the NGOs are critical in providing support to enhance climate variability and change adaptation strategies in Zimbabwe.

Map 2.1: The location of some meteorological stations with climatic data in Zimbabwe (adapted from Mugandani *et al*., 2012:364)



From Map 2.1 it can also be deduced that the distance between the meteorological stations for recording climatic data for Zimbabwe increases towards peripheral and marginal areas, specifically in the southern and the northern borders. These areas present challenges in terms of the climatic calamities which besiege them (Mugandani *et al*., 2012). This calls for more research in these areas to provide advice on better ways of harnessing and sustaining livelihoods thus, the purpose of the present research in Muzarabani Rural District.

2.9 GOVERNANCE OF CLIMATE VARIABILITY AND CHANGE

Governance and institutional arrangements are key components in adaptation issues to climate variability and change (Haque *et al*., 2016; IPCC, 2014; Keskitalo *et al*., 2016). However, Keskitalo *et al*. (2016) reiterate that the phenomenon still lacks sufficient integration into the regulative structure of legislation and policy-making of various nations. Governance of mitigation and adaptation strategies, according to IPCC (2014), still lacks international commitment and national political will. This is seen in some nations like in the case of New Zealand (Harker *et al*., 2016). Any national government foresees the coordination of adaptation policies, measures being implemented and the capacity of its citizens to implement agreed strategies (Shemdoe *et al*., 2015). Thus, it is one of those factors that are critical in enforcing adaptation to climate variability and change as IPCC (2014) states:

> *Adaptation and mitigation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods and behavioral and lifestyle choices.*
>
> IPCC (2014:110)

Climate variability and change is thus a phenomenon whose agenda can be traced from 1979 (Bodansky and Rajamani, 2015). By then there were no major talks about the issue until 1988 when commitment was shown through the establishment of the IPCC (Gupta, 2016). Events continued to unfold which included the signing of some major agreements by Heads of States like the UNFCCC in 1992, the Kyoto Protocol in 1997, Copenhagen Accord in 2009, only to mention a few (Bodansky and Rajamani, 2015; IPCC, 2014). The COP which now counts up to 21 with the most recent, Paris COP21 of 2015, continues with the compilation of report on the matter (Brechin, 2016; Gupta, 2016; Ross *et al*.; 2013). Annually, there are conferences and/ or summits to share experiences and map the way for a green and sustainable future. It is from this background that the governance of climate variability and change is considered crucial and multilateral. It therefore needs also to be assessed at a local level to ensure no one is left out and adaptation is enforced.

Table 2.2: Global governance of climate change timelines (adopted from IPCC, 2014)

YEAR	EVENT
1979	1st World Climate Conference, organized by World Meteorological Organization and the adoption of the Convention on Long-Range Transboundary Air Pollution (CLRTAP)
1985	Vienna Convention for the Protection of the Ozone Layer (Bodansky, 2011)
1987	Montreal Protocol on Substances that Deplete the Ozone Layer (Bodansky, 2011)
1988	IPCC was established and climate change was considered a “common concern of mankind” (Bodansky and Rajamani, 2015:7)
1990	1st IPCC report noted climate change as a critical issue with global mean temperature assumed to increase by about 0.3°C per decade if no action is taken and thus solutions were proposed during the 2nd World Climate Conference. Some developed countries (22) adopted domestic greenhouse gas reduction targets (Gupta, 2016:197).
1992	UNFCCC signed by 154 nations at Rio Conference.
1993	Cities for Climate Protection Program launched.
1995	2nd IPCC report assessed the seriousness of climate change by various states (Gupta, 2016).
1997	Agreement of Kyoto Protocol was established to focus on specific regulations on greenhouse gas emissions reduction (UNFCCC, Article 4.2). It promulgates legally-binding emission target commitments for post 2000 with numerically assessed national performance standards processes following a ‘top-down’ international approach (Bodansky, 2011).
2001	3rd IPCC reported on the Joint Implementation, the CDM, and Emissions Trading set in the Kyoto Protocol and United States announced its withdrawal from Kyoto Protocol.
2002	Association of Southeast Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution
2005	Kyoto Treaty signed by all major industrialized nations except US and the Large Cities Climate Leadership Group was founded.
2007	4th IPCC report and Western Climate Initiative was founded under the Bali Action Plan.
2008	Adaptation fund was operationalized and Poznan Technology mechanism and Nationally Appropriate Mitigation Actions (NAMAs) were encouraged (Brechin, 2016).
2009	Copenhagen Accord at 15th session of COP and 3rd World Climate Conference had binding emission targets replacing voluntary pledges to fund adaptation (McGee and Steffek, 2016).
2010	Cancún Agreements adopted and encouraged the reduction of greenhouse gas emissions by 25-40% by 2020 in developed countries and established Green Climate Fund. This heralded a turn from the top-down approach towards the bottom-up approach (Gupta, 2016).
2011	Durban Platform focused on “strengthening the multilateral, rules-based regime under the Convention” (Bodansky, 2012:1) and concern towards addressing mitigation, adaptation, finance, technology, capacity building, and transparency issues regarding climate variability and change.
2012	Kyoto Protocol no longer legally binding but its continuation was endorsed by Copenhagen Accord. It fostered a top-down approach in dealing with climate change.
2013	Warsaw International Mechanism for Loss and Damage, Warsaw Framework for REDD+ Climate Technology Centre and Network were discussed. Parties were urged to work on ‘intended nationally determined contributions’ (INDCs) which needed to be submited by 2015 (Bodansky and Rajamani, 2015:53).
2014	Lima Call to Climate Action sets the stage for the 2015 agreement, by urging countries to declare their (INDCs) by 2015 and Green Climate Fund was to enter into operations.
2015	Paris Climate Change Agreement sought to utilize the bottom–up approach and incorporated both the developed and the developing nations in dealing with climate change. It is based on flexibility, circumstances and capacities of each country. Focuses on long-term solutions of reducing greenhouse gas emissions (Brechin, 2016; Bodansky, 2016; Kato and Ellis, 2016).

Table 2.2 further describes some of the significant events in the global governance of climate variability and change. Bodansky and Rajamani (2015), Brechin (2016) and Gupta (2016) all concur on the problem confronted by the UNFCCC in reaching a consensus on the approach to consider between the ‘top-down’ (contractual) which supports the binding targets and timeframe and the ‘bottom-up’ (facilitative) which encourages unilaterally defined voluntary actions.

The general commitment called for by the UNFCCC was for all countries to establish their “national greenhouse gas inventories; formulate their national mitigation and adaptation programs; promote and cooperate in scientific research, education, training and public awareness (Arts. 4.1, 5, 6)” (Bodansky and Rajamani, 2015:54).

While at the international fora there are conventions, Conferences of Parties, signing of agreement and many governance issues being pursued pertaining to climate change as alluded to, there is a need to consider what is happening at grassroots level. A follow up on the regulations regarding greening the environment, adapting rural livelihoods to climate variability and change and reducing climate change impacts is of great importance and is one of the key issues for this study.

The issue of climate change governance kept on attracting more adaptation and mitigation strategies and mechanisms linked to policy development (Cadman, 2013). The governance on the phenomenon has changed from governmental roles to include other private and public players. Thus, the stakeholder role analysis is critical to generate a better understanding of the issue. The following observation was made:

> *Although it is mostly state actors who exercise authority on the basis of their control at the national level, climate change governance is simultaneously global and local, state and non-state, and it is characterized by the existence of many forms of authority through which different constellations of actors interact to shape policy outcomes.*
>
> Cadman (2013:2)

Such a governance analysis advocates for more players to be involved in the issues of climate change. This promotes collaboration as a current way of enforcing sustainable development (Baird *et al*., 2016).

Muchanga (2012) in Zambia observed public participation as a better way of achieving more acceptable decisions regarding climate variability and change adaptation. Kelman (2016) further reiterated that public participation on climate variability and change adaptation is enhanced through the structural adjustment of the political and social facets. This, however, called for public education and awareness on the issues at stake.

While noting the stakeholders to climate variability and change issues and their roles, Kupika and Nhamo (2016), Lin *et al*. (2016) and Muchanga (2012) claim public awareness or education on the phenomenon to be the first port of call in order to achieve full and positive participation in climate variability and change. Mainstreaming educational values in communities, open avenues for better attention by the local government and goals are achieved (Keskitalo *et al*., 2016; Muchanga, 2012; Wamsler and Pauleit, 2016). Molnar (2010) and Muchanga (2012) further assert that passive participation by local communities pushes responsibility on climate variability and change issues to the government and other organizations with all members of the community being mere recipients and spectators. The participation of civil society in the crafting of the country's position on climate change in Zimbabwe has been underexplored (Dodman and Mitlin, 2015). While consultations with the civil society organizations and the general public are done by the Zimbabwean government, they are rather few and urban based due to limited financial resources allocated (Dodman and Mitlin, 2015). However, there was a wide involvement during the launch of the Zimbabwe's National Climate Change Response Strategy in Harare in November 2015. Generally, the task is left to the government bureaucrats and a small section of the research community mainly in towns who are ill funded (Shackleton *et al*., 2015). This is problematic as it breeds exclusivity and unsustainability in climate change adaptation strategies.

Self-mobilization and interactive participation categories are recommended as they promote creativeness and strengthen local participation in issues concerning their lives (Muchanga, 2012). Under these typologies of participation, the individuals are able to make independent decisions, are empowered and aim for high performance. As Few *et al*. (2006) state, national governments or other institutions like NGOs cannot solve effectively the issues of climate variability and change on their own without the local community. Current environmental governance since the Agenda 21 promotes democratic approaches to societal issues as they yield more results once accepted by the community.

2.10 CONCLUSION

The link between rural livelihoods and adaptation to climate variability and change still occupy the center stage topping agendas at both national and international fora. The understanding of this climate variability and change issue is still scant at various levels thus, engaging the globe at large to look into making human life sustainable on this planet (Bodansky and Rajamani, 2015; Dodman and Mitlin, 2015; Lawson, 2016). Climate variability and change is a multi-sector impact factor capable of halting the natural and human processes if not checked and abated (Shackleton *et al*., 2015). Livelihoods adaptation efforts to climate variability and change are being pursued at different levels (Bryan *et al*., 2009; Dyszynski, 2011; Nyanga *et al*., 2011; Below *et al*., 2012; Juana *et al*., 2013; Wheeler *et al*., 2013; Nkomwa *et al*., 2014; Berkhout *et al*., 2015). Urquhart *et al*. (2014) report that adaptation practices need to be contextualized given the diversity of socio-economic, political and biophysical environments the world over. The study of Chadereka Ward 1 with respect to this issue is one of the numerous endeavors towards creating awareness of the phenomenon (climate variability and change), exploring actions being taken and promoting sustainable living. In this regard, consideration should also be given towards policy and institutional development networks, curriculum innovation networks and capacity development for climate compatible development researchers, teachers and other stakeholders (Urquhart *et al*., 2014). Climate variability and change is an all stakeholder endeavor.

Chapter 2 focused on the review of literature being guided by the stipulated research objectives. Gaps of knowledge were identified which substantiate the need for the current study. IPCC (2014) in its report claims that the poor are the most vulnerable to the impacts of climate variability and change given their over-reliance principally on traditional and natural ways of life which have since been altered. Thus, research in these marginal communities contributed to informing policy makers to make better decisions.

CHAPTER THREE

THEORETICAL AND CONCEPTUAL FRAMEWORK

3.1 INTRODUCTION

Rural livelihoods in the developing world have become closely linked to climate variability and change debates as they are mainly dependent upon the natural environment, particularly climate which provides water for their execution (Sharma *et al*., 2014). Adaptation to climate variability and change is thus considered a fundamental issue in the sustenance of livelihoods given the level of extreme events so far experienced globally. It has been extensively publicized that climate change is ubiquitous, without any boundary and indirectly or directly affecting food security, water availability and people's health (IPCC, 2014; Bola *et al*., 2014; Nkomwa *et al*., 2014). Thus, the understanding of the connection between rural livelihoods and adaptation to climate variability and change is interdisciplinary considering the socio-economic and the biophysical aspects involved. The present Chapter provides the theoretical and conceptual underpinnings which guide the discussion regarding rural livelihoods and adaptation to climate variability and change. Principally the focus is on the SRLF and the CHES.

3.2 THE SUSTAINABLE RURAL LIVELIHOODS FRAMEWORK (SRLF)

According to Scoones (2009), the study of livelihoods has evolved over different theoretical perspectives within the rural communities. Butt *et al*. (2015) and Scoones (2009) indicate that the approaches have continued to change. These changes range from those of village studies to household economics and gender analyzes, farming systems research, agro-ecosystem analysis, rapid and participatory appraisal, studies of socio-environmental change, political ecology, sustainability science, resilience studies and Farmer Field School (FFS), among others. Such frameworks provide distinct insights into the manner in which rural livelihoods are connected to the political, socio-economic and environmental processes embedded in both the natural and social sciences. The current approaches are geared towards capacity building among rural and vulnerable communities (Sharma *et al*., 2014). Scoones (2015) in the 1990s located the livelihoods perspective in the SRLF which is useful in this research.

From its emergence in 1987, the SRLF initiated a unique dimension in considering people-oriented development particularly focusing on the rural poor (Saxena *et al*., 2016; Addinsall *et al*., 2015). SRLF became the focal issue in the Food 2000 report for the Bruntdland Commission and later in conferences in which Chambers and Conway (1992) expressed the following concepts:

> *A livelihood comprises the capabilities, assets (including both material and social resources) and activities for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base.*
>
> (Saxena *et al*., 2016:1196)

The provided definition of a livelihood points to the main factors that are essential in any life sustenance undertaken by the rural people (Bhatta *et al*., 2015; Department for International Development (DFID), 1999; Ncube *et al*., 2016). Cong *et al*. (2016) identified the factors as capitals (human, social, financial, physical and natural), vulnerability context (climate variability and change, trends and shocks), transforming structures or processes, livelihood strategies and outcomes. The SRLF (presented in Figure 3.1) in the present research is used as both a methodological and analytical tool in sustainable rural livelihoods analysis given its people centeredness, flexibility and accommodativeness of wide issues (De Zoysa and Inoue, 2016; Saxena *et al*., 2016). The approach is now extensively accepted as an evaluative framework in the development of policies and programs to do with poverty reduction at a micro level (Cramb and Culasero, 2003; Scoones, 1998; 2015). SRLF clearly spells out the human-natural systems linkage to do with the present research theme.

Climate variability and change can be contextualized as a prohibitive condition to sustainable rural livelihoods which thrive on the interconnectedness of physical, natural, financial, social, human and other capitals as presented by Scoones (1998; 2009; 2015). The operations of different institutions and structures at global, national and local levels determine what, where, how and when activities are done (Wang *et al*., 2016). Thus, livelihoods strategies to do with adaptation to climate variability and change in rural areas become more confined to mainly natural resource extraction, particularly agriculture (Huq *et al*., 2015). However, a variety of off-farm livelihoods like migration (Ito, 2010; Woods, 2012), cannot be ignored as they complement the on-farm activities. Ncube *et al*. (2016) note that livelihood diversification brings better lives and sustainable outcomes in general. This enhances resilience and reduces vulnerability. The SRLF (Figure 3.1) encompasses most of the aspects to deal with the analysis of rural livelihoods and climate change adaptation in Muzarabani Rural District, particularly in Chadereka Ward 1. Addinsall *et al*. (2015), Cramb and Culasero (2003), Huq *et al*. (2016) and Msholapheko *et al*. (2012) further consider the SRLF as a tool for the development of an understanding of the complexity and dynamic realities of rural households.

The approach is based on evolving thinking about poverty reduction, lifestyle of the poor/ vulnerable and the significance of the structural and institutional issues (Butler and Mazur, 2007). The framework also considers development activities which are people-centered, responsive and participatory, multilevel, conducted in partnership with the public and private sectors, dynamic and sustainable (Woods, 2012; McDonagh, 2014). The livelihood approach assists in organizing factors that hinder or promote livelihood opportunities and show how they link to each other, thus it goes beyond any analytical tool (Serrat, 2008).

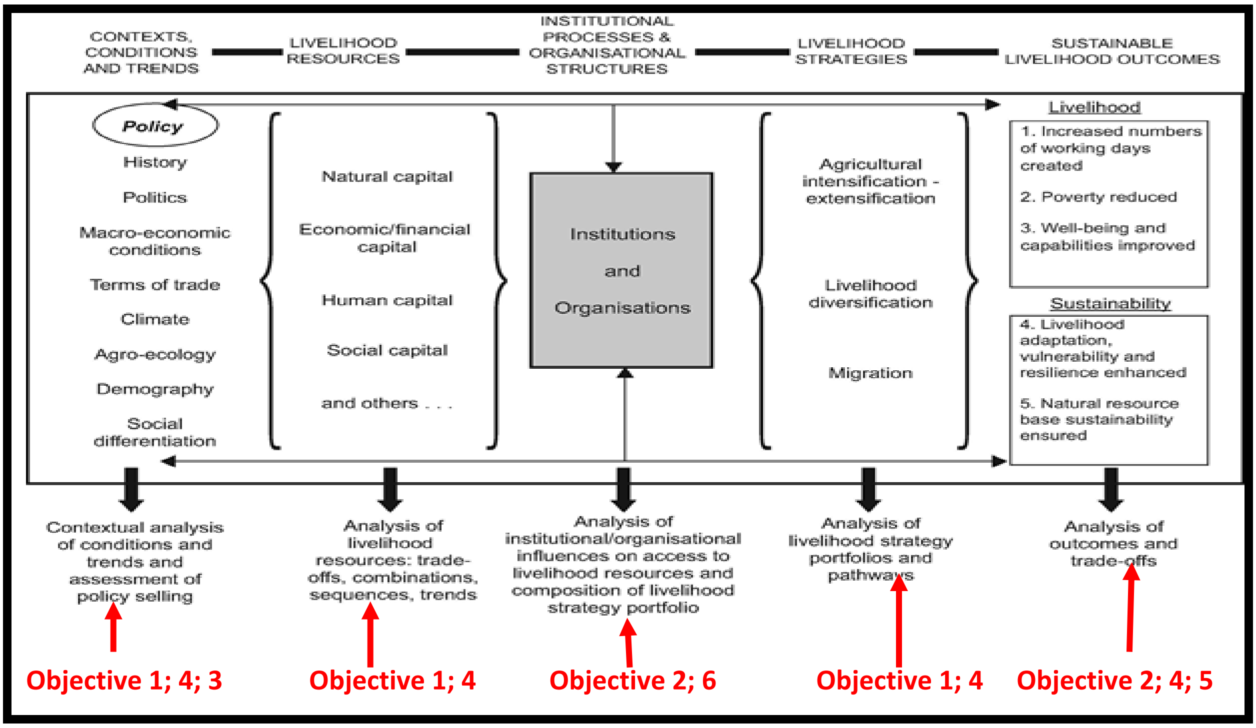


Figure 3.1: The SRLF (adapted from Scoones, 2015:36)

In the context of the study area, as depicted in Figure 3.1, basically the framework shows that rural households conduct their activities within the context of vulnerability, which is being affected by various factors including climate variability and change (Kollmair and Gamper, 2002). Accessibility to different livelihood assets (human, social, financial, physical and natural) is enhanced in this context being guided by the existing social institutions and organizational structures (local government, NGOs, private sectors, traditional leaders, donors and households) (DFID, 1999; Petersen and Pedersen, 2010; Wang *et al*., 2016). The processes which cover the laws, policies, incentives and services are critical in transforming the lives of rural people in the research area (Scoones, 2015). Thus, these have a bearing on the livelihood strategies engaged by the households and the diversity of livelihood outcomes (Butler and Mazur, 2007). The framework acts as a pointer to the linkages and critical facets indispensable to human survival and well-being. Rural or any other livelihoods cannot be treated as simple phenomena since they are more complex (Butler and Mazur, 2007; Goswami and Paul, 2012), thus the need to explore this in the context of a local rural area in Chadereka Ward 1. A further analysis of the aspects of the SRLF is provided in the subsequent sections.

3.2.1 Vulnerability Context

DFID (1999) and Petersen and Pedersen (2010) explain the vulnerability context to include all the external environmental factors which impact on people's asset accumulation or livelihoods. This comes in the form of different trends such as demographic, resource and governance, biophysical shocks (like natural hazards and climate variability and change) and socio-economic shocks (such as human well-being status, health status of livestock or crop and governance issues) and seasonality which portray variations in prices, output or products or employment opportunities (DFID, 1999; Wang *et al*., 2016). Ncube *et al*. (2016), Panthi *et al*. (2015), Petersen and Pedersen (2010) and Sharma *et al*. (2014), among others, suggest that the vulnerability context of the SRLF may lay far off (outside) the stakeholder's control and is not always negative and uniform in all places. The conditions, depending on the prevailing circumstances, may provide new opportunities to secure rural livelihoods. The vulnerability context in the case of Chadereka Ward 1 is explored in this research.

3.2.2 Livelihood Assets

As suggested by various authors who include Chambers and Conway (1992), Scoones (1998; 2009; 2015) and Sharma *et al*. (2014), the livelihoods framework is pivoted on people and their socio-economic well-being or assets (capital) at their disposal. Thus, the livelihood outcome status directly depends on the assets or capital available (Goswami and Paul, 2012). Livelihood assets vary according to the local context and they promote the status of the households within a particular place (Huai, 2016). As suggested by Petersen and Pedersen (2010), the assets or capital are not uniform but dynamic for every individual, household or community, thus creating diversity in terms of social well-being. This can be depicted by the asset pentagon changing shapes as it shows the status of the capital prevalent at any given time and locality (Cong *et al*., 2016; Goswami and Paul, 2012). Asset analysis, according to Petersen and Pedersen (2010), is important as a tool in empirical research like the present to determine rural poverty status, including the sustainability of the rural livelihood ventures undertaken by households. Furthermore, an exploration on possibilities for the substitution of assets in cases where other forms of capital are not doing well is enhanced, for instance, lack of financial capital may be replaced by the social or physical capital (Shisanya and Mafongoya, 2016). A brief description of the livelihood assets is given in the following sub-sections. Also see Figure 3.2 for Chadereka Ward 1.

3.2.2.1 Human Capital

DFID (1999) defined human capital as the fundamental and empowering asset that enables people to venture into diverse livelihood strategies and achieve their livelihood objectives or goals. This includes the skills, knowledge, ability to work and good health (Petersen and Pedersen, 2010). Human capital differs according to household size, educational or skills level, leadership and decision-making potential, and health status, among others (Goswami and Paul, 2012; Huai, 2016). Sharma *et al*. (2014) point out that changes in the status of human capital strongly affect all other assets. Considerations in the variations of this capital (Figure 3.2) among households in the case of Chadereka Ward 1 are important in assessing the sustainability of the livelihood strategies in the face of climate variability and change.

3.2.2.2 Social Capital

Jonah *et al*. (2015) and Kollmair and Gamper (2002) refer to social capital as a social resource which include networks and connectedness, relationships among groups of people, their trust, mutual understanding and have shared values and access to institutions. People use such resources (social capital) as safety nets in time of difficult circumstances (Masud *et al*., 2016). The authors further observe that during the economic recession in Zimbabwe like in 2008, the majority of the people were assisted by relatives and friends who were sending remittances from the diaspora. Several factors such as birth, age, gender and caste influence access and amount of social capital within and between households. DFID (1999), Huai (2016) Huq *et al*. (2016) and Lienert and Burger (2015) discuss that social capital has both positive and negative effects on livelihoods development and is critical in times of extreme disaster when people are gathered in refugee camps where informal networks are prevalent. The value of this asset is also explored in the case of the current research (see Figure 3.2).

3.2.2.3 Natural Capital

Natural capital refers to all the stock of natural resources or assets that are God-given and create a prolonged supply of goods or services (Masud *et al*., 2016). Jonah *et al*. (2015) exemplify natural resources to include water, forests, land, air quality, biodiversity, climate and environmental services such as the water cycle. These provide the base for rural livelihoods development (Huq *et al*., 2016). Natural assets are closely related to the vulnerability context given the extreme events and many shocks (natural hazards) like floods and drought which destroy the natural capital for livelihoods development (Aberman *et al*., 2015; Lienert and Burger, 2015). Egbe *et al*. (2014), Gentle and Maraseni (2012), Goswami and Paul (2012), Rahman and Alam (2016) and Saxena *et al*. (2016) observed that an increase in natural assets may also raise income and revenue for the rural poor through the collection and selling of forest products. Thus, the standard of living and the buying power is improved. The natural capital is therefore critical in the adaptation to climate change discourse as is worth discussing in the case of Chadereka Ward 1 in Muzarabani Rural District. Figure 3.2 illustrates the natural assets considered in the case of the study area.

3.2.2.4 Physical Capital

Physical capital is a factor of production which consists of basic infrastructure, tools and technology which supports livelihoods development (Huai *et al*., 2016). Examples of such assets include transport, roads, secure shelter and buildings, water supply for domestic and livestock use, sanitation, clean and affordable energy, and access to information (De Zoysa and Inoue, 2016; Petersen and Pedersen, 2010). Huai (2016) further critiques that poor infrastructure, limited access to resources and obsolete technology increase vulnerability among the rural populace. This asset is also fundamental in sustainable livelihood strategies and outcomes for adaptation to climate variability and change (Saxena *et al*., 2016). For instance, poor infrastructure directly affects the flow of information, education, access to health services and trade within the affected area (Goswami and Paul, 2012). This also retards the execution of productive activities as more time is spent on activities like water collection (Kollmair and Gamper, 2002; Serrat, 2008). Exploring this physical asset with respect to Chadereka Ward 1 is important (see Figure 3.2).

3.2.2.5 Financial Capital

This is all about the financial resources needed to achieve livelihoods outcomes (Huai, 2016; Petersen and Pedersen, 2010). DFID (1999) refers financial capital to all the cash or equivalent available to secure the adoption of different livelihood strategies. Kollmair and Gamper (2002) identified two main sources of financial capital which are the available cash, bank deposits or liquid assets such as livestock and ornamental stocks and regular inflows of money through labor income, pensions or other transfers from the government and remittances from well-wishers. Serrat (2008) suggests that all savings, credits, remittances and pensions form financial assets. Financial capital can be converted into any other capital already explained and can be used to acquire directly some livelihood outcomes like the buying of food to avert food insecurity (Cong *et al*., 2016; DFID, 1999; Lienert and Burger, 2015). It is the scarcest capital among the rural poor people who directly rely on the natural resource base (Masud *et al*., 2016). Figure 3.2 summarizes the livelihood assets considered under this section.

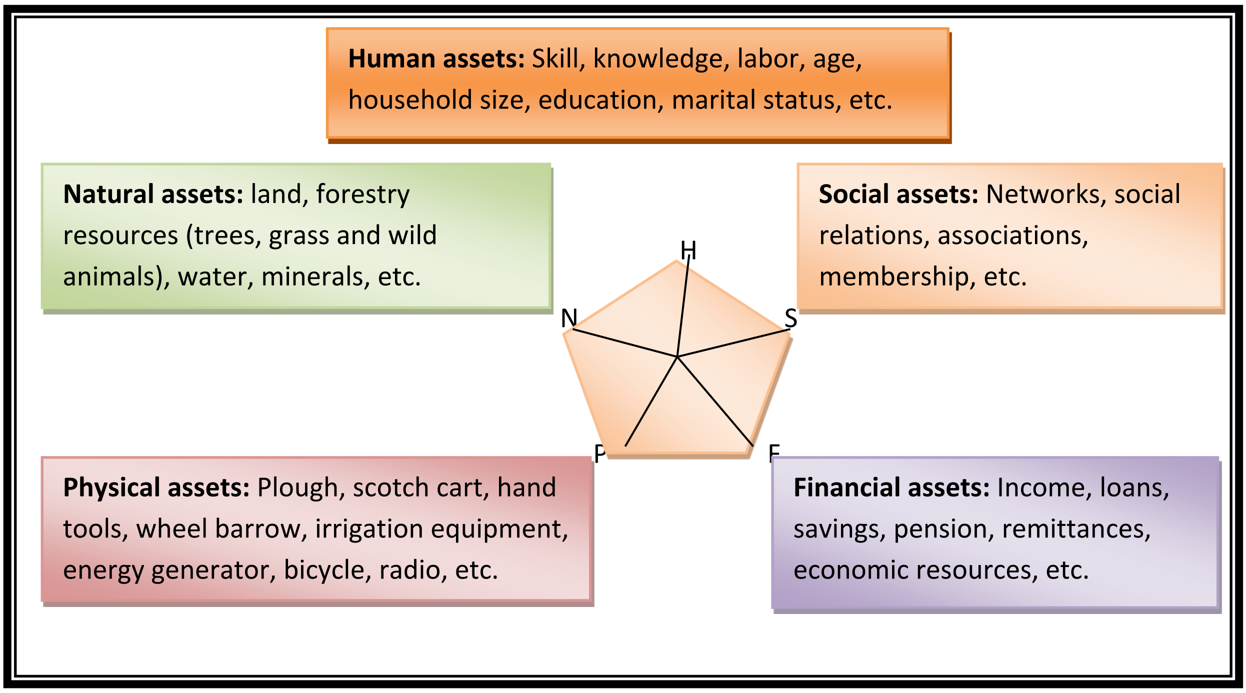


Figure 3.2: Livelihood assets assessed in Chadereka Ward 1 (adopted from Masud *et al*., 2016:774)

3.2.3 Organizational Structures and Institutional Processes

Institutions or organizations and policies or legislations are the structures and processes that help shape the livelihoods strategies and outcomes (DFID, 1999). They comprise of social, economic, and political contexts within which people pursue their livelihoods strategies. These cut across all components of the livelihood framework playing a determinant role (Serrat, 2008). Huai (2016) argues that livelihood outcomes result from a combination of the already discussed capitals and the transforming structures and processes. Organizational structures comprise of different stakeholders who influence access to shelter and land whether in the public or private sectors (Jonah *et al*., 2015). These are the decision-makers setting and implementing the processes referring to the policies and legislation, that is, the laws and regulations that govern the operations (DFID, 1999). Jonah *et al*. (2015) further suggest that institution and structures cover issues to do with markets, power relations (gender), societal norms and beliefs. Lienert and Burger (2016) put forward the view that transformational structures and processes are critical as they directly promote or hinder livelihood exploitation and development. In some cases, issues to do with ownership and control of the resources available are decisive as compared to the mere lack of capital endowments (Masud *et al*., 2016). Thus, in the case of the study area, an analysis of the institutional structures and processes is essential in determining the types and sustainability of livelihoods strategies and outcomes as indicated by Sharma *et al*. (2014).

3.2.4 Livelihood Strategies

According to Kollmair and Gamper (2002) and Wright *et al*. (2016), livelihood strategies constitute a wide range of practices and choices undertaken by different people or communities with the aim of meeting the expected livelihood goals. The activities vary depending on the components or asset status found within the livelihood framework as applied to different geographical places and time (Scoones, 2015). Serrat (2008) even considers the livelihood strategies to be household or individual specific. The strategies are influenced directly or indirectly by the conditions prevalent within the SRLF components (Petersen and Pedersen, 2010). Cong *et al*. (2016) observe that issues to do with ownership of the resources and competition among households bring about the differentiated times within which livelihood goals are achieved. The livelihood strategies can be based on the natural resource while others do not depend on natural resources. In addition, strategies can be on farm or off-farm (Ncube-Phiri, 2015). The present research therefore seeks to identify and assess the sustainability of the livelihood strategies given the changing climatic conditions in the case of Chadereka Ward 1.

3.2.5 Livelihood Outcomes

Livelihood outcomes answer the question, 'what do people aim to obtain'? Livelihood outcomes are the end products of the livelihood strategies, like more money or cash, increased well-being, increased resilience to vulnerabilities of climate variability and change, improved food security and increased sustainability in natural resource usage, among others (Butt *et al*., 2015; Lin *et al*., 2011; Scoones, 2009). These outcomes also vary greatly depending on how the SRLF elements are combined within a given household, community or place (Huai, 2016; Park *et al*., 2009). Outcomes motivate stakeholder participation in different livelihood strategies towards poverty reduction (Msomba *et al*., 2016). Ansell *et al*. (2016) observe that livelihood outcomes provide opportunities for further exploration into new livelihood strategies. Thus, they influence the shape or form of the asset pentagon as revealed by DFID (1999).

3.2.6 Relevance of SRLF for this Study

Several reasons can be provided for the use of SRLF in this research. Given that the research follows a case study design focusing on a particular Ward, the framework is the most appropriate and relevant to analyze data in relation to a local area (Masud *et al*., 2016). Huai (2016) further suggests that the framework integrates easily with other theoretical frameworks which try to clarify the connection among different factors which influence the way people respond to various calamities which befall communities like climate variability and change. Thus, it offers a holistic and better approach in the identification, processing and examination of the complexities and multi-dimensional factors that affect people's livelihoods like those linked to climate variability and change (Ansell *et al*., 2016; Butler and Mazur, 2007). Furthermore, given other characteristics of the framework like being people-centered, flexible, responsive and participatory, multi-level and dynamic; it helps identify the source of strength for enhancing the sustainability of livelihoods in rural areas and building resilience among rural people (Ansell *et al*., 2016; Msomba *et al*., 2016; Park *et al*., 2009). That is, both the strength and weaknesses faced by rural people are easily analyzed.

Thus, the framework is a useful analytical tool. It broadens the reaction or response capacity of rural people to disturbing factors to their livelihoods development. Butt *et al*. (2015) discuss that the SRLF helps expose the importance of the creation of synergies or linkages among sectors and individuals in fostering sustainable adaptation strategies to, for example, climate variability and change in the case of Chadereka Ward 1. The framework or approach liberates rural people from the conventional ways of problem solving which are narrow and natural resource dependent to those which place people at the center (Saxena *et al*., 2016) People are therefore empowered to be innovative and find solutions within their social-ecological systems (SESs) (communities and surroundings) (Wright *et al*., 2016). It fosters multiple entry points to problem solving. Solutions to any problem in the community should be addressed in a process-oriented perspective (Goswami and Paul, 2012). In fact, the framework supports the move from universality to locality in policy appraisal activities. Thus, with this framework there is a clear understanding of institutions and the synergies that contribute to development. In the present research, for instance, the stakeholder roles in promoting sustainable livelihoods adaptation to climate variability and change are easily established and synthesized (Government of Zimbabwe, 2015). The framework fosters the promotion of macro and micro linkages.

All this helps in unearthing ways of making the livelihoods sustainable given the prevailing socio-economic, political and natural conditions like climate variability and change. With the SRLF one can easily identify the most functional system within a rural system (Wright *et al*., 2016). The SRLF can be used as a checklist and a way of organizing ideas (Serrat, 2008). An evaluation of the capacity of the livelihood strategies done in the area to adapt to climate variability and change was done. This was achieved by using the sustainable livelihoods framework where the five capitals or assets (human, social, physical, financial and natural) are considered (Saxena *et al*., 2016). It promotes the planning and implementation of more effective development interventions like adaptation strategies to climate variability and change in the study area.

The usefulness of the approach comes with some criticisms. Kollmair and Gamper (2002) critique that the SRLF does not address adequately institutional and management processes. It also fails to consider the effects of promoting one's livelihood on another livelihood (Ansell *et al*., 2016). The framework lacks the capacity to fully address issues of the vulnerability context as this can also be worsened by macro-economic trends and conflicts (Sunanda *et al.,* 2014; Norton and Foster, 2001). It is also limited in scope as it considers assets to be developed in a general and incremental way (Lundy and Adebayo, 2016). Problems still exist in the measurement criteria for sustainable livelihoods. Ansell *et al*. (2016) also argue that assets, besides providing only a living for the people, enable them to create change or transform the world in which they live. In addition, the authors observe that some assets are needed to access others.

The framework helps the research to establish and analyze the state of all the five capitals in Chadereka Ward 1 with regard to adaptation to climate variability and change. It fosters a bottom-up approach in the choice of adaptation strategies (Kanaskar *et al*., 2013). The SRLF helped in coming up with an assessment of rural livelihoods in terms of their sustainability in the study area.

3.3 THE COUPLED HUMAN–ENVIRONMENTAL SYSTEMS (CHES) APPROACH

The link between rural livelihoods and climate variability and change is an expression of the interdisciplinary science of sustainability which examines such a relationship (Hossain *et al*., 2016; Liu *et al*., 2016). This ensures that CHES become more resilient and less vulnerable to external forces (Turner II, 2010). Currently, the CHES considers sustainable community or societal efforts in fostering their well-being while reducing vulnerability from natural hazards (Hossain *et al*., 2016). The CHES approach is also referred to as coupled human and natural systems (CHANS) or SESs by Liu *et al*. (2016), Kok *et al*. (2016), Leslie *et al*. (2015), Prosperi *et al*. (2016) and Turner II (2010). The approach expresses the dynamic nature of the interdependency or synergy of the environmental/ natural and humankind/ social sub-systems as determinants to the kind of responses given to any calamity of the sub-system or a full system (Leslie *et al*., 2015; Prosperi *et al*., 2016). Such a situation constitutes a social construct which calls for a holistic analysis of the system which is currently topical (Allen and Prosperi, 2016). Kok *et al*. (2016) observe that similar to the SRLF, the environmental or ecological system is the natural capital consisting of all the natural resources important in human survival or processes. The human system therefore directly encompasses the social, physical, financial and human capital (Prosperi *et al*., 2016). Figure 3.3 illustrates the CHES approach.

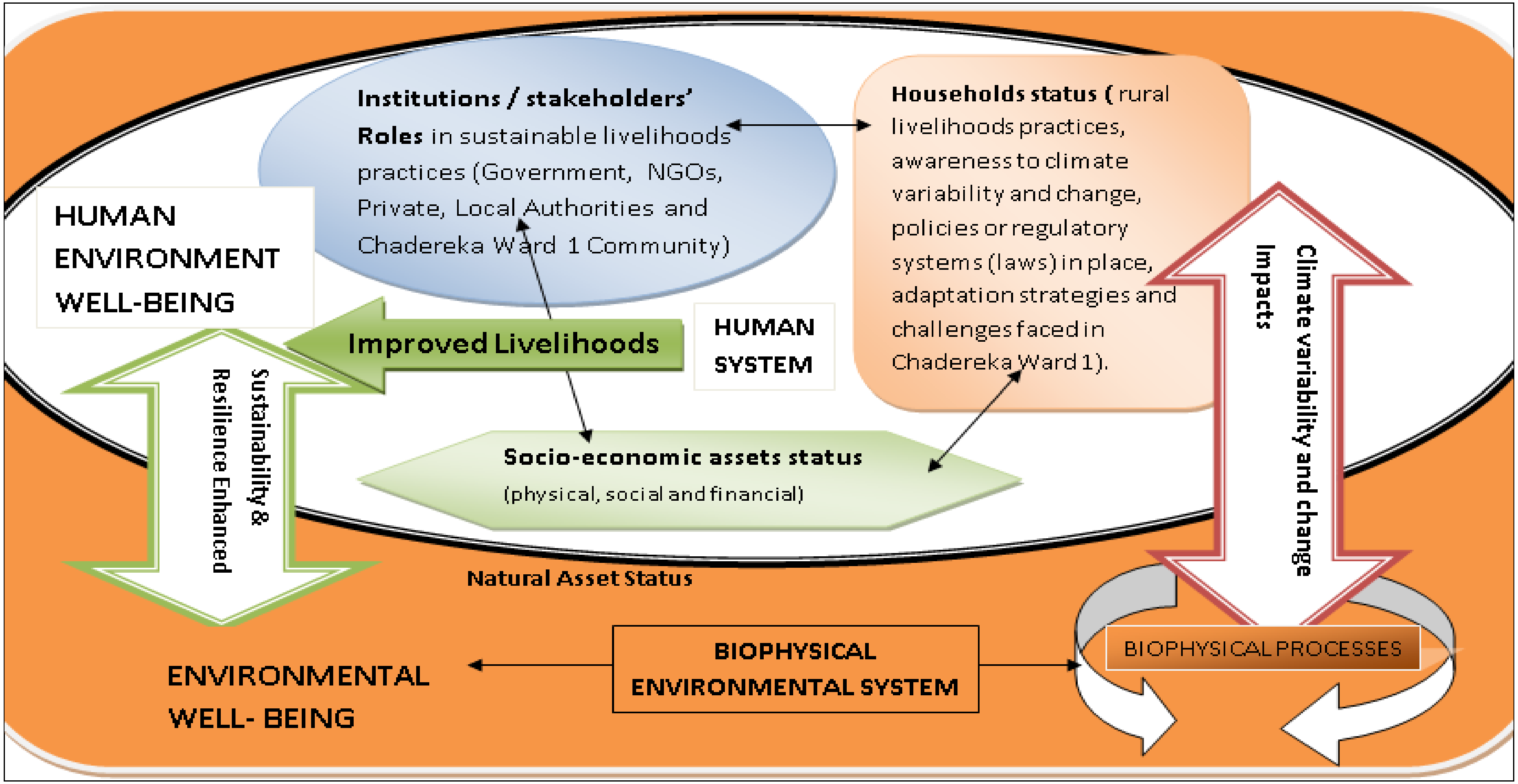


Figure 3.3: A conceptual framework (CHES) for understanding the linkage in fostering sustainability of the rural livelihoods in the face of climate variability and change in Chadereka Ward 1 in Muzarabani Rural District (adopted from Tian, 2012:3)

Marina *et al*. (2011) consider CHES to be an integrated scientific framework which expresses an interface and reciprocal interactions between the human (economic, political and social) and natural (biophysical) aspects. CHES assists in fostering a clear understanding of human–nature relationships guiding its sustainability (An and López-Carr, 2012). Given this purpose for CHES, it becomes important also to establish sustainable practices and conservation mechanisms used in ecosystems and societies (Leslie *et al*., 2015). McDowell *et al*. (2016) and Scholz and Steiner (2016) suggest that research involving CHES builds on the disciplines of human ecology, ecological anthropology, environmental geography and economics; among other eco-bio-geo-physical fields. This paradigm moves beyond some of the usual traditional research methods in socio-natural phenomena to broader and complex investigations of reciprocal humans-natural environment interactions and feedbacks (Scholz and Steiner, 2016). Liu *et al*. (2016) postulated that there is non-linearity in dealing with coupled systems.

Liu *et al*. (2016), Kok *et al*. (2016), Leslie *et al*. (2015) and Prosperi *et al*. (2016) further postulate that new patterns, processes and solutions emerge in combining the study of human and natural systems. One other characteristic of the CHES is that they are dynamic and they change over time (Liu *et al*., 2016). Given the current study of rural livelihoods and adaptation to climate variability and change, the framework is appropriate as each day experiences a unique development as local inhabitants interact within and with their environment (Hossain *et al*., 2016).

Figure 3.3 illustrates the modified CHES framework considering the aim and objectives of this research. The human system operates within the biophysical or natural environmental systems. Household understanding of climate variability and change impacts on both the biophysical and human systems is critical and worth exploring in fostering sustainable adaptive mechanisms. Rules and regulations governing the exploitation of the natural resources together with the institutional roles also work together and provide the level of sustainability of rural livelihoods developed with the area of study. Thus, the level of sustainability can be deduced from production levels as well as human and biophysical environmental well-being. Further steps are taken to deal with drawbacks to sustainability within the human-natural systems interaction. The CHES framework has the tendency to be inward looking at prioritize internal aspects. The SRLF, however, in focusing on the five assets prevalent in communities examines these in relation to both internal and external factors. Thus, the SRLF and CHES complement each other.

3.3.1 Relevance of the CHES Framework in this Study

The CHES framework can be applied to this study of rural livelihoods and adaptation to climate variability and change given the current ontological (acceptable knowledge of the world) (Binder *et al*., 2013) and epistemological (acquisition of knowledge) focus of the human-nature integrated study (Castree, 2016; Sarantakos, 2013). Castree (2016) further posits the idea that the global present research is multidisciplinary, combining the social and the geo-bio-ecological facets. Thus, it is influenced by several factors which include global processes, government policies and local processes involving human-nature interactions (Liu *et al*., 2016). Since the present study seeks to respond to questions on livelihood practices and governance, awareness to climate variability and change, the socio-economic and biophysical impacts of climate variability and change, adaptation strategies, adaptation challenges and stakeholder participation; it is imperative to consider the CHES given its prominent integrative character (Leslie *et al*., 2015; Prosperi *et al*., 2016). While climate is natural, its variability and change lie in both biophysical and socio-economic systems, strengthening the need to engage the framework. In addition, it is also flexible in site-specific studies, an observation made by Liu *et al*. (2016) and Tian (2012).

The sustainability of rural livelihoods in this era of climate variability and change can only be achieved through advocating for sustainable human-nature management practices (Allen and Prosperi, 2016). The framework also enhances a proper understanding of resilience to climate variability and change impacts through integrating the socio-ecological systems in adaptation strategies (Scholz and Steiner, 2016). Furthermore, the framework allows for the use of integrative and interdisciplinary research portfolios which are qualitative and quantitative (Kok *et al*., 2016; Leslie *et al*., 2015). Thus, CHES complements SRLF which also adopts an integrative and multidisciplinary approach. These result in a better and richer understanding of phenomena developing in particular places, thus promoting favorable planning and management systems (Reeds *et al*., 2013). The uniqueness of particular localities is clearly articulated. Reeds *et al*. (2013) further support that the framework combines well with other frameworks studying human-nature relationships like the SRLF also alluded to earlier in this Chapter. Tian (2012) puts across the idea that in responding to climate change, technologies fall short to solve the environmental problems on their own, rather alternative approaches should be sought which consider human actions, biophysical processes, and the relationships between them. This is facilitated by a close analysis of the human-natural systems (the CHES approach). The idea is to foster sustainability of livelihoods in adaptation to climate variability and change in different localities such as in Chadereka Ward 1 in Muzarabani Rural District.

Tian (2012) also points out that given the low levels of development in less economically developed countries and greater risks of the impacts of climate variability and change, the developing countries remain vulnerable to the natural disasters which retard development. Thus, using the CHES approach, climate variability and change issues are analyzed and the sustainability of adaptive strategies unpacked (Reeds *et al*., 2013). The framework acts as a guide to development initiatives, policy-making processes and provides another window for understanding the dynamics of rural livelihoods in relation to climate variability and change. The CHES approach allows for stakeholder interventions in attenuating circumstances befalling communities like climate variability and change (McDowell *et al*., 2016; Scholz and Steiner, 2016).

The main issue on this approach is to consider the well-being, sustainability and resilience of the human-nature interconnected environments in dealing with the adaptive strategies in the calamity of climate variability and change. Well-being in CHES approach, as Tian (2012) indicates, refers to the good outcome from the exposure of the human system in this case to climatic variability and change. This increases the level of livelihood development and sensitivity to the environmental problems within the natural system. The system's endurance to the impacts of climate variability and change becomes its resilience as already highlighted (Molnar, 2010). Applying the science of complexity inherent in the CHES and SRLF integrating with ideas from climate change research into a larger framework of sustainability, the present research attempts to operationalize the concept of sustainability and provide analyzes that are useful for achieving sustainability in less developed places vulnerable to climatic hazards like Chadereka Ward 1. Figure 3.4 shows the interactions of the natural system and the human system with a set of household assets resulting in livelihood outcomes which promote sustainable, resilient and well-being lifestyles within the community. The Figure clearly shows that the CHES is a more comprehensive approach, however, it lacks focus that SRLF provides by framing livelihood issues in relation to human, social, financial, physical and natural assets.

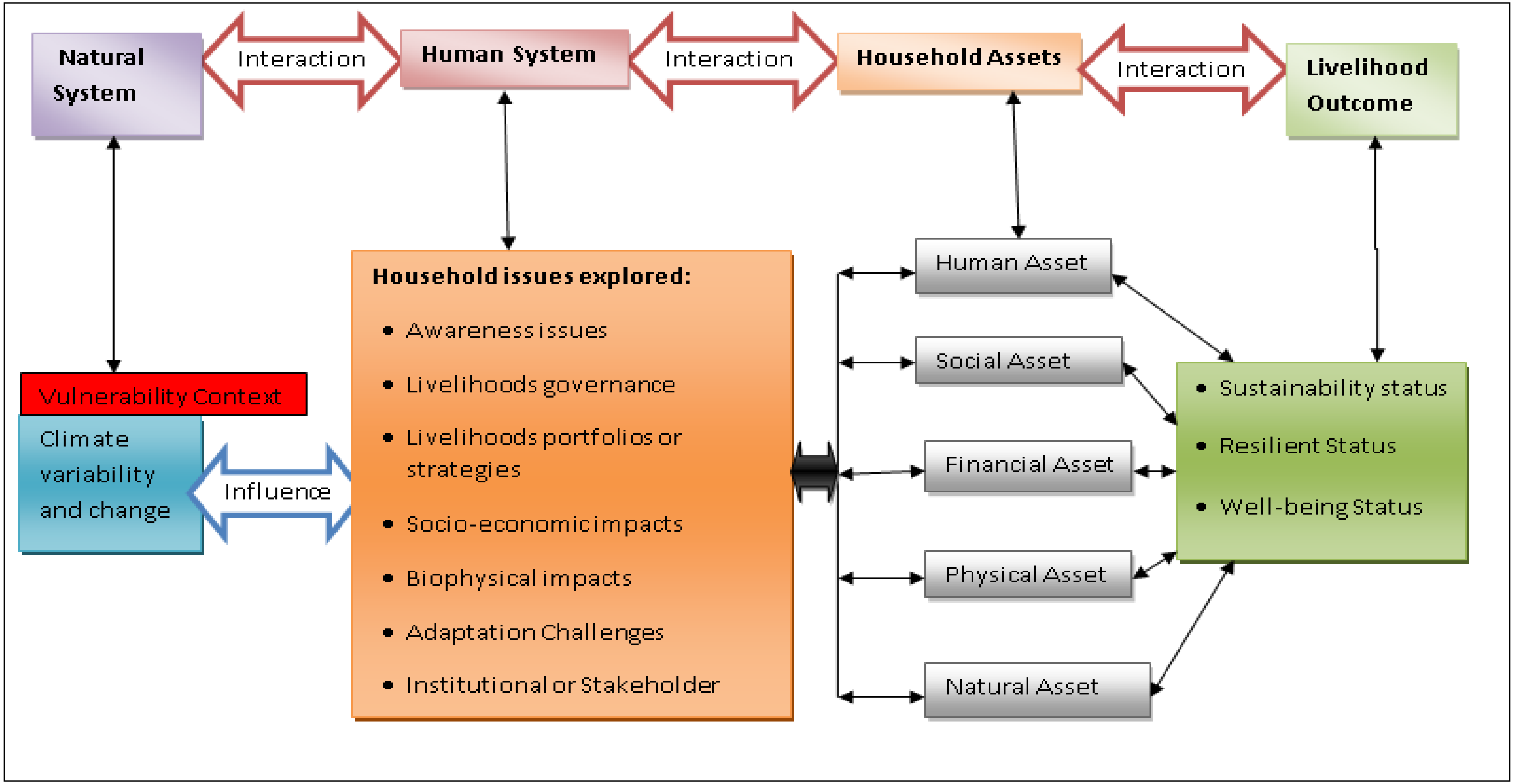


Figure 3.4: The Combined SRLF and the CHES conceptual framework in assessing the sustainability of rural livelihood adaptation to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District

3.4 CONCLUSION

This Chapter presented the theoretical and conceptual frameworks (SRLF and CHES) which were applied to this study of rural livelihoods and adaptation to climate variability and change in Chadereka Ward 1. Rural livelihoods and climate variability and change are two critical socio-natural ontologies or philosophies upon which all other concepts for this study like adaptation strategies, impacts, legislation, stakeholders and challenges are anchored. The SRLF with its human, social, financial, physical and natural assets direct the manner in which rural livelihoods can be discussed and understood. Thus, its central location guides the human-nature relationship.

The fusion of the frameworks (SRLF and CHES) portrays the complexity in the interpretation of the current global calamities whose solution is still far reaching. The drive is to promote well-being, resilience and sustainability in adaptive mechanisms employed by the rural poor. As rural people interact with and within their environment they should be aware of the consequences of their activities. The frameworks also allow for choices to be made on approaches which are either top-down and or bottom-up as households contemplate on adaptive strategies to climate variability and change. The frameworks were described and their relevance to this study discussed. The flexibility of the two frameworks directs the manner in which the aim of the research was achieved articulating the objectives chronologically as illustrated in Figure 3.4 on which the two frameworks are merged. Generally, the outcomes of the research shall strengthen the present and the future knowledge base about the correlation between climate variability and change and livelihood adaptive systems within space and time.

To frame the research, key operational procedures include identifying variables and suitable methods for acquiring and analyzing the data to address the research questions were identified. This is the focus of the next chapter.

CHAPTER FOUR

RESEARCH METHODOLOGY AND STUDY AREA

4.1 INTRODUCTION

Geographical study is so extensive and broad that it cannot suffice through the use of one methodological paradigm of the natural sciences (Wilson, 2016). In fact, given the mandate that it studies the human-nature environmental linkages, it calls for more robust research methodologies that unveil the intricate synergies inherent to the geography discipline (Castree, 2016). Simply put, geography bridges the social sciences (human geography) with the natural sciences (physical geography) (Kong *et al*., 2016). Castree (2016) further suggests that solutions to the current problematic global human-natural events like rural livelihoods and adaptation to climate variability and change require a multidisciplinary or mixed methods approach routed in an informed selection of appropriate research methods.

Rajasekar *et al*. (2013) define research methodology as a systematic way in solving a problem and directs the manner in which research ought to be done. This is crucial in any research activity for it guides procedures in describing, explaining and predicting phenomena. A research methodology also prescribes the methods used in gaining knowledge thus availing the work plan for the research endeavor (Green *et al*., 2015). This Chapter therefore provides details of what was done in data gathering. The Chapter specifically discusses the research methods useful for answering the research questions set for this study. It also provides a description of the geo-physiographic conditions of the study area, the research design, data collection instruments, sampling procedures, as well as data analysis procedures used.

4.1.1 Research Questions

Chapter one presented the purpose of this study as an assessment of rural livelihoods and climate variability and change adaptation strategies in terms of their sustainability in Muzarabani Rural District of Zimbabwe using the case study of Chadereka Ward 1. Thus, the study seeks to respond to the following research questions:

(i) What is the knowledge base of the community on climatic variability and change issues in Chadereka Ward 1 in Muzarabani Rural District?

(ii) What are the impacts of climate variability and change on the biophysical and socio-economic environment in Chadereka Ward 1 in Muzarabani Rural District?

(iii) What are the current rural livelihood strategies being practiced in Chadereka Ward 1 in the face of climate variability and change and which are the policies or regulatory systems (laws) governing their sustainable use in the study area?

(iv) How are the livelihood strategies adapting to climate variability and change in the study area?

(v) To what extend are rural livelihoods strategies sustainable among Muzarabani Rural District Chadereka Ward 1 households in the face of climate variability and change?

(vi) What challenges are faced by the inhabitants in Chadereka Ward 1 as they try to adapt to climate variability and change?

(vii) What role do the different stakeholders in the study area play towards promoting sustainable rural livelihood adaptation to climate variability and change?

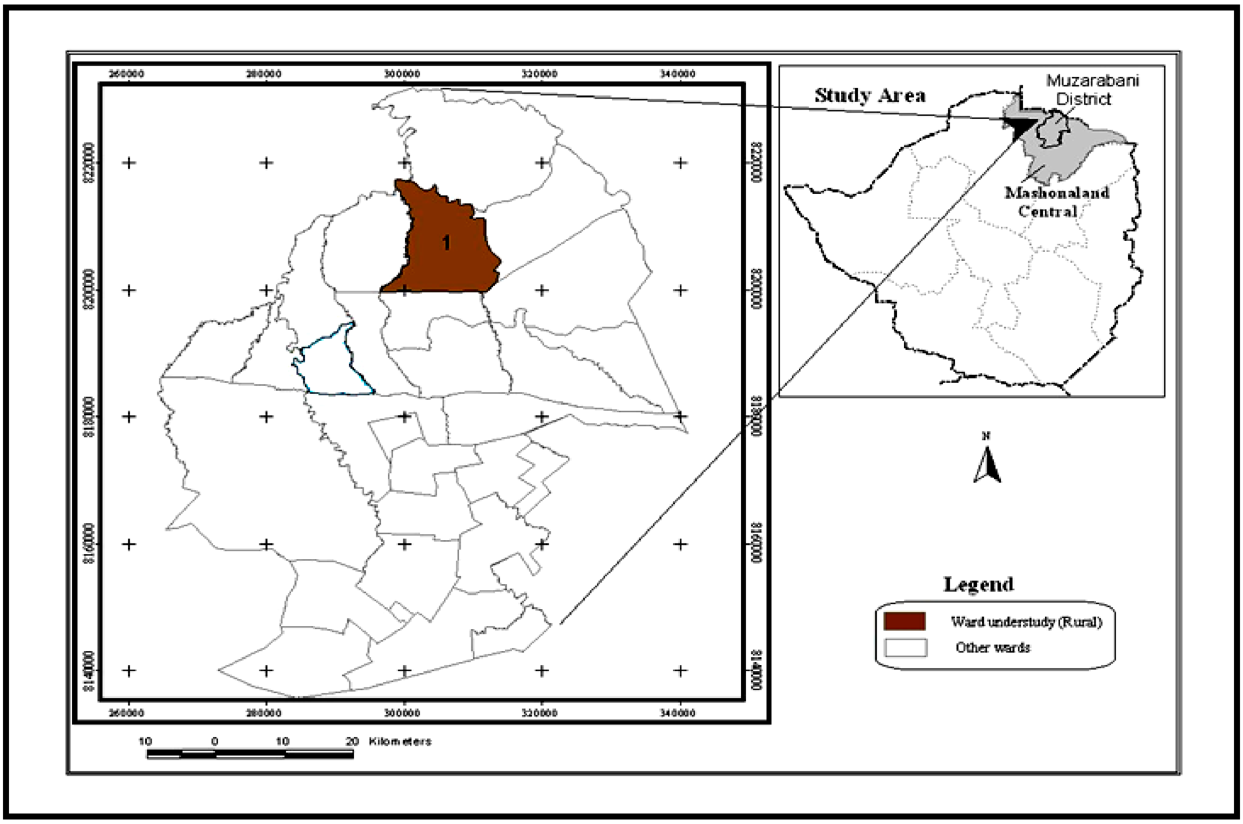
4.2 THE STUDY AREA: SOME GEOGRAPHICAL CHARACTERISTICS

Zimbabwe, a country in which Muzarabani Rural District (study area) lies (Map 4.1), is one of the most vulnerable sub-tropical African countries to the impacts of climate variability and change. Its vulnerability stems from its geophysical, socio-economic and political conditions which reduce adaptive and copying capacity considerably. The Ward is a remote area often neglected in terms of infrastructural development. As a tropical country, it is prone to seasonal climatic variations with hot-wet and dry-cold conditions. Unganai (1996) and Mugandani *et al*. (2012) gave its precise location as a country which lies in the southern hemisphere between latitudes 15.5^0 and 22.5^0 to the South and longitudes 25^0 and 33^0 to the East of the Greenwich Meridian. It covers an area of 390 580 km^2 (Mugandani *et al*., 2012).

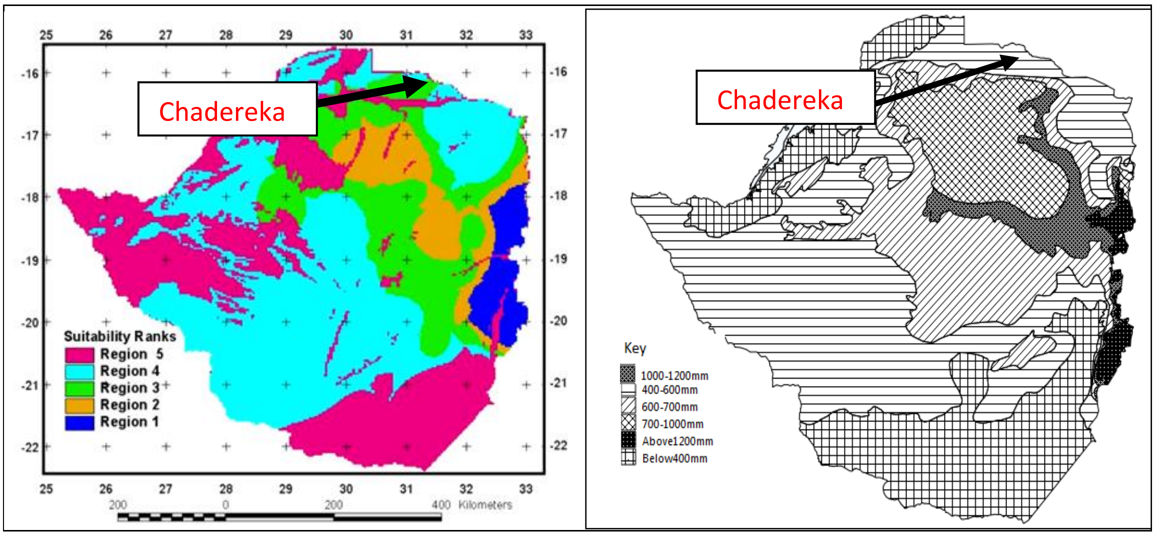
The specific area studied, Chadereka Ward 1 (Map 4.2a) is in the northern lowveld of the country experiencing extreme climatic conditions. Moyo *et al*. (2012) state that Chadereka Ward I occupies the agro-ecological zone IV characterized by little rainfall averaging 550 mm per year (Map 4.2b) and excessively high temperatures (up to 40^0C during the hot season of September to November). Thus, the area is prone to prolonged seasonal droughts and severe dry spells in between summer months (Campbell *et al*., 1997; Murwira *et al*., 2012).

Floods are experienced occasionally, according to Murwira *et al*. (2012). This entails the variation in climate in the area as postulated by Matarira *et al*. (2013). Unganai (1996) and Matarira *et al*. (2013) concur that the inter-annual rainfall variations are known to be explained by the El Nino Southern Oscillation (ENSO) phenomenon, among other factors. This supports some common crop varieties grown in the study area like maize, sorghum, pearl millet (*mhunga)*, finger millet (*rapoko*) and cotton in addition to the keeping of a variety of small to large livestock. Households generally practice rain-fed subsistence crop farming, livestock rearing, wild fruit gathering *(masau* and *mauyu berries)* and other off-farm activities. Hunting of wild animals has since deteriorated. Commercial cotton production is practiced though it is no longer lucrative.

Map 4.1: Map of Zimbabwe showing Chadereka Ward 1 in Muzarabani Rural District of Mashonaland Central Province



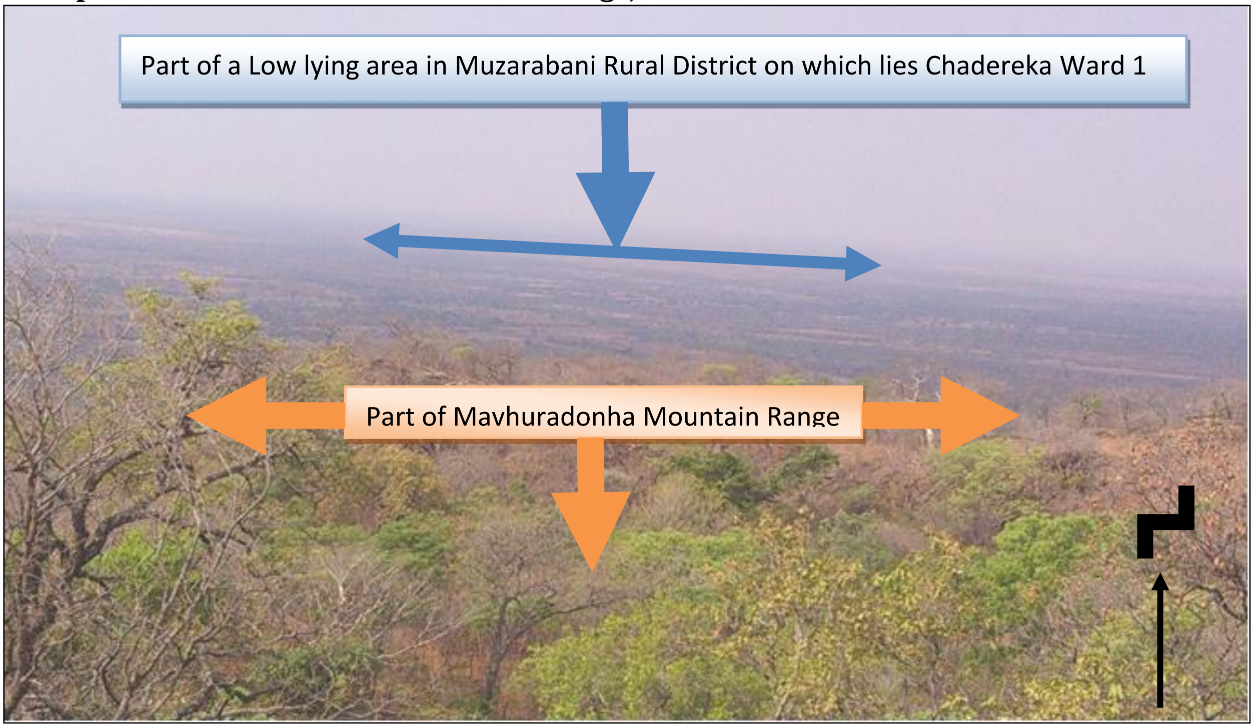
Map 4.2: Maps of Zimbabwe showing agro-ecological regions (a) and precipitation (b) in conformity with climate variability and change (adapted from Mugandani *et al*., 2012:365)



(a) (b)

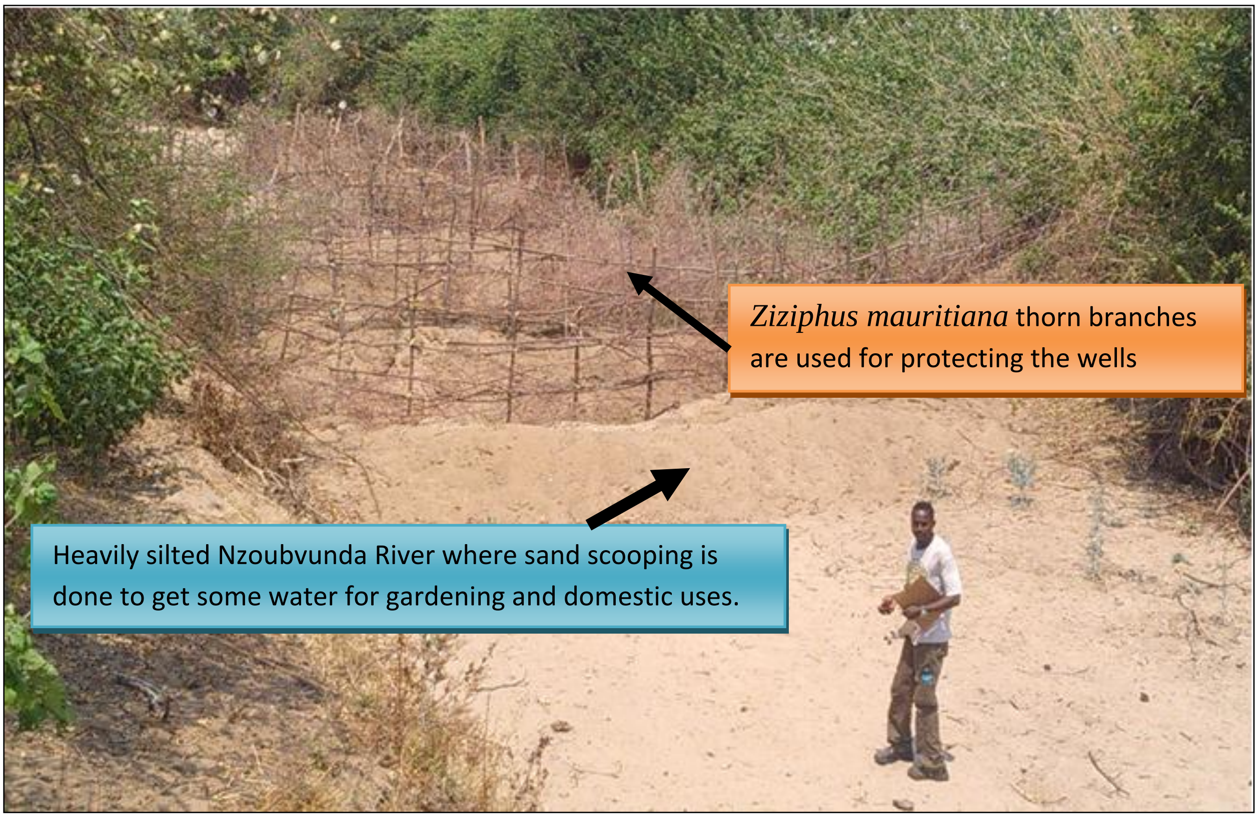
The term ‘muzarabani’ is an indigenous concept referring to a flat and low-lying area which is a floodplain. Image 4.1 illustrates the lowveld as viewed from an elevated area on the Mavhuradonha mountain range. The mountain range divides the Lower Muzarabani area below from the Upper Muzarabani area above as one travels from north towards south. According to one elderly community member interviewed, the term describes the area explicitly: ‘muzara’ literally meaning ‘full of’ and ‘bani’ signifying a ‘vlei’ or ‘flood plain’. This was also revealed by Chanza (2014) in his study of ‘Indigenous Knowledge and Climate Change: Insights from Muzarabani, Zimbabwe’. The Lower Muzarabani area stretches from the piedmont zone of Mavhuradonha in the south to the Zambezi River in the North. The main drainage systems with effect in Chadereka Ward 1 are Hoya, Nzoumvunda, Musingwa and Musengezi Rivers. The Hoya and Nzoubvunda Rivers which are heavily silted drain towards the Zambezi River Basin from the Mavhuradonha Mountain Range (over 1 600 m) (Lister, 1987) which occupies the northern part of the Zimbabwe’s Central Watershed. Though mostly dry, they are the source of life in Chadereka Ward 1.

Image 4.1: Part of the low lying area in Muzarabani Rural District (photograph taken from part of Mavhuradonha Mountain Range)



Initially, the extensive floodplain used to be covered with fertile alluvium associated with wet conditions. While soils display variations due to the Pedogenesis processes, currently in Chadereka Ward 1 the soils are chromic luvisols which are sandy textured making them prone to wind and fluvial erosion (Nyamapfene, 1991). The author further pointed out that these soils have low nitrogen, phosphorus and other organic content. Their water retention capacity is generally poor and the rivers are always silted and dry for a longer period of the year affecting livelihood practices in the area. Households practice sand scooping during the dry season to water their gardens and for other domestic uses as shown in Image 4.2. Image 4.2 further shows how households protect the temporary sand scooped wells from wild and domestic animals using the thorn branches of *'musau'* trees (*Ziziphus mauritiana),* riverine vegetation and poles of mopane-terminalia woodland (*Colophospermum* mopane and Terminalia *stulhmani)* and mopane-combretum woodland (*Colophospermum mopane* and *Combretum apiculatum)* (Chanza, 2014), abundant in the area. Generally, Nzoumvunda River remains silted with no surface water flow for almost two thirds of the year from April to November. However, the alluvial soils on the banks along Nzoubvunda and Hoya Rivers are rich soils with a favorable water retention capacity and have the ability to sustain the flood recession cultivation of maize, a practice known as *'mudzedze'* by the locals during the autumn and winter seasons.

Image 4.2: Water sources and management in Muzarabani Rural District, Chadereka Ward 1



Chadereka Ward 1 occupies the interfluve sandwiched between Hoya River to the east and Nzoubvunda River to the west. It stretches from the confluence of these two rivers towards the south were it borders with Ward 7. From the focus group discussions with household heads and some key informants like the Ward counselor it emerged that flooding in Chadereka Ward 1 is caused by the back flow of Hoya and Nzoumvunda Rivers which fail to drain in Musengezi River after some heavy down pours within the catchment areas of these rivers.

The Ward has 7 505 people, some of whom are migrants from other parts of Zimbabwe and they speak the vernacular Shona language (ZIMSTAT, 2012). A mixed cultural belief of Christianity and ancestral worship exists which shape their IKS on climate variability and change issues (Chanza, 2014). In terms of institutional aspects, customary law continues to be practiced in the area as evidenced by the Traditional Leadership Act with a mandate on natural resources management or conservation and the Communal Lands Act which deals with land allocation (Chanza, 2014). Chadereka is one of the Wards under Chief Kasekete (also known to be Chief Muzarabani). Under the Chief there are the Ward Councilors and kraal heads or Headman who work directly with the local households. Government officials and some officials from NGOs (like World Vision and Red Cross) are also active in the community.

4.3 RESEARCH DESIGN

Social researchers normally focus on descriptive and explanatory research answering the questions ‘what’ ‘how’ ‘where’ and ‘why’ (Punch, 2012; Rajasekar *et al*., 2013; Sarantakos, 2013). As geography is concerned with the spatial distribution of phenomena, it falls short if it doesn’t provide the reasons for that distribution. Hence, the terms ‘description’ and ‘explanation’ continue to form the fundamental principles of inquiry in any geographical research (Ryan, 2016). The terms provide the basis for understanding the research design of a particular issue (Ryan, 2016). A research design is defined as a work plan or logical structure of an inquiry or research (Baran and Jones, 2016; Swanborn, 2010). Creswell (2013) suggests that a research design serves to minimize falsifying causal inferences from collected data and thus, evidence provided on a particular research should assist in giving valuable answers to questions. Punch (2012) points out that a research design expresses how data on a research problem is gathered and analyzed responding to questions like what strategy, within what framework, from whom and how? The present research is an applied descriptive case study given that the findings are locally based and may be used to reinforce solutions, reduce or adapt to the impacts of climate variability and change at household level in Chadereka Ward 1 in Muzarabani Rural District at the same time improving their rural livelihoods.

A mixed methodological approach of qualitative and quantitative methods was pursued (Figure 4.1). This in a way captured both textual and numerical data at once which were useful in responding to the research questions already presented in this Chapter. Creswell (2013) and Plastow (2016) referred to this type of mixed methodology as convergent, concurrent, parallel or simultaneous studies designs. It also makes the triangulation (comparison or relation or confirmation) of a diversity of data collection techniques possible for the validity and reliability of the research findings (Adam *et al*., 2014; Below *et al*., 2012). The mixed or concurrent research design also permits separate publications of results from qualitative and quantitative methods pursued in the same research (Creswell, 2014). Plastow (2016) further presents that the weaknesses of one approach are compensated by the strengths of the other, thus, enhancing the validity of the results.

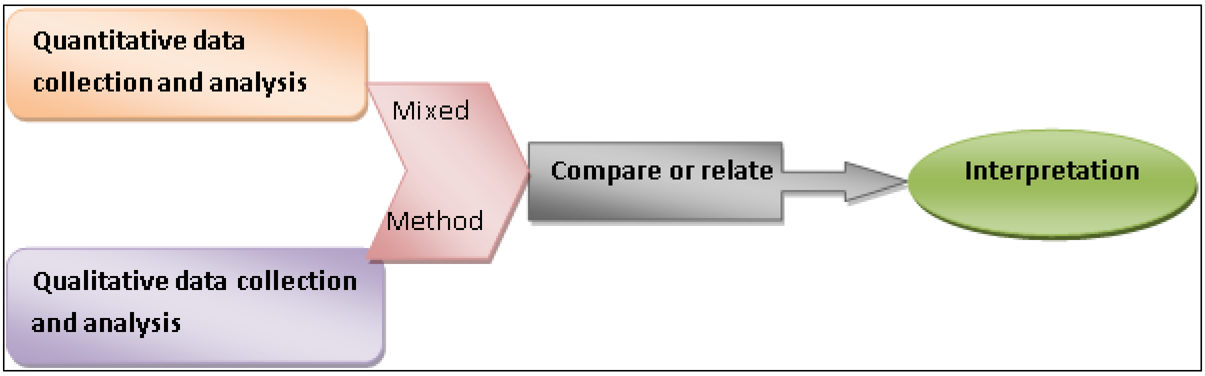


Figure 4.1: Concurrent mixed method adopted (Source: Creswell, 2014:220)

The concurrent research design considered in this research (Figure 4.1) requires more effort on the part of the researcher as more data is collected from structured household questionnaire interviews, key informant interviews, focused group discussions and the observation instruments as affirmed by Sarantakos (2013). Similar to the approach suggested by Baran and Jones (2016) and Ryan (2016), in this study assistant researchers were trained and engaged to help in data collection. In cases were gathered data were dissimilar, verification was done by re-examining the collected data, revisiting the area and re-engaging some key informants or households as advocated by Plastow (2016).

This research used a case study of Chadereka Ward 1 which was purposively chosen given its contrasting climatic conditions of flooding and drought annually which increase its vulnerability to food insecurity and health pandemics. This testifies the varying and changing climate in the area. The Ward has therefore become one of the focal points for humanitarian organizations like the Zimbabwe Red Cross Society and the World Vision which try to capacitate households in the area with various life skills and materials. Details about the procedure and key research instruments used in the collection and analysis of data are key issues in this Chapter.

The mixed or qualitative and quantitative approaches are not an end by themselves without criticism. Methodological purists challenge the combined use of the two paradigms (Bryman, 2008; Creswell, 2013). As pointed out by Bryman (2008) and Wirtz and Strohmer (2016), quantitated qualitative data is vulnerable to misconstruction and obscurity. While the mixed approach is popular currently, it calls for researchers who are well versed with the two (quantitative and qualitative), otherwise statistical or textual issues would suffer analysis (Hartas, 2015; Hussein, 2009; Plastow, 2016). The approach is also feared to be time consuming and expensive (Creswell, 2013; Sheperis *et al*., 2016). The present research safeguarded against all this by focusing on one ward and engaging three research assistants.

4.4 DATA COLLECTION INSTRUMENTS

Swanborn *et al*. (2010) and Creswell (2014) identify the methods for collecting research data as qualitative or quantitative. This classification considers the manner and form in which the data is gathered. However, sources of data can also be reflected in these methods as either primary or secondary data sources (Adams *et al*., 2014). Primary data sources involve the researcher and the assistants collecting the data themselves for their own use while secondary data sources are generally about desk top and document analysis, where the researchers consult the available data collected by other people for their own use (Merriam and Tisdell, 2015). For the purpose of this research, mainly primary data collection instruments were used.

The basic distinction between qualitative and quantitative methods is that the former provides data in word or visual form while data for the latter is numerical (Kumari *et al*., 2014; Sarantakos, 2013). Of importance to note is that the two are complementary, especially when dealing with data from both the social and natural sciences like the one on rural livelihoods strategies and adaptation to climate variability and change. The distinctions between quantitative and qualitative research, according Swanborn *et al*. (2010), are tabulated in Table 4.1. Creswell (2014) and Kumari *et al*. (2014) also concur with these characteristics.

Table 4.1: Qualitative versus quantitative research (adapted from Swanborn *et al*., 2010:5-6)

Qualitative	Quantitative
Objective is to discover and summarize meanings once the researcher becomes immersed in the data.	Objective is to test hypotheses that the researcher generates.
Concepts generated are in themes, topics, generalizations and categorizations.	Concepts are in the form of different variables.
Measures are more specific to the individual setting (case of Chadereka Ward 1) or researcher.	Measures are standardized and systematically preconceived before data collection.
Data from observations and transcripts are in the form of words or text though some quantitative one can also be used.	Numerical data from precise measurement or questionnaire schedules is used.
Theory can be causal or non-causal and is often inductive - posteriori.	Theory is largely causal and is deductive - apriori.
Research procedures are particular, and replication is not possible.	Procedures are standardized, and replication is possible.
Analysis follows the extraction of themes, patterns or generalizations from evidence and organizing data through encoding to provide a coherent and consistent picture. The generalizations are then used to generate hypotheses.	Analysis is done using SPSS like version 21 through which statistical tests are used like in this research the Multinomial Logit Regression Model (MLRM). Tables and charts were used in the presentation of data followed by a discussion on how they relate the phenomena under study.

The MLRM is useful to examine relationships between different variables. In this study, how selected socio-demographic factors (such as age, education, household size and marital status) influence the uptake of rural livelihood and climate change adaptation strategies are examined. It is important to note that the MLRM will indicate whether the factors are likely to influence the uptake of rural livelihood and climate change adaptation strategies but do not provide reasons. This limitation is addressed by integrating qualitative research that probes the reasons for statistical results.

With clarifications from the distinctive properties of qualitative and quantitative data collection methods, a combination of the two was used in this research as already pointed out. This facilitated the triangulation of different data collection techniques for the checking of validity and reliability of the research findings (Below *et al*., 2012; Creswell, 2014; Kumari *et al*., 2014). Since a case study approach is adopted, where Chadereka Ward 1 in Muzarabani Rural District was purposively chosen for this study, key instruments in the collection of qualitative data were interview guides, observation guides (photo visioning) and focus group discussion guides which conforms to Swanborn (2010), Kumari *et al*. (2014) and Sarantakos' (2013) assertions of what constitutes qualitative research. These characteristics made the approaches relevant to the study. Household surveys with both structured and a few non- structured questionnaire schedules were employed in gathering quantitative data. The way how these were employed is detailed in the following sub-sections.

4.4.1 Quantitative Research Methods

Quantitative research methods principally sought the numeric description of household views, attitudes, trends and practices regarding their rural livelihoods and how they are adapting to climate variability and change through the household questionnaire surveys (Creswell, 2014). Since several quantitative research methods exist, according to Swanborn *et al*. (2010) and Kumari *et al*. (2014), the present research used the survey method. As inferential statistics is involved according to Punch (2012) and Sarantakos (2013), the MLRM was computed for this research. The next sub-section describes in detail the survey (household questionnaire interview), the quantitative research method adopted for this research.

4.4.1.1 The Household Survey

Given the diversity of meanings for 'household' as given by various cultural groups, this research considers the definition by Malleson *et al*. (2008:7) who describe it as "a group of people living together in the same house who regularly cook and eat from the same pot". For this particular research, a survey, which is a quantitative primary method of collecting data from sampled people, was used. Specifically, a household questionnaire interview survey was used in gathering quantitative data in Chadereka Ward 1. This was appropriate in that data from the sample of three hundred and ten (310) households was obtained in relatively less time and the instrument simplified data analysis through the use of SPSS version 21. However, due to a few technical terms involved and the relatively low level of education in the area, some household respondents had to be assisted in completing the questionnaire as it involved translating the questions into the vernacular Shona language in the majority of the cases. Thus, all the responses given were recorded on the spaces provided. The survey targeted the household representatives that were either male or female. The individual had to be 18 years or older to comply with ethical requirements.

The household survey (Appendix A) was a principal research data collection method and in its design, five sections were considered: Section A - Demographic Data; Section B – Livelihoods (strategies for a living) and Assets; Section C - Awareness of Climate Issues at Household Level; Section D - Adaptation Issues; and Section E - Stakeholder Participation. The objectives and research questions of the study were broadly covered in these sections. The survey was meant to capture more data on the subject from household representatives who were the main stakeholders in this research as also noted by Below *et al*. (2012).

The instrument employed both closed and open-ended questions. The closed questions which were the majority were useful in the quantification of the data given by the respondents. Some of the viewpoints, perceptions or beliefs of the respondents regarding the issues of rural livelihoods and adaptation to climate variability and change in Chadereka Ward 1 were captured by the open-ended questions. It was easier to enter data from closed-ended questions into the SPSS version 21. More time was taken for the open-ended questions which required responses to be coded prior to entering the data in the computer.

Ethical issues were addressed by an introductory consent letter written in English and in Shona which was attached to each questionnaire (Appendix A). Basically the letter was informative with respect to the brief biography of the researcher, the purpose of the research, and assured the respondents of anonymity in whatever contributions were to be made regarding the research. Withdrawal from the survey was also permitted. Permission to visit the ward was sought from the Provincial Administrator, the District Administrator and local authorities (Chief and Ward Counselor) in Chadereka Ward 1.

Due to the reasonably large number of the respondents, three research assistants helped as fieldworkers who were well versed with the socio-economic and political systems in Muzarabani Rural District and were former undergraduate students of the Bindura University of Science Education. They were selected by the principal researcher who considered their level of knowledge and understanding regarding the conduct of research in communities. However, some induction sessions were conducted during the pilot study which ensured proper execution during the actual survey. As an advantage, the survey method allowed for the collection of data from many people in a short space of time with reduced expenses. However, the intensive involvement of the researcher and the assistants in translating the questions to Shona and completing the schedules on behalf of illiterate household respondents, consumed more time and money than expected. However, the assistance given ensured a hundred percent return of the surveys administered. Biasness was also minimized as many households were responding to similar issues. The method allowed for the probing of some responses, especially in relation to the open-ended questions used. The duration time for data collection was from August 2014 to October 2015 as the researchers could not do this on a daily basis. This also permitted a greater understanding of the research area.

4.4.2 Qualitative Research Methods

As there exists different beliefs, perceptions, interpretations, responses and understanding about geographical phenomena like rural livelihoods and adaptation to climate variability and change, Brosius *et al*. (2012) and Plastow (2016) suggest that the integration of quantitative and qualitative research methods in such cases provides clear understanding of connections between issues like social vulnerability and climate variability and change. Beliefs and perceptions are better studied by the use of qualitative research approaches, some of which are identified and described by Arino *et al*. (2016):

- Ethnomethodology: Is useful in cultural investigations for theoretical development where the intention is to solicit beliefs and perceptions of a group of people regarding their understanding of particular emerging issues in their community like climate variability and change in Chadereka Ward 1 in Muzarabani Rural District.
- Critical Social Research: For understanding communication issues among people and finding the symbolic meaning attached.
- Historical Research: Focuses on the past, present and future events in the context of present conditions aimed at developing solutions to current issues and problems. Questions include: How were the climatic conditions in the past? How are they now? What are your projections into the future? These are useful in the context of the current study.
- Grounded Theory: An inductive research type anchored or "grounded" in the observations or data or events. Makes use of an assortment of data sources which include quantitative data, review of records, interviews, observation and surveys.
- Phenomenology: Identifies the ‘subjective reality’ of an event, as perceived by community under study. It studies a phenomenon like climate variability and change or rural livelihoods.
- Case Study: Applied here as the main study in Chadereka Ward 1 investigating rural livelihoods in the face of climate variability and change which is a current issue. Multiple instruments of data collection analysis were used as advocated by Sarantakos (2013).

In the present study not all of the quantitative and qualitative research approaches were used. The approaches whose characteristics were relevant in gathering and analyzing the data were considered. The primary qualitative data collection instruments used were the key informant interview guides, focus group discussion guides and the observation guides. Thus, the majority of the tabulated qualitative approaches found their application in one way or the other given their objectives which align with the issues involved in this research. The following sections describe in detail the qualitative data collection techniques used in the research.

4.4.2.1 Key Informant Interview

Interview guides (Appendix C) were prepared to solicit data from the key informants who were the Counselor of the Ward, Chief, MRDA, Head Officials or representative from the (CPU) or EMA, representatives from NGOs who normally assisted in the District during adverse climatic events like floods and drought, Director or Appointee of the ZMSD and Agritex official(s). A health personnel (Sister-in-Charge) at Chadereka Clinic was also interviewed at the clinic. A total of ten (10) key informants were interviewed.

The guide which had open-ended (unstructured) questions captured information directly linked to the research objectives such as the current rural livelihood strategies in the area, natural resources management strategies, awareness of climate variability and change, the impacts of climate variability and change, sustainability of adaptation strategies to climate variability and change, challenges encountered as households try to adapt to climate variability and change, and the roles of stakeholders in rural livelihoods and adaptation to climate variability and change. All the interviewees could not be met in the same day and appointments were made well in advance. Some were visited at their workplaces while others at their homes (Image 4.3) and social gatherings throughout the study period that is from 2013 to 2016. Face-to-face interviews were conducted by the researcher and the three assistants. The technique allowed some follow up questions as the interviewer sought clarifications, as advocated by Creswell (2013; 2014) and Sarantakos (2013). During the face to face interview, the interviewers noted down the responses given by the interviewee.

Image 4.3: The researcher carrying out a 'face-to-face' key informant interview with the Chadereka Ward 1 counselor at his home

4.4.2.2 Focus Group Discussion

Three focus group discussions (see Appendix B for the Focus Group Interview Guide) were conducted with those respondents who participated in the household survey in the Ward. The researcher solicited venues for the discussions from the Ward. These were Chimoi Primary School, Chadereka Service Center and Gunduza Service Center. The activity was performed on separate days and registers for participants were generated and counter checked each time the discussion was held as a way to avoid repeaters. As the researcher and the three research assistants visited households administering the questionnaire interviews, the respondents were given the freedom to participate in a focus group discussion scheduled for a specified date and venue. Fridays, Saturdays and Sundays were targeted for the focus group discussions since the majority of household heads would be free with some visiting places of interest like the Chadereka Service Center for leisure, church activities or other business.

Both males and female were free to participate during the focus group discussions. A maximum of 12 people and a minimum of 8 people per each focus group discussion were permissible as suggested by Arino *et al*. (2016). For this research 12 participants were targeted. The researcher used this method to gain more insights into the livelihoods in the rural Ward and how households were adapting to climate variability and change. This also clarified the results obtained from the household survey and key informant interviews conducted. Other responses were recorded on separate sheets then organized immediately after the discussion. Image 4.4 shows the researcher conducting a focus group discussion while two research assistants were writing down the responses and the other assistant was taking photographs of the proceedings.

Image 4.4: A focus group discussion in progress in one of the class rooms at Chimoi Primary School

4.4.2.3 The Observation Method

The observation method was used to capture non-verbal data to examine the current situation in Chadereka Ward 1 regarding the theme of the research: rural livelihoods and adaptation to climate variability and change. Specifically, the method used was photo visioning, which according to Mudavanhu *et al*. (2012), involves the taking of photographs of salient biophysical and socio-economic aspects like livelihoods, natural resources (land, rivers, water sources and others.) and other human artifacts including infrastructure relevant to the study. Thus, smart phones and digital cameras were used. These were important in the verification and authentication of some claims by the household respondents. The aspects that the instrument considered are illustrated in Appendix D.

4.5 SAMPLING

Sampling is a process of selecting a portion of the whole population (Adams *et al*., 2014; Sarantakos, 2013; Teddlie and Yu, 2007). Palinkas *et al*. (2015) suggest consistency when sampling and considering aims and assumptions of the research methods for the benefit of maximum efficiency and validity. While quantitative research method requires samples which support generalization of results, the qualitative research approach is for the one which yields a deep understanding of the phenomenon (Palinkas *et al*., 2015). Sampling is useful since it is physically and economically difficult to study the entire population (Baran and Jones, 2016; Marshall, 1996). Baran and Jones (2016) further expresses that sampling guides any research against loss of time, high costs, inaccuracy, inaccessibility and destructive observations. This research was carried out in a purposively sampled Ward in Muzarabani Rural District in Zimbabwe. Chadereka Ward 1 was selected considering its accessibility, physiographic characteristics which include proneness to drought and floods, and socio-economic and political challenges experienced in the area. It also represents a typical poverty-stricken rural community. Table 4.4 illustrates further the sampling of the households in the research area.

Table 4.2: Household survey sample size in Chadereka Ward 1 in Muzarabani Rural District

Ward	Total Households	Number of Villages	Number of Households Sampled	Confidence Level (%)	Confidence Interval
Chadereka Ward 1	1 594	51	310	95	5

According to the ZIMSTAT (2012), Chadereka Ward I has a total number of 1 594 households within 51 villages. The Survey System Sample Size Calculator software was used in determining the number of households for this research. Table 4.4 shows that at 95% confidence level using a confidence interval of 5 the sample size was calculated to be 310 households. This is statistically significant and representative. Thus, an average of 6 households per village was selected at random to minimize bias. During the random selection of the households, the village heads from the Ward supplied lists of household names per village which then were assigned computer generated random numbers by the researcher and the assistants. Therefore, a multilevel mixed sampling method was followed (Adams *et al*., 2014; Teddlie and Yu, 2007; Malleson *et al*., 2008). Figure 4.2 summarizes the sampling methods, research methods and data collected.

For the focus group discussions, household representatives who participated in the household questionnaire interviews and key informant interview were randomly selected considering their willingness to participate in further discussions on the key issues covered in this study. The key informants are known due to their designations and were approached at their usual social or work places. Thus, for the focus group discussions and the key informant interviews, purposive sampling was useful as indicated by Adams *et al*. (2014) and Malleson *et al*. (2008).

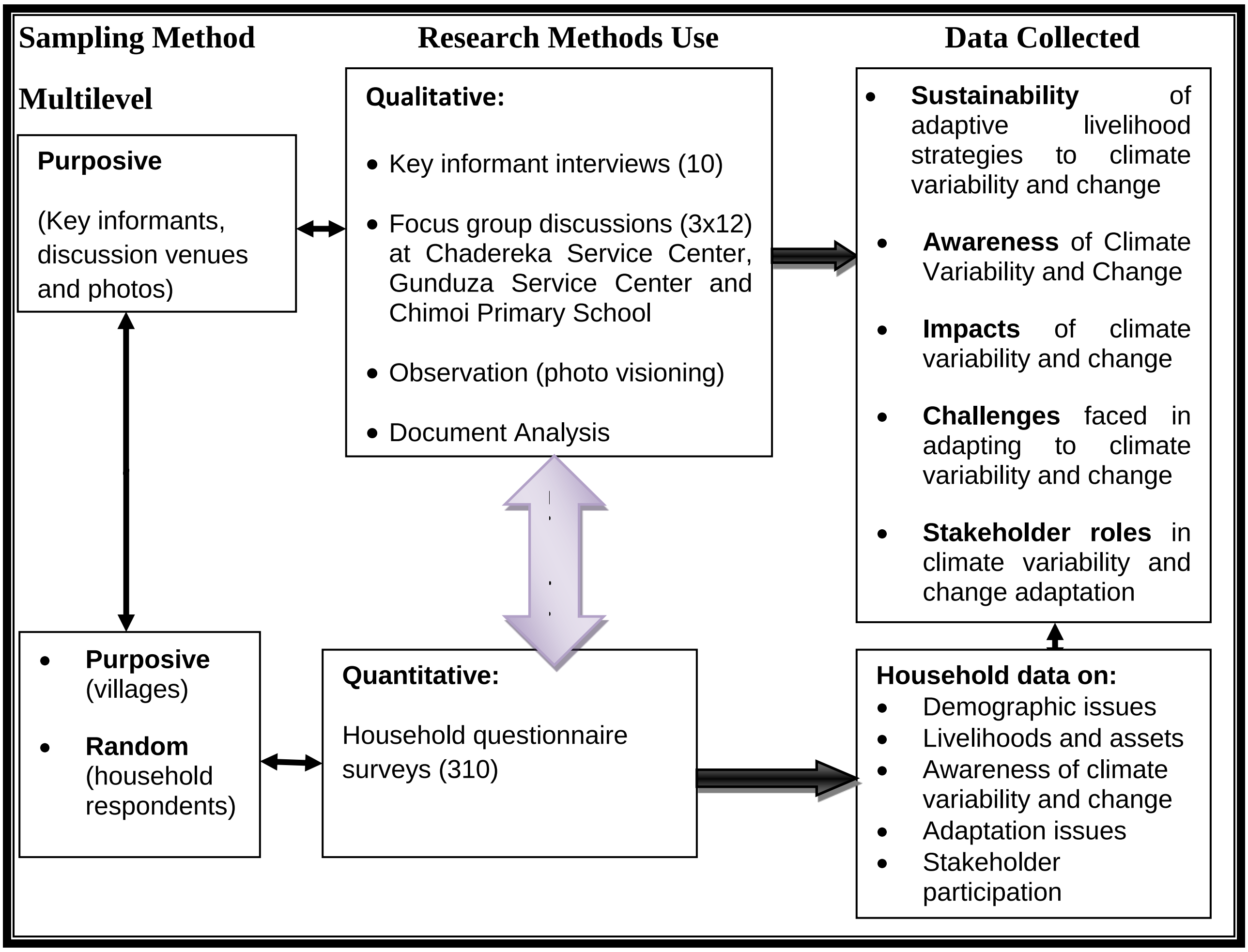


Figure 4.2: Sampling, research methods used and data collected

The diversity of the research methods presented in this Chapter fostered a holistic approach to the gathering of data for the study as advocated by Creswell (2013; 2014). Table 4.5 summarizes the research methods, sources and type of data collected for this research. As an interdisciplinary research endeavor, a mixed approach research design was used and facilitated the triangulation of diverse data collection techniques to enhance validity and reliability of the data. Taking cognizance of the theoretical underpinning of the research elaborated in Chapter

3, the data gathering instruments were designed addressing issues outlined in the research aim and objectives as reflected in the attached appendices.

Table 4.3: **Research methods, source and type of data to be collected**

RESEARCH METHOD	**SOURCE/ TARGET GROUP**	**TYPE OF DATA COLLECTED**
Qualitative design: Primary sources		
Key Informant Interview (10)	Village Heads, Ward Councilor, Chief, District Administration official, Head Officials from the CPU or EMA, NGOs, ZMSD Official, School head, Clinic head and Agritex Officers in the ward.	Current livelihoods strategies, policies or laws, climate variability and change impacts, adaptation strategies to climate risks, challenges encountered and stakeholder roles in promoting sustainable rural livelihoods.
Focus Group Discussion (3)	Three groups of maximum twelve (12) purposively sampled mixed household representatives in Chadereka Ward1 in Muzarabani Rural District.	Current livelihoods practices, laws, climate variability and change impacts, adaptation strategies to climate risks in Muzarabani Rural District, challenges encountered and stakeholder roles in promoting sustainable rural livelihoods.
Observation	Biophysical and human assets like water sources, livelihoods and infrastructure.	Visioning current livelihoods strategies, household assets climate variability and change impacts on biophysical and human environments.
Quantitative Design: Household Survey (310)	Three hundred and ten (310) randomly sampled households from villages in Chadereka Ward 1.	Current livelihoods strategies, laws biophysical and socio-economic impacts of climate variability and change, adaptation strategies to climate risks, challenges encountered and stakeholder roles in promoting sustainable livelihoods.

4.6 DATA ANALYSIS

Data analysis is the sorting of responses given and ordering or categorizing the collected data considering the design and techniques employed in the research (Creswell, 2014). The qualitative data from key informant interviews and focus group discussions were analyzed through coding (putting data into thematic areas) and this started during the data collection phase as expressed by Adams *et al*. (2014) and Sarantakos (2013). From the two qualitative sources, a summary of responses per question asked was written while some direct quotations were considered and noted. Thus, a content quote analysis technique was used for most of the qualitative data collected. Similar to Ofuoku (2011), some of the collected data was subjected to descriptive statistical analysis such as frequency counts and percentages from the likert scales used. In analyzing the household responses on the sustainability status of rural livelihood strategies in the face of climate variability and change in the study area, ranking with the use of a likert scale was done by participants as follows: '1'- sustainable; '2'- moderately sustainable and '3'- not sustainable. Similarly, the effectiveness of the stakeholder roles in promoting sustainable rural livelihood strategies in the face of climate variability and change in Chadereka Ward 1 was also rated as '0'- not effective; '1'- less effective and '2'- effective. Thus, the opinions of the respondents were captured and recorded in this manner. Photos were presented wherever they served as evidence of the prevalent situation during the fieldwork and data collection exercise.

The qualitatively analyzed data was concurrently presented and discussed together with the household questionnaire data analyzed quantitatively using SPSS version 21. The two designs focused on one issue: rural livelihoods and adaptation to climate variability and change and the themes for their foci were guided by same aim and objectives. Thus, triangulation of the mixed methods authenticated the validity of the outcomes of the research. The combined framework (SRLF and CHES) (Figure 3.4) was also useful as a tool for data analysis as shared by Scoones (2015). These helped in the identification and presentation of the rural livelihood assets in Chadereka Ward 1. The research question items used were identified with the framework, making the analysis easier and the provision of the sustainability status for the rural livelihood strategies pursued in Chadereka Ward 1 in the face of climate variability and change clearer.

A MNRM which is an analytical model that is commonly used in adoption decision studies involving more than two multiple choices (Balama *et al*., 2016; Yegbemey *et al*., 2014) was computed to analyze how selected socio-demographic factors influenced the uptake of rural livelihood and adaptation strategies in Chadereka Ward 1 in the face of climate variability and change. For the application of this analysis in this research, rural livelihood strategies included farming, mining, hunting and gathering (dependent variables) were considered. The independent variables were age, gender, marital status, house hold size and education. Adaptation strategies analyzed were the growing of crops and keeping of animals which are drought tolerant, conservation farming, changing of crop calendar, livelihood diversification (on-farm and off-farm activities), flood recession cultivation, irrigation, agroforestry (carbon projects), climate insurance cover and others which included mulching and food rationing The suitability of the model was also confirmed using the SPSS version 21 software. Geographical Information Systems (GIS) was important in the mapping of the area studied. Finally, tables, graphs, images, maps and diagrams were used for data representation.

4.7 SCOPE AND LIMITATION OF THE STUDY

The focus of the research is to assess rural livelihoods and adaptation strategies to climate variability and change in terms of their sustainability in Chadereka Ward 1 in Muzarabani Rural District. It supports the examination of practices by rural households whose economic base is mainly rain-fed agriculture. Generally, climate change is not well understood in marginal rural areas where information dissemination is limited. The research, being a case study, is limited to Chadereka Ward 1 which is strongly affected by extreme weather conditions including floods and droughts. Chadereka Ward 1 is one of the wards in Muzarabani Rural District with 1 594 households (Zimbabwe National Statistics Agency [ZIMSTAT], 2012; 2013). It is usually a flood prone area in the northern lowveld of Zimbabwe.

Sampled household representatives and key informants comprising of the local authority, government and NGOs officials and parastatal heads constituted the study respondents. Language, especially, some technical terms involved and time constraints limited engagement with the sampled household representatives and other respondents. However, the study tried to make use of the indigenous Shona language and its sample representative by calculating it using the Sample Size Calculator.

4.8 CONCLUSION

This Chapter focused on the methodological issues for data collection, analysis and representation. In this research on rural livelihoods and adaptation to climate variability and change, a mixed research methodology was adopted which supported the use of varied data collection techniques, namely, household questionnaire surveys (quantitative), key informant interview guides, focus group discussion guides and observation guide (qualitative). The justification of such methods was given principally as being relevant to a case study research design followed. Thus, the data analysis considered corresponded to the pathways in which the data was collected principally content analysis, descriptive statistics and MNRM. It is also within this Chapter that a comprehensive description of the study area of Chadereka Ward 1 was given. The next Chapter presents and discusses the analyzed research results.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 INTRODUCTION

Having dealt with the other essential components of this research which involve the orientation of the study, the conceptual and theoretical frameworks, literature review and the research methodology in the preceding four Chapters, this Chapter presents, discusses and analyzed results. The analysis procedures previously described were generally two fold: content analysis and numerical or statistical analysis given the mixed methodological (qualitative and quantitative) design adopted. Thus, the results from the corresponding instruments for data collection are concurrently and chronologically presented and discussed in relation to the research questions or objectives. The presentation is done in thematic themes or sub-headings which directly link to the outlined research questions or objectives.

The study sought to assess rural livelihood practices and adaptation strategies in terms of their sustainability in the face of climate variability and change in Chadereka Ward 1 in Muzarabani Rural District in Zimbabwe. The results presented herein were obtained using the 310 household questionnaire interviews, the 10 key informant interviews, 3 focus group discussions, and some general observations evidenced by scenic photographs. An extensive review of relevant literature to the issues under study was done and this reinforced the outcome discussions.

This Chapter firstly presents the demographic and socio-economic characteristics of the respondents which have a bearing on the interview responses and guide the overall analysis and discussion in the subsequent sections of the research data presentation. The current rural livelihoods, their sustainability status and the policies or regulatory systems governing their execution in Chadereka Ward 1 are presented thereafter, followed by community awareness status on climate variability and change issues. The biophysical and socio-economic impacts of climate variability and change in the Ward are then presented noting the conceptual framework adopted in this research. The remaining aspects focus on rural livelihoods and adaptation strategies, challenges faced and stakeholder roles in promoting sustainable rural livelihoods to climate variability and change in the area studied.

5.2 DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS IN CHADEREKA WARD 1

Usually actions taken by communities when confronted by societal problems reflect their demographic and socio-economic characteristics within their biophysical environment (the human-nature relationship). Such characteristics interact to frame a community's response to climate variability and change (Van Aelst and Holvoet, 2016). It is therefore prudent to initiate the presentation of data by providing demographic and socio-economic information of the respondents. Table 5.1 shows the gender distribution of the household respondents in Chadereka Ward 1in Muzarabani Rural District.

Table 5.1: Gender distribution of household respondents (n=310)

GENDER	FREQUENCY	PERCENT
Male	184	59.4
Female	126	40.6
Total	310	100

Table 5.1 shows that 59.4% of the respondents were males while the remainder (41.6%) was females. The current economic situation in Zimbabwe, where there is unemployment or retrenchment in towns (ZIMSTAT, 2012; 2013), has seen some men leaving towns to partake in livelihoods activities at their rural homes such as subsistence farming. Social disturbances in towns like the 'Operation Restore Order' also known as *"murambatsvina"* (in Shona vernacular) was characterized by the demolition of unplanned shelters and also witnessed a great number of people moving from towns to rural areas (Dorman, 2016). This caused a general increase in Zimbabwean rural population from 65% to 67% (Zimbabwe Vulnerability Assessment Committee [ZimVac]), 2010; ZIMSTAT, 2013). More males joined their female partners in the communal areas. Zimbabwe is a patriarchal society hence male respondents were more than the females. This could have a bearing on the responses which would appear as male biased. However, other data collected from the key informants and participants during the focus group discussions validated the responses. For instance, on why people left towns to rural areas, one male focus group discussion participant confirmed (English translated):

Life had become so difficult in towns. After having been retrenched I resorted to the selling of second hand clothes renting an outside building for accommodation. One evening I found it demolished with all my belongings piled in front of the mainhouse for the land owner. As I tried to find an alternative accommodation, one evening all my wares were burnt and could not manage the pressure and came home.

Such a situation was experienced by many people who had to go to their rural homes where they were faced with climate variability and change impacting on their rural livelihoods. However, Bob and Babugura (2014) emphasize the importance of visualizing climate variability and change issues with a gender lens given the distinct roles assigned. Thus, this study does examine responses from a gendered perspective.

Figure 5.1 shows response rates per age group as a percentage. The age distribution shows male dominance in two thirds of the age group categories. Only in the age group of above 61 years females marginally surpass their male counterparts while those aged 18 to 20 years were at par and being the least (0.3%). The highest percentage (17.7%) was recorded for males within the 21 to 30 age group and the highest record (13.9%) for females was for the age group above 61 years. The 41 to 50 and 51 to 60 years age groups had almost similar distribution within 3% for females and 6% for males. Two respondents were aged 18 to 20 years and were still pursuing their studies. Such gendered age group distribution has a strong bearing on rural livelihoods and their adaptation to climate variability and change pursued by households in Chadereka Ward 1.

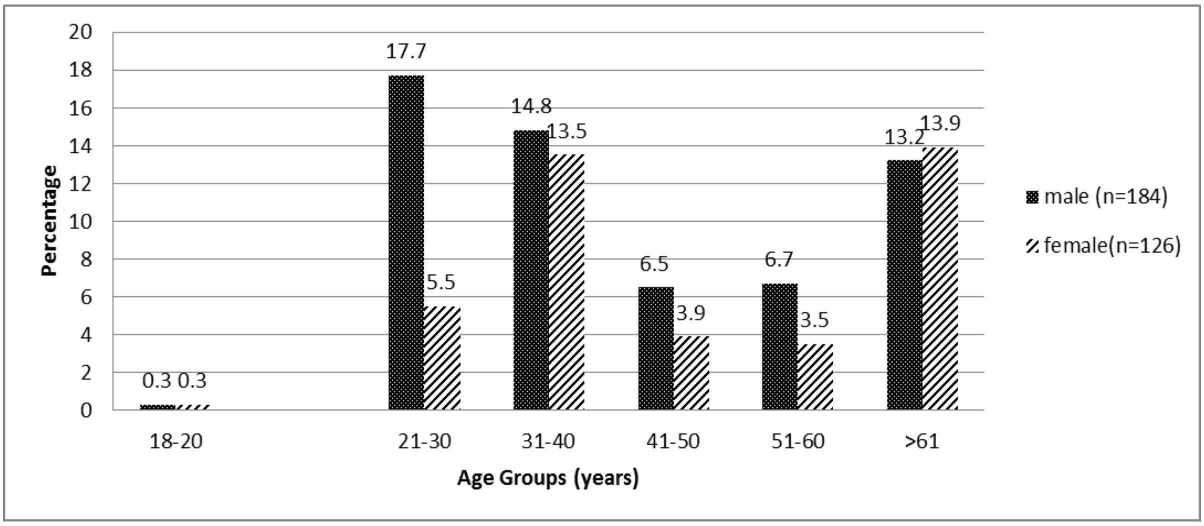


Figure 5.1: Age group of household respondents according to gender (n=310)

Mudzonga (2012) and Mugi-Ngenga *et al*. (2016) confirm that age has a bearing on the livelihoods pursued in adapting to climate variability and change. In rural areas where farming is the principal livelihood activity, young farmers adapt easily to varied technologies introduced like minimum tillage (conservation farming) which is labor intensive and counts on fitness as revealed by Jiri *et al*. (2015a). Farming in this marginal area in Muzarabani is labor intensive given the types of farm implements owned by the households mainly hand tools, ploughs and scotch carts (see Table 5.20). Hence, economically active age groups are found constituting the greatest percentage. Usually women, children and the elderly provide the general agricultural labor while the able bodied men would have pursued wage labor in the neighborhood or engage in informal trade within the Ward or District or across borders to supplement family needs. This has also been observed by Ansell *et al*. (2016), Ito (2010), Saxena *et al*. (2016) and ZimVac (2010). Successful migrants who crossed the Zambezi River to Mozambique or Zambia normally bring some products like dried fish (Kapenta) and second hand clothes for petty trade as revealed during the focus group discussions. The scenario on age groups 41 to 60 years portrays the impact of HIV/AIDS and movement from the Ward due to economic hardships being experienced and increasing vulnerability of the community to the impacts of climate variability and change as also reported by Dube *et al*. (2016). From the focus group discussions, it emerged that some people have moved to Upper Muzarabani (South of Mavhuradonha Mountain Range) where prospects for tobacco growing are lucrative since cotton growing has lost its market value in Zimbabwe. Cotton market failure also emerged in ZimVac (2010). The Chief said:

> *After independence cotton production was profitable here in Muzarabani and attracted young men from other provinces like Masvingo. These, upon getting here they intermarried and together with the general uncontrolled birth in the District caused an increase in the number of people who mainly relied on cotton production. The commodity was suitable given the prevailing climatic conditions. Currently the once 'white gold' has lost its value.*

Marital status is one social attribute solicited from the respondents (Figure 5.2). It emerged that 68.4% of the respondents (49.7% males and 18.7% females) were married. About eighteen percent (18.4%) comprising of 4.5% males and 13.9% females were widowed. Divorcees and other marital status like single and separated had the least total percentages (3.5% and 9.7%, respectively). This is yet another aspect which strongly impacts on the choices for rural livelihoods and adaptation portfolios to climate variability and change in the study area, a variable also noted by Jiri *et al*. (2015a), Ogunleye and Yekinni (2012) and Van Aelst and Holvoet (2016).

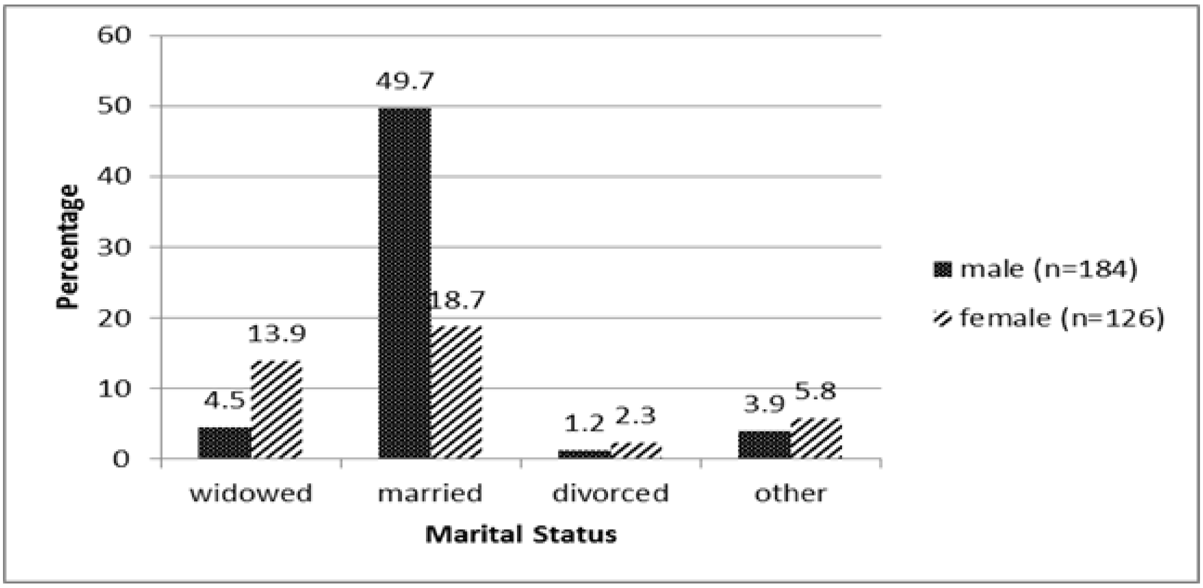


Figure 5.2: Marital Status for respondents (n=310)

In the marginal areas like Chadereka Ward 1, marriage is respected and valued as men and women do not commit adultery for fear of '*runyoka'* - a Shona-Korekore cultural practice to curb infidelity among couples. Marital status secures couples access to resources, especially women as in most African countries since they rarely own land, a practice also observed by Ansell *et al*. (2016), Ngugi and Nyariki (2005), Sharaunga *et al*. (2016) and Van Aelst and Holvoet (2016). In rural Australia, again noted that women do not play a significant role in controlling or managing household resources which is generally done by men. In rural Zimbabwe like in Chadereka Ward 1, normally women get access to resources such as land through their husbands who are allocated a piece of arable land by the chief or the father upon getting married. Moreso, Bob and Babugura (2014) Muzari *et al*. (2016) and Zimmerer and Vanek (2016) reviewed that livelihoods in communities are not gender neutral as men hold larger pieces of land than women who generally only produce for family consumption. Such discrepancies are a common feature in the area studied and imply that there is need for conscientizing the community on gender issues. Comparing widowhood between males and females, the results confirm the Zimbabwe National Population Census of 2012 which revealed more widowhood among women than males (ZIMSTAT, 2013). Normally males engage in hard and strenuous work which is labor intensive and they have high risk behaviors which increase their mortality. Thus, they succumb to the HIV/AIDS pandemic. Males also migrate more than their female counterparts to expand their livelihoods base, a situation already alluded to.

Educational level is yet another element of influence in relation to rural livelihoods and adaptation to climate variability and change strategies pursued in an area as revealed by Debela *et al*. (2015), Ogunleye and Yekinni (2012), and Olutegbe and Fadairo (2016). Figure 5.3 shows that 8% of the respondents have not received any formal education, with more females (4.5%) than males (3.5%). Close to a third of the respondents (33.6%) received primary education, with more males (25.2%) than females (18.4%). The percentage of respondents with secondary education was 40.3% (24.5% males and 15.8% females). Eight percent had tertiary education with 6.1% males and 1.9% females. Generally, the data shows gender bias with respect to education as more priority is given to males than females, particularly in rural and marginal areas (Masud *et al*., 2016; Mugi-Ngenga *et al*., 2016). Ngugi and Nyariki (2005) also observed that females in Kenya are less educated than males. Usually females are considered as child bearers in African traditional societies and get married earlier than males. Some religious sectors even discourage parents to send their girl children to school. With regard to rural livelihoods in Chadereka Ward 1 and how people are adapting to the adverse climatic conditions, education level which is part of the human capital is critical.

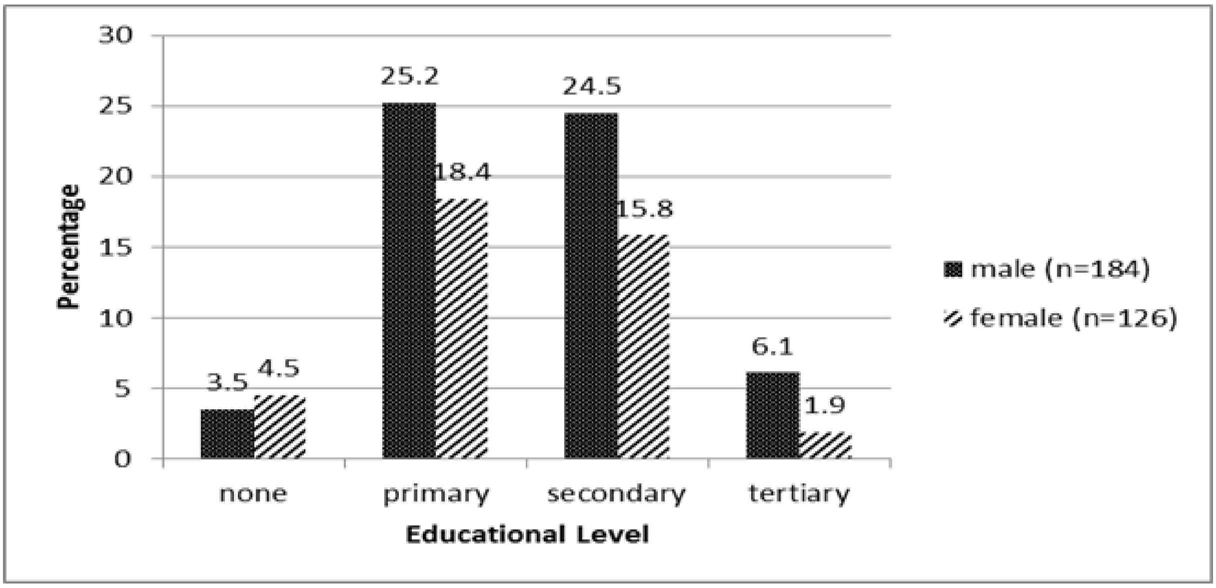


Figure 5.3: Respondents' educational level according to gender (n=310)

The implication from the education level distribution in Chadereka Ward 1 among household respondents is that human capacity development through education campaigns and extension services as also revealed in the Malaysian study by Masud *et al*. (2016) need to be promoted. Values of sending children to school should be instilled within the community. Debela *et al*. (2015) point out that education level increases access to climate information and a positive potential reaction. From ZimVac (2010) it emerged that the livelihoods portfolio is limited in terms of diversity due to the lack of vocational education which supports inventions to make them sustainable. However, the Zimbabwean literacy rate has been increasing through the education reforms like the 'near universal primary education for all in the 1990s' (Government of Zimbabwe, 2012). Currently, through the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset) framework, education is highly regarded and curriculum change is being implemented to develop Zimbabwean citizens who are innovative and respond to challenges (Government of Zimbabwe, 2015). As such, a high percentage of the respondents (83.9%) has acquired at least secondary education which is a positive step in people having thw ability and capacity to initiate their survival strategies in this era of climate variability and change.

The research established the household sizes of the respondents as shown in Figure 5.4. There was an almost even distribution in categorized household sizes of 3 to 6 members (ranging from 12% for 4 and 17.1% for 4 and 6). Household respondents with greater than six members constituted the greatest percentage (32.9%). This compares favorablely with other research by Jiri *et al*. (2015a) and Debela *et al*. (2015) with an average household size of 7. The computed average household size for this study was 4.28 and this does not conform to the national average of 6 as reported in ZimVac (2010). The household sizes of 5 and 6 members had 17.1% of the respondents on each category. Twelve percent and 16.1% of the respondents had household sizes of 4 and 3 members, respectively. Close to four percent (4.2%) comprised of households with 2 members and only two respondents lived as individuals.

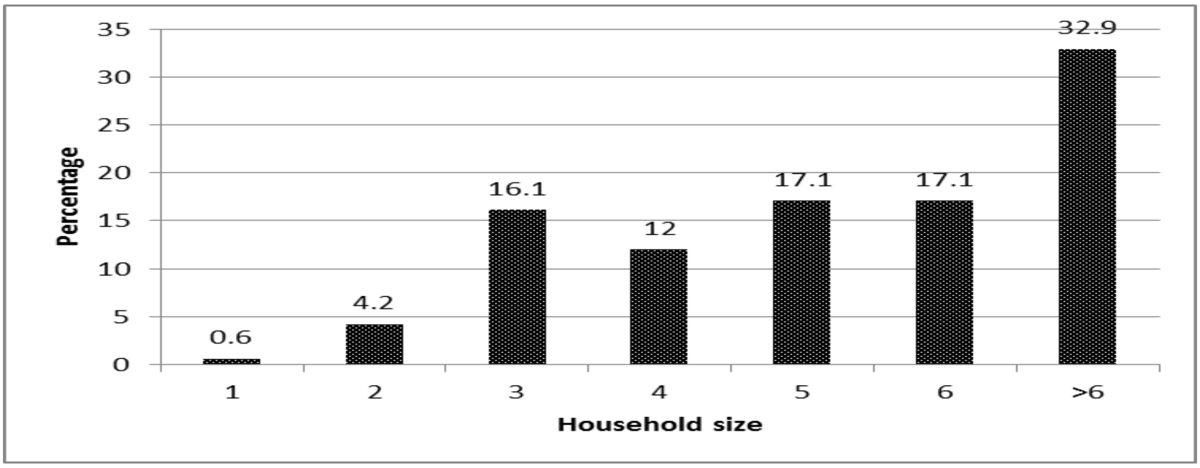


Figure 5.4: Household responses on household sizes (n=310, x=4.28)

Household sizes are a critical variable in rural livelihoods which are mainly labor intensive as exposed by Mudzonga (2012) and Jiri *et al*. (2015a). Large families enable the household to participate in diversified adaptation strategies to climate variability and change as indicated by Balama *et al*. (2016), Katanha and Chigunwe (2014) and Mugi-Ngenga *et al*. (2016). Thus, it is expected that the greater the household size the more the livelihood outcome as there is a lot of division of labor for more livelihood portfolios (Muzamhindo *et al*., 2015). For example, during cotton production, more labor was found locally available. Since cotton had been affected by the reduced market pricing as already revealed, it became difficult for the redundant labor force to be absorbed in Chadereka Ward 1. The greater household size also has increased demand for natural resources which sustain lives in rural areas. Thus, there is more demand for most of the natural resources like wood, wild fruit and water in the Ward. Hence, bigger families are normally a liability and are affected by income and food shortages, especially when confronted with adverse climatic conditions as stated by Goulden *et al*. (2013). In the study area food shortages are a common phenomenon being worsened by climate variability and change among other socio-economic factors as highlighted by Bob and Babugura (2014). This implies that the promotion of self-help projects in the Ward would create opportunities for the redundant labor force. Capacity building on improving trade products and services, among other livelihoods, is an important step towards livelihood sustainability in the face of climate variability and change for the Chadereka community. Besides, new technologies and access to credit and extension serve to improve the adaptation capacity of the local people (Muzamhindo *et al*., 2015).

Generally, Zimbabwe is a multidenominational country with regards to religion. According to household respondents in Chadereka Ward 1, there are more Christians (73.5%) than any other religion. This is followed by traditional beliefs (14.8%) and Muslims (8.7%). Smaller percentages of 2.3% and 0.6% suggested none or other religions, respectively. Figure 5.5 illustrates the percentage responses.

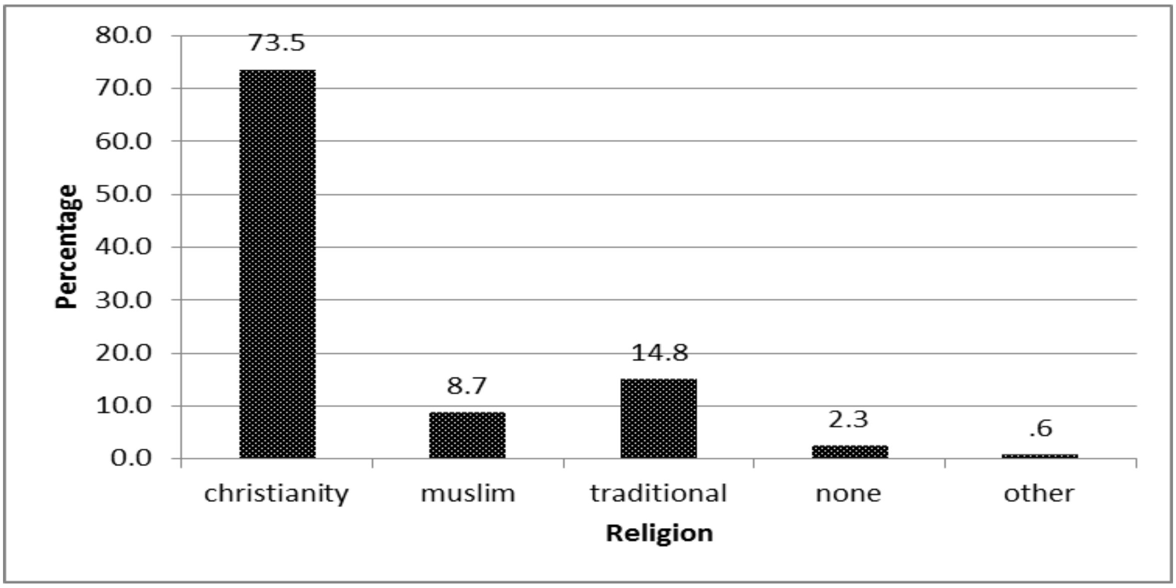


Figure 5.5: Respondents' religious affiliation (n=310)

Religion has a strong bearing on the rural livelihoods and adaptation strategies to climate variability and change pursued by the inhabitants of the area as also revealed by Murphy *et al*. (2016) and Watson and Kochore (2012). Normally it affects the execution time and type of rural livelihoods. Some religions have set aside days of worship on which no one is allowed to work like in Chadereka Ward 1. Either Saturdays or Sundays have been set aside as holy and prayer days by most Christians as revealed during the focus group discussions. The traditional followers practice piggery as one of the livelihood practices within the Ward which some religions consider as sinful. However, some Christians are not concerned in the type of livelihoods practised. For example, in the study area some Christians also practice piggery and eat pork, while others drink beer and smoke tobacco. Hence, this contradicts the general statement by Egbe *et al*. (2014) that uptake of adaptation strategies to climate variability and change vary according to religious understanding. Murphy *et al*. (2016) even noted that religious beliefs were dynamic. While most Christians view climate change as an act of God and use prayers for God to intervene and normalize climatic hazards, the traditionalists and other Christians believe in ancestral spirits and perform ritual practices like brewing beer to appease them and provide rains in good times as indicated during the focus group discussions. Thus, efforts pursued in relation to adaptation strategies tend to differ as forwarded by Murphy *et al*. (2016), Shackleton *et al*. (2015) and Watson and Kochore (2012). Also, other religions promote polygamy which increases the number of children in households and thus practise labor intensive adaptation strategies like minimum tillage. All these affect the livelihoods and adaptation to climate variability and change outcomes. Thus, religion can either enhance or act as a barrier to livelihood development and adaptation to climate change portfolios. Murphy *et al*. (2016) and Shackleton *et al*. (2015) therefore state that adaptation opportunities and enablers which involve such socio-cultural issues so far discussed need more attention in order to approach the challenge of climate variability and change from an informed stance.

Household respondents were asked to indicate their birth places (Figure 5.6). The majority of the respondents (64.2%) are from Muzarabani Rural District by origin while 35.2% confirmed that they were from other Districts in Zimbabwe and had migrated to the area, attracted by 'white gold' (cotton production). Only two respondents (0.6%) were of Mozambican origin who came some time back and were married in Zimbabwe.

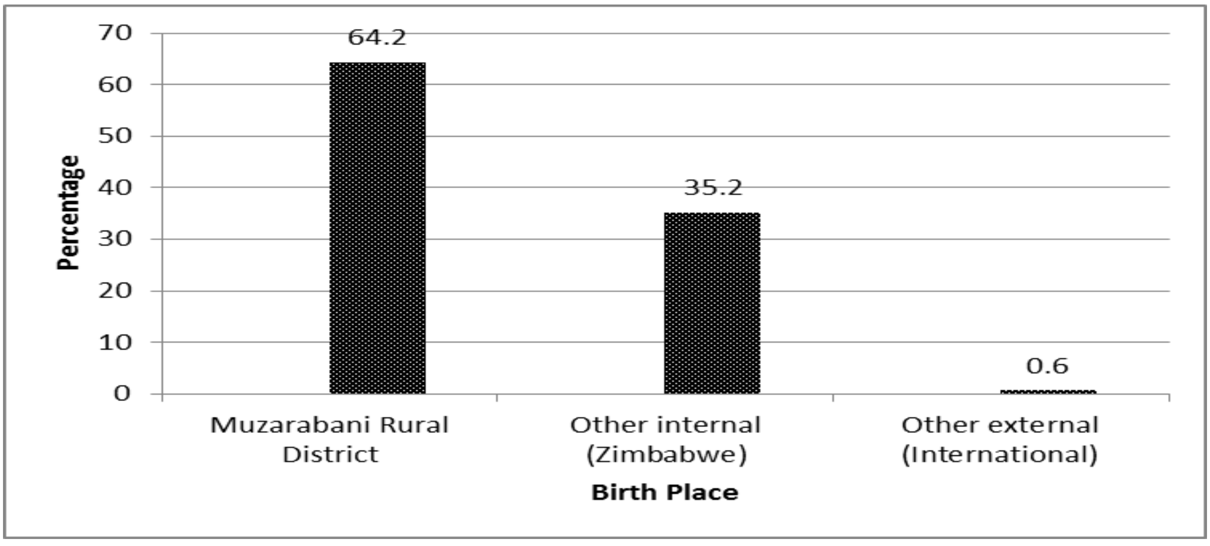


Figure 5.6: **Respondents' birth place (n=310)**

Birth place is an important aspect in this research presentation as the real experiences and perceptions of the household respondents are captured regarding the rural livelihoods practised and adaptation strategies to climate variability and change pursued. Jonah *et al*. (2015) suggest birth characteristics as determinants for livelihoods practised. Important data regarding the trends of the climatic variables like temperature and rainfall in different time series in the area studied is provided and compared. The Ward counselor said:

> *Before independence, Chadereka was sparsely populated with fewer people than now. Wild animals like kudus, impalas, bucks, buffalos, warthogs, hares and even elephants used to be abundant in the area. Now these are scarce and have moved to the Mavhuradonha Mountain Range and the Zambezi River in search of food and water. The increase in population created demand for land and the clearance of once densely forested areas.*

This shows that the people in Chadereka Ward 1 have different origins. With independence, legislation was relaxed and people became free to move to other areas with the blessing of the Chiefs and traditional leaders in the area of destination. The analysis serves to develop an understanding of socio-cultural aspects which influence the livelihoods and adaptation strategies pursued.

The respondents further supplied data on their time of stay in the Ward (Figure 5.7). The largest percentage (44.2%) indicated that they had stayed for between 11 to 20 years. This is followed by 28.4% whose stay was from 21 to 30 years. Close to fifteen percent of the respondent (14.5%) had stayed for 10 years or less, while few respondents (6.1% and 6.8%) had stayed for 31 to 40 years and more than 40 years, respectively. The average length of stay in the Ward was 20.5 years. On the issue of birth place, useful experience on livelihood practices and adaptation strategies pursued depend on the duration of stay in the Ward as also observed by Balama *et al*. (2016) and Saxena *et al*. (2016). The longer the inhabitants stay in their locality the more they construct their understanding of their environment and know how to respond to any shortcoming locally. The implication is that in any issues to deal with communities, consultation and involvement are two approaches which yield better results.

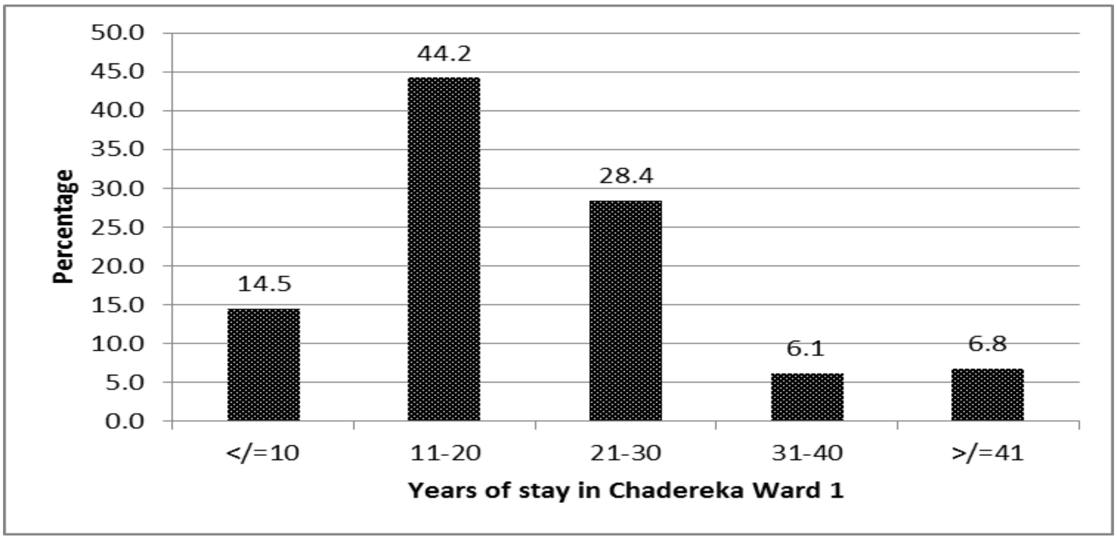


Figure 5.7: Years of stay in Chadereka Ward 1 by respondents (n=310, x=20.5, r=35)

Figure 5.8 presents the languages spoken by the household respondents. Shona, the native language, dominated and is used by 98.4% of the respondents. This is followed by some households (18.7%) who spoke English language. Ndebele is spoken by 7.1% of the respondents. The least percentages of 0.6% corresponded to individuals who spoke other languages such as Portuguese. Language is a critical factor in the transmission of information about livelihoods and adaptation to climate variability and change (Shackleton *et al.*, 2015). Some meanings of concepts are distorted and hinder adaptation to climate variability and change. Muzamhindo (2015) noted the positive influence of access to extension services in promoting adaptation strategies as a condition which fully depends on the language used.

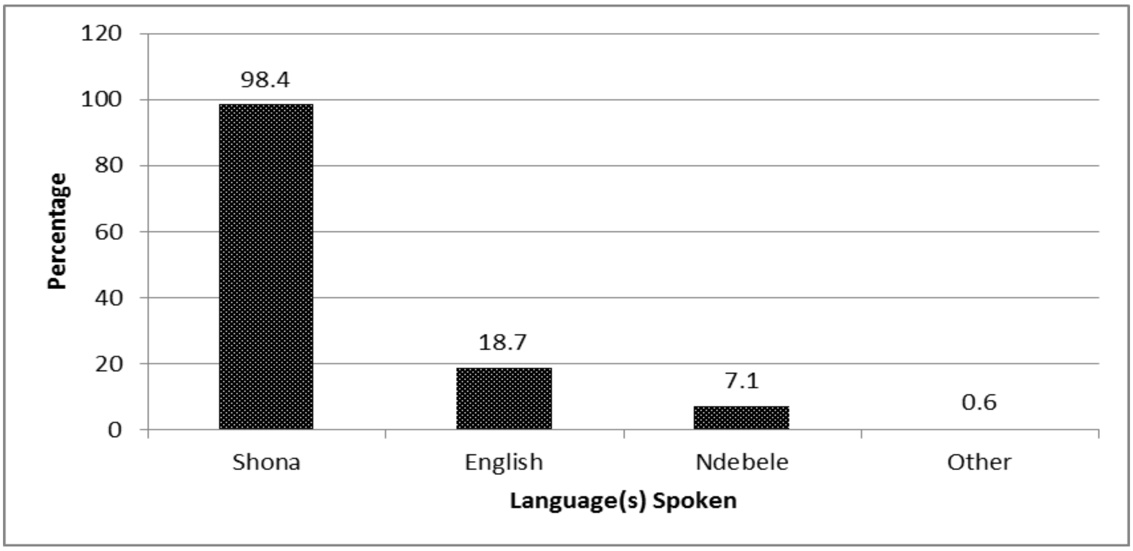


Figure 5.8: Languages spoken by respondents (n=310): Multiple responses

In Chadereka Ward 1, language use cannot be underrated. In this case the local language (Shona) had a great influence on the administration of the household questionnaires. All the questions were translated into Shona. Despite some respondents having acquired secondary education the technical terms involved in the issues studied needed Shona translation so as to capture the real situation on the ground. The importance of the use of local language is also revealed by Debela *et al*. (2015), Shackleton *et al*. (2015) and Wang *et al*. (2016). Most Zimbabweans are bilingual due to the expanded education system as already highlighted. They use both Shona and English languages but in the marginal areas such as Chadereka Ward 1, speaking in English (the official language) is considered a sign of disrespect to the elderly and one is not guaranteed community cooperation and favorable responses. Thus, in rural areas most surveys are done in the native languages principally Shona and Ndebele. This implies that information to deal with climate change adaptation needs proper presentation and dissemination that consider language issues in order to reach the intended audience and achieve positive results.

Figure 5.9 provides the household respondents' relationship to the household head. The highest percentage (25.8%) was for the wives while 15.5% was for siblings of the household heads. The children of the household heads constituted the least percentage (3.2%). This meant that the household heads who responded constituted the remaining 55.5%. The position of the individual in the household (especially whether the head and relationship to the head) has a bearing on the livelihoods and adaptation strategies to climate variability and change pursued in the study area.

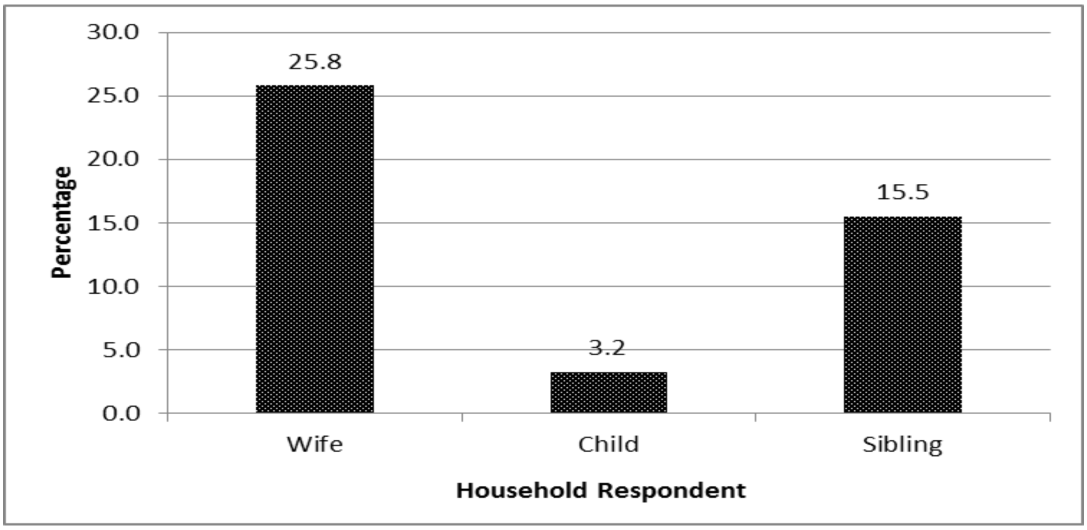


Figure 5.9: Respondents' relationship to household head (n=138)

Decision-making on livelihoods and climate change issues usually rests upon adults who can be spouses within a household. However, at the household level whoever is the household head in any given situation and time often makes decisions. Mugi-Ngenga *et al*. (2016) confirmed that decisions of what livelihoods or climate change adaptation strategies to pursue rests upon the elderly members of the household who are usually the household heads. Some communities in the marginal areas like Chadereka Ward 1, the Chief and the Ward Councilor usually make decision for major projects. Generally, consultations are prolonged at times and delay execution. Empowerment of household members and the community is a critical issue for consideration to ensure prompt decisions and effective response mechanisms as suggested by Wang *et al*. (2016).

5.3 RURAL LIVELIHOODS PRACTICES AND THEIR REGULATION/ GOVERNANCE IN CHADEREKA WARD 1

5.3.1 Introduction

This sub-section focuses on the identification of current rural livelihood strategies in Chadereka Ward 1 which have a bearing on the examination of their links to adaptation to climate variability and change, one of the major thrusts of this research. The sustainability of such efforts is deduced from the responses given through the key informant interviews and the household interviews. Specifically, the assessment focuses on the sustainability of rural livelihood strategies and their adaptation to climate variability and change. Thus, the livelihood practices and assets together with their regulations in Chadereka Ward 1 are presented and discussed.

5.3.2 Current Rural Livelihoods and Assets in Chadereka Ward 1

The rural livelihoods portfolios and their execution mainly depends on the availability of different assets which are defined by Simatele and Simatele (2015) and Butt *et al*. (2015) as stocks of natural, physical, human, financial and social resources (see Figure 3.1). These capital endowments can be acquired, improved, developed and transferred from one generation to the other depending on the prevailing circumstances. In this section, they are analyzed with respect to Chadereka Ward 1 using the SRLF (Scoones, 2009; 2015). The availability of these assets in rural areas determines the vulnerability and adaptation levels to climate variability and change impacts. Through the varied data collection methods used, the analysis of the responses revealed the livelihood assets status in the study area. Some photo illustrations are also displayed to aid the description of specific aspects. Under this thematic presentation, critical issues noted were the livelihood portfolios in relation to household characteristics, household participation time in the execution of the activities, quantity of crop and animal varieties produced among other related issues to rural livelihoods. Both regenerative and extractive livelihoods as distinguished and classified by Ngugi and Nyariki (2005) were reported in Chadereka Ward 1. Household responses on livelihood practices are illustrated in Table 5.2.

Table 5.2 clearly shows that the principal livelihood practiced by the inhabitants in Chadereka Ward 1 is farming with 99.6% of the responses. This is followed by gathering (64.5%), service provision (41.9%) and mining (13.5%). Hunting and other practices were 4.2% and 8.7%, respectively. Farming is a common practice by most of the communal people in the developing world, particularly in sub-Saharan Africa (Below *et al*., 2012; Gentle and Maraseni, 2012; Juana *et al*., 2013; Moyo *et al*., 2012; Sharma *et al*., 2014). Similar to most marginal and vulnerable communities the practice is rain-fed and depends entirely on natural systems (Dube *et al*., 2016; Milan and Ho, 2014; Musiyiwa *et al*., 2014; Sango and Godwell, 2015b; Van Aelst and Holvoet, 2016). Both crop and animal production are practised, according to household respondents. Noteworthy is market gardening practiced by households with access to valley land (fields for flood recession cultivation) as published by Van Aelst and Holvoet (2016). Immediately after the heavy rains (late February and early March) when water ceases to flow on the banks of the two rivers, Nzoumvunda and Hoya, flood recession cultivation of short seasoned maize varieties and some kind of vegetables are grown, a traditional practice known as *'mudzedze'* in Shona.

Table 5.2: Current livelihood practices in Chadereka Ward 1 (n=310): Multiple responses

LIVELIHOOD PRACTICE	CATEGORY	FREQUENCY	PERCENTAGE
Farming	Yes	308	99.4
	No	2	0.6
Gathering	Yes	200	64.5
	No	110	35.5
Hunting	Yes	13	4.2
	No	297	95.8
Service provision (trade)	Yes	130	41.9
	No	180	58.1
Mining	Yes	42	13.5
	No	268	86.5
Other like migration	Yes	27	8.7
	No	283	91.3

Flood recession cultivation promotes the cultivation of the staple crop, maize, twice in a year without artificially aided irrigation. Usually the soil remains moist until the ripening of the crops at the end of June. While this can be an adaptation strategy to climate variability and change in Chadereka Ward 1, the practice is selective as it is only done by those with access to valley fields as already alluded to. At times there is drought which inhibits the practice, a situation also revealed by Jiri *et al*. (2015a). There are no dams constructed in the Ward to support the rest of the households in irrigation projects. Some use inland artificial ponds which do not sustain the crops for long as they quickly run dry due to the scotching sun in the area (Image 5.1a). These livelihoods were confirmed during the focus group discussions where one participant further elaborated:

> *Here we grow crops of various kinds and keep livestock, especially cattle and goats. Some people practise barter trade with commodities which are in short supply like groceries and clothes. They exchange with chickens, goats, pigs and natural fruit (Ziziphus mauritiana and adansonia digitata (baobab) berries) which is a safety net during times of food insecurity. Young adults provide migrant labor to those households with more production, especially in the Upper Muzarabani where tobacco is grown. Normally cattle are sold when there is great need for cash.*

Water in the study area is really a problem and limits the sustainability of some adaptation strategies. For market gardening some households practice sand scooping (see Image 4.2) while others dig wells (Image 5.1b) for watering their vegetables and animals following the decreasing water table. Once these dry up, the 27 widely spaced government and NGO donated drilled boreholes become the only sources of water for both households and animals (Image 5.2). In some locations the borehole water is saline and presents challenges in its domestic use. When the boreholes break down or run dry it becomes a crisis and households travel several kilometers looking for water from Musengezi River or other Wards. However, given these circumstances which also emerged during the focus group discussions and key informant interviews, both crop and animal production is done in accordance with the prevailing capital assets in the Ward. Similar to the observation by Dube *et al*. (2016), as the climatic conditions continue to change for the worse, households continue to diversify their livelihoods as some people change fields moving from the Lower Muzarabani Rural District in which Chadereka Ward 1 lies to the Upper Muzarabani Rural District (to the south of Mavhuradonha mountain range) (see Image 4.1) where market gardening is perennially aided by small-scale irrigation. Thus, this distinguishes the livelihood status in Chadereka Ward 1 from other livelihoods in other places in the world. Water harvesting techniques should be reinforced to reduce the impacts of water shortages (Scott *et al*., 2016). The land which is essential in farming practices is further discussed under the natural assets section.

Image 5.1: (a) Inland dry pond (b) An artificial well sunk to supplement water for market gardening

Image 5.2: Cattle drinking water at a borehole when all rivers run dry

Second on the list of livelihoods practiced is the gathering of wild fruit especially, *Ziziphus mauritiana* and *adansonia digitata* berries confirmed by 64.5% of the respondents. Sharma *et al*. (2014) also observed the dependence on collecting non-timber forest products in Odisha State of India. *Ziziphus mauritiana* are riverine trees which provide edible wild fruit. These are used as safety nets to food security in Muzarabani Rural District in general and Chadereka Ward 1 in particular, a situation also observed by Kashaigili *et al*. (2014) and Muzari *et al*. (2014). The wild berries supplement family food and income as they can be sold for cash or exchanged with other food items. While *Ziziphus mauritiana* are considered wild fruit, due to their commercialization, households in Chadereka Ward 1 expropriate wild fruit trees found in their fields or adjacent land. This leaves other inhabitants vulnerable to fewer livelihoods options and food insecurity.

Sango and Godwell (2015a) even argue that these wild fruit were becoming scarce due to variations and changes in climatic conditions undermining their natural recovery. In some cases, they get dry due to continuous debarking as their barks are used for medicinal purposes by the inhabitants.

The excessively high temperatures and change of climate constantly shrink the wet season to only few months in a year. In some instances, livestock owners migrate with their animals to the Musengezi or Zambezi Rivers where they camp with their animals during the extreme hot and dry weather conditions. The practice, however, brings about some conflicts as residents in those places feel threatened by the invasion. This practice of migration was also reported as a practice in Zambia by Ito (2010). The rate at which livestock succumb to drought in Muzarabani is lower than in Chiredzi in the Southern Lowveld of Zimbabwe (Brown *et al*., 2012; Government of Zimbabwe, 2015).

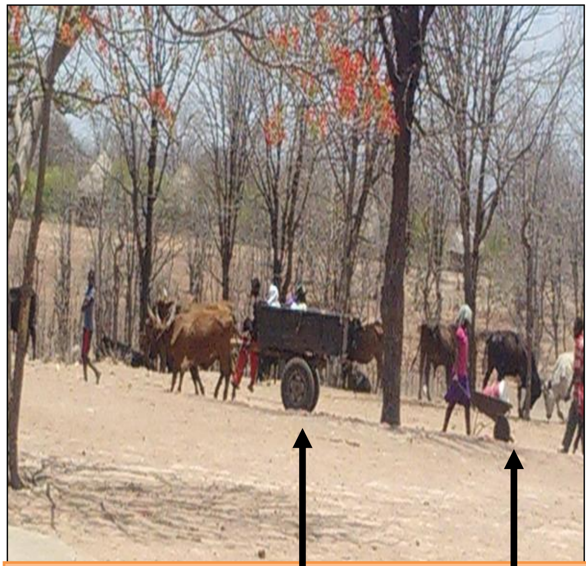
Generally, climate variability and change is causing a shift in the seasons endangering the farming livelihood practice in Chadereka Ward 1. The Agritex officer in the Ward described how climate had varied and changed their livelihoods stating:

> *The rainfall season has become shorter than before. The area used to receive early rains in October ending late April. Currently the rain season starts late November or early December and end in March. They are more months of dry than wet weather. Droughts and Floods are experienced in the same season. For example, floods occur in February to early March while in between the summer months there are some dry spells which greatly affect our crop production.*

This is in agreement with Chanza (2014) who presented a general shift of the rainy season since the pre-1970s to the post 1990s, a clear indication of changing climate.

The provision of services is another prominent livelihood practice which comes third according to household respondents and involves trade in both items and labor. Some households are involved in the transport sector ferrying different goods for people like water, firewood, wild fruit and beasts using various modes of transport which include lorries, scotch carts, wheel barrows and motor cycles (Image 5.3). Few households have bought bicycles. The transport infrastructure like roads is deplorable and during the rainy season the ward is inaccessible. Provision of services in this research has been coded to encompass all other varieties of livelihood portfolios (including the few professional jobs like teaching and nursing) since they are identified as buffers to the major farming activity.

Image 5.3: Some of the transport systems in Chadereka Ward 1



(a) Ox drawn scotch cart and wheel barrow

(b) A household crossing Musingwa River with a motor cycle. The bridge was destroyed by floods.

Hunting, which used to be important in Chadereka Ward 1, has since been condemned and a national legislation system put in place as a way to preserve the extinction of some natural resources, particularly animal species. This is being enforced by EMA and anyone caught is heavily punished. Wright *et al*. (2016) discussed hunting as an important livelihood in West and Central Africa. However, few households in the study area use snares and fire to catch small animals like hare, mice, rabbits and birds (see Image 5.4) which are still found in the area. The confirmation of the practices emerged during the focus group discussions. Large wild animals are feared to be disappearing slowly as their habitats are being invaded by increasing populations and succumbing to environmental degradation like deforestation and river siltation (Sango and Godwell, 2015a). Some of these large wild animals, like elephants have migrated towards the Zambezi River and Mavhuradonha Mountain Range in search of water and food. Fishing has completely stopped due to water scarcity and siltation of rivers. One participant during the focus group discussion added:

> *We used to catch a lot of fish in Nzoumvunda and Hoya rivers, but now the rivers are heavily silted. This has greatly affected some of our livelihoods.*

Mining, though it was mentioned during the interviews, was rejected as being practiced in the Ward by the focus group discussants and key informant interviewees. It was reported to be done only when young men visited the Upper Muzarabani Rural District. Kima *et al*. (2015) present this practice as off-farm activity which is important in climate change adaptation though Muzari *et al*. (2016) viewed it as an emitter of the toxic substances which affect climate and contaminated water for the general populace.

Image 5.4: A snare erected around a sand scooped water hole to catch birds as they come for water

Other livelihood strategies presented by respondents were honey extraction, brick moulding, gifts or remittances (from emigrants), marketing of grass and firewood and craft work (basketry and mats weaving). Some of these are promoted by donor agents who would be supporting infrastructural development like repairing of flood damaged schools, roads, bridges and community homes or shelter (Kima *et al*., 2015).

Table 5.3: Livelihood execution time in percentage (n=310): Multiple responses

Livelihood	Permanent	Seasonal	Temporal	Not involved
Farming	60.0	39.4	0	0.6
Gathering	2.6	2.3	59.7	35.5
Service provision	8.7	16.5	16.8	58.1
Hunting	0	0.6	3.6	95.8
Mining	0	3.5	10.0	86.5
Other	0.6	1.6	6.5	91.3

In characterizing rural livelihoods in Chadereka Ward 1, duration in their execution was sought. The time was categorized as permanent, seasonal, temporal and not involved (Table 5.3). Almost all the households (99.4%) are involved in farming as only two did not participate in the activity. However, their execution times differed. Farming was considered a permanent activity by 60% of the household respondents, while 39.4% responded that it was done seasonally. The responses clearly distinguished the types of farmers found in the study area. Those whose farming is seasonal imply that they only focus on crop production which is rain-fed and they do not tend to livestock which is a full time activity. Yields from the farming activity also depend on time. It is expected that more yields are obtained from full time farming.

More than half of the respondents (59.7%) considered fruit gathering as a temporal activity given that it is of a specific time period, especially during the spring season. Slightly more than a third of the respondents (35.5%) acknowledged that they were not involved in fruit gathering. The household respondents who considered fruit gathering as permanent (2.6%) and seasonal (2.3%) activies usually preserve the fruit by drying them in the sun and sell or consume them during any time of the year. Muzari *et al*. (2016) acknowledge the increase of this kind of livelihood in rural areas in Zimbabwe. However, Dube and Phiri (2013) and Sango and Godwell (2015a) noted that wild fruit were disappearing due to over exploitation by rural communities. Thus, regulations on the proper use of natural resources need sritical consideration in the Ward.

Service provision is almost equally distributed in the execution time by those who participate in the activity. Some household respondents have permanent jobs (8.7%) like teaching, nursing and farm extension workers; while others work as contract farm workers, domestic workers, petty traders and other activities as already discussed. Thus, seasonal and temporal working time had 16.5% and 16.8% of the household respondents, respectively. More than half of the respondents (58.1%) did not acknowledge service provision as one of their livelihoods. Strengtherning livelihood diversification through service provision is critically needed in the Ward to withstand the impacts of climate variability and change as also noted by Mugi-Ngenga *et al*. (2016) and Smucker *et al*. (2015).

For the few respondents who practice hunting, they identified seasonal (0.6%) and temporal (3.6%) as their execution time. It clearly shows that it is an activity which has lost value in the community and households can no long rely on it. The same applies to mining with seasonal execution time being acknowledged by 3.5% of the respondents and temporal by 10%. Other livelihoods like honey extraction, brick molding and building are not significant in this discussion though they are worth pursuing in the Ward. Bharwani *et al*. (2015) also observed honey extraction as an important coping and adaptation strategy to climate change in Cameroon.

Muzari *et al*. (2016) advise that having varied livelihoods is critical in responding to climate variability and change since mitigation takes a long time if the community has a low adaptive capacity. The implication lies in communities spreading their risk through varied livelihoods and innovations in different time periods (ANSTI, COVIDSET, 2013; Bhatta *et al*., 2015; Dube *et al*., 2016; Kongsager *et al*., 2016; Maninder and Singh, 2015).

A MLRM was computed using SPSS version 21 to analyze how some of the socio-demographic factors already presented influence the uptake of rural livelihood strategies by household respondents in Chadereka Ward 1 in the face of climate variability and change at the 95% confidence level. Findings reveal that age, education, household size and marital status are statistically significant ($P<0.05$) in influencing households' choices of some rural livelihood strategies in Chadereka Ward 1 (Table 5.4). Specifically, age was found to have a significant influence in farming and hunting, while education greatly influences the uptake of farming, mining and service provision rural livelihood strategies. Marital status has been calculated to be a significant factor in service provision. This in one way or the other is in agreement with some research at various levels and scales exemplified by Balama *et al*. (2016), Debela *et al*. (2015), Jiri *et al*. (2015a), Kima *et al*. (2015), Mudzonga (2012), Ncube *et al*. (2016), Wheeler *et al*. (2013) and Yegbemey *et al*. (2014).

Table 5.4: MLRM analysis results of how selected socio-demographic factors influenced the uptake of rural livelihood strategies at statistical significance ($p<0.05$) in Chadereka Ward 1

Livelihood Strategies	**Socio-demographic factors (Chi-Square p-values)**				
	Age	Gender	Marital Status	Household Size	Education
Farming	**0.001**	0.965	0.230	0.556	**0.000**
Mining	0.199	0.460	0.190	0.351	**0.000**
Hunting	**0.002**	0.070	0.412	0.981	0.247
Gathering	0.890	0.965	0.191	0.376	0.512
Services Provision	0.601	0.730	**0.000**	**0.002**	**0.005**

Highlighted Chi-square p-values indicate significant relationship at the 95% confidence level

For instance, Jiri *et al*. (2015a) using the MLRM in a study of Smallholder Farmer Perceptions on Climate Change and Variability in Zimbabwe observed a significant positive relationship between the farmers' age and their adaptation options to climate variability and change. Balama *et al*. (2016) argue that the number of adaptation strategies decrease as one grows older contrary to Tazeze *et al*. (2012) who reported increased strategies with experience gained with age. In the present study some older farmers, like in a study by Yegbemey *et al*. (2014), are fully committed to their traditional ways of farming such as the practice of flood recession cultivation disregarding the environmental laws of ploughing 30 meters away from the river banks. At the same time, they no longer have enough energy for labor intensive adaptation strategies (Balama *et al*., 2016). Young and middle aged households in Chadereka Ward 1 cooperate in embracing new farming systems or technology like minimum tillage as they are introduced in the Ward. A similar analysis was revealed by Muzamhindo *et al*. (2015) and Debela *et al*. (2015) in their studies. However, Jiri *et al*. (2015a) further comment that some researchers found age to be insignificant given the reluctance by the aged to embrace new ideas as there are introduced in communities which is similar to this study.

During the focus group discussions, it also emerged from the participants that the young and the able bodied household members usually participate in migrant labor or change farmland to upper Muzarabani Rural Area where they grow tobacco. The growing of tobacco is labor intensive and is done mainly by the economically active people. The Agritex officer during a key informant interview pointed out that the uptake of the new methods of farming like conservation agriculture is easier with younger farmers than those who are older. Thus, age remains critical in adaptation to climate change.

On hunting as a livelihood strategy, age is also critical and significant. This involves running and chasing the wild animals, a practice which is done better by those who are younger. The livelihood is risky and usually the elderly made use of snares to catch birds like the one erected around a sand scooped water hole shown in Image 5.4. While the activity is illegal, like the informal mining (gold panning) in Zimbabwe, young men without any formal employment engage in the activity to earn a living. Poaching activities are rampant along the Zambezi Valley especially in game parks and anti-poaching campaigns have been launched. This has also been noted in another study by Rahman and Alam (2016). Balama *et al*. (2016) further identified the practice as a gendered livelihood done by males while females would be involved in mushroom and firewood collection. Further, Bharwani *et al*. (2015) note hunting to be an activity done by the poor. However, Balama *et al*. (2016) further report an insignificant negative influence of forest rules to adaptation strategies, a situation similar to the current study. The elderly people in Chadereka Ward 1 do not consider as important the environmental management rules of the EMA. They continue to practise stream bank cultivation *(mudzedze)* which has been discouraged by the EMA.

In Chadereka Ward 1 education has a significant influence at the 95% confidence level on the farming livelihood. The level of education determines farmers' uptake of farming types and how they respond to climate change as argued by Jiri *et al*. (2015b), Mugi-Ngenga *et al*. (2016) and Umunakwe *et al*. (2014). Thus, households with high education levels make better decisions in their farming livelihood. In Chadereka Ward 1 the majority have since resorted to the production of small grains and varied livestock. Balama *et al*. (2016) also acknowledge the positive influence of education and experience on better knowledge and information regarding climate issues within an area hence promoting new technology uptake. Better adaptation choices are argued to be made by better educated people (Tazeze *et al*., 2012; Yegbemey *et al*., 2014). The same scenario is also revealed in the case of Chadereka Ward 1 were the literacy rate is relatively high, though differentiated according to gender. Traditional/ indigenous knowledge is of great significance as it compliments scientific knowledge in reducing vulnerability of households to climate variability and change impacts on farming practices in Muzarabani Rural District as supported by Chanza (2014).

MLRM also revealed that the education level of the household was a significant positive factor on the uptake of off-farm rural livelihoods like mining and service provision, reducing the risks resulting from the varying and changing climatic conditions in Chadereka Ward 1 as revealed by Kima *et al*. (2015) and Balama *et al*. (2016). The more educated households are, the more they diversify livelihoods (Olutegbe and Fadairo, 2016). In some households, members, especially those who are not married, migrate to areas where mining is done and camp there. This also applies to those practising petty trade. As such marital status is also found as having a significant impact on service provision practice. Most single persons find freedom in venturing into a trade or cross border businesses without family restrictions. It can be noted that while other factors have a significant influence on the rural livelihoods uptake, others are insignificant. This depends on the community attributes in relation to the issues being discussed. The determinants, however, do not always result in increased outputs from the livelihoods. Thus, some of these attributes need material or resource intervention to be of valuable and significant use. The participants during the interviews even pointed out that they needed material support for them to participate effectively in livelihood activities. One participant pointed out:

> *Here the situation is becoming worse each year. We do not have money to start any project. For us married women, we remain with children while our husbands go out to find what can help the family. In most cases what they bring is not enough to start even a small project at home or take us through to the other harvesting period. We cannot leave children alone and we gather wild fruit for eating and selling together with firewood as we wait for food relief from donors and the government as we rely on wild fruit.*

Household size has been found to be positively significant at the 95% confidence level in relation to service provision. As household size increases so does the diversity of livelihoods as this correlates positively with an increase in labor force and distinct expertise, a situation also observed by Kima *et al*. (2015) and Mano and Nhemachena (2007). In Chadereka Ward 1, while some family members may be collecting and selling wild fruit (*Ziziphus mauritiana* and *adansonia digitata* berries), others could be delivering firewood and water for cash or exchange for food. Some family members hire their labor to some households. This ensures food security at the household level in some cases which are different from households with smaller sizes. Focus group discussions and key informant interviews conducted confirmed these issues.

Although in this study gender is not statistically significant at $P<0.05$, it has been confirmed as having a positive influence by Balama *et al*. (2016) and Jiri *et al*. (2015a) as it increases the livelihood portfolios in relation to adaptation to climate change. The preceding contribution by one woman during the focus group discussion testifies some of the gender roles in Chadereka Ward 1. Thus, gender roles need to be better understood in relation to livelihood strategies for they increase the well-being, sustainability and resilience of the practices when properly considered (Bob and Babugura, 2014).

The sub-section discussed the current livelihood practices in Chadereka Ward 1. Their relation to the human asset in the Ward has also been examined considering aspects such as age, gender, educational level, matital status and household size. The following sub-section focuses on the natural, physical, financial and social assets as found in the study area.

5.3.2.1 Natural assets and rural livelihoods in Chadereka Ward 1 in Muzarabani Rural District

In the generation of more data on the livelihoods in Chadereka Ward 1, households provided additional details on some natural assets in the area. The household respondents confirmed that the dominant natural resources in the area were land, water and vegetation; particularly trees as also revealed in other studies by Ansell *et al*. (2016), Lienert and Burger (2015) and Masud *et al*. (2016). This was confirmed during the focus group discussions conducted in the Ward. One focus group discussion participant stated:

> *The natural resources we normally use here in Chadereka Ward 1 include land, trees, grass and water. However, some of these resources are now in short supply like water and grass. Our livestock, especially cattle, goats and sheep are now browsers and rely on mopane and Ziziphus mauritiania leaves. Our crops usually dry up before maturity and we bank on livestock. We get water for both domestic and animal use from the boreholes drilled by the government and NGOs after all sources have dried up.*

Table 5.5 illustrates the responses by the household interviewed on the issue of natural capital in Chadereka Ward 1.

Table 5.5: Natural resources locally available in Chadereka Ward 1 (N=310): Multiple responses

Natural Resource	YES		NO	
	Frequency	Percent	Frequency	Percent
Land	305	98.4	5	1.6
Vegetation (trees and grass)	308	99.4	2	0.6
Water	303	97.7	7	2.3
Minerals	5	1.6	305	98.4
Wild animals	23	7.4	287	92.6
Other	3	1.0	307	99.0

The almost hundred percent responses by the respondents on land (98.4%), vegetation (99.4%) and water (97.7%) confirm the unquestionable dependence on the natural resource base for life in the Ward which is similar to a Kenyan study by Jonah *et al*. (2015). This is followed by wild animals with 7.4%. Minerals and other resources (1.6% and 1.0%, respectively) are insignificant in relation to livelihood support systems in the Ward. The conditions in which the natural resources are found determine the sustainability of the livelihood portfolios in the Ward. Wild animals used to be many in the area but due to the increase in the number of people they have been hunted and others have since migrated as already revealed. The MRDA said:

Before independence, Chadereka Ward 1 was sparsely populated with fewer people than now. Wild animals like kudus, impalas, bucks, buffalos, warthogs, hares and even elephants used to be abundant in the area. Now these are scarce and have moved to the Mavhuradonha Mountain Range and the Zambezi Valley in search of food and water. The increase in population created demand for land and the clearance of once densely forested areas.

Thus, there is need to understand the livelihoods which are supported by the identified natural resources as shown in Table 5.6. From Table 5.6, land and water are the main supporters of farming confirmed by 99% and 80% of the household respondents, respectively, in the Ward. The other resources like vegetation (9.0%), wild animals (1.0) and other (0.6%) have an insignificant role on farming. Vegetation and water are of great importance for domestic uses. Vegetation in particular is the sole source of enegy for heating and lighting in the Ward. While this is the case, wild animals disturb farming activities as they attack the fields on the household plots. The over-dependence on natural resources increases the vulnerability of the households to climate variability and change and limit their adaptive capacity as also revealed by Aberman *et al*. (2015). Thus, similar to the suggestion by Sharma *et al*. (2014), capacity building in relation to natural resource management is critically needed in the Ward to enhance sustainability of the practices.

Table 5.6: Livelihoods supported by natural resources (n=310): Multiple responses (in %)

Livelihood Activity	Category	Land	Vegetation (trees and grass)	Wild animals	Water	Other
Farming	**YES**	99.0	9.0	1.0	80	0.6
	NO	1.0	90.9	99.0	20	99.4
Crafting	**YES**	1.6	18.7	0.3	1.0	0
	NO	98.4	81.3	99.7	99.0	100
Domestic use	**YES**	5.8	81.9	94.5	97.1	0.6
	NO	94.2	18.1	5.5	2.9	99.4
Energy (fuel)	**YES**	1.0	83.2	0	1.0	1.0
	NO	99.0	16.7	100	99.0	99.0
Building material	**YES**	13.9	89.0	0	47.7	0
	NO	86.1	11.0	100	52,3	100
Other	**YES**	0.3	1.0	0.3	0	0.3
	NO	99.7	99.0	99.7	100	99.7

Vegetation, both trees and grass, are widely used in the study area despite their seemingly limited direct role in farming. For instance, household responses on its role on domestic use were 81.9%, on energy (fuel) 83.2% and as building material 89.0%. For domestic use, vegetation is critical for it supports the vending or trading of wild berries (Z*iziphus mauritiana* and *adansonia digitata*), an activity which tops the list of viable livelihoods practices in Chadereka Ward 1. These fruit are a safety net for the people in Chadereka as they use them for various purposes. Egbe *et al*. (2014) in Nigeria, Gentle and Maraseni (2012) in Nepal, Goswami and Paul (2012) and Saha and Bahal (2010) in West Bengal, Rahman and Alam (2016) in Bangladesh and Saxena *et al*. (2014) in India confirm the significant role played by non-timber forest products in boosting livelihoods in rural communities. Some of the vegetation in Chadereka Ward 1 is also used as medicinal plants. Above all, vegetation has a climate change mitigatory effect as it acts as a carbon sink through sequestration as further revealed by Dube *et al*. (2016) and Rahman and Alam (2016). The vegetation in the Ward is the source of fuelwood essential, for heating and cooking in such a rural area without electricity as already discussed. ZIMSTAT (2012) also pointed out that 90% of households in Zimbabwe rely on fuelwood for cooking and heating. Some vegetation species are cut and crafted into objects or artifacts for sale and this remains a venture for the people in Chadereka Ward 1 which has not been fully exploited. As already discussed earlier, vegetation is very useful as building material in the Ward, a situation also revealed by Kashaigili *et al*. (2014) and Rahman and Alam (2016). Household respondents (89.0%) and some focus group discussants confirmed the use of vegetation as building material. They use poles in the construction of most structures like houses, huts, grain storage structures as well as cattle, goats and sheep pens, among others. However, grass for thatching and even for grazing their animals is scarce and they buy it from other wards.

Water is an indispensible ingredient for farming as such household responses identify it as important even for domestic purposes (97.1%) and building material (47.7%). However, in the case of Chadereka Ward 1, water for seasonal farming is only available during the summer months which have since reduced due to climate variability and change. The rain-fed farming, confirmed by Chikodzi *et al*. (2013), Debela *et al*. (2015), Mugi-Ngenga *et al*. (2016) and Olutegbe and Fadairo (2016), among others, is a characteristic type of farming in the Ward and generally done from December to March of each year. Households usually supplement rain water through the use of the 27 donated boreholes and foot pumps by some NGOs, deep wells sunk in their gardens and some practise sand scooping on the river bed (see Images 5.1 (a) and (b), 5.2 and 5.4)**.** There is not much of crafting, pottery or energy generation which uses water in the area. This implies that there is need for putting in place more water management and conservation systems such as the construction of concrete ring water tanks, field ponds and dam construction as recommended in another study by Rahman and Alam (2016).

In a further analysis on natural resources available for use in the livelihoods of the study area, the frequency of natural resource use was computed. Five categories were used which are every day, once per week, once per month, once per year and not at all. Table 5.7 illustrates the household responses. Generally, the frequencies of use of the three natural resources mainly used in Chadereka Ward 1 point to their daily usage: land (61.6%), vegetation (96.1%) and water (98.4%). In relation to land, 37.1% of the respondents suggested a once per week usage of the resource. This is due to water scarcity for the two resources (water and land) which are normally used together. The remaining three (minerals, wild animals and others) had responses of over 96% on the 'not at all' category. Wild animals used to be of great value in the Ward but have since lost popularity and are now few in number as already noted. Key informants and focus group discussants also confirmed these results.

Table 5.7: Frequency of natural resource usage (n=310): Multiple responses (in %)

Natural Resource	**Everyday**	**Once a week**	**Once a month**	**Once a year**	**Not at all**
Land	61.6	37.1	0	0	1.3
Vegetation (trees and grass)	96.1	2.3	0.3	0	1.3
Water	98.4	0.3	0	0	1.3
Minerals	0	0	0	0.6	99.4
Wild animals	0	0	0	3.5	96.5
Other	1.0	0.3	0	0	98.7

The results show that households base their livelihoods on natural resources hence their sustainability depends on how carefully they exploit and manage these resources as argued by Masud *et al*. (2016). Poor farming methods usually lead to land degradation in the form of silted rivers, deep gullies and deforestation as stressed by Lienert and Burger (2015). All these have a negative impact on water availability and proper soil structure and fertility for crop and livestock production. Chadereka Ward 1 already shows signs of severe water shortages evidenced by the number of boreholes in the Ward and the absence of surface run off in rivers for three quarters of the year. One participant during the focus group discussion noted:

Here, in Chadereka Ward 1 green vegetables are a problem during the rest of the dry season due to water shortages. We therefore grow vegetables in summer and dry them in the sun for future use.

The scenario threatens the sustainability of the livelihoods pursued with the use of natural resources, especially the growing of vegetables (market gardening) which needs to be done with the availability of water throughout the year.

Details on the land resource which include farm size, land ownership and acquisition were further solicited from household respondents. Table 5.8 illustrates that the highest percentage of the respondents (59.4%) had a farm size of 1-5 hectares. This is followed by those with less than a hectare (22.6%). The percentage of respondents on farm sizes generally decreases with increase in their sizes. Thus, 15.8% of the household respondents have 6-10 hectares, 1.6% has 11-15 hectares and 0.6% has above 15 hectares. In all this distribution, female percentage share is far less than that of their male counterparts except on smaller pieces of land, a situation highlighted by Bob and Babugura (2014). The average farm size was noted as 1.99 hectares with a range of 16-20 hectares.

Table 5.8: Farm size distribution by gender (n=310) (in %)

Farm Size	**Males**	**Females**	**Total**
<1 hectare	5.5	17.1	22.6
1-5 hectares	39.4	20	59.4
6-10 hectares	12.6	3.2	15.8
11-15 hectares	1.3	0.3	1.6
>15 hectares	0.6	0	0.6
Total	59.4	40.6	100

Similar to other traditional African societies, in rural Zimbabwe land is communally owned. Thus, due to fragmentation hectrage per household is small as also reported by Umunakwe *et al*. (2014). Further, within the Shona culture, before the resettlement program, land was inherited from the father who distributed it among the male children. This customary arrangement on the land issues was also reported by Ansell *et al*. (2016). Female children accessed land from their husbands upon being married. One kraal head on the issue said:

> *In our Zimbabwean traditional culture, a woman leaves her clan and all other rights to family property upon getting married and joins the one for her husband. She is just allocated a family small field for nuts by her husband who has the right to land when married. Bigger fields are for the husband who grows the main crop for the staple food like maize. This means the issue of land and what to practise on it are gendered. Due to changes in climatic conditions here, in Chadereka Ward 1 the main crop is sorghum, cotton and other drought tolerant cultivars.*

Gender disparities are noted regarding access to land and could have a bearing on adaptation strategies. However, Ansell *et al*. (2016) noted that the marriage barrier to the acquisition of land had been reduced in some African countries as the distribution of land to the landless, for both men and women, is now the duty of the land committees and Chiefs. The implication lies in mobilizing support for gender equality and mainstreaming in resource distribution across the socio-economic fabric as underscored by Bob and Babugura (2014) and Olutegbe and Fadairo (2016).

In Chadereka Ward 1, some dry farm areas usually far from river banks are left furrow and are for grazing livestock. The mean farm size was less than 5 hectares similar to observations by Ofuoku (2011). Umunakwe *et al*. (2014) further observed that adoption of new innovations in climate change adaptation is dependent upon farm size. For example, Juana *et al*. (2013) reported cropland shortage as a drawback to climate variability and change adaptation. For Chadereka Ward 1, the early inhabitants, who happen to be influential in community decisions, have most of their farms on valley lands or located on river banks where they practise flood recession cultivation. The majority occupy small dry fields making if difficulty to diversify their adaptation strategies. A participant during the focus group discussions stated:

> *The first people to settle in Chadereka took large pieces of land for themselves and their children and most of the fields are located on river banks for flood recession cultivation contrary to laws governing natural resource utilization in the area. Now the two rivers, Hoya and Nzoumvunda, are no longer perennial as they are heavily silted. Some of our fields are small.*

Given all this, adaptation to climate variability and change is directly influenced by farm size among other factors in Chadereka Ward 1, similar to the findings by Kunzekweguta *et al*. (2016) and Olutegbe and Fadairo (2016).

Household responses on land ownership are presented in Table 5.9. The land is self and communally owned with 68.7% and 27.7%, respectively. Other forms of ownership suggested by the respondents were cooperative and private with 0.3% each. State and other forms have 1.9% and 1.0%, respectively.

Table 5.9: Responses by households on land ownership (n=310)

Land Ownership	Frequency	Percentage
Cooperative	1	0.3
Community	86	27.7
Self	213	68.7
State	6	1.9
Private	1	0.3
Other	3	1.0
Total	310	100

The small household percentage responses noted on the other forms of land ownership result from the lack of knowledge on land tenure by some people (Moyo *et al*., 2016). On 'other' forms the three households suggested the regulated leasehold with the individual who had been allocated the land. The existing land tenure systems in Zimbabwe are freehold title, regulated leasehold, permit system and communal or traditional tenure system according to Dube and Guveya (2013) and Scoones (2009). The latter, also known as the customary tenure system, is the dominant system in Chadereka Ward 1 as revealed during the focus group discussions and the key informant interviews. The respondents who indicated self-ownership were traditionally given by the chief or inherited from parents following the traditional or customary norms. Generally, the land for the communal people in Zimbabwe is state owned contrary to Malaysia as revealed by Masud *et al*. (2016). However, people erroneously claim ownership due to lack of knowledge. Women, as revealed earlier, have no access to land which is owned following the traditional patriarchal biases as also observed by Scoones (2009). However, with the new land reform policy the plight for women is being considered and currently they are allowed to apply for agricultural land.

Dube and Guveya (2013) observe the importance of land tenure which enables farmers to access loans from banks and acquire technology for better farming and adaptation strategies. This is also seconded by Butt *et al*. (2015). The situation in Chaderekka Ward 1 worsens as some households continue with their malpractices which degrade the environment. That is, some natural resources are becoming degraded or depleted and rivers getting silted. While the custodians who foresee the utilization of communal resources are there (such as the chief, councilors and headman) their traditional powers have been ignored for they also flout the regulations (Scoones, 2009). Vegetation which is found in the communal open space areas is for the whole community, creating challenges in terms of management. However, there is need for rationalization to ensure sustainability of common resources. These natural resource attributes need special address to ensure full cooperation from the community regarding the issues under discussion.

Household respondents were further asked on how they acquired the land (Table 5.10). The highest percentage (67.7%) responded that they had been given the land by the chief while 27.7% states that that they inherited the land from their parents. A few respondents (3.9%) borrowed the land, 0.3% acquired it through land reform and 0.6% through other means which imply that they informally or unceremoniously acquired the land.

Table 5.10: Household response on land acquisition (n=310)

Land Acquisition Mode	Frequency	Percent
Borrowed	12	3.9
Given by chief	210	67.7
Inherited	85	27.4
Landform	1	.3
Other	2	.6
Total	310	100.0

Customary norms of land distribution are prevalent in the area although some corrupt tendencies can be seen. This is evidenced by the allocation of land to households whose origin is from another district or province as revealed during the focus group discussions.

From this sub-section, natural resources or assets have a great impact on rural livelihoods and their adaptation to climate variability and change. In Chadereka Ward 1, it has been revealed that water has become scarce, vegetation is succumbing to land clearance and domestic uses (firewood) while land is not enough for every household. This situation, as noted by Muzari *et al*. (2016), increases vulnerability to the impacts of climate variability and change at the household level. The adaptation to climate variability and change strategies which depend intirely on these natural resources like agroforestry or carbon projects, crop cultivation and conservation farming among others have been negatively affected and their sustainability in the Ward compromised. This had also been confirmed by Dodman and Mitlin (2015). The dynamics of these natural resources, in rural areas should not be ignored in trying to achieve well-being, resilient and sustainable livelihoods in the face of climate variability and change. This has also been noted by Mamonova (2016) in the case of Ukraine and Manyeruke *et al*. (2013) in Zimbabwe.

5.3.2.2 Physical assets and rural livelihood in Chadereka Ward 1 in Muzarabani Rural District

The sustainability of rural livelihoods in these times of climate variability and change is also influenced by the physical assets possessed by each household in the studied Ward. These assets include all kinds of infrastructure ranging from constructions at each homestead, implements used in carrying out the livelihood activities to all other forms of physical infrastructure in the Ward like roads and bridges and buildings of different types and functions. This sub-section focuses on the acquisition of the main house, ownership of any other building structure elsewhere and household livelihood implements. Figure 5.10 shows how respondents acquired their main houses.

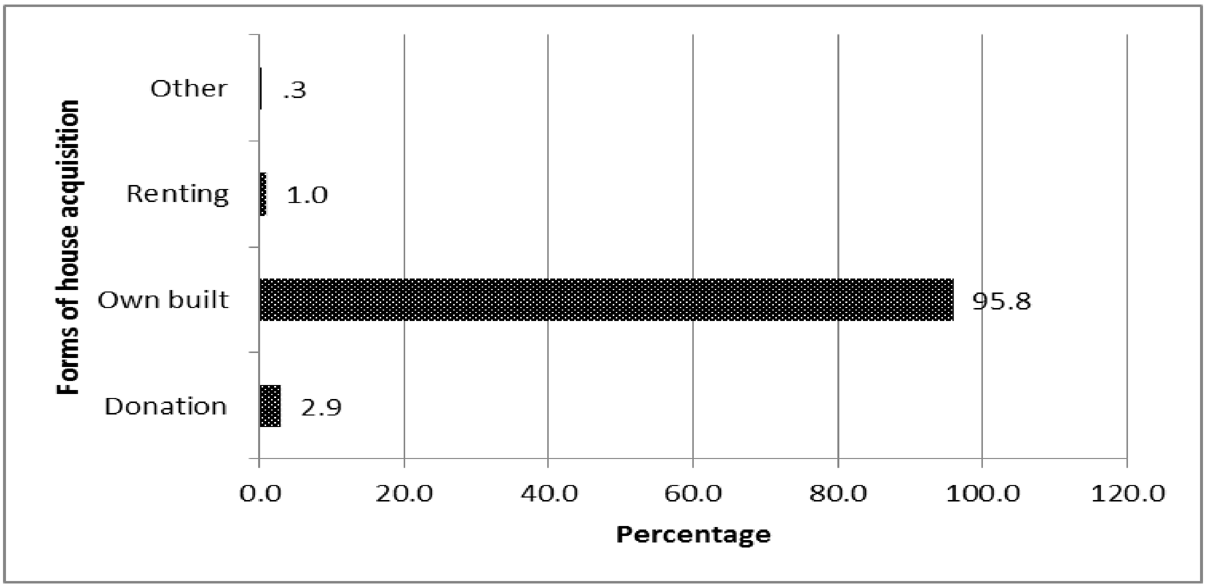


Figure 5.10: Forms of main house acquisition by respondents (n=310)

The majority of the respondents (95.8%) reside in their own built houses. A few respondents (2.9%) indicated that their houses were donated by the International Maritime Organization (IMO), a NGO which was after the devastating effects of cyclone Eline in 2000 as also noted by Musarurwa and Lunga (2012). Only a single percentage of the respondents are renting, while 0.3% reside with relatives. Generally, the houses are built of locally available resources like poles and grass (16.1%), poles, dagga and grass (15.5%) and other materials (like maize and sorghum stalks) (20.0%) (Figure 5.11). For some donated houses the material is of farm bricks, pole and asbestos (48.4%). Houses built of pole, dagga, crop stalk and grass are not durable and need to be constantly repaired, especially the replacement of grass on grass thatched roofs. In times of floods, normally the dagga and some farm brick built houses get soaked in water and collapse. After such disasters some NGOs usually provide tents as temporary shelter for the victims as they construct or repair their houses.

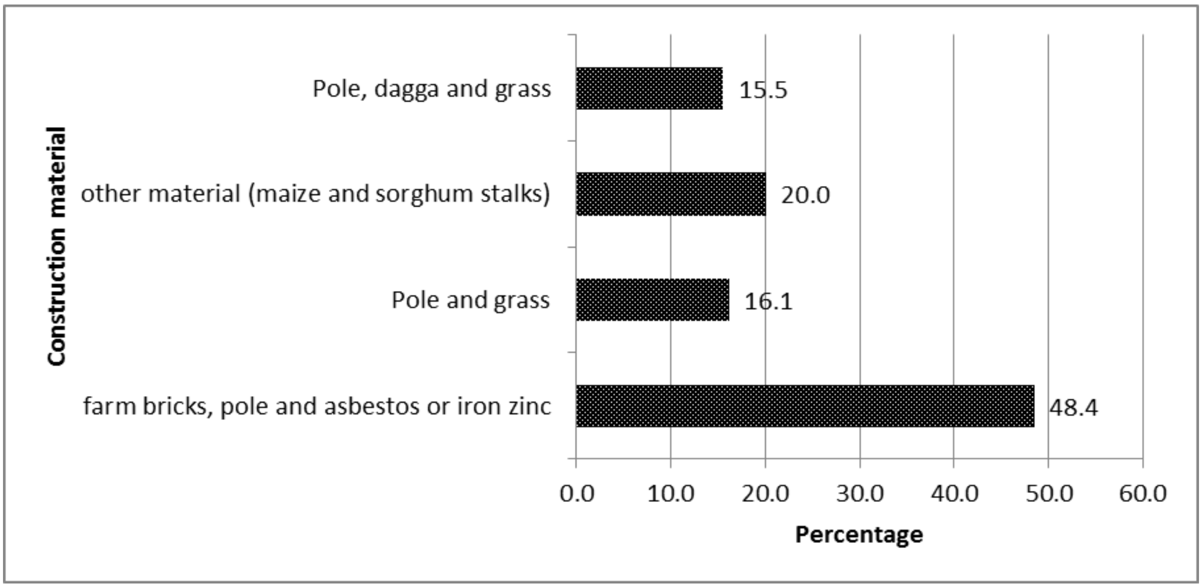


Figure 5.11: Material used in the construction of respondent's houses or shelters (n=310)

Built up structures are critical for the protection of households, their food and farm implements against harsh weather and climatic conditions like rainfall, floods and the scotching sun. On several occasions, the inhabitants in Chadereka Ward 1 had their household belongings destroyed by floods, a situation also reported by Cong *et al*. (2016) in the case of Vietnam. One official from the NGOs echoed:

> *When floods occur and destroy homes, some households refuse to be relocated permanently from the flood prone areas to safe places as they expect to be given some donations by the NGOs. They just relocate temporarily and once the floods recede they return to their usual places. They wish if floods could always be there for them to get humanitarian assistance which has turned out to be one of their other livelihood strategies in the Ward. The households are given donations in various forms like food, clothes, blankets, tents for temporary shelter among other wares.*

In Chadereka Ward 1, after floods and during drought periods, NGOs such as the World Vision, Christian Care, Red Cross Society in Zimbabwe, World Food Program and Fachig, among others, bring humanitarian aid in various forms which include tents for shelter, food, water and sanitation, and farm inputs, among others. Such assistance has also been noted in other studies by de Leon and Pittock (2016). However, Chagutah (2010) highlight the need for coordination among the NGOs to avoid duplication of assistance. Also the NGOs should include capacity building in the assistance given. This had been confirmed also during the focus group discussions. The humanitarian assistance, besides being a coping strategy in the Ward, is becoming an adaptation strategy given the prolonged period of operation in the area. More education and capacity building at the household level is essential for improving their well-being and self-sustenance under these times of climate variability and change.

As a follow up to the issue of shelter, the households provided information on the existence of other structure(s) or homes in other location besides the homestead (Table 5.11). While the highest percentage (79.7%) denied the existence of other structures, 14.5% acknowledged structures constructed in the fields referred to as field shelters. Smaller percentages (1.9% and 2.9%) of the households have flood shelters and store rooms, respectively constructed on designated high ground away from the flood plains. Only one percent confirmed either owning a house or a tuck shop at the service center or in another place. The fowl runs have also been constructed in such a way that the birds are not affected by floods.

Table 5.11: Function(s) and location of other building(s) (n=310)

Function(s) of the other building or structure	Location	Frequency	Percent
Field shelter	In the field	45	14.5
Flood shelter	At designated high ground	6	1.9
Store room	At designated high ground	9	2.9
Other (like tuck shop, house)	At service center or other Ward	3	1.0
Not applicable	Not applicable	247	79.7

Usually field shelters constructed on the flood plains are makeshifts of cheap material not meant to last long. At times it is just an open space as temperatures are usually high (Image 5.5). The structures provide shelter during flood recession cultivation. Households need to be close and guard their fields to ensure they are not destroyed by stray cattle, pigs, goats and sheep. They would also be maximizing time tending to their fields. Thus, this kind of livelihood is valuable in Chadereka Ward 1 and it contributes to its uniqueness in Muzarabani Rural District.

Image 5.5: Field shelters and household utensils (a) during growth and (b) during harvesting

Some households have adopted different building codes like that of erecting their buildings on top of rocks or deeply inserted logs or pillars as shown in Image 5.6. Even their grain storage structures are raised from the ground. The structures preserve the grain from moisture damage. Such flood management strategies on buildings have been reported by Rahman and Alam (2016) in the case of Bangladesh. Hanger *et al*. (2015) support the idea of coming up with building codes with suit the anticipated climate variability and change impacts.

Image 5.6: A homestead with houses, a granary *(hozi)* under construction and a post-harvest grain storage structure *(dyanga)* in Chadereka Ward 1

Data was also gathered on other types of implements used and owned by the household respondents besides livestock and buildings. Figure 5.12 illustrates the household responses on each physical asset. Ploughs and hand tools (especially hoes and axes) are confirmed to be owned by over eighty percent of the household (87.7% and 83.2%, respectively). Other assets possessed by the household respondents are radios (69.4%), scorch carts (42.6%), wheel barrows (31.0%), bicycles (28.4%) and energy generators like solar panels (25.2%). Also, see Images 5.3 for some of these properties. Implements or assets like motor cycles (3.9%), television (7.4%) and irrigation equipment (2.9%) usually are beyond the affordability of many households. As for televisions, the transmission system for reception is generally poor in the Zambezi Valley Area and due to water scarcity irrigation equipment is seldomly used except by wealthy households with deep wells in their gardens or households who received donations from the NGOs operating in the area (see Image 5.7).

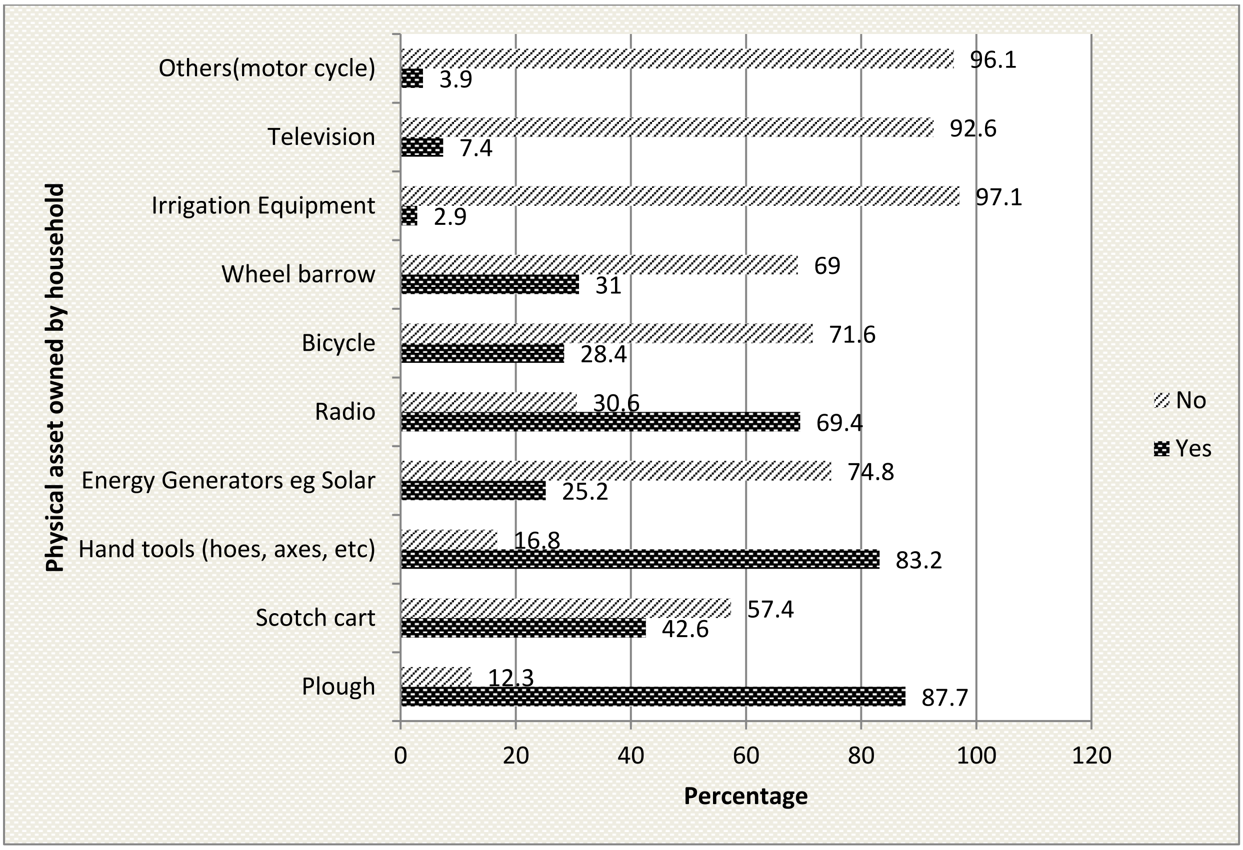


Figure 5.12: Some physical assets used and owned by respondents (n=310): Multiple responses

Image 5.7: Men drawing water from under riverbed using a foot pump donated by a NGO to the community in Chadereka Ward 1 in Muzarabani Rural District

Household implements are important physical assets for any livelihood undertaking. For instance, farming which is the dominant rural livelihood in Chadereka Ward 1, requires households to have ploughing equipments like ploughs, hoes and even cattle which are used as draught power in rural Zimbabwe. This is also confirmed by Lin *et al*. (2016) and Simatele and Simatele (2015). Cattle drawn scotch carts, wheel barrows, bicycles and motor cycles are essential for the transportation of inputs, harvested crops and other items to and from the fields. However, transport for long distances (like to visit the market place, the only one health center in the area and the police post) is one of the major challenges in the Ward with poor roads and broken bridges. Whenever households need to travel long distances, they rely on few public transport systems which charge exorbitant fares and are only accessible after two or more hours of walking. This situation negatively affects the adaptation strategies to climate variability and change at household level.

Generally, most rural livelihood ventures in Zimbabwe are nature-based as revealed earlier and also confirmed by Juana *et al*. (2013), Kanaskar *et al*. (2013), Piya *et al*. (2016) and Wright *et al*. (2015). Due to water scarcity, irrigation was necessary but households do not have the necessary infrastructure. Integrated management of water resources which include water harvesting and storage mechanisms should be enhanced as also suggested by Lotz-Sisitka and Urquhart (2014) in another study. Communication on weather reports from the ZMSD is also hampered by poor radio signals and networks. All these shortfalls are in line with what Lienert and Burger (2015) note as the inadequecy of infrastructural services which are barriers to livelihood security and climate change adaptation. While Masud *et al*. (2016) note physical assets to be promoted by economic development in Malaysia, in Chadereka Ward 1, these are not favorable and are negatively affecting adaptation strategies to climate variability and change. The Ward counselor stressed:

> *At times the food insecurity situation prevalent in this Ward results from shortages of farm equipment. Usually when a household does not have a plough, has to work for those who have and by the time a plough is offered the early rains would have gone. Minimum tillage, which is recommended, is demanding in terms of labor (for digging holes and weeding) and is usually done by the young adults and those with bigger household sizes. Thus, hiring or begging for farm implements is not sustainable even though some inputs like seeds are provided by well-wishers including the government.*

The above shows that physical assets are critical in rural households' livelihood strategies in Chadereka Ward 1 and even affect their adaptation strategies to climate variability and change. Communication systems which include television and transport systems are not accessed by many as already discussed thereby increasing their vulnerability to extreme weather conditions. The Ward is inaccessible yet it is valuable in livestock production among other natural resources. Hanger *et al*. (2015) proposed 'climate proofing' newly constructed roads, bridges or any other infrastructure making them resilient to expected impacts of climate variability and change. This is exemplified in the Ward by a foot bridge which had been constructed across Nzoumvunda River at the end of 2013, to help children access schools during times of floods which was impossible before.

There are no weather stations in Chadereka Ward 1 to keep households informed of the weather and climatic conditions. The ones nearby, Guruve and Mount Darwin, are more than 120 kilometers away (see Map 2.1 and Mugandani, 2012). Usually the households are caught unaware by floods before any weather forecast has been relayed to them. However, their IKS such as their knowledge about the use of animal behaviors and some plants at times is distorted by the level of degradation experienced and observed in the Ward and also confirmed during the focus group discussions. Briggs and Moyo (2012) also discussed similar issues in their study. Despite the post-independence Rural Electrification Program in Zimbabwe since the eighties, Chadereka Ward 1 still does not have access to electricity. The focus group discussants and key informants confirmed the non-availability of electricity in the Ward. Scaling up solar energy generation which still remains low, according to household respondents, saves to reduce the deforestation in the area and improve the sustainability of some strategies in adapting to climate variability and change. This issue resonates with the observation by Lotz-Sisitka and Urquhart (2014). Other physical assets like dip tanks, schools, clinics and other service provision structures are a cause of concern and an impediment to sustainability of some livelihood ventures in the Ward. Brown *et al*. (2012) also indicate that adaptive capacity to climate variability and change is hampered by poor infrastructure and services, weak institutions, marginalization from processes for decision-making and planning, among other impediments. This is further supported by Shackleton *et al*. (2015), Matthews *et al*. (2015), among others. The discussion of the human capital has been included within the sub-section on demographic characteristics. Thus, the following sub-sections consider financial and social assets within Chadreka Ward 1.

5.3.2.3. Financial assets and rural livelihood in Chadereka Ward 1 in Muzarabani Rural District

Financial assets take various forms like savings, wages, loans or money in saleable household property like agricultural (livestock and crops) and natural products like wild fruit, firewood, among others, similar to observations by Ansell *et al*. (2016). This sub-section presents and discusses production quantities of crops and livestock and the availability of other financial assets in Chadereka Ward 1. This provides useful data in assessing the sustainability of the rural livelihood practices and their adaptation to climate variability and change in Chadereka Ward 1 as undertaken by Lienert and Burger (2015), Masud *et al*. (2016) and Svubure *et al*. (2016). Financial assets are also indicative of food security in the Ward. Both crop and livestock production which are also part of the physical assets are assessed in terms of quantity and production trends for the past ten or more years and the perceived monetary benefit from the major rural livelihoods, similar to research undertaken by Cong *et al*. (2016).

Table 5.12 describes the quantities of main crops produced by the household respondents. Maize production, which is the staple food in Zimbabwe, was suggested to be less or equal to half a tonne (>=500 kg) by 87.7% of the household respondents. The same quantity was also suggested for sorghum bicolor production by 53.5% of the respondents. The responses on quantities for cowpeas and cotton of less or equal to 500 kg was almost at par (47.7% and

47.4%, respectively) and that for vegetables of all kind was 32.9%. The rest of the other commodities which were pearl millet, finger millet and others had less than 10% of the respondents. The crops with a response rate of less than 10% were not a popular practice in the Ward. Very few respondents suggested that their yields surpass either 500 kg or 1000 kg.

Table 5.12: Quantity of crops grown by respondents (n=310): Multiple responses

Crops Grown	</=500 kg	501-1000 kg	>1000 kg	Not applicable	No
Maize	87.7	3.9	3.5	2.6	2.3
Sorghum bicolor	53.5	1.9	0.6	16.1	27.7
Pearl millet	3.2	0.3	0.3	50.3	45.8
Finger millet	3.9	0	0.3	51.0	44.8
Vegetables (all kinds)	32.9	0	0	42.9	24.2
Cotton	47.4	3.5	1.3	10.3	37.4
Cowpeas	47.7	0	0.3	21.6	30.3
Sugar beans	3.9	0	0	49.7	46.5
Other	9.0	0.3	0	50.6	40.0

Generally, the production is at subsistence level and does not fully meet the yearly requirements by households. One participant during a focus group discussion said:

> *The crop yields we get here barely last up to June of each year. Those better off households have the opportunity to practice flood recession cultivation. The rest provide hired labor to such households who pay in grain or other food stuff.*

The quantities of yields clearly demonstrate the inadequacy of food. ZimVac (2010) in its assessment of livelihoods in the Northern Zambezi Valley concluded the crop yields as poor. Cotton, which used to be the number one commercial crop and financial asset booster, has since lost popularity due to low market prices. One kraal head, aged 59 years, stated:

> *Here most people rely on drought tolerant crops like sorghum, millet and cotton. Cotton is no longer giving us good money as before. Flood recession cultivation of maize is done by those with fields on flood plains (mudzedze). Livestock such as cattle and goats which browse the mopane and Ziziphus mauritiana tree leaves are kept together with chickens (road runners) and guinea fowls. People do not mind that mudzedze is a stream bank cultivation which is prohibited together with hunting. They are only after survival.*

Other crops not mentioned by name include groundnuts which are normally considered a female crop for the production of peanut butter which is used in place of cooking oil. Despite the production of a wide variety of crops reported, their sustainability is limited due to their rain-fed nature which is strongly impacted by climate variability and change (Svubure *et al*., 2016). The quantity is barely enough to cater for household families' needs from one season to the other as reported in research in Masvingo conducted by Kunzekweguta *et al*. (2016). Manyeruke (2013) reviewed an increase in food shortages from the past twenty years both at national and household levels. Thus, the households rely on food aid from the government, NGOs and some private entrepreneur who sells it for cash. Knowledge about the production status at the household level is important as this informs planners to promote locally acceptable and sustainable measures to reduce climate variability and change vulnerability (Cong *et al*., 2016). Manyeruke (2013) further attributed food insecurity to weak institutional policies such as that for agriculture which is not comprehensive and the non-existence of some policies, for example, the one for climate variability and change (Government of Zimbabwe, 2015). Thus, the role of crop production as a financial asset in Chadereka Ward 1 is no longer feasible.

Table 5.13 shows the production trend assessment of crops in Chadereka Ward 1. Household respondents were requested to provide their assessment on crop yields since the last ten or more years.

Table 5.13: Quantity of crop yields since ten or more years ago (n=310): Multiple responses (in %)

Crops Grown	Greatly Increased	Increased	Neutral	Greatly Decreased	Decreased	No Comment
Maize	1.3	4.2	11.6	24.8	56.1	1.9
Pearl millet	0	2.6	1.9	3.2	5.5	86.8
Sorghum bicolor	1.0	20.3	11.6	16.1	24.2	26.8
Finger millet	0	0.6	1.9	1.9	2.3	93.2
Vegetables (all kinds)	1.0	9.7	31.9	5.8	6.5	45.2
Cotton	0	1.6	11.0	39.7	32.6	15.2
Cowpeas	0	12.9	36.8	6.5	9.4	34.5
Sugar beans	0	1.9	7.1	1.6	1.0	88.4
Other	0	0.6	3.5	0.3	1.6	93.9

Generally, no major crops had a resounding increase in production since the past ten or more years in the study area. Instead they are all on a downward trend. Only sorghum bicolor, vegetables and cowpeas had double digital percentages of 20.3%, 10.7% and 12.9%, respectively showing some positive outcomes though minor. Combining the increased and the greatly increased category percentages for crops like pearl millet, finger millet, cotton and sugar beans, among others, they do not add up to 5% except for maize with 5.5% of the household respondents. Categories of decreased, greatly decreased and no comment recorded high percentages. For instance, a total of 82.8%, 95.5% and 67.1% of the respondents indicated maize, pearl millet and sorghum bicolor to have been reduced, respectively. Other crops with a similar trend are finger millet (97.4%), vegetables (57.5%), cotton (87.5%), cowpeas (50.4%), sugar beans (91%) and others like groundnuts (95.8%). From the percentages it becomes clear that there is food insecurity in Chadereka Ward 1 rendering their crop production livelihood unsustainable. While the drought tolerant commodities like pearl millet, finger millet and cotton are significant adaptation strategies and recommended (Jiri *et al*., 2015a; Rahman and Alam, 2016), their uptake in Chadereka Ward 1 is still low given the high percentages in the 'no comment' categories. The trend analysis of crop production in the study area for the past ten or more years shows that crops are not doing well generally in the area. One focus group participant stated:

> *While we are encouraged to grow drought tolerant and short seasoned varieties, some of these crops are destroyed by pests like quelea birds which attack small grains, others are difficult to prepare and others do not taste good.*

Similar observations were also reported by Nkomwa *et al*. (2014). Thus, most of the respondents are into other non-farm livelihood strategies to meet their daily food requirements and financial needs, a situation presented earlier by several authors who include Below *et al*. (2012) and Gentle and Maraseni (2012). This also demonstrates that crop production has ceased to be a viable and reliable financial asset in the Ward.

A similar production assessment was also done for livestock. Table 5.14 illuatrates the quantity of major livestock kept by the household respondents. The percentages of respondents owning livestock vary greatly. The highest percentage own chicken or guinea fowls (90.6%). This is followed by cattle (75.4%) and then goats with 67.8%. Sheep, pigs and others are owned by few household respondents: 17.7%, 12.9% and 1.0%, respectively. Differences were also noted on the quantities of these livestock per household responses. More than sixty percent (67.7%) of the household respondents own less or equal to ten cattle and the percentage decreases as the quantity of cattle increases with 1.6% owning more than sixteen cattle. Almost a quarter of the respondents (24.5%) do not own livestock. Cattle are of great value in the Ward. Besides providing meat, milk and green fertilizer for the household, they are also a source of draught power (see sub-section 5.3.1.2 and Image 5.3 [a]). In addition, Kayigema and Rugege (2014) also note the importance of cattle as a source of nutrition and food security in Rwanda. Muzari *et al*. (2016) and Yegbemey *et al*. (2014) observe that a short-term adaptation strategy to climate variability and change in Southern Africa was to switch from crop farming to livestock production.

Table 5.14: Quantity of livestock kept by respondents (n=310): Multiple responses (in %)

Livestock kept	<5	5-10	11-15	>16	Not Applicable	No
Cattle	36.1	31.6	6.1	1.6	7.4	17.1
Goats	35.5	25.8	4.2	2.3	28.1	4.2
Sheep	4.5	8.7	1.3	3.2	44.5	37.7
Chicken or guinea fowls	14.8	13.5	24.5	37.7	5.2	4.2
Pigs	8.1	4.2	0.6	0	54.8	32.3
Other	1.0	0	0	0	67.4	31.6

Goats are another valuable livestock in the study area. Generally, they are income safety nets as they are sold quickly together with chicken or guinea fowls when any immediate need for cash arises. Like for cattle, the quantity owned by household respondents decreases with an increase in their percentage. That is, 61.3% of the household respondents own ten or less goats. Household respondents who do not own goats are slightly more than thirty percent (32.3%). Usually small livestock are sources of livelihood in arid and semi-arid environment which are always dry (Bongo *et al*., 2015; Gao *et al*., 2015; Msomba *et al*., 2016).

The highest percentage (90.6%) of household respondents own chicken or guinea fowls. These non-ruminants livestock, especially guinea fowls, have been noted to be resistant to Newcastle, a poultry disease (ZimVac, 2010). Due to their small sizes they do not demand more feed than other livestock and can feed from household leftovers. They are a source of protein and cash for the household and their turn over is also fast. From Table 5.14, it can be noted that the highest percentage of household (37.7%) own more than 16 birds. Notwithstanding this response, some households reported massive deaths of their birds due to diseases. Despite these challenges, this is the most viable financial asset which improves household adaptative capacity to climate variability and change according to participants during focus group discussions.

Pigs, sheep and other animals are owned by a few individuals due to religious beliefs. For instance, some indigenous religions in Zimbabwe like the Apostolic Faith Mission of Africa *(Mwazha), 'Johane Masowe'* and *'Madzibaba eChishanu'* do not practise piggery for they believe that pigs have been condemned by God. This prohibits some of the livelihood practices in the Ward under study. Some Christians, on the other hand, do not attach any religious value to livestock but simply believe in prayers. Watson and Kochore (2012) discussed the issue of religion in Kenya and revealed how it was attached to livestock and utensils. In Chaderka Ward 1, some religions due to traditional belief of totems do not keep sheep nor consume mutton (sheep's meat). The consumption of other small animals like rabbits are not favored by the household respondents. While the variations in livestock production exist, Chikodzi *et al*. (2013) and Msomba *et al*. (2016) note the great significance of this kind of production as compared to crops in areas which are more arid. Thus, if livestock and wildstock production is done properly, ancillary industries like tourism, tanneries and meat processing could be developed as suggested by Chikodzi *et al*. (2013). Livestock production is a valuable financial asset in Chadereka Ward 1 and a viable adaptation strategy to climate variability and change.

A trend analysis was also done in terms of the quantity of livestock since the past ten or more years. Livestock quantity in this research also provides useful information to assess the sustainability of the livelihood (Kunzekweguta *et al.*, 2016). Table 5.15 describes the perceptions of changes in relation to the number of livestock in Chadereka Ward 1, according to the household responses. For the analysis, a likert scale was adopted to indicate whether the livestock had greatly increased, increased, neutral, greatly decreased, decreased or no comment. All the percentage responses were below 50% in each category. For instance, combining the greatly increased and the increased categories, it emerged that the household responses did not surpass 40%. Of this category goats recorded 37.1%, chicken or guinea fowls 35.8% and cattle 19.6%. Sheep, pigs and other livestock, like rabbits, had the least percentage of less than 6%. The greatest percentages of over 80% of the responses on these livestock were recorded in the 'no comment' category with sheep having 83.5%, pigs 90.3% and other (rabbits) 99.0%. Such a high percentage suggests that households do not produce such livestock or once these livestock are produced they are quickly disposed off as the households solve pressing family needs. Other reasons which may affect the numbers of the livestock include water shortages, lack of supplementary feed or some households are so poor that they do not own any livestock.

Table 5.15: Quantity of livestock since ten or more years ago (n=310): Multiple responses (in %)

Livestock	Greatly Increased	Increased	Neutral	Greatly Decreased	Decreased	No Comment
Cattle	4.8	14.8	23.5	6.5	30.0	20.3
Goats	4.2	32.9	17.1	4.8	19.7	21.3
Sheep	1.3	4.2	3.5	1.9	5.5	83.5
Chicken or Guinea fowls	4.5	31.3	30.3	5.2	19.4	9.4
Pigs	0	1.0	5.2	2.3	1.3	90.3
Other	0.3	0.3	0	0.3	0	99.0

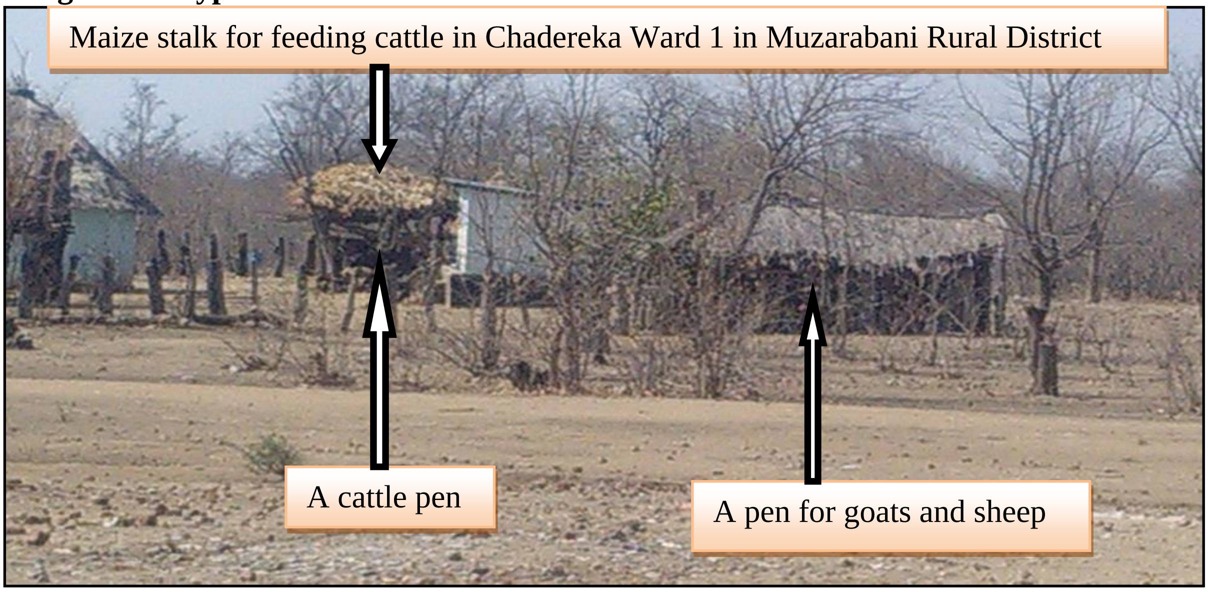
The neutral category had sizeable percentages of household responses with chicken or guinea fowls having the highest percentage (30.3%) followed by cattle with 23.5% and goats with 17.1%. This meant that livestock numbers for some households maintained a state of equilibrium with those that are sold or consumed being replaced by those being reproduced. Sheep and pigs had 3.5% and 5.2%, respectively, with no other record in these categories. Since livestock are important as they can be used for various purposes like boosting the financial asset (Chikodzi *et al*., 2013; Msomba *et al*., 2016), it is of concern that their numbers per household remains low due to sales in meeting household needs of various kinds as indicated during the focus group discussions and key informant interviews. The Chief stated that almost on a daily basis livestock are being sold in Chadereka Ward 1 by different households. Despite the low percentages, livestock remains valuable in the Ward. These act as a key adaptive strategy to climate variability and change given that crops are more sensitive to the lack of rain than livestock. One participant during a focus group discussion said:

> *Livestock here in Chadereka Ward 1 are of great value and a source of life and capital for household needs. Due to the sweet veld and other conducive climatic conditions, they quickly multiply. Goats at times produce two or more kids in a year without any artificial aid. Livestock are our pillar for survival since crop production is a problem because of water shortages. We sell livestock whenever we need cash.*

Generally, livestock play a significant role in the lives of communities in arid and semi-arid regions and where rainfall is erratic like in Chadereka Ward 1 in Muzarabani Rural District. This kind of production is not greatly affected by rainfall variability as compared to crops (Kunzekweguta *et al*., 2016; Rahman and Alam, 2016). However, pasture shortages, lack of supplementary feed like stalks of maize and other crop residues, and lack of drinking water can cause death to livestock as experienced in the southern lowveld of Zimbabwe. In Chadereka

Ward 1 case of livestock succumbing to these challenges are rare. Image 5.8 shows one of the homesteads in Chadereka Ward 1 with maize stalk harnessed for cattle as a supplementary feed.

Image 5.8: A typical homestead in Chadereka Ward 1 with a maize stalk



While livestock production is a more sustainable livelihood practice in Chadereka Ward 1, shortage of veterinary services (only one vetenary station) in addition to water challenges affect their full production. Stock thefts have been managed by the establishment of a Zimbabwe Republic Police (ZRP) post at Chadereka Business Center. On this issue of stock theft, the health personnel interviewed said:

> *There used to be numerous stock thefts here in Chadereka Ward 1 before the ZRP post was mounted here near the clinic. It is now rare to hear of households with stolen livestock.*

Various factors were noted to be contributing to the diversity in terms of quantity for both crops and livestock in the past ten or more years. Principal among the factors is climate variability and change and its direct and indirect effects as also noted by Chikodzi *et al*. (2013), Dube *et al*. (2016) and Huq *et al*. (2015) in other studies. For crop production, 80.0% of the household respondents suggested climate variability and change to have caused the greatest impact in the reduction of crop yields and surface water bodies. Other complementary causes cited were financial constraints in the purchase of inputs and poor farm management with 15.5% and 5.5%, respectively. The remaining percentage responses were distributed in the different combinations of these causes. For instance, climate variability and change and its effects combined with financial constraints had 10.3% of the responses, while combined with poor farm management had 1.0%. The three combined (climate variability and change and its effects, financial constraints and poor farm management) had 3.9%. Other reasons had 6.1% of the respondents (Table 5.16).

Table 5.16: Respondents' views on the causes of variations in the quantities of crops and livestock for the past ten or more years (n=310): Multiple responses (in %)

Causes of variations	**Crops**		**Livestock**	
	Yes	**No**	**Yes**	**No**
Climate variability and change and its effects	80.0	20.0	41.6	58.4
Poor Management	5.5	94.5	17.7	82.3
Financial Constraints	15.5	84.5	45,8	54.2
Climate variability and change and its effects and poor management	1.0	99.0	1.0	99.0
Climate variability and change and its effects and financial constraints	10.3	89.7	16.1	83.9
Climate variability and change and its effects, poor management and financial constraints	3.9	96.1	3.2	96.8
Other reasons (selling or trading)	6.1	93.9	32,3	67.7

From the focus group discussions all the participants concurred on climate variability and change being the major setback in crop production which is also argued by Phiri *et al*. (2014). However, some households do not properly plan their planting and other farming activities. Others degrade their environment through malpractices like stream bank cultivation. This causes siltation and limits the water holding capacity of rivers essential in vegetable production during the dry season. Additionally, poor timing of planting leads to crops being affected by dry spells as argued by Sango and Godwell (2015b).

For other crops, low market prices have greatly affected the commodities like cotton. This is due to the economic situation compounded by the political environment in Zimbabwe. Participants during the focus group discussion were reluctant to publicly criticize the political environment for fear of victimization. However, they noted lack of commitment by the government in promoting cotton production evidenced by the conversion of the once great ginnery plant into a fertilizer production unit in the town of Bindura. The low yields in sorghum bicolor, pearl millet and finger millet were attributed to the attacks of the crops by pests such as the red-billed quelea birds which have a devastating effect on grains. While the causes are similar for the two commodities, crops and livestock, differences were cited in relation to other reasons.

For livestock production, financial constraints were noted to have the greatest impact as identified by 45.5% of the respondents. This was followed by climate variability and change and its effects which was confirmed by 41.6% of the respondents. Slightly above thirty percent (32.3%) of the respondents noted other reasons while poor management was suggested by 17.7%. A combination of climate variability and change and its effects and financial constraints had 16.1% while the other combinations of climate variability and change and its effects and poor management and climate variability and change and its effects, poor management and financial constraints had 1.0% and 3.5% of the respondents, respectively. This is also shown in Table 5.16.

During the focus group discussions, participants suggested that livestock quantities were generally affected by the selling or trading practice as households tried to supplement food shortages which are common in the Ward. The numbers of the livestock, especially cattle, had been also kept minimal for them to be sustained by the natural pastures which diminish as numbers get bigger. Besides, veterinary services are inadequate in the Ward to advise farmers on any problems with their livestock. Some therefore are affected by sickness. Few households supplement the feed for their livestock. The rest, including pigs, are left out to run around the yards in search of food. One key informant also explained the value attached to livestock by the households and expressed concern over the diminishing natural pastures due to changing climate and few dip tanks in the Ward to protect cattle from ticks and other diseases. Generally, the climate is changing. Reduction in livestock feed due to pasture and water shortages resulting from climate variability and change is being experienced in Chadereka Ward 1 as highlighted by the responses. This was also noted by Gurukurume (2013) and Kima *et al*. (2015). However, livestock remains a valuable financial asset in the Ward.

It became clear that while the crops were greatly affected by climate variability and change impacts, livestock became the buffer livelihood within the Ward which in turn is reduced as dry conditions persist. Thus, these livelihoods (crop and livestock production) are complimentary and limited in terms of their sustainability calling for more diverse and non-farm activities. Adaptation to climate variability and change is therefore of paramount importance. This also implies that extension and veterinary services, reliable markets for both crop and livestock products, and marketing information need to be provided freely and extensively to the inhabitants in Chadereka Ward 1. As suggested by Holman *et al*. (2016), a drive towards policy options of encouraging and supporting innovation, best use of land and improved climate variability and change management strategies assist in reducing vulnerability of the rural communities to the dangers of climatic hazards.

Monetary benefits from the major livelihood practices were solicited from the household respondents. Table 5.17 provides the statistics. Converting all the livelihoods portfolios to monetary value, respondents suggested that their households rarely get more than US$50.00 per month which is far below the poverty datum line in Zimbabwe of US$481.00 per month within a household of five members (ZIMSTAT, 2012). In fact, having some cash in the marginal areas like Chadereka Ward 1 is rare. Cash is only available immediately after selling an asset like a livestock and is not banked but kept at home. No sales are done on crops except cotton before market distortions on the commodity. At times they sell wild fruit (*Ziziphus mauritiana* and *adansonia digitata* berries) for cash but in most cases they exchange their livestock for maize or items for household use like clothes. Farming, which is the major livelihood currently, inadequately sustains the lives of household respondents in the area given an average household size of 6 members, according to ZIMSTAT (2012). Two-third of the household respondents (66.7%) confirmed that farming provided them with less than US$50 per month. Thus, an individual survives on less than thirty cents per day. When asked about the decline on farming productivity as well as the unreliability thereof, some household respondents pointed out to the unpredictable and erratic rainfall and high temperatures which were being experienced more often than before. Others blamed the political environment within the country which had failed to promote economic development in general. Insteady, corruption and abuse of public assets had escalated dissuading investors and contributing to the vulnerable socio-economic conditions experienced which include lack of employment opportunities and over-reliance on a declining and increasingly degraded natural resource base. This was reported during focus group discussions. Thus, while the biophysical environment, which encompasses climate variability and change, is contributing to the dwindling livelihoods assets like financial capital in Chadereka Ward 1, the human environment has a significant impact as well. These have had adverse impacts on farm production making the sustainability of livelihoods in the Ward limited.

Table 5.17: Responses on monthly monetary benefit from livelihoods practiced (n=310): Multiple responses (in %)

Livelihood practice	<US$50	US$50-US$100	US$101-US$150	US$151-US$200	>US$200	Nil
Farming	66.8	7.7	1.6	2.9	5.8	15.2
Wild fruit gathering	47.4	0.6	0.3	0.3	0.3	51.0
Service provision	40.6	3.2	1.3	1.0	1.6	52.3
Hunting	0.6	0	0	0	0	99.4
Mining	0.6	0.3	0	0	0	99.0
Remittances	27.4	3.2	0	0	0	69.4
Government donations	39.7	1.6	0.6	1.3	0	56.8
NGO donations	46.5	0.6	0	0	0	52.9
Other institutions	5.2	0.3	0	0	0	94.5
Other	0.3	0.3	0.6	0	1.6	97.1

Market fluctuations already discussed were a cause for concern among the households. The major market, especially for livestock is Harare (more than 260 km from Chadereka Ward 1) and offers very low prices for the commodities. One key informant said:

> *People from Harare come to buy livestock at low prices such as US$100 per beast citing high transport costs due to the poor roads and broken bridges. With no option one sells the beast in order to buy maize, our staple food which is in short supply. When we run out of food stuff usually in December and January, a beast can be exchanged for only 350 kg of maize.*

Single digit percentage responses in Table 5.18 were for monetary benefit in excess of US$50. For instance, on farming, only 7.7% of the respondents indicated that they get between US$50-US$100, while 1.6% receive between US$101–US$150, 2.9% get between US$151-US$200 and 5.8% receive over US$200. Slightly above fifteen percent (15.2%) indicated that they get no money from farming. The monetary benefits from livelihoods undertaken by households vary due to individual family's capabilities and assets owned, which is similar to the report by Dube and Phiri (2013). Thus, commercialization information through training the households is a positive step towards improving sustainability of household ventures in the face of climate variability and change in Chadereka Ward 1.

For other livelihoods the percentage responses on their monetary benefits were less than US$50. That is, for wild fruit gathering the response was 47.4%, service provision (like trade) 40.6%, remittances 27.4%, government donations 39.7% and NGO donations 46.5%. Monetary benefits from hunting, mining and institutional donations like churches were 0.6%, 0.6% and 5.2%, respectively. Except for farming, over 50% of the household respondents indicated that they do not benefit in monetary terms from each of the remaining livelihoods. That is, for wild fruit gathering the response rate was 51%, service provision 52.3%, hunting 99.4%, mining 99% and institutions like churches 94.5%. This shows that there are limited mainstay livelihood portfolios in the area as almost all households rely on agriculture.

However, livelihoods diversification like venturing into service provision which encompasses petty trading, provision of casual labor in fields and herding cattle, among others, are worth recognizing as they are a source of financial capital and they supplement family incomes as reported by Aberman *et al*. (2015), Maninder and Singh (2015) and Noble *et al*. (2014). Such livelihoods, generally, are not seasonal and could be done anywhere and at any time. Arku (2013) also found petty trading ranked the most significant livelihood in the semi-arid region of Ghana. However, as appraised earlier, some of these livelihoods are not reliable due to market fluctuations and scarcity in the marginal areas with poor infrastructure. As such, infrastructural support and the introduction of new forms of livelihoods will be important to improve the sustainability and well-being of the households in Chadereka Ward 1.

For a greater understanding of the sustainability status and contribution of some rural livelihoods to the well-being and resilience of the Chadereka Ward 1 households, sale times for livestock were obtained from household respondents and analyzed (Table 5.18). Generally, the frequency of sale times of livestock is determined by several factors which include quantity of such livestock per household, the price for the livestock, and the pressing needs by the household, among other reasons similar to those reported by Ansell *et al*. (2016). Larger livestock like cattle are sold once in a year as indicated by 50.6% of the respondents. Cattle normally fetch more money than small livestock, according to the respondents, despite some market distortions. Hence, once sold the money can resolve more household pressing needs. On the other hand, the sale without a fast replacement increases household vulnerability as they would have lost a physical asset.

Table 5.18: Responses on livestock sale times (n=310): Multiple responses (in %)

Livestock	Weekly	Monthly	Seasonally	Yearly	Do not Sale	No Comment
Cattle	0	0.3	12.9	50.6	15.2	21.0
Goats	0.3	12.3	24.8	10.3	10.6	41.6
Sheep	0.6	2.3	4.5	2.6	6.1	83.9
Chicken or guinea fowls	5.5	30.0	34.8	4.2	18.4	7.1
Pigs	0	1.0	2.3	1.9	3.5	91.3
Other	0	0	0	0	1.6	98.4

In contrast, the selling times for chicken or guinea fowls are weekly with 5.5%, monthly with 30.0% and seasonally (34.8%). ZimVac (2010) assesses that guinea fowls are resistant to the Newcastle disease for poultry, hence they quickly multiple and serve as safety nets for the households during challenging times. The selling time for goats comes second after that for chickens or guinea fowls and is more seasonal than monthly and weekly. For instance, 24.8% of the respondents indicated seasonal selling of goats while 12.3% stated monthly. Goats multiply annually unlike cattle. Pigs also have a high multiplication rate but they are not favored due to religious and other beliefs in Chadereka Ward 1. The issue of livestock as an adaptation strategy to climate variability and change is in line with observations by Chikodzi and Mutowo (2014), Gukurume (2013) and Jiri *et al*. (2015a). Those who responded that they do not sell any livestock either do not have them or they are fewer in number. Cattle for instance, perform various tasks as discussed earlier. Once sold, they leave a gap in terms of draught power and green fertilizer for improving soil fertility. Responses on the sale of sheep, pigs and others are highest on the 'no comment' category (83.9%, 91.3% and 98.4%, respectively) suggesting that few households own these livestock. Given the impacts of rainfall shortages in the presence of some physiographic conditions like mopane and other herbaceous vegetation in Chadereka Ward 1, animal husbandry becomes a more sustainable livelihood option compared to crop production. Thus, more support in terms of infrastructure like dip tanks or veterinary services in general should be made available to the households in this marginal area as already suggested. This would reduce the vulnerability of the households to the impacts of climate variability and change.

The research further solicited information on the types of financial accounts owned by the households (Table 5.19). This served to further understand the financial assets that households in the Ward have. Above eighty percent (87.4%) of the households confirmed that they kept their money at home whenever they hade cash. Only a small percentage (7.7%) had some savings account. Households receiving pension made up of 1.3% while 1.6% was for those with other financial assets. A few resepondents (1.9%) indicated that they did not own any financial asset. Aberman *et al*. (2015) and Simatele and Simatele (2015) also reported lack of financial accounts and assets as a challenge for adapting to climate variability and change among households in rural areas.

Table 5.19: Types of financial accounts owned by households in Chadereka Ward 1 (n=310)

Financial asset owned	Frequency	Percent
Cash at home	271	87.4
Savings	24	7.7
Pension	4	1.3
Other	5	1.6
None	6	1.9
Total	310	100.0

One participant during a focus group discussion expressed:

> *Besides not having enough money for keeping in the banks, those who have some cash are afraid of keeping it in the banks as it has appeared to be costly to travel to the banks. Again, when one gets to the bank, say in Mount Darwin or Bindura, there is a withdrawal limit and exorbitant bank charges. We do not even have a Post Office Savings Bank here in Muzarabani Growth Point which is nearby like in some Districts in Zimbabwe. In fact, we are far behind in terms of infrastructural development and we are always struggling to make ends meet.*

From the above sentiments, acquiring and keeping financial assets are a challenge in the Ward and negatively affect the sustainability of strategies to adapt to climate variability and change. Group financial mobilization or communal pooling as observed by Aberman *et al*. (2015) is fundamental to financial assets and rural livelihoods sustainability. Also, some micro finance projects would assist in such marginalized communities.

A further discussion is given on labor in relation to the rural livelihoods pursued in the Ward. In relation to most of the livelihoods done by the households in Chadereka Ward 1, household members are the source of labor as indicated by 94.2% of the household respondents (Table 5.20). Since their agricultural practice is done at the subsistence level, they do not have enough resources to engage waged or hired labor thus, women usually are the providers of most of the labor as revealed by Jonah *et al*. (2016). Generally, few individual households (2.6%), especially those with more land and practising flood recession cultivation, hire individuals to help them in herding cattle, goats and sheep as well as tending the field crops. Once the individuals are hired, they are paid mostly in kind. That is, they are given grain like maize for food (Bhatta *et al*., 2015; Ansell *et al*., 2016). Rarely are they given cash. The other practices in terms of labor sources do not have any substantial percentages. For instance, community cooperative and a combination of household labor, hired labor and community cooperative had one respondent each. Household and hired labor had 1.9% while household and community cooperative had 0.6% of the respondents. Given the over dependence of most of the livelihoods in the Ward on natural rainfall, its scarcity due to climate variability and change forces some members of the family to migrate to other Wards or towns in search of paid labor to meet household needs. This had also been noted by Ansell *et al*. (2016), Jiri *et al*. (2015a) and Sharma *et al*. (2014). The complexity of securing livelihoods through migrant labor has also been studied in Zambia by Ito (2010). Thus, migrant labor also contributes to financial capital in Chadereka Ward 1.

Table 5.20: Labor sources according to household respondents (n=310)

Labor source	Frequency	Percentage
Household members	292	94.2
Hired labor	8	2.6
Community cooperative	1	.3
Household and hired labor	6	1.9
Household and community cooperative	2	.6
Household, hired labor and community cooperative	1	.3
Total	310	100.0

Skilled labor is scarce in rural areas such as Chadereka Ward 1. Besides those holding public office positions like nurses, teachers, Agritex officers, police officers at Chadereka base and veterinary surgeon, the rest provide manual labor in brick molding, fencing water sources, thatching, building huts (as in Sango and Godwell, 2015a), or do nothing. The human capital and the financial capital are also influenced by the education level attained by people in the Ward. Given these circumstances, microcredit programs, social clubs, and other forms of innovation are critically needed in Chadereka Ward 1 to increase the sustainability of livelihood strategies by the community in the face of climate variability and change. With the relatively high number of family members, appropriate advices or physical assets and information on climate variability and change, the labor available could be put to good use and explore more beneficial livelihood portfolios for the households.

5.3.3 Rural livelihoods regulation or governance in Chadereka Ward 1

This theme seeks to explore the laws, policies, regulations or management strategies operationalizing and governing the execution of rural livelihoods in Chadereka Ward 1 from the household respondents' and key informants' points of view. Given that rural livelihoods in the Ward are based principally on natural resources (land, water, vegetation, and wild animals), an overview of regulations (management strategies) used in Zimbabwe to protect the environment from excessive degradation are points of reference. The local leadership usually is the custodian of the communal laws governing the use of these natural resources (Dube and Guveya, 2013). As such this analysis and discussion helps to examine management practices employed by households in the Ward to safeguard the sustainability of the livelihood assets essential for their survival. Which regulations exist in relation to rural livelihood resource or environmental management in Chadereka Ward 1?

Table 5.21 shows summarized responses on how natural resources were being managed in the Ward. Participants during the focus group discussions and key informants agreed with the identified regulations. It emerged that these were the management strategies as stipulated by EMA and households were expected to adhere to them. However, the focus group discussants pointed out that the management strategies were not strictly being followed. For instance, households, especially those in the local administration, were flouting the regulation on restricting stream bank cultivation (flood recession cultivation) and ploughing at least 30 m from the river bank for that was also their practice. The Ward counselor commented:

> *Households are hard pressed with staple food shortages and limited livelihood diversity due to these climatic changes and socio-economic challenges currently affecting the country and they end up practising some of the prohibited activities like hunting, cutting down and selling of fuelwood. Some even practice flood recession cultivation on river banks not considering the distance of 30 m from the river bank which is allowed by EMA before any cultivation takes place. Thus, the majority of the regulations are flouted as these natural resources are our only source of living.*

Table 5.21: Summary of how households have managed natural resources in Chadereka Ward 1

Natural resource	Management strategies
Land	Minimum tillage, land furrowing, destocking, fencing, contour ploughing, prohibition of pulling logs or ploughs, ploughing at least 30m from the river banks, destocking and resettlement, use of green fertilizer.
Vegetation	Use of dry fuelwood for heating and cooking, prohibition of veld fires and deforestation, fencing and the expropriation of the indigenous natural fruit trees (like *Ziziphus mauritiana)* within their fields, reforestation, destocking.
Water	Digging and protecting wells and boreholes against animals, sand scooping, water recycling (used domestic water is reserved to water animals), use of water storage containers and mulching**.**
Minerals	None
Wild animals	Using statutory law of Zimbabwe which prohibits hunting without a licence or poaching, migration of some wild animals to areas with water and more vegetation like the Zambezi River banks and Mavhuradonha Mountain Range.
Other (Solar enegy)	Construction of shelters at homesteads and the acquisition and use of solar panels for lighting, for powering radios and phone charging.

Further analyzing the responses on natural resource management strategies, for land, minimum tillage and destocking are not being followed by all. Some families face labor shortages in practising minimum tillage due to small household sizes, while destocking is not done as their livestock numbers are already low due to sale in meeting family needs as highlighted earlier. The use of green manure is selectively done due to variations in livestock ownership. Given the increasing aridity and financial constraints, households no longer use artificial fertilizer in their fields though they sometimes spray pesticides similar to what was noted by Rahman and Alam (2016).

More contradictions exist in the management of vegetation as indicated by Thomas and Twyman (2005). Vegetation is the main source of fuelwood and material for field protection and shelter building in Chadereka Ward 1. Hence, controlling deforestation in the area using EMA regulations is a challenge. Households argue that there are no other alternative energy sources for heating and cooking except fuelwood. Selling firewood is also another source of income and survival. However, they agreed in their community to protect fruit trees and those which are for building purposes and browzing by their livestock. This has been effective since households are found fencing their fields and expropriating *Ziziphus mauritiana* natural fruit trees within their homesteads. Aforestation is limited due to water shortages. However, local authorities continue to encourage the use of naturally dry fuelwood.

Management of water is also a great challenge in Chadereka Ward 1. Due to surface water scarcity, watering points like wells and boreholes were erected to tap water from underground sources with the help of mainly NGOs and the government. These sites are protected by branches and logs against animals. The sites for boreholes are generally far from the homesteads and households secure plastic and other types of containers for fetching water. In some places the water is saline. Thus, households spend a lot of time in accessing water as also revealed by Jonah *et al*. (2015). Water management issues have been cited in different studies by Chisanya and Mafongoya (2016), Liernet and Burger, (2015), Rahman and Alam (2016) and Svubure *et al*. (2016). Those households located near rivers practice sand scooping. For some of the water management strategies see Images 5.1 (b), 5.2 and 5.4. Water recycling is done as households make use of used domestic water in watering their animals and some plants. Moisture in vegetable production is maintained by mulching but not done on a large-scale**.**

Wild animals are protected by the statutory laws of Zimbabwe which prohibits hunting or poaching unless given permission to do so as also observed by Balama *et al*. (2016). Some animals migrate to areas with water and pasture like the Zambezi River and Mavhuradonha Mountain Range. There is no manegenent strategy for mineral as these are non -xistent in the Ward. For other natural resources, like solar energy, households still need more assistance for them to acquire the solar panels and utilize energy from the sun. When it is very hot they seek shelter under tree shade or artificially constructed structures to avoid direct heat.

In analyzing perceptions of the number of management strategies on each natural resource in Chadereka Ward 1, Table 5.2 illustrates the percentage responses.

Table 5.22: Quantity of natural resource management strategies (n=310) (in %)

Rural livelihood (natural) resource	Few management strategies (less than 3)	Several management strategies (more than 3)	None
Land	87.7	1.9	10.3
Vegetation (trees and grass)	88.1	1.0	11.0
Water	88.7	1.0	10.3
Wild animals	9.7	0.3	90.0
Other	0.3	0	99.7

Few management strategies (less than 3) where reported on land (87.7%), vegetation (88.1%) and water (88.7%). Wild animals had 9.7% and other resources had 0.3% in the same category. Respondents who cited more than three management strategies per natural resource were less than two percent. That is, 1.9%, 1.0%, 1.0% and 0.3% for land, vegetation, water and wild animals, respectively. For wild animals and other natural resources like solar energy, 90% and 99.7% suggested no management strategies, respectively. The quantity of management strategies has an implication for the deterioration and sustainability of the natural environment. The more the natural resource management strategies are (and if they are implemented), the more their sustainability is promoted. As such, more management strategies for the dominant natural resources used in Chadereka Ward 1 need to be developed in a manner which considers indigenous knowledge and customary practices to ensure their sustainability and adaptation to climate variability and change in the area. The imposition of government statutory laws is a source of conflict in most countries of sub-Saharan Africa where rural livelihoods are natural resource based (Thomas and Twyman, 2005). Harmonization with the customary tenure systems prevalent in a given community promotes cooperation and proper execution by all.

Wright *et al*. (2016) commended the improvement of the local community attitudes and perceptions towards conservation and good management of the natural resources and mutual cooperation between resource users and the law enforcers as the best strategy in dealing with the problems of natural resource management. This enhances community ownership and empowerment which promote environmental sustainability.

The research further sought to establish the existence of policies or regulations governing the promotion of sustainable adaptation strategies in times of drought and floods, the two major climatic elements bedeviling Chadereka Ward 1. Figure 5.13 shows that the respondents generally acknowledged the presence of regulations governing the use of water and vegetation and the production of crops and livestock during drought and flood times. Above sixy percent acknowledged the existence of regulations for water management, vegetation management and livestock management during drought with 70.6%, 73.5% and 63.5%, respectively. The lowest percentage (33.5%) was for crop management since infrastructure for irrigation is not yet in place and some crops like cotton have lost their market value. In the case of floods, more than seventy percent confirmed the practice of all the four management systems. These are livestock management (72.3%), crop management (74.2%), vegetation management (78.7%) and water management (73.2%). Thus, more attention is placed on flood challenges than drought.

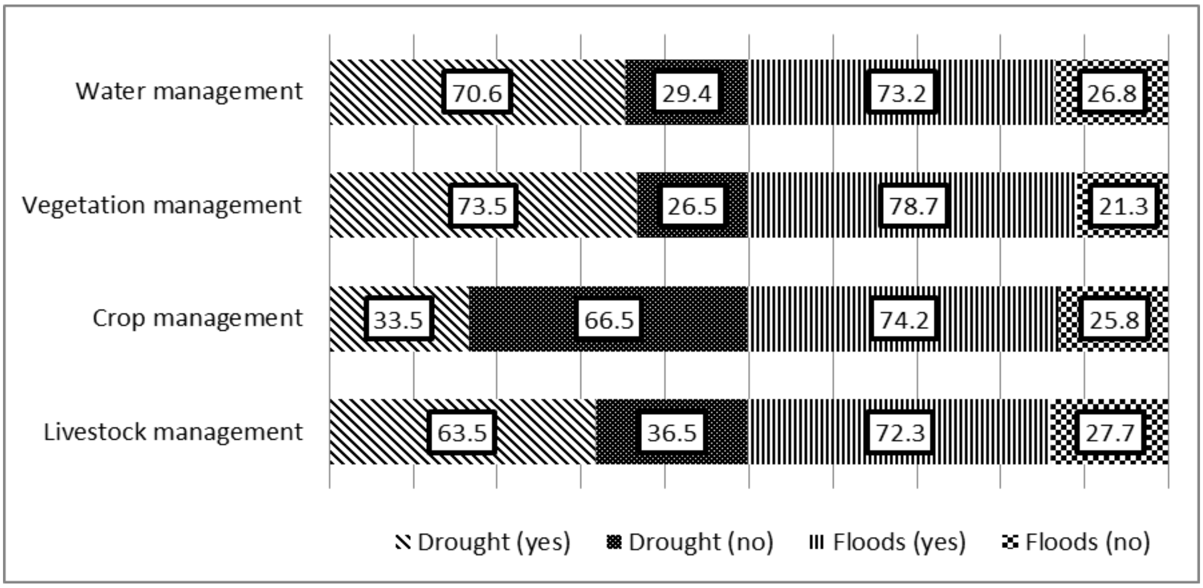


Figure 5.13: Policies or regulation systems (laws) to promote sustainable adaptation to drought and floods (n=310): Multiple responses (in %)

These results were also confirmed by the Ward Counselor who said:

> *The Ward members are not allowed to cut down trees willy-nilly, neither are they allowed to pull logs which loosens the soil making it prone to erosion by water during floods and by wind during drought periods. They are not allowed to gather unripened natural fruit like Ziziphus mauritiana berries. Stream bank cultivation is not allowed as well. The households are allowed to keep a limited number of cattle but no restrictions on small livestock. Anyone found on the wrong side of the law is fined a goat which is taken to the chief and eaten by the elders of the Ward. We have had challenges with stream bank cultivation. The anti-poaching law is effective as the ZRP currently has a base at Chadereka Service Center and monitors the situation. Generally, for other regulations, there is minimum monitoring as households are concerned in securing food for their families.*

From the statement it is clear that some regulations are put in place governing the use of resources and livelihoods in the Ward. However, monitoring is ineffective given that some of the elders in the Ward normally breach the laws. From the sub-section it is clear that households are aware of the existence of regulations governing the use of their natural resources. However, compliance is a challenge given the over-reliance on the natural resource base for survival. This is compounded by the EMA officials who rarely visit the Ward to monitor the enforcement of the regulations.

5.4 AWARENESS OF CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1

This research also sought to establish the awareness levels of climate variability and change among the inhabitants in Chadereka Ward 1. The knowledge base of the phenomenon has a bearing on the rural livelihoods practices and adaptation strategies to the calamity examined in the area as observed in other studies by Chifamba and Mashavira (2011), Jiri *et al*. (2015b), Madobi (2014), Olutegbe and Fadairo (2016) and Toole *et al*. (2016). In this endeavor, sampled households, participants during focus group discussions and key informants provided information through their responses to questions on the subject matter. Thus, for the purpose of this thematic discussion, awareness levels which form part of the social capital were deduced through percentage responses on information regarding the reception, type and provider of climatic data, household assessment of climatic conditions in Chadereka Ward 1 and climate variability and change awareness campaigns conducted in the area.

Close to three quarters of the respondents (74.8%) confirmed that they had not received any information to do with climate. Close to a quarter (25.2%) acknowledged receipt of some information. The few who received the information were generally the local leadership like the Chief, the kraal heads and the counselor who were normally invited to attend to workshops and conferences where such issues were discussed in towns. This implies that the majority of the households have little knowledge regarding climate variability and change from the scientific point of view though they interpret weather conditions through the use of their IKS similar to what was revealed by Adetayo (2013), Betzold (2015) and Ogunleye and Yekinni (2012). Such issues need to involve the entire grassroots level for the community to respond positively to the call for solutions. The Chief commented:

> *In this area it is rare to receive climate information except for those with radios which in most cases do not have battery power. The traditional leadership is seldom called for workshops and when they come they do not effectively and properly disseminate the information to the people. Usually the young ones who go to school have a better knowledge than the adult households. The majority of the households receive information, especially when some NGOs visit the Ward to share what they would want to offer to the community.*

This implies that awareness levels on climate variability and change among households is generally low given that no proper and effective channels of communication are in place currently.

Households also provided information on the suppliers of climate variability and change data. According to Table 5.23, 20.3% of the respondents indicated that climatic data was supplied by government organs (comprising of officers either from the ZMSD, Agritex, EMA, CPU, health or education departments), 5.4% by NGOs, 0.6% by traditional leaders and 1.0% from other sources like civil societies. Above seventy percent (74.8%) did not receive climatic information from anyone. During the focus group discussions it also emerged that households felt neglected and deprived of climate information. One participant expressed:

> *The providers of such important information do not want to come to experience the heat and other problems we have here. Why does it take so long to repair even the cyclone Elene damaged bridges to improve the transport system since 2000?Most government officials only visit when they want to be voted for positions in government. Once they win they forget about us. We need information and assistance here.*

Table 5.23: Providers of climate variability and change information (n=310): Multiple responses

Provider of climate variability and change information	Frequency	Percent
Government organs	63	20.3
NGO	17	5.4
None	231	74.5
Other	3	1.0
Traditional leaders	2	0.6

Various sources of information on climate change exist. UNFCCC. (2011) and Olutegbe and Fadairo (2016) noted radio, television, newspapers, magazines, extension agents, internet and books as key sources to share information. Some of these sources are rare in Chadereka Ward 1 which is a remote area with poor infrastructure. The government organs like the ZMSD and the EMA seldom visit the households. For the few households who receive the information, it comes through their school children. There is only one Agritex officer with limited mobility. Traditional leaders usually attend seminars and conferences where such issues are discussed but do not properly disseminate the information to the households. Knowledge sources are paramount in this discussion. Hence, given this situation, the awareness level of households to climate change becomes low and limited, despite the existance of some forms of IKS discussed by Risiro *et al*. (2013), Muyambo and Maposa (2014) and Nyantakyi-Frimpong (2013). This implies that accessibility of the Ward has to be considered and prioritized. Roads and bridges need urgent attention. Information deficit is also compounded by the lack of weather stations in the Ward. Thus, the installation of automated weather stations ought to be considered.

In probing further on awareness to climate variability and change issue, the household respondents provided the type of climatic data they received (Table 5.24). Of those who received the information, 10% suggested that it was on weather conditions, 8.4% confirmed that it sensitized them on climate variability and change adaptation strategies and 3.5% received information on climate variability and change and the same percentage was for other information to do with disaster education and environmental sustainability.

Table 5.24: Type of information provided to households (n=310)

Provided Information	Frequency	Percent
Climate variability and change adaptation strategies	26	8.4
Climate variability and change information	11	3.5
None/ not applicable	231	74.5
Other	11	3.5
Weather	31	10.0
Total	310	100.0

Generally, the information provided to households on climate variability and change is inadequate and lacks clarity leading to their low level of knowledge of the phenomenon as also revealed by Adetayo (2013) and Shemdoe *et al*. (2015). This is seen by the level of preparedness and attitudes of the households to the changes and variations in climate which have since started to be experienced. Some households are still practising livelihoods which degrade the environment as discussed earlier. The households lack sufficient knowledge anove climate variability and change as well as options on how to respond sustainably to the phenomenon, and they are not proactive to deal with climatic hazards like floods which are regularly experienced in the Ward. This calls for more new and innovative ways of disseminating climatic information. In Chadereka Ward 1 there is the need to marry IKS with the scientific knowledge as noted by Masinde and Bagula (2012).

The level of awareness to climate issues was also deduced through household responses to whether there had been climate change awareness campaign(s) in the Ward. Close to a third (32.6%) confirmed that some climate change awareness campaign(s) were carried out in Chadereka Ward 1 while almost two thirds (67.4%) indicated that climate change awareness campaign(s) were not carried out. Participants during the focus group discussions identified NGOs such as the World Vision and Red Cross Society in Zimbabwe which presented to them issues to do with disaster resilience. Such organizations operate from Muzarabani Growth Point where they have established their offices. Some key informants noted the advice given was useful to improve their livelihoods. The participants confirmed and applauded the regular visits by such organizations.

Awareness campaigns are vital in any community as they educate households on impending issues like that of climate variability and change. Thus, some government organs and the NGOs take up the task of conscientizing households on climate variability and change issues as revealed by Ogunleye and Yekinni (2012) and Umunakwe *et al*. (2014). This in a way assists in the dissemination of climate information and adaptation strategies which could be adopted depending on the socio-economic, biophysical and the prevalent political factors. Given this scenario, household awareness levels of climate variability and change in Chadereka Ward 1 can be considered as low. This concurs with Madobi (2014) who also reported the awareness levels to be general and limited in the case of Marondera, Zimbabwe.

Figure 5.14 shows that the providers of climate change awareness campaign(s), according to household respondents, are NGOs (18.8%), government organs (14.9%), traditional leaders and other sources with 0.3% apiece. The majority (72.3%) suggested that no one provided the awareness campaigns in the Ward. The provision of climate change awareness campaigns by the government organs like EMA and NGOs like the World Vision and the Red Cross Society in Zimbabwe have also been confirmed by Madobi (2014).

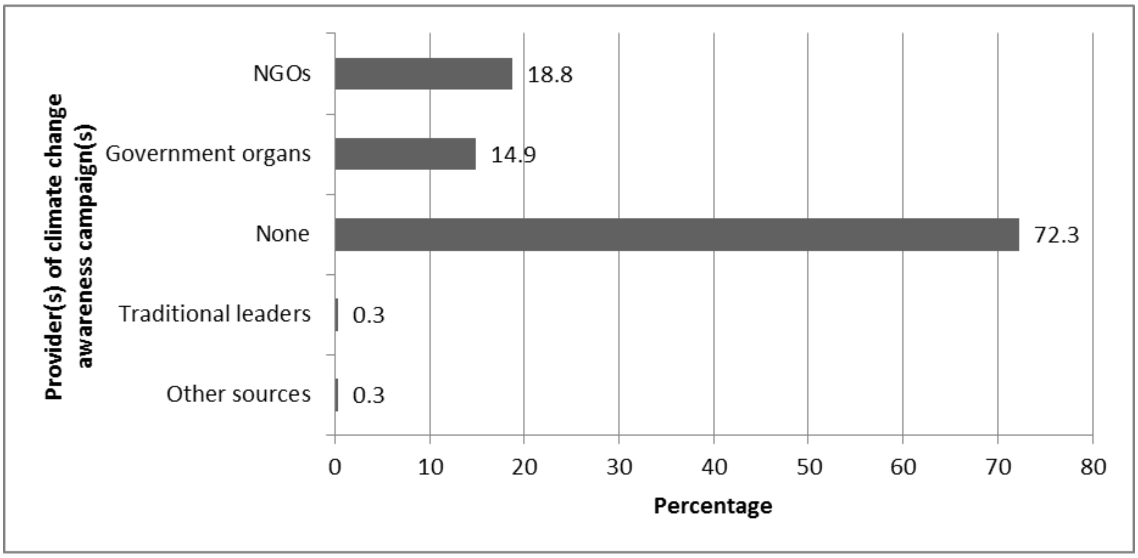


Figure 5.14: Providers of climate change awareness campaigns (n=310): Multiple responses

Brown *et al*. (2012) also made reference to the idea of raising awareness through campaigns. While the NGOs, the government and its organs, the traditional leaders and other sources like mass media are useful in disseminating climate variability and change information, Dodman and Mitlin (2015) added that civil society organizations like the Civil Society Climate Change Working Group in Zimbabwe are also essential instruments in increasing awareness levels of the phenomena. The low percentages generally suggest limitations by people in marginal areas like Chadereka Ward 1 in receiving information on climate variability and change. This implies that more approaches need to be considered in order to improve climate change awareness, especially among the rural poor who are more dependent on natural resources and more vulnerable to climate change impacts.

The household respondents were further questioned on their perceptions or views regarding the climatic conditions in their Ward since the past ten or more years. Figure 5.15 shows that 99.7% of the household respondents indicated that the climate has changed. However, they are variations on the degree of change. Thus, the majority (63.5%) merely indicated that climatic conditions have changed while 29.7% suggested that they have greatly changed and 6.5% noticed a slight change. Only one individual (0.3%) perceived no change. During the focus group discussions, the participants clearly indicated that the Ward was experiencing more strong winds, heat waves, excessive floods and droughts than before. Various research (Balama *et al*., 2016; Chitende, 2013; Kashaigili, *et al*. 2014; Mudzonga, 2012; Ogunleye and Yekinni, 2012; Umunakwe *et al*., 2014) also agree with this observation that the climate has changed. This seems contradictory to the presented low level of awareness to climate variability and change. While the respondents perceived changes in climate due to their experiences in the Ward, the scientific dynamics of the phenomenon are little known in the Ward.

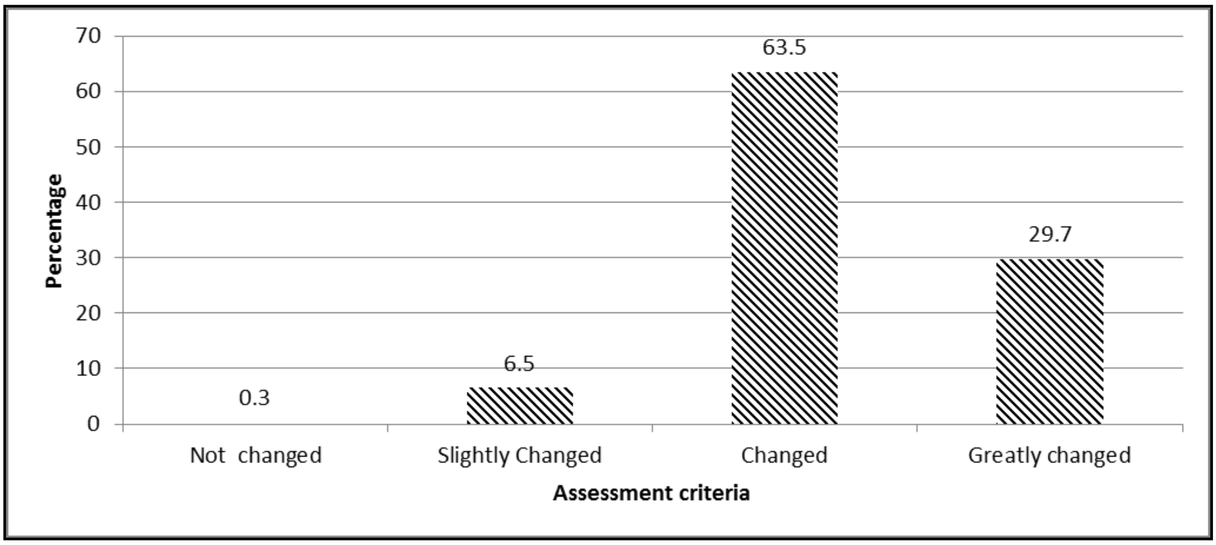


Figure 5.15: Assessment on climatic conditions in Chadereka Ward 1 since the past ten or more years (n=310)

In the same manner, household respondents provided their assessments on the situation regarding two climatic elements (temperature and rainfall) and the observations are shown in Table 5.25.

Table 5.25: Respondents' assessment on temperature and rainfall in the Ward (n=310)

Assessment Criteria	Temperature (^0C)		Rainfall (mm)	
	Frequency	Percentage	Frequency	Percentage
Greatly Increased	55	17.7	3	1.0
Increased	86	27.7	55	17.7
Neutral	20	6.5	10	3.2
No Change	39	12.6	18	5.8
Decreased	104	33.5	160	51.6
Greatly Decreased	6	1.9	64	20.6
Total	310	100	310	100

Generally, while 45.4% of the household respondents suggested temperature to have either increased (27.7%) or greatly increased (17.7%), 35.4% suggested that it had either decreased (33.5%) or greatly decreased (1.9%). The remaining 19.1% of the respondents were either neutral (6.5%) or observed no change (12.6%). For rainfall, the majority of the respondents (72.2%) observed a decrease (51.6%) and a great decrease (20.6%). Only 18.7% of the respondents reported that rainfall had increased (17.7%) or greatly increased (1.0%). Nine percent of the respondents either remained neutral (3.2%) or observed no change (5.8%). The respondents' perceptions on climate change significantly correlate with the actual data as given by Rurinda *et al*. (2014), Unganai (1996) and ZMSD (2014).

The assessment by the household respondents clearly confirms a change in climatic conditions in Chadereka Ward 1, similar to a study by Muzamhindo *et al*. (2015). Despite the low level of awareness probed and revealed in the preceding responses and discussions, the majority of the respondents through their experiences in the Ward are in agreement with Mugandani *et al*. (2012) who published increased aridity in Natural Regions 4 and 5 of Zimbabwe, that is, in the Save-Limpopo lowveld and the Zambezi Valley lowveld in which lies Chadereka Ward 1 (see Table 2.1). This was also confirmed in research by Chifamba and Mashavira (2011), Dube *et al*. (2016), Jiri *et al*. (2015a), Madobi (2014), Mazvimavi (2010), Pinto *et al*. (2016), Sango and Godwell (2015b), Twomlow *et al*. (2008) and Unganai (1996). More knowledge generation and dissemination regarding climate variability and change is critical in ensuring the sustainability of rural livelihoods and adaptation endeavors.

5.5 THE IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON BIOPHYSICAL AND SOCIO-ECONOMIC CONDITIONS IN CHADEREKA WARD 1

The foregoing section revealed household respondents' awareness level to climatic information in the Ward which is generally low. This has a bearing on the present discussion of the impacts of climate variability and change on the biophysical and socio-economic conditions within the community under study. The noted variations in climatic elements like increased temperature and reduced precipitation have effects on the natural resources used by the households and their rural livelihood strategies. This section therefore is set to present and discuss the results on the mentioned environments. In the discussion, climatic variables of great concern in the area are also presented.

5.5.1 Climate variability and change and the biophysical environment in Chadereka Ward 1

Household respondents provided information on how the biophysical environment was being affected by climate variability and change in their Ward. Table 5.26 shows repondents' assessment of the impacts on each of the principal natural resources considered in this research. The assessment criteria were done using a five point likert scale in which the impact was classified as 'no impact', 'minor impact', 'moderate impact', 'severe impact' and 'neutral', similar to that used by Belachew and Zuberi (2015). High percentage responses were noted on moderate and severe impacts in the case of the three mostly used natural resources in the Ward which are land, vegetation and water. Specifically, for land, a total of 83.9% of the households indicated the climatic impacts to be moderate (41.6%) and severe (42.3%) while for vegetation, a total of 85.5% stated the impacts to be moderate (19.0%) and severe (66.5%) and for water, a total of 90% noted moderate (20.3%) and severe (69.7%). The responses were not substantial for the 'neutral' and the 'no impact' categories on these three natural resources. The responses were the opposite in the case of minerals, wild animals and other resources and had highest percentages on the 'no impact' category. That is, for this category minerals scored 82.3% while wild animals scored 75.5% and other resources like solar energy scored 80.6%. However, for the minerals and other resources, 16.5% and 18.7%, respectively remained neutral on the issue. A sizeable percentage of the respondents (12.6%) acknowledged climate variability and change impacts to be severe on wild animals. This is also noted during the earlier discussion in relation to key informant interviews where is was indicated that some wild animals have even migrated to other areas.

Table 5.26 Assessment of climate variability and change impact on natural resources (n=310) (in %)

Natural Resource	Assessment criteria					Total
	No Impact	Minor Impact	Moderate Impact	Severe Impact	Neutral	
Land	3.2	11.9	41.6	42.3	1.0	100
Vegetation	4.5	9.0	19.0	66.5	1.0	100
Water	1.9	7.1	20.3	69.7	1.0	100
Minerals	82.3	0	0	1.3	16.5	100
Wild animals	75.5	1.0	3.2	12.6	0.3	100
Other	80.6	0	0.3	0.3	18.7	100

The results show that while the households have no adequate technical information about climate variability and change as previously alluded to, the outcome from this assessment suggests a relatively high level of awareness on the impacts. The observation tallies with Belachew and Zuberi (2015) and Basak *et al*. (2015) noted a reduction in agricultural land as a constraint on adaptive capacity due to climate variability and change. The IPCC (2014) discussed extensively the severity of the impacts of climate variability and change on biophysical aspects like water, land and the natural plant and animal species, similar to the responses in this research. The outcomes of household assessment on land, water and vegetation is in agreement with Bola *et al*. (2014) and Yanda (2010) who even projected the extinction of some species given the persistent climatic conditions. Aberman *et al*. (2015) and Huq *et al*. (2015) note a reduction in surface water, a situation prevalent in Chadereka Ward 1 as reported by household respondents. Given these impacts, adaptation strategies need extensive implementation and education to reduce the total destruction of such biophysical environmental aspects and promote sustainability. Having most of the livelihood being naturally based, legislation on the usage of these resources also needs to be enforced and harmonized with the promotion of local adaptation strategies to climate variability and change.

The high percentage responses on the 'no impact' category to natural resources not popular in Chadereka Ward 1 (minerals, wild animals and others like solar energy) in some way portray lack of knowledge and capacity to tap these resources for their benefit. Some communities are now extensively using the high temperatures for the generation of solar energy for lighting and other domestic uses. Due to unpredictable variations in rainfall, other households have diversified into mining in the region, especially in the upper Muzarabani and other regions in Zimbabwe. The respondents who noted the impact of climate variability and change as severe on wild animals is because they have become scarce in the Ward due to the reduction in the natural resources for their survival such as grass and water, hence more have migrated to other areas similar to the report by Wang *et al*. (2016). Participants during the focus group discussions also concur with these results.

Table 5.27 illustrates responses on changes which they have noted on the natural resources resulting from climate variability and change. The assessment criteria for the changes employed eight categories which described the level of change. Thus, for the three mainly used natural resources (land, vegetation and water), high percentage responses were noted within the combination of 'degraded and greatly degraded' category, that is, 94.8%, 93.5% and 95.5%, respectively. Less than 5% of household respondents acknowledged 'no change' on each of the natural resources considered in this analysis: (land (4.8%), minerals (0.3%), vegetation (3.5%), wild animals (0.6%), water (1.6%) and others (0.3%). Only a single household in relation to vegetation and water resources agreed that the two resources were sustainably managed. The rest of the household respondents did not agree. 'Migration' and 'extinction' categories were noted as relatively high for wild animals (21.6%) and vegetation (0.3%) being very low. The responses for those who suggested 'not applicable' and 'no response' categories were greatest for minerals (99.7%) followed by 'other' (88.4%) and wild animals (75.5%).

Table 5.27 Responses on changes on natural resources due to climate variability and change (n=310) (in %)

Assessment criteria	Land	Minerals	Vegetation	Wild animals	Water	Other
Greatly degraded/ depleted/ reduced	1.6	0	1.6	0	2.9	0.6
Degraded/ depleted/ reduced	93.2	0	91.9	2.3	92.3	0.6
No change	4.8	0.3	3.5	0.6	1.6	0.3
Sustainably managed	0	0	0.3	0	0.3	0
Migration	0	0	0	17.1	0	0
Extinction	0	0	0.3	4.5	0	0
Not applicable	0	98.4	0.6	68.7	1.3	85.5
No response	0.3	1.3	1.6	6.8	1.6	2.9
Total percentage	100	100	100	100	100	100

The results suggest that climate variability and change is leading or contributing to the degradation of natural resources, a situation also reported by Huq *et al*. (2016). This directly affects the livelihoods and adaptation strategies pursued by the household respondents in the Ward. Balama *et al*. (2014) and Rahman and Alam (2016) illustrate the negative impacts of climate variability and change on natural resources, a situation also observed in this case study. The implication is for households to diversify their livelihoods strategies and venture into those which are less directly dependent on climate like petty trade. Also, ways of generating solar energy need to be pursued to reduce deforestation which has been reported due to the over-reliance on wood as the main source of power for heating and lighting.

5.5.2 Climate variability and change and the socio-economic conditions in Chadereka Ward 1

The research further analyzed and interpreted the impacts of climate variability and change on the socio-economic conditions in Chadereka Ward 1. While the impacts of climate variability and change on the socio-economic conditions had been generally noted in the previous sub-sections, like sub-section 5.3.1.3, this sub-section discusses those of droughts and floods in detail.

Figure 5.16 shows droughts (94.2%) and floods (87.1%) as the two major climatic variables which have critically affected rural livelihoods in Chadereka Ward 1 for the past ten or more years. Hailstorm (24.8%) and others like wind (4.5%) were identified by household respondents as ones with less impact on household livelihoods. This is supported by the response given by one of the participants during the focus group discussions:

> *In Chadereka Ward 1 our livelihoods are greatly affected by climate variability and change. In a single year if we do not experience drought, we are hit by floods which leave us homeless and food insecure. Rivers are now dry and heavily silted. Hailstorm is rare but wind is currently increasing, especially in deforested open spaces. Generally, rainfall seasons have changed and become short.*

Muzari *et al*. (2014:1725) state that "in addition, years of below-normal rainfall are becoming more frequent, semi-arid areas are getting drier, temperatures have increased, and droughts and floods are often occurring back-to-back in the same season". This also signals the intensity of climate variability and change. While hailstorm and wind are considered insignificant whenever they occur they are very destructive to both natural phenomena and human landscapes. They even strip away vegetation leaves and branches, and dust storms also destroy infrastructure. At times children fail to go to school since streams and rivers are flooded.

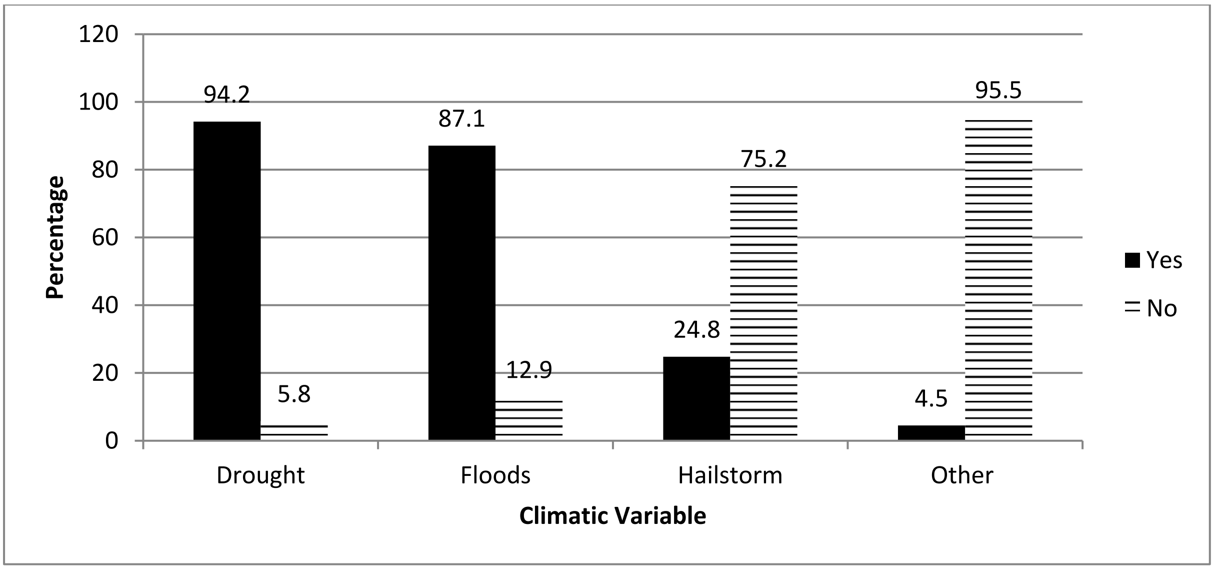


Figure 5.16: Climatic variables that affected Chadereka Ward 1 livelihoods in the past 10 or more years (n=310): Multiple responses

Farai *et al*. (2012) and Madobi (2014) in Masvingo and Marondera, respectively, noted the increasing frequency of drought coupled with changes in farming seasons as reducing farm productivity, a situation also revealed in this study. Muzari *et al*. (2014) also noted drought resulting from climate variability and change to be affecting vegetation and water sources which is undisputable in the case of Chadereka Ward 1. Evidence of silted rivers and dried water ponds indicate the gravity of the matter in the study area. In the case of floods, Phiri *et* *al*. (2014) note that they affect some soil properties like texture and structure leading to reduced production. The results of this study confirm these observations.

When the respondents were asked on the changes in relation to their livelihoods regarding the observed climatic conditions (Figure 5.17), 74.5% indicated decreased or reduced varieties of livelihoods, 22.2% increased varieties of livelihoods, 0.3% changed calendar of livelihoods and 1.9% indicated no change. Only 1% remained neutral. The decreased or reduced livelihood varieties were principally a result of the negative biophysical impacts of increased climate variability and change in the Ward as acknowledged also by the key informants. Increased varieties of rural livelihoods were noted by those respondents who had diversified their livelihoods. Some supplemented their farming through vending natural fruit and firewood, while other are migrant laborers. The calendar of livelihoods like farming is constantly changing in the Ward as already noted. The rain season had become shorter and households are encouraged to change their usual crops into short seasoned and drought resistant options. The households who had not stayed long and experienced much in the Ward noted no change.

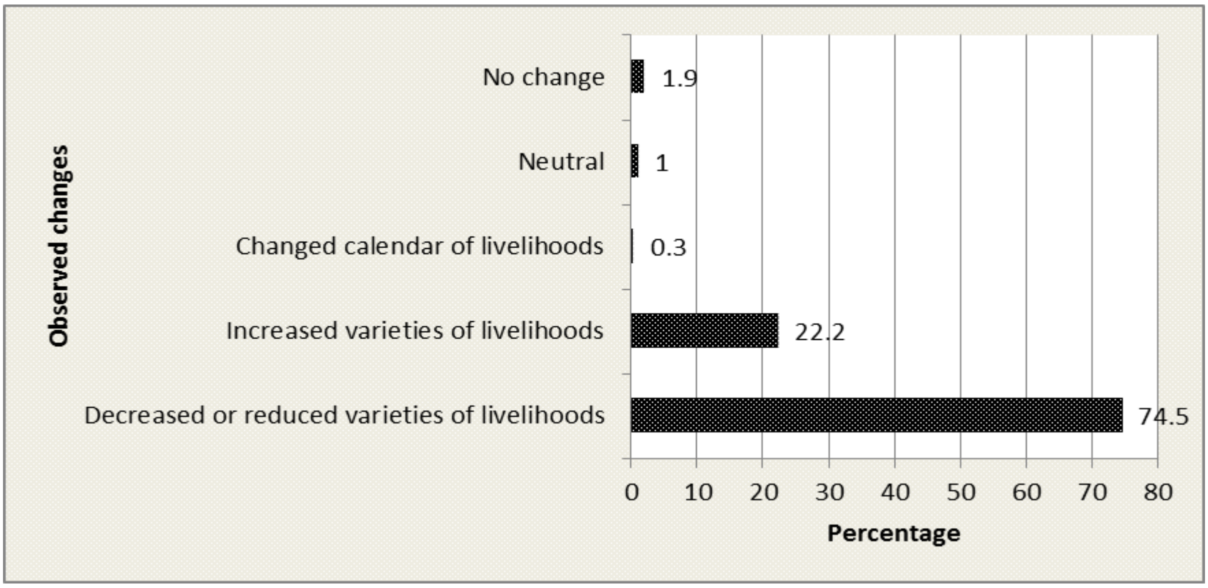


Figure 5.17: Observed changes on rural livelihoods due to climate variability and change (n=310)

Considering that rural livelihoods in most of the less economically developed countries particularly in sub-Saharan Africa are pivoted on rain-fed agriculture as noted earlier by Balama *et al*. (2015), Dube *et al*. (2016) and Jiri *et al*. (2015a), their variety is greatly affected by persistent droughts in the region as confirmed in this study. However, for a few, the prevailing conditions open up new avenues for livelihood diversification as noted by Zimmerer and Vanek (2016). Rural livelihood diversification is one of the urgent strategies to pursue given the increasing negative impacts of climate variability and change on the environment.

The negative impacts of climate variability and change in Chadereka Ward 1, according to the key informants and participants during the focus group discussions, include reduced crop yields and pastures, increased commodity prices, unfavorable petty trade or exchange of goods, inadequate water supply, increased flood recession cultivation though selective and increased migration to other areas. This implies that there is the need to mobilize support towards sustainable natural resource management and solicit help in making their livestock and crop production viable through improved marketing strategies.

5.6 LIVELIHOOD ADAPTATION STRATEGIES TO CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1

The previous sub-section noted generally negative impacts of reduced production and degraded biophysical environment due to climate variability and change in Chadereka Ward 1. Given this scenario, the research further sought information on livelihood adaptation strategies being practised in Chadereka Ward 1 by household respondents. Given the dominant role of farming as a livelihood strategy in the Ward, its execution strategies in the face of climate variability and change were identified. The following Figure 5.18 illustrates the distribution on the household responses on the adaptation strategies.

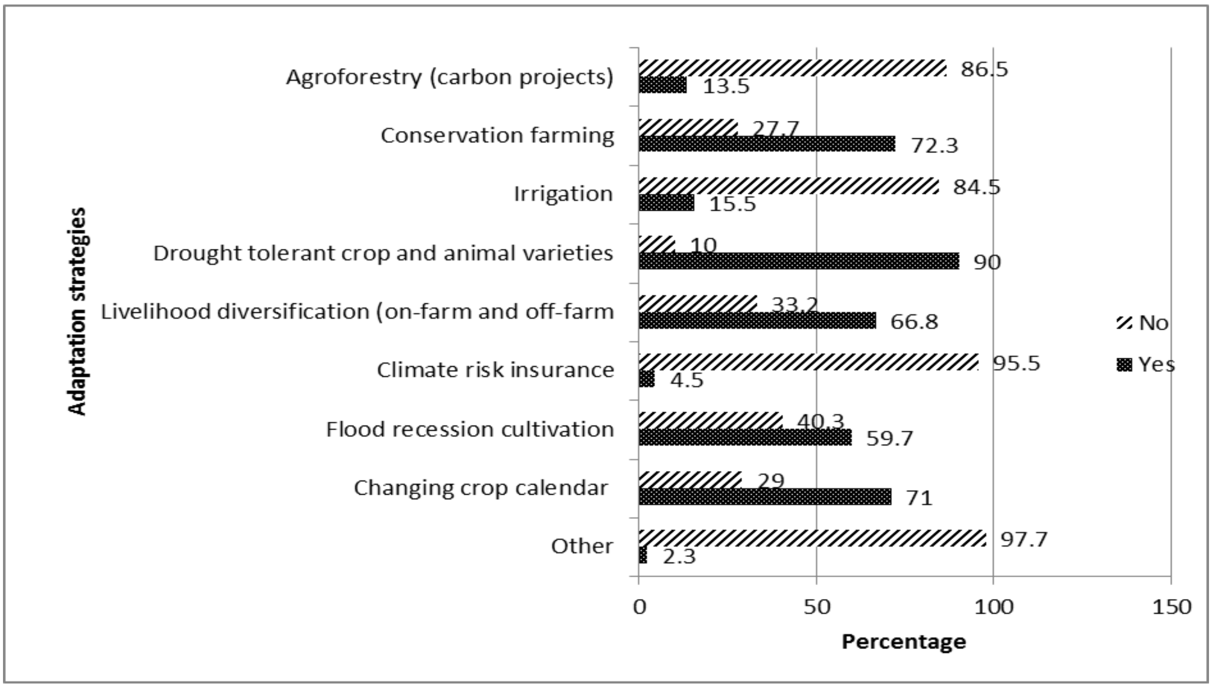


Figure 5.18: Livelihood adaptation strategies to climate variability and change practised at household level in Chadereka Ward 1 (n=310): Multiple responses

A variety of adaptation strategies to climate variability and change are being pursued in Chadereka Ward 1. From Figure 5.18, the growing of crops and keeping of animals which are drought tolerant were identified by 90% of the respondents and conservation farming and changing of crop calendar by 72.3% and 71%, respectively. Other significant responses were on livelihood diversification (on-farm and off-farm activities) and flood recession cultivation with 66.8% and 59.7%, respectively. The adaptation strategies mentioned by relatively fewer household respondents were irrigation (15.5%), agroforestry (carbon projects) (13.5%), climate insurance cover (4.5%) and others which included mulching and food rationing (2.3%). These adaptation strategies were also confirmed by Gandure *et al*. (2013) and Muzamhindo *et al*. (2014).

Table 5.28 illustrates the identified adaptation strategies classified into incremental and transformational as suggested by Abel *et al*. (2016) and Park *et al*. (2012).

Table 5.28: Classification of adaptation strategies to climate variability and change practiced in Chadereka Ward 1

Incremental	Transformational
Livelihood diversification (on-farm and off-farm activities) (66.8%)	Conservation farming (72.3%)
Flood recession cultivation (59.7%)	Drought tolerant crops and animals production (90%)
Irrigation (15.5%)	Changing of crop calendar (71%)
Agroforestry (carbon projects) (13.5%)	Climate insurance cover (4.5%)
Other strategies (like food rationing) (2.3%)	

There are more incremental adaptation strategies in Chadreka Ward 1 than transformational. However, contrary to the classification by Noble *et al*. (2014), diversification of livelihood strategies can also be considered transformational in the Ward given that with the increasing intensity of climate variability and change, respondents are forced to shift from farming into completely different livelihoods like trading and providing services. Climate insurance cover had not been fully considered as households lack resources and fear the risk of loosing their investment in an unstable economic situation in Zimbabwe. The lower percentages on irrigation and agroforestry are due to water scarcity being experienced. The increased focus on the identified transformational adaptation strategies are due to their promotion and assistance given to the households by NGOs, government and civil society organizations (although still currently limited). The changing of the crop calendar is naturally determined given the late commencing and the early departure of the rainy season. One participant said:

> *The government, the NGOs like World Vision and the Red Cross Society in Zimbabwe teach us how to practice conservation farming and to change our traditional farming systems into drought tolerant varieties. They even provide us with the necessary inputs.*

This signifies that the adaptation strategies practised by the hosueholds are more reactive than anticipatory and limited due to lack of resources (Noble *et al*., 2014). This implies that more support is needed to socially and economically empower the households in the Ward. This will ensure their well-being, resilience and the sustainability of their livelihoods.

The various adaptation strategies pursued depend on the demographic and social characteristics at the household level. The determinants for the execution of the adaptation strategies also lie in the status of each household livelihood assets presented in the conceptual framework (Figure 3.4). A MLRM was again computed to analyze the significant influence of the socio-demographic characteristics on the identified adaptation strategies. The model is appropriate in this case since it is commonly used in climate change adaptation research (Bauer and Steurer, 2014; Tessema *et al*., 2013) and where they were more than two multiple responses on this issue of adaptation strategies, similar to the research by Balama *et al*. (2016). Thus, one household has the liberty of practising one or a combination of adaptation strategies (Tessema *et al*., 2013; Yegbemey *et al*., 2014). Table 5.29 illustrates the outcomes of the statistical test computed using SPSS version 21. The MLRM results suggested that gender, marital status, age, household size and education were statistically significant in influencing one or more adaptation strategy in Chadereka Ward 1. This is in agreement with research carried out by Balama *et al*. (2016), Debela *et al*. (2015), Jiri *et al*. (2015a), Juana *et al*. (2013), Ncube *et al*. (2016), Tessema *et al*. (2013) and Yegbemey *et al*. (2014) as already noted.

Table 5.29 MLRM analysis results of how selected socio-demographic factors influenced the uptake of adaptation strategies at statistical significance of $p<0.05\%$ in Chadereka Ward 1

Adaptation strategies	Socio-demographic factors (Chi-Square p-values)				
	Gender	Marital Status	Age	Household Size	Education
Agroforestry or carbon projects	0.139	0.899	0.015	0.237	0.011
Conservation farming	0.273	0.925	0.002	0.006	0.203
Irrigation	0.481	0.224	0.041	0.533	0.859
Drought tolerant crop and animal farming	0.226	0.628	0.001	0.407	0.153
Livelihood diversification	0.004	0.003	0.046	0.000	0.492
Climate insurance cover	0.695	0.220	0.166	0.401	0.356
Flood recession cultivation	0.117	0.059	0.022	0.000	0.002

Highlighted Chi-square p-values indicate significant relationship at the 95% confidence level

Age

Age was found to be significant at the 95% confidence level in almost all the selected adaptation strategies except for climate insurance cover which was not significantly determined by any of the socio-demographic parameters considered for this aspect. Balama *et al*. (2016) conclude that as one grows old the combination of adaptation strategies gets reduced. This was considered appropriate as more adaptation strategies are labor intensive like conservation farming using minimum tillage which dominates in flood recession cultivation and they require economically active and able-bodied people. At the same time, Yegbemey *et al*. (2014) establish that adaptation to new farming technologies by aged farmers like changing farm calendar was also difficult. However, Tazeze *et al*. (2012) argue that the aged were more knowledgeable of indigenous knowledge practices and systems which are useful in forecasting weather that reduces vulnerability to the adversities of climate variability and change. In this study, both the young and the aged had complementary roles in adaptation to climate variability and change. The young being energetic, were effective in conservation farming and were eager to practice the new technologies. On the other hand, the aged provide the indigenous knowledge and approaches in their livelihoods. The young also practiced bucket irrigation using sand scooped water before its water table becomes low and inaccessible. However, such practice in the area is hampered by water scarcity.

Household Size

Uptake of several adaptation strategies is greatly determined by household size as revealed by Jiri *et al*. (2015a) and Yegbemey *et al.* (2014). There would be more labor for the adaptation portfolios. This conforms with the statistical inference outcome for this research in Chadereka Ward 1 which shows household size as an undisputable significant determinant for conservation farming, livelihood diversification and flood recession cultivation (Table 5.29). In this case, more labor is required in the recommended minimum tillage during flood recession cultivation. Bigger families are able to venture into different on-farm and off-farm livelihood adaptation options like micro-trade, hired labor, farm assistant, care takers, wild fruit *(Zizphus mauritiana)* gatherers and vendors.

Education

While generally education is considered significantly valuable in increasing household perceptions of climate variability and change and their impacts on agriculture at the local level (Debela *et al*., 2015), this is observed differently in the case of its determinant role in adaptation to climate variability and change in Chadereka Ward 1. The computed statistical inference suggests that education is a significant factor in determining agroforestry (carbon projects) and flood recession cultivation while it is not significant in relation to other adaptation strategies. Education increases awareness levels to the causes of climate variability and change and ways of reducing its impact as already depicted by Madobi (2014), Kima *et al*. (2015) and Musarurwa and Lunga (2012), among others. Hence, the educated in Chadereka Ward 1 are generally young and are disregarded in decision-making to influence fully the execution of the identified adaptation strategies. The uneducated who are generally the elderly in the Ward use their IKS and practise flood recession cultivation at times within the river banks increasing siltation of the Hoya and the Nzoumvunda Rivers. They argue in support of the practice as the majority inherited the practice from their ancestors and are not worried about keeping the practice 30 m away from the river banks as recommended by the EMA in Zimbabwe. Higher levels of knowledge and household to household extension which are part of the social capital are required as suggested by Debela *et al*. (2015) and Tessema *et al*. (2013). While agroforestry or carbon projects are significantly determined by education, their practice is hindered by water scarcity in the area. However, a combination of the IKS with the old and the scientific knowledge with the young can be recognized in the manner in which indigenous trees (mopane, musawu and muuyu) are being preserved and protected in the area since they have a socio-economic value at the household level.

Marital Status

Marital status is a significant determinant factor for adaptation strategies particularly livelihood diversification and flood recession cultivation strategies. Married couples often engage in an assortment of adaptation strategies to ensure that they are not affected by the failure of any one portfolio as revealed by Umunakwe *et al*. (2014). Marriage usually secures labor for different livelihoods and increases the social capital which bails families out whenever they are in short supply of household needs. Marriage is also critical in decision-making as there is need for consultation between partners on strategies to pursue. In the case of Chadereka, dominated by the patriarch custom, males make decisions with their male counterparts which influence their practices. This has also been discussed by Jiri *et al*. (2015a). However, proper and significant decisions are made when ideas are shared within the family as these are linked to resource mobilization.

Gender

Adaptation strategies are also determined by gender. In this case gender has been established to be statistically significant at the 95% confidence level in influencing livelihood diversification in Chadereka Ward 1. This confirms with the research by Below *et al*. (2012), Bryan *et al*. (2009) and Wheeler *et al*. (2013) who viewed uptake of new technologies to be determined by the gender of the household head. Usually the male counterpart has the major say in decision-making. This implies that there is need for more gender equality campaigns in the Ward.

From this discussion, generally the human capital and the social capital were statistically significant at the 95% confidence level in determining the uptake of climate variability and change adaptation strategies in the Ward. The uptake of the adaptation strategies, however, had been low given the challenges confronted by the households. This had been exacerbated by the over-reliance on natural capital which constantly vary and change due to climatic conditions. The state of the environment has negatively changed as already revealed. Hence, this implies the need for extensive education or awareness campaigns on climate variability and change through various media like radios, televisions, video cassettes and pamphlets to ensure the sustainability of the practices.

5.6.1 Duration in practising the adaptation strategies to climate variability and change

Information on the duration in practising the indicated adaptation strategies was gathered from respondents (Table 5.30). The majority of the respondents had practiced the strategies for a relatively shorter period, 1 to 5 years (47.4%) and 6 to 10 years (33.5%). Those who had practised for 11 to 15 years and more than 21 years were 7.7% each. Close to 2% of the respondents had practised the strategies for less than a year (1.6%) and 16 to 20 years (1.9%). Within 1 to 10 years of practice, drought tolerant crops and animal farming strategy had the highest percentage (20.7%), followed by livelihood diversification (14.5%). In the same year band, 13.3% practised conservation farming, 13.2% flood recession cultivation and 11.9% changed the crop calendar. The rest of the year bands, less than a year, 11 to 15 years, 16 to 20 years and more than 20 years were indicated by less than 2% of the respondents on each of the adaptation strategies. These responses reveal that a total of 80.9% had not practised the adaptation strategies for over a decade. This could be because climate variability and change phenomena are relatively new in Chadereka Ward 1 and their full comprehension is still lacking. The other reason might be that the respondents had not stayed for long in the Ward. This also tallies with the findings on the existing levels of awareness of the phenomena prevalent in the area which was found to be relatively low.

Respondents whose duration in practising the adaptation strategies surpassed ten years summed up to 17.3%. These could be the households whose birth place is Chadereka Ward 1 and have access to the flood recession cultivation, which, according to the household respondents, is long dated. Irrigation practice, however, was not new in the area though it had a low percentage response. Households extensively used the bucket system in their vegetable production (market gardening) practices during the dry season when rivers were still flowing. These adaptation strategies had also been acknowledged to be common in sub-Saharan Africa by Juana *et al*.

(2013), Niles *et al*. (2016) and Musiyiwa *et al*. (2014). The practice had since faced challenges of water scarcity. As suggested by Moyo *et al*. (2016), there is need for a properly functional extension system with well-defined water harvesting technologies in order to have sustainable irrigation schemes in the Ward.

Table 5:30 Responses on the duration practising the adaptation strategies to climate variability and change in Chadereka Ward 1 (n=310): Multiple responses (in %)

Adaptation strategies	Duration in practising the adaptation strategies to climate variability and change						
	<1 year	1-5 years	6-10 years	11-15 years	16-20 years	>21 years	Total
Changing crop calendar	0	8.4	3.5	2.6	0.6	1.9	17.1
Flood recession cultivation	0	9	4.2	0	0	1.9	15.2
Climate insurance cover	0	0.3	0.6	0	0	0	1
Livelihood diversification	0.3	9	5.5	1.3	0.6	0.3	17.1
Drought tolerant crop and animal farming	0.6	9.4	11.3	1.6	0	0	22.9
Irrigation	0.3	1.9	1	0.3	0	0.3	3.9
Conservation farming	0.3	6.8	6.5	1.9	0.3	2.6	18.4
Agroforestry	0	2.6	1	0	0.3	0.6	4.5
Total	1.6	47.4	33.5	7.7	1.9	7.7	100

Similar to a research by Mudavanhu *et al*. (2012), a Pearson's Product Moment Correlation (PPMC) statistical analysis was computed to determine if there existed a significant relationship between the sustainability of the adaptation strategies to climate variability and change and the duration of the practice in Chadereka Ward 1. Results showed that there was a strong positive relationship ($p<0.001$). The positive correlation noted suggests that the more the time of practice of the adaptation strategy, the more the sustainability of the adaptation strategy. However, those who had practiced for more time, were also engaged in practices which degrade the environment like flood recession cultivation.

5.6.2 Coping or survival strategies to major climatic variance in Chadereka Ward 1

Data on the immediate reaction by household respondents to climatic variables (drought and floods) which affect the Ward was also gathered from the respondents. This is critical as some of these short-term coping strategies may develop into long-term adaptation strategies once the phenomena are prolonged as confirmed by Dube *et al*. (2016) and Ansell *et al*. (2016). The household percentage responses on the coping strategies to these environmental concerns are illustrated in Table 5.31. Household's confirmation to the four of the five identified coping strategies during drought was substantial. That is, consumption of less food had 50%, production of drought tolerant crops and/ or animal varieties had 60.3%, while grants or donations from the government or NGOs had 62.3%. The selling of household assets had the highest percentage (84.5%), though this increases vulnerability. Remittances, which featured more in the study of Zambia by Ito (2010) and in rural area of KwaZulu-Natal Province by Sharaunga *et al*. (2016), had been critical during the period of economic recession in Zimbabwe in 2008 and depended strongly on the social capital status of each household. In this case few households (8.1% and 4.8%) confirmed it as a copying strategy to both drought and flood, respectively. Further, the confirmation by households on coping strategies during flood events was found to be generally low. That is, only the selling of household assets and the receiving of grants and donations from government and NGOs had percentage responses of 72.3% and 74.5%, respectively. Consumption of less food had 21.3% and the production of flood tolerant crops and animals had 43.2%.

Table 5.31: Household percentage responses on coping strategies during drought or floods (n=310): Multiple responses (in %)

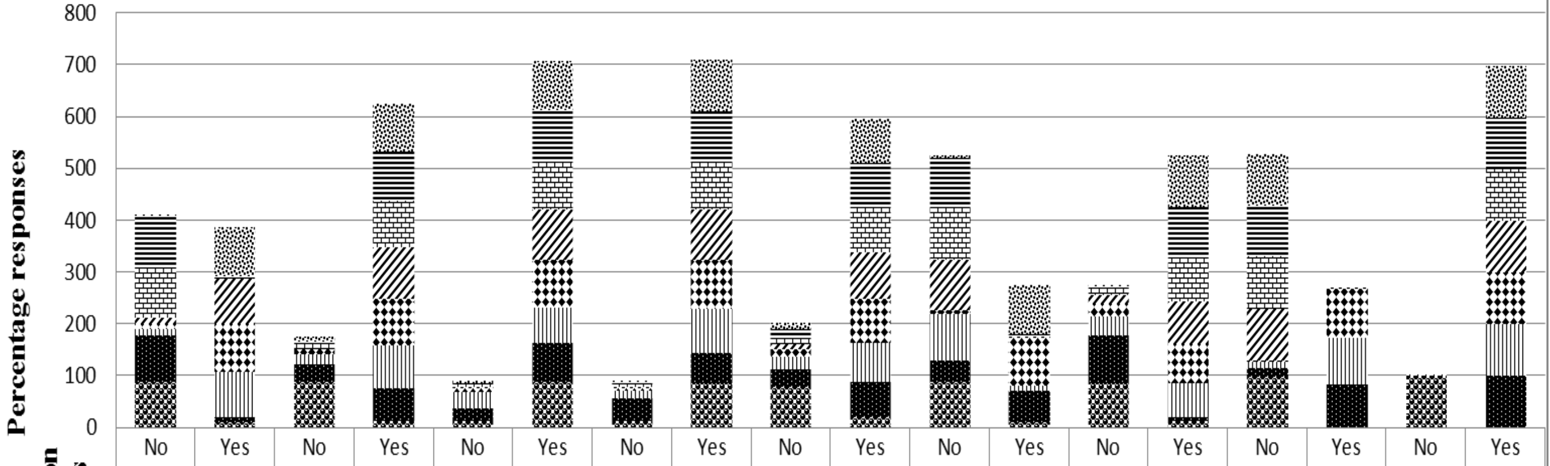
Household coping strategies	During drought		During flood	
	Yes	No	Yes	No
Remittances	8.1	91.9	4.8	95.2
Producing drought or flood tolerant crops or livestock	60.3	39.7	43.2	56.8
Grants or donations from government or NGOs	62.3	37.7	74.5	25.5
Consumption of less food	50.0	50.0	21.3	78.7
Selling household assets	84.5	15.5	72.3	27.7

The coping strategies have also been confirmed in various ways by Farai *et al*. (2012), Madobi (2014), Manatsa and Gadzirai (2010) and Zaman *et al*. (2015). Production of drought tolerant crops and animals was discussed under section 5.3.2. From the focus group discussions and key informants, in addition to the identified coping strategies, petty trade and borrowing from neighbours were also highlighted. Only the production of drought or flood tolerant crops or livestock was identified as a technological strategy while the rest are management strategies. This implies that more investment and priority into technological innovation by the local community, the government and other concerned stakeholders as also observed by Katanha and Chigunwe (2014) is needed. Tripathi and Singh (2014) highlighted technological innovation in the economic growth of India, a process which could be emulated in the case of Chadereka Ward 1.

5.7 CHALLENGES IN ADAPTING TO CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1

The household respondents in the study area were asked to confirm the challenges they encounter in adapting to climate variability and change. The purpose was to further identify the opportunities inherent in the discussion. It should not be overemphasized that climate variability and change are a global phenomenon whose adaptation is site-specific (IPCC, 2007). Though the barriers to adaptation are multifold, including socio-economic, physiological and psychological as stressed by Shackleton *et al*. (2015), they are also political and site-specific (Chikodzi *et al*., 2013). All the facets of sustainable development which are important in human resilience and well-being have been endangered by climate variability and change (Giri and Tiwari, 2013; Zaman *et al*., 2015). In this section, the constraints were crosstabulated with the adaptation strategies provided by the household respondents. Figure 5.32 illustrates the scenario.

It generally emerged that almost all the adaptation strategies to climate variability and change practised by household respondents in Chadereka Ward 1 have a combination of socio-economic, political and natural components. Though there are variations in percentage responses per adaptation strategy in relation to the identified constraint, they are all evident in the case study. For instance, adapting to agroforestry practices is hampered by lack of capital, lack of institutional support, natural disasters and lack of alternative sources of fuel confirmed by 88.1%, 91.9%, 88.1% and 96.1 % of the respondents, respectively. In the area deforestation is inevitable given the over-reliance on firewood as the only source of energy for cooking in the Ward which is similar to observations by Muzari *et al*. (2016). The rural electrification program in Zimbabwe had not done much, especially in marginal and disaster risk areas like Chadereka Ward 1. The respondents argued that tree planting is challenged by water shortages which had become a perennial issue. The seedlings dry up during the long dry seasons. However, the growing of the indigenous trees should be encouraged. The benefits from carbon credits noted in Banerjee (2015) and Kongsager *et al*. (2016) have not yet been disseminated enough to the community for them to protect the forests. Only valuable trees to their day to day lives like the *Ziziphus mauritiana* which gives edible berries and the mopane trees browsed by their cattle are given maximum care. For the use of drought tolerant crop and animal varieties of the given challenges, only labor is not a major problem.



Challenges / Adaptation strategies	Agroforestry (Carbon projects)		Use of drought tolerant crop and animal varieties		Flood recession cultivation		Conservation farming		Livelihood diversification (on-farm and off-farm)		Changing farm calendar and pattern		Irrigation		Climate risk insurance cover		Other like migration	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Natural disaster	3.9	96.1	9.7	90.3	5.2	94.8	1	99	13.9	86.1	4.5	95.5	1.6	98.4	100	0	0	100
Poor infrastructure	98.1	1.9	4.2	95.8	0	100	3.2	96.8	15.2	84.8	96.5	3.5	2.3	97.7	98.7	1.3	0	100
Lack of market	99.4	0.6	9.7	90.3	7.4	92.6	6.4	93.5	13.5	86.5	99	1	14.2	85.8	100	0	0.3	99.7
Lack of alternative sources of energy	11.9	88.1	0.6	99.4	2.9	97.1	1.9	98.1	8.7	91.3	98.1	1.9	18.1	81.9	99.4	0.6	0.3	99.7
Lack of institutional support	8.1	91.9	9.7	90.3	7.8	92.2	5.8	94.2	15.2	84.8	7.7	92.3	25.2	74.8	4.2	95.8	0	100
Lack of capital	11.9	88.1	19	81	31.6	68.4	15.5	84.5	24.5	75.5	90.3	9.7	35.5	64.5	10.6	89.4	0.3	99.7
Lack of knowledge	90.3	9.7	35.2	64.8	24.2	75.8	41.9	58.1	32.9	67.1	40.3	59.7	91.3	8.7	18.4	81.6	0.3	99.7
Labour shortage	89	11	87.7	12.3	12.3	87.7	13.9	86.1	79.7	20.3	88.4	11.6	87.1	12.9	97.7	2.3	100	0

Figure 5.19: Responses on the challenges faced in practising the adaptation strategies to climate variability and change (N=310): Multiple responses (in %)

5.7.1 Natural disaster challenges

Natural disaster challenges have been confirmed to strongly affect most of the adaptation strategies except for climate risk insurance cover with none of the respondents noting this as it emerged that this (climate risk insurance cover) was beyond the understanding by the majority of the household respondents. Over 85% of the respondents acknowledged natural disaster constraint on the identified adaptation strategies, namely, agroforestry (96.1%), use of drought tolerant crop and animal varieties (90.3%), flood recession cultivation (94.8%), conservation farming (99%), livelihood diversification (86.1%), changing farm calendar and pattern (95.5%), irrigation (98.4%), and others like migration (100%). These disasters come mainly in the form of drought and floods and greatly influence crop and livestock in varied ways as already analyzed and discussed. Similar to the study in Vietnam by Cong *et al*. (2016) and in Malaysia by Masud *et al*. (2016), generally natural disasters are so unpredictable and problematic in almost all the adaptation strategies making it difficult for the community to plan their livelihoods. One kraal head in Chadereka Ward 1 even said:

> *In as much as we would want to grow the drought tolerant crops, last year when sorghum was almost ripe quelea birds became a menace until people had to surrender the chase and they finished all the crops (sorghum) in the fields. The birds are no longer scared by the beating of drums and tins. They also invade the field during odd hours like very early in the morning and late evening. At times rainfall becomes scarce and no flood occurs affecting our double cropping system in a year facilitated by flood recession cultivation.*

There is the need for households in the Ward to be innovative and try other means of transforming the nature to their benefit with technical help from Agritex, veterinary surgeons and other institutions. This implies that experience sharing through workshops and general discussion within the Ward villages is essential. Such issues have also been observed by Conway and Schipper (2010) in Ethiopia.

5.7.2 Institutional and financial support challenges

Challenges hindering adaptation to climate variability and change were also confirmed as the lack of institutional and financial support. While the Government of Zimbabwe is correct for putting in place the responsible Ministry of Environment, Water and Climate to deal with the issue of climate change (Government of Zimbabwe, 2015), Climate Change Management Department, the one entrusted to develop climate related policies and strategies, to coordinate climate research among other tasks, was ill funded and relied strongly on external donations including for technical support. This was evidence enough to suggest the impairment of some strategies to deal with climate variability and change. The respondents confirmed lack of institutional support in all the nine suggested adaptation strategies to climate variability and change though with varying percentages of 70% and above. However, the support provided mainly in the form of donations, was only part of the coping strategies usually with a political agenda as this type of assistance was generally a once off event.

Given this scenario, the household respondents who implement the adaptation strategies in Chadereka Ward 1 lack the financial resources, a situation also reported by Adger *et al*. (2015), Katanha and Chigunwe (2014) and Toole *et al*. (2016). Eight of the nine adaptation strategies have been confirmed by the household respondents to be seriously affected by finance shortages. The changing farm calendar strategy was the only one which had the lowest percentage of 9.8% when referring to lack of capital. Thus, it was not surprising to have household respondents unanimously pointing out financial deficiency by an average surpassing ninety percent (90.7%). Worse still, research into the climate change phenomenon lacks funding, especially in Zimbabwe and other developing countries. There are no technical innovations without financial backing. The implication is for nations to create a levy for climate change initiative development and the governments to allocate enough resources through their budgets. More research and policy reforms are needed in Chadereka Ward 1.

5.7.3 Knowledge barriers

Knowledge on climate variability and change phenomena in marginal areas like Chadereka Ward 1 was found to be low, though Chifamba and Mashavira (2011), Masinde and Bagura (2012) and Risiro *et al*. (2013) suggested that the phenomena were not knew. For instance, households in the study area were still practicing stream bank cultivation as flood recession cultivation whose consequences had degenerated into land degradation and water scarcity through siltation of the rivers, similar to the findings by Enete and Amusa (2010), Enete (2013), Gukurume (2013), Jiri *et al*. (2015a) and Chikodzi and Mutowo (2014). On seven out of nine of the suggested adaptation strategy options, lack of knowledge has featured with well over 50% responses and this implies the necessity for expanding awareness campaigns to generally cater for everyone in Zimbabwe and Chadereka Ward 1 in particular. Butt *et al*. (2015) explore the positive impacts of the Farmer Field School (FFS) which is participatory and provokes creativeness. Such a model could also be tried in the case of Chadereka Ward 1 to raise the awareness levels and positively deal with climate variability and change impacts. The idea is to technically equip and capacitate the households to deal with any emerging climate variability and change related situation in their locality.

Further, more household respondents suggested that some adaptation options were not pursued due to lack of knowledge as also revealed by Anandhi *et al*. (2016) and Shemdoe *et al*. (2015). In as much as households have heard about insurance policies, very few households knew of climate risk insurance cover. Upon explanation, the majority of the respondents responded that the challenges were that of lack of knowledge (81.6%), lack of institutional support (95.8%) and lack of capital (89.4%). Climate risk insurance cover being a relatively new adaptation strategy in the developing world, resources permitting, is worth pursuing as urged by Surminski *et al*. (2016). With the unstable economic situation in Zimbabwe, the rural people, inclusive of those in Chadereka Ward 1 felt more secure with their assets at home. This is quite different in the case of the developed nations who are guaranteed of their investments. However, more debates are still being engaged in trying to amplify climate variability and change adaptation options in such remote areas.

2.7.4 Infrastructural challenges

Significant percentage responses on infrastructural challenges had been recorded on six of the nine suggested adaptation strategies to climate variability and change. To be specific, most of the adaptation strategies in Chadereka Ward 1 required external services which were facilitated by good transport networks and well serviced electrical grid system and improved water supply. This was hindered by the poor roads and broken bridges, also reported in other literature by Brown *et al*. (2012), Dodman and Mitlin (2015) and Sharaunga *et al*. (2016), which link the Ward to the Muzarabani Growth Point and beyond. Thus, there was delayed access to the inputs for drought tolerant cultivars like sorghum. During each rain season, flood recession cultivation was disturbed by the destroyed field shelters and the destruction of the poorly sited and constructed household structures for grain storage and living. The implication was that infrastructural challenges were often site or household specific and building codes in such an area needed to be enforced. There had never been a national electricity grid connection in the Ward to assist in livelihood diversification as some activities require the use of electricity. This also concurs with the findings in an Indian study by Wise *et al*. (2015). The only existing electric connections were found at the Chadereka service center and clinic being powered by diesel generators. The state of the roads and bridges at times hindered the transportation of the diesel to the clinic, especially during the rainy season. The boreholes, which were reported as the main sources of water during the dry season, are part of the infrastructure. Due to overworking some broke down and water became a great challenge. Infrastructure, from the reponses by the focus group participants, was one of the major constraints for any development initiative in Chadreka Ward 1. Urquhart *et al*. (2014) expressed concern on the state of the national infrastructure for the development of climate change research in developing countries in general. In the same way infrastructure for research development in Chadereka Ward 1 is not properly in place.

5.7.5 Lack of market

Marketing systems for agricultural commodities in Zimbabwe have always been problematic as they are closely linked to transport infrastructure, an observation also put forward by Kok *et al*. (2016). The household respondents confirmed that in Chadereka Ward 1 marketing services had deteriorated drastically due to unbalanced trade in their livestock and other products. For instance, market was confirmed as being problematic in relation to adaptation strategies such as in the practice of drought tolerant crops and animal variety strategy (90.3%), flood recession cultivation (92.6%), conservation farming (93.5%), livelihood diversification (86.5%), irrigation (85.8%) and other strategies like migration (99.7%). Sonwa *et al*. (2016) also agreed with this challenge. The growing of cotton had since lost value in the Ward due to lower market prices, as such, some households have since stopped its production even though it is a drought tolerant crop recommended for the prevalent climatic conditions. In a similar study by Olutegbe and Fadairo (2016) upon computing the Pearson's Product Moment Correlation (PPMC), deduced that there existed a significant relationship between challenges faced by households in adapting to climate variability and change and the adaptation strategies at the 95% confidence level. This means that the more households face constraints in employing one form of adaptation strategy. In this light, the production is mainly for family consumption with little being traded. The Chief said:

> *The other challenge we face here is that of no cash. Though it has become a national problem, here in the rural areas, it has become worse. Our beasts are now being offered for little money because of no choice as one needs to buy food. The rest is exchanged.*

The households remain more vulnerable to climate variability and change. Proper marketing strategies need to be promoted and pursued in the area.

5.7.6 Shortage of labor

Household respondents have generally perceived labor as not being critical in adaptation to climate variability and change in Chadereka Ward 1, as echoed by Shackleton *et al*. (2015). In this case, most of the high percentage responses were on the 'no' category for the seven out of nine suggested adaptation strategies. That is, labor shortage was confirmed not to be significant in agroforestry (89%), use of drought tolerant crop and animal variety (87.7%), livelihood diversification (79.7%), changing farm calendar (88.4%), irrigation (87.1%), climate risk insurance cover (97.7%) and others like migration (all respondents). Section 5.1 also discussed the issue of household size in relation to labor and concluded that the Ward has redundant labor due to limited livelihood portfolios. In as much as labor (for water collection) was important in irrigation practices (Jonah *et al*., 2015), water scarcity affected strongly the adaptation strategy to an extent that it is only done until the water table can no longer be accessed through sand scooping. Labor shortage was therefore reported as significant on flood recession cultivation (87.9%) and conservation farming (86.1%) since the practices are largely manual and require personpower (Juana *et al*., 2013; Muzari *et al*., 2016; Sonwa *et al*., 2016). In Chadereka Ward 1, flood recession cultivation is not for everyone as already indicated thus, at times, landholders contract the locally available labor. Some of the adaptation strategies lie untapped fully due to the lack of expertise. For instance, apiculture is not practised yet the climatic conditions are conducive. People rely on natural hives. Thus, it can be argued that the issue of labor shortage is relative. The implication lies in capacity building within the area. The community needs extension services and expert or technical help in order to fully utilize their locality advantages and sustainably adapt to climate variability and change.

The mutual linkage of the adaptation challenges in Chadereka Ward 1 makes the adaptation to climate variability and change difficult for households who rely on handouts or donations (Shackleton *et al*., 2015). The opportunities to transform the maladaptation in marginal areas lie in the creation of partnerships, collaborations and synergies within the community and with the external world. Thus, the sustainability of the adaptation portfolios in Chadereka Ward 1 critically lies in limiting challenges confronted during implementation. Given this presentation and discussion on challenges faced by household respondents, the sustainability of the adaptation strategies is negatively affected.

5.8 STAKEHOLDERS' PARTICIPATION IN SUSTAINABLE RURAL LIVELIHOOD AND ADAPTATION TO CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1

Sustainable rural livelihoods and adaptation to climate variability and change requires multi-stakeholder involvement at different levels, times and scales as echoed by Bohensky *et al*. (2016). This is part of the social capital which is critical in the study area. This research, among other issues, was set to establish the stakeholders and their roles in promoting sustainable rural livelihood adaptation to climate variability and change at a local level. Household perceptions on the effectiveness of stakeholder roles and participation were also examined.

According to participants in the focus group discussions, government and its various organs like those in the Ministry of Environment, Water and Climate, Health and Child Welfare, educationists including academics, Agritex officers, officers from the CPU or EMA and the ZMSD, the NGOs, local authorities such as the MRDA, the Chief, Ward counselor, kraal heads and the local community members have been identified as important stakeholders in climate variability and change matters in the Ward. These portfolios have also been considered in the studies by Baudoin *et al*. (2016), Dilling and Berggren, (2015), Haque *et al*. (2016), Mafongoya *et al*. (2016), Prokopy *et al*. (2015) and Sango and Godwell (2015a). The stakeholder roles vary from global down to the local level. The roles are normally attached to the access to resources. Thus, for the present research, an assessment of stakeholder roles was considered useful to provide some insights on the matter in a marginal and local area in Chadereka Ward 1 in Muzarabani Rural District. For this purpose, the effectiveness of the stakeholder roles had been assessed using a three pointer likert scale of 'less effective', 'effective' and 'not effective'. The current governance framework for climate change in Zimbabwe is also discussed.

Table 5.29 illustrates the summarized responses during the focus group discussions on stakeholders, and the effectiveness of their roles in promoting sustainable rural livelihood adaptation to climate variability and change. According to the participants, the government through its various ministries and organs provides services to the inhabitants in Chadereka ranging from agricultural support in terms of inputs and extension services to disaster relief, including flood and drought relief whenever they occur. Most of the issues regarding climate variability and change in the Ward still remain centralized and underfunded as noted by Dodman and Mitlin (2015). The participants also noted that some services were understaffed with, for instance, one Agritex officer in the whole Ward, one Chadereka clinic with only one qualified nurse and some primary and secondary schools with most of the teaching staff being unqualified. The area is prone to malaria due to the prevailing climatic conditions. Given these institutional, financial and human capacity shortcomings in service provision by the government and its related sectors, the participants assessed the roles as less effective and considered their Ward as being neglected.

However, it can also be noted that the government showed concern regarding climate change at international and national levels by signing and ratifying the UNFCCC in 1992 and acceding to the Kyoto Protocol in 2009 (Government of Zimbabwe, 2015). It is also plausible that the government allowed some NGOs to perform their humanitarian roles in different areas of the country. Further, in its current ZimAsset 2013-2018 policy, the government recognizes climate variability and change impacts like drought and floods which negatively affect the largely rain-fed agricultural based economy. Thus, it therefore partnered with some organizations for financial and technical support like UNDP, Common Market for East and Southern Africa (COMESA), UNICEF and Global Water Partnership and launched Zimbabwe's National Climate Change Response Strategy in November 2015, in line with recommendations by the UNFCCC (Bodansky and Rajamani, 2015). This, according to the Government of Zimbabwe (2015:ii), aims to:

> *…create a climate change resilient nation while its mission statement is to ensure sustainable development and a climate proofed economy through engaging all stakeholders and recognizing the vulnerable nature of Zimbabwe's natural resources and society.*

While the vision and the mission statements support multi-stakeholder involvement, the participants pointed out the lack of transparency, accountability, commitment and the corrupt tendencies in the management and distribution of resources (institutional, financial and human) aimed at promoting adaptation and mitigation strategies in the Ward. One participant pointed out:

> *We are only told what to do by the authorities without them taking into consideration our capacities and what we want done in our community. Look at the roads, bridges and other infrastructure. Our Ward is inaccessible during the rainy season making communication and resource exchange difficult. Thus, the government's commitment on us is limited.*

The proposed governance framework for climate change in Zimbabwe, according to the Government of Zimbabwe (2015), is organized as shown in Figure 5.29. The framework portrays a top down approach given that the resource distribution is centralized. On top is the Cabinet Committee on Climate Change which together with the Minister of Environment, Water and Climate are responsible for all communications to do with climate change at national, regional and international scales like the engagement with the UNFCCC and the production of national communication to the COP. The National Climate Change Platform is considered to be a multi-stakeholder forum involving representatives from all the governance levels including other economic sectors like agriculture, forestry, transport and infrustracture, manufacturing industry, water and environmental management. This is where climate change strategies are formulated, discussed and recommended.

However, according to focus group discussants, the representatives especially at Ward level do not bring adequate and clear information and at times do not communicate to the rest of the households as they usually target reporting on gatherings during funerals and whenever there is a social function like receiving some donation from NGOs. At times, despite having been invited, some fail to go due to financial and transport problems. It is within the National Climate Change Platform that the Zimbabwe National Climate Change Response Strategy was launched in November 2015. Below this platform comes the Provincial Climate Change Platform followed by the Local Urban and Rural Authority Climate Change Platform. Rarely have there been noteworthy activities at these levels publicized regarding climate change. However, they authorize researchers and some organizations who would want to support the households in the Ward. When resources are available they call for meetings, share information on climate change and distribute agricultural inputs. Despite the affirmation by Dodman and Mitlin (2015) that climate variability and change information is disseminated regularly through the print and broadcast media, these rarely get to the rest of the households in Chadereka Ward 1 due to infrastructural and accessibility challenges.

Just below each of these platforms are the technical, capacity building, resource mobilization, advocacy and awareness sub-committees which, for the general populace are non-existent as they are resource constrained in the execution of their mandates. One participant during the focus group discussion regarded them as '*paper sub-committees'* whose roles are still to be fulfilled. This implies the need for capacity building at their levels to ensure that they initiate projects which are viable, income generating and invest in their adaptation strategies to climate variability and change.

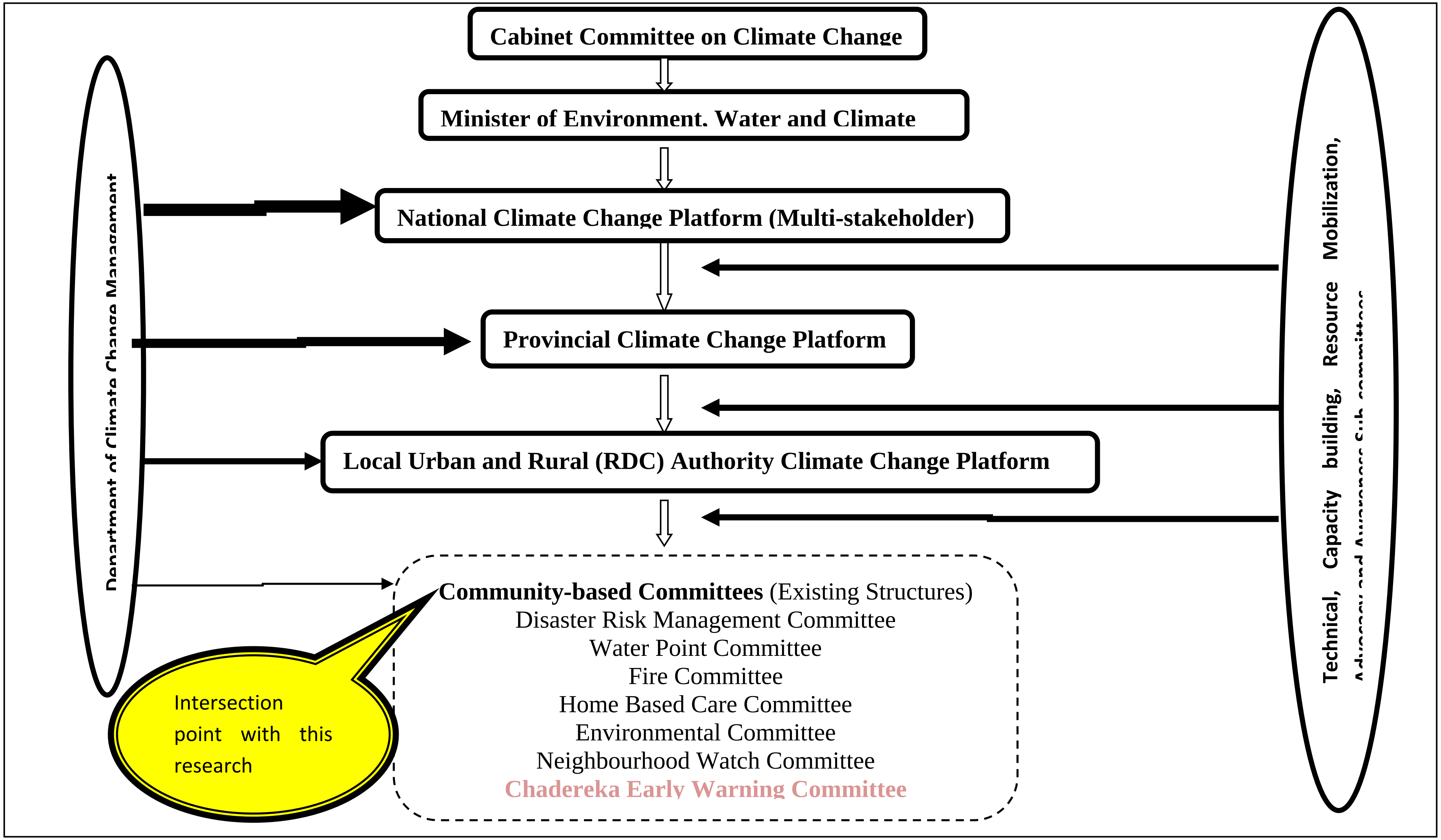


Figure 5.20: Proposed governance framework for climate change in Zimbabwe (adapted from Government of Zimbabwe, 2015:65)

At the bottom of the framework there are the various Community-based Committees constituted by some civil society groups and the locals. This is the target for the current study. Engagement of the locals in climate change debates generates valuable data in terms of the impacts and possible solutions to the issue of climate variability and change as alluded to by Belachew and Zuberi (2015). This disputes the idea of top-down approaches in climate change issues. Discussants argued that the experts and higher authorities should always visit the Ward and get the correct information about the whole issue of climate variability and change and then work together towards the solution. Instead, they agreed that the NGOs were helpful and always visit the Ward, educate households on climate change and disaster issues and some provide help in various ways. An example was given of the Red Cross Society in Zimbabwe which in June of 2016 carried out a four days' workshop on Community-based Health and Disaster Management (CBHDM) with some households in Chadereka Ward 1. The workshop focused on Community-driven Early Warning Systems. The Chadereka Early Warning Committee actively participated in the workshop. This instills the sense of ownership among the households as they actively participate in solving local problems using their local capacities. It then emerged from the workshop, according to one participant during the focus group discussion, that:

> *There are no proper measuring equipment such as rain gauges and thermometers for the Chadereka Early Warning Committee to constantly monitor and record weather in their area. In fact, there is not even a single weather station in the Ward. Communication amongst committee members and even out of the Ward to high authorities is poor. We then proposed solutions like asking for help from well-wishers for the weather instruments. For communication, we resolved to use cell phones/ whatsApp, inter-committee meetings and even sending messengers for internal communication. School children also help pass on messages among other forms.*

From the above, the benefits of 'self-mobilization' and 'interactive' dimensions of stakeholder participation in climate variability and change issues as opposed to 'passive' ones can be realized. This is in agreement with Muchanga (2012). However, while Muchanga (2012) argues that the 'consultative' approach is not too inclusive, for Chadereka Ward 1 which is not fully self-sustaining in terms of skilled personpower, financial and other infrastructural facility requirements still need support by the authorities or NGOs and collaboration to address the issues of climate variability and change. The activities done during the workshop by the Chadereka Early Warning Systems Committee and other participants served as clear evidence of human capacity building at local level. These were facilitated by the Zimbabwe Red Cross

Society which is a NGO. With this approach, issues to do with climate change are tackled easier with maximum cooperation. Hence, capacity building is instrumental in shaping the contours of climate change adaptation and mitigation for sustainable rural livelihoods development.

The Department of Climate Change formed in 2013 has the mandate for spearheading the development of policies and strategies linked to climate change in Zimbabwe. Thus, it created specific offices which focus on critical areas in climate change fora like mitigation, adaptation, research, CDM, national communications, projects and publicity (Government of Zimbabwe, 2015). The department has great influence in all other platforms in the governance framework for climate change in Zimbabwe (Figure 5.20). Despite housing such offices, its coordination role is hampered by a shortage of resources as revealed by one key informant. It therefore becomes less influential at local levels as reiterated by participants who rated the government roles and most of its organs as less effective. The Department of Climate Change opened its doors to academic researchers who share anh interest in climate change issues. The households at the local level were not familiar with this department including the governance structure. This implies that involvement in climate variability and change issues should incorporate those at grassroots level who generally bear the direct impacts of the phenomena as their survival is entirely dependent on agriculture which is rain-fed, a situation already emphasized by Balama *et al*. (2016) and Mugi-Ngenga *et al*. (2015). This also concurs with Bohensky *et al*. (2016) and Wise *et al*. (2015).

Table 5.32 isolates that ZMSD has a critical role in climate variability and change as it deals with the scientific measurement, prediction and forecast of climatic elements like precipitation and temperature among others. The behavior of the two elements (temperature and rainfall) in the Ward is a cause of concern, especially when in their extremes. According to the focus group discussants, the role of the ZMSD is rated as not effective due to the lack of a single weather station in the area, their weather communication is only accessed by few households and the officers rarely visit the Ward. In this case households rely on their IKS as discussed by Bohensky *et al*. (2016) and Chanza and De Wit (2016). For instance, during the focus group discussion, it emerged that households predict flooding in Chadereka Ward 1, which normally occurs as back flow by the presents of hippopotamus in their area during or after heavy down pours. The amount of water in the flood plains also alerts the households of impending floods. Even though households with radios and television sets receive communication on weather reports and forecast, these media are not reliable due to low signal in the valley and lack of power for the machines. The nearby weather stations are some hundreds of kilometers away, namely, Kanyemba, Mount Darwin and Guruve Weather Stations (see Map 2.1).

Table 5.32: Summary of focus group participants' assessment on stakeholder roles in promoting sustainable rural livelihood adaptation to climate variability and change in Chadereka Ward 1

Stakeholder	Role(s) in promoting sustainable rural livelihood adaptation to climate variability and change	Effectiveness
Government (District Administrator)	Provision of inputs (though not timeously), provision of clinic services (like provision of nursing staff), education services (like deployment of qualified teaching staff) and disaster relief though not enough.	Less effective
NGOs (UNICEF, IMO, Help from Germany, World Vision, Zimbabwe Red Cross Society)	Help from Germany - provision of farm inputs. World Vision - provision of sanitation and water (boreholes). UNICEF - provision of education material. RED CROSS - provision of education, water and sanitation IMO - once built houses for flood victims.	Effective
Chief	Lobby for development of the area, takes Ward issues and challenges to the government.	Effective
Kraal head	Enforces laws/ regulations, pass resolutions to minor altercations in the village, report to the councilor on issues arising in the village and participates in the distribution of the land.	Less effective
ZMSD	Provide weather reports/ forecasts through the radio otherwise they are not physically seen in the area as there is no meteorological sub-stations.	Less effective
Agritex Department	Encourage good farming practices like conservation farming and the production of drought tolerant commodities.	Less effective
Ward Councilor(s)	Foresees ward governance and law maintenance in the Ward, oversees the distribution of relief goods in the ward, attend meetings/ workshops/ conferences with NGOs to do with communities.	Less effective
CPU/ EMA	Provide education on natural disasters.	Less effective
Local households	Implement the rural livelihoods adaptation strategies to climate variability and change.	Effective

The infrastructure such as roads and bridges which connect Chadereka Ward 1 with other places like Muzarabani Growth Point, are in a dilapidated state as already affirmed by one participant. During the rainy season, the Ward is inaccessible, worsening the situation. There are no monetary resources allocated for developing the area, especially in the current economic conditions when the government is struggling to pay its civil servants. The CPU likewise provides education and awareness to disaster issues but rarely was it found in the area. These normally combine their visit with the NGOs which frequent the area as they come to monitor projects being done in the Ward by households. The MRDA, the Chief, the Ward counselor and the kraal heads are the channels of communication for the households and link them with the government which is the main decision-making board. The participants unanimously appraised the role played by the NGOs as effective. The Ward household participants acknowledged the physical, financial, social and human capacity building support rendered. The Ward counselor even recapped:

> *Various NGOs provide assistance in the Ward. They donate farm inputs, drill boreholes, and repair other infrastructure like bridges and schools after floods. For example, the IMO has constructed shelter for flood victims. Even all the schools received stationery donated by UNICEF. Some households learnt some early warning systems linked to climate change, among other disasters being spearheaded by NGOs.*

The role played by the Chief was commended and rated effective by the participants. The Chief brought feedback from meeting to the households. However, they noted that the government delayed in attending to challenges experienced in the Ward due to resource constraints rather other than the political will as reported by IPCC (2014). On the other hand, the kraal heads and the councilor who enforce and foresee the compliance with the environmental laws or regulations including the best practices in the execution of the livelihoods were considered less effective as they are also found violating the laws by practising stream bank cultivation leading to siltation of rivers.

The local households rated themselves effective as they pointed out that they were compliant and implemented whatever was needed within their capacities. For instance, they suggested that they provided labor in the implementation of some adaptation strategies which were not capital intensive. They worked with the NGOs and even government organs whenever they came with programs for Chadereka Ward 1. The local community even suggests areas where they needed assistance within their Ward like repairing of schools and bridges damaged by floods and the construction of foot bridges. Some of these issues were still pending due to the lack of capital. Another example provided during the survey was that some community members moulded bricks and fetched pit sand and river sand during the repairs of classroom blocks damaged by floods. Given these and more experiences, they rated their participation as effective. The Chadereka local people are at the receiving end and beneficiaries of strategies recommended.

The respondents' level of participation in policy formulation process regarding sustainable rural livelihood adaptation to climate variability and change in Chadereka Ward 1 was probed. Forty-eight percent of the household respondents confirmed that they greatly participate followed by 21% whose participation was less. Eighteen percent of the household respondents remained neutral, while 13% acknowledged non-participation. Figure 5.21 shows the distribution of the responses.

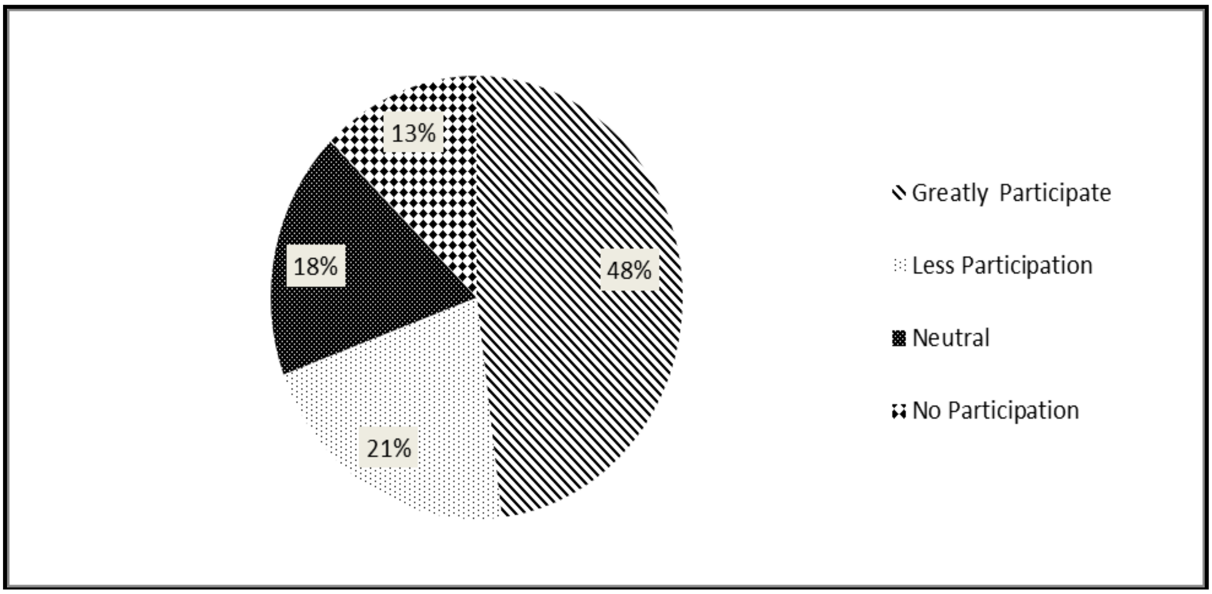


Figure 5.21: Responses on the level of participation in policy formulation process in promoting sustainable rural livelihood adaptation to climate variability and change (n=310)

The households who confirmed participation in policy formulation the process (69%) might have included the key informants and those individual households who are followers of current events in the Ward. When requested to indicate in which way they take part, Figure 5.22 illustrates that 56% indicated that they were involved in the implementation stage while 13% provided ideas during planning, an indication that they attended to the National Climate Change Platform where this was done. The remainder (31%) were not involved in any way. This portrays a weak participation among some of the locals on decisions which matter the most, particularly in their Ward. Despite the assertion by Dodman and Mitlin (2015) and the Government of Zimbabwe (2015) that the country has yet did not have a standalone policy or legislation on climate change, the existing sectoral laws like the environmental laws advocating for reductions in pollution and environmental degradation were examined. The EMA in Zimbabwe for instance is at the helm of ensuring that citizens abide by these policies. Success stories for EMA had been recorded by Manatsa and Gadzirai (2010) and UNDP (2013) among others, but these had concentrated on the southern lowveld of Zimbabwe where Chiredzi, Chivi, Bikita and Masvingo are found leaving little coverage of the northern lowveld in which lies Chadereka Ward 1 in Muzarabani Rural District. Thus, this research adds more literature on rural livelihoods and climate change issues in the northern part of Zimbabwe.

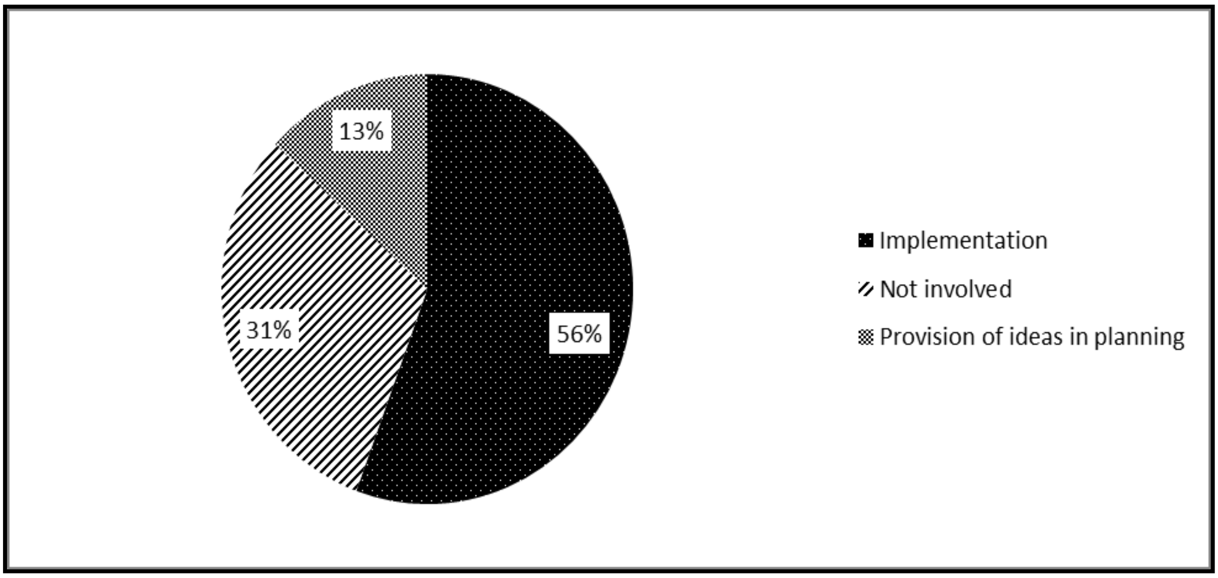


Figure 5.22: Respondents' involvement in the policy or regulation systems (laws) in Chadereka Ward 1

Given these observations, the use of automated weather stations would augment the IKS and help the community reduce the negative impacts of climate variability and change. Once the households develop full knowledge of the climate change phenomenon and each of the stakeholders performs their roles diligently and effectively, it would become easier to increase resilience and reduce community vulnerability to climate variability and change which will foster sustainability of the adaptation endeavors. The implication involves partnership of the rural community especially in Chadereka Ward 1 with some civil society groups, NGOs and the relevant sectors of the government.

In the quest to know whether household respondents were provided with any awareness training regarding climate variability and change, Figure 5.23 illustrates the percentage responses. There was almost a striking balance between the recipients of training (56%) and non-recipients (44%). Of those who were trained, 38% indicated that they were trained on sustainable natural resource use and management while 18% received community disaster survival education, especially in relation to floods and drought which are prevalent in the Ward. Even though some of the household respondents argued against their exclusion from deliberations on climate variability and change issues at higher levels, initial training to understand the phenomenon is critical. Knowledge is best developed within the context of the local area visiting the relevant fields as revealed by Butt *et al*. (2015). Households therefore are in support of change of venue for the workshops and seminars or deliberations, that is, they are requested to be held in the rural areas where the impacts of climate variability and change are worse. However, residents commended the training conducted by NGOs such as the Zimbabwe Red Cross Society on early warning systems. On this issue, limited awareness regarding climate variability and change had been acknowledged and noted.

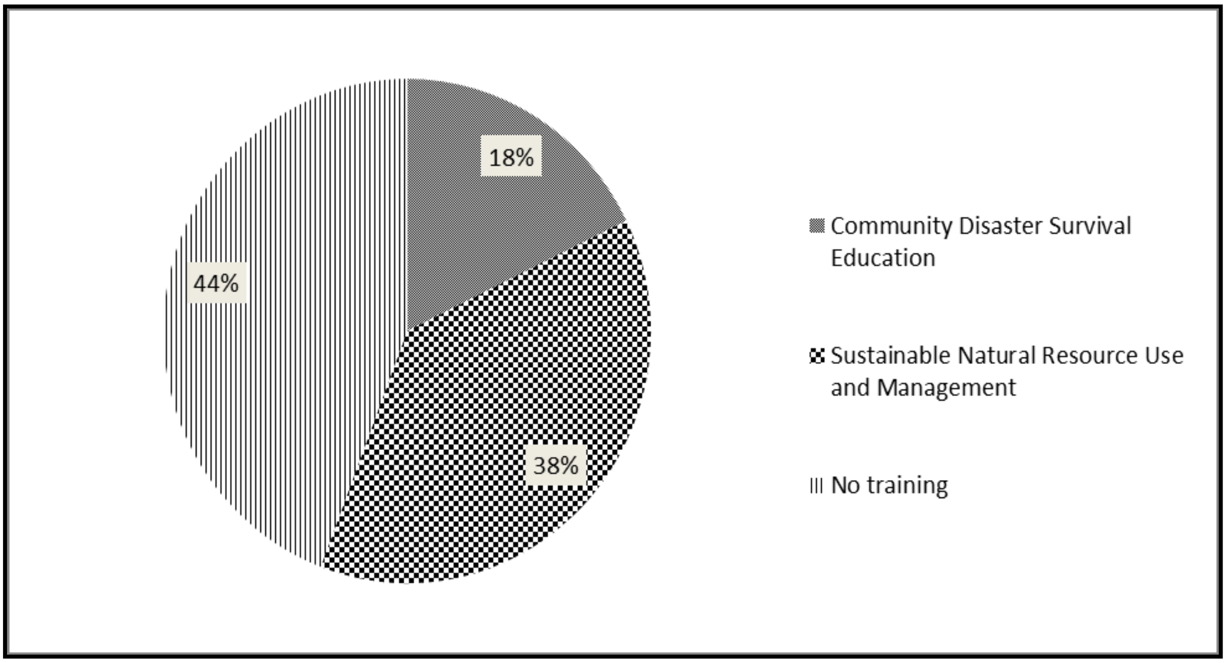


Figure 5.23: Responses on the training received to enhance livelihood or adaptation strategies to climate variability and change (n=310)

The providers of the training shown in Figure 5.24 were identified as the NGOs with the highest percentage (32.9%), followed by the government organs with 27.4% and finally, the local leadership with 4.2%. Local leadership mainly report outcomes of the deliberations from workshops, seminars and conferences attended at district, provincial and national levels to the households. In all the three sets of trainers, the percentage of household respondents who did not acknowledge any trainers widely surpassed those who were trained. The current dimension of assistance rendered to vulnerable communities is through capacity building (life skills training) so that they become self-relient and there would be continuity in the absence of the NGOs. Mechanisms to ensure that every household attends such training need to be enforced.

As part of government effort to have the message of climate variability and change reach communities, Musarurwa (2012b) discussed the university institutional roles. Musarurwa (2012b) made it clear for universities to find relevance in communities which they serve by encorporating or infusing problematic physio-societal issues like climate variability and change into their curricula. Exchange of scientific and IKS to foster sound adaptation strategies to the phenomenon are encouraged. In response to this, Bindura University of Science Education which lies in Mashonaland Central in which Chadererka Ward 1 in Muzarabani Rural District is located, through the Memorandum of Understanding with the ZMSD, had established a weather station equiped with instruments for recording weather elements and there are programs on climate change in its carricula. Since 2013, climatic data was being generated for use in climatological studies. Further, programs which take into account climate variability and change issues are being run and improved. Thus, candidates who would later disseminate climate change information and adaptation options are being educated and trained.

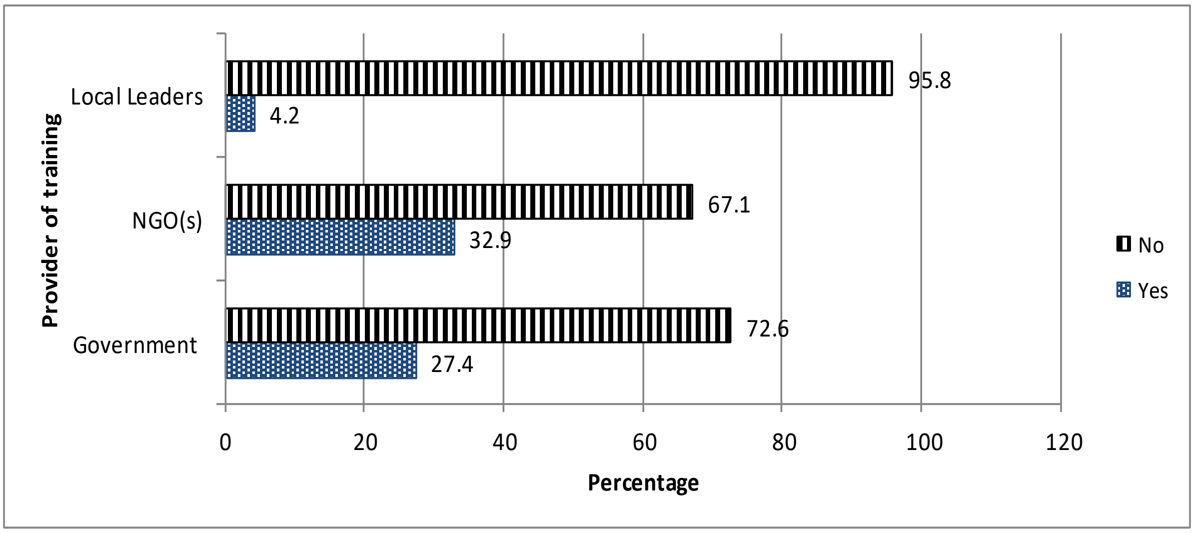


Figure 5.24: Responses on the provider of training to enhance livelihood adaptation strategies in the face of climate variability and change (n=310): Multiple responses

From this thematic discusson it has been clarified that stakeholder roles on the issue of climate variability and change are diverse and should not be underrated. In the case of Chadereka Ward 1, generally the roles are effective to a limited extend as there is no timeframe for their execution and they are resource constrained. The visit to the Ward by other stakeholders is usually less frequent. However, NGOs were commended to be of great help in the Ward as they offer support ranging from training to other material donations. Human empowerment is the advocacy to reduce the donor syndrome and foster creativeness. Strengthening of collaborations and partnerships among government, NGOs, the private sector and the local community should be reinforced for sustainable adaptation to climate variability and change.

5.9 THE SUSTAINABILITY OF RURAL LIVELIHOOD IN THE FACE OF CLIMATE VARIABILITY AND CHANGE IN CHADEREKA WARD 1

The respondents provided their views on the sustainability of their livelihoods adaptation strategies to climate variability and change (Figure 5.25). Seventy-two percent suggested that they were not sustainable, while 23% and 5% were of the view that they were moderately sustainable and sustainable, respectively. The results clearly indicate the limited sustainability of the practices in the Ward. Participants during focus group discussions also confirmed that, while some of their practices like agroforestry and use of drought tolerant cultivars promote sustainability, they were affected by factors beyond their control and capacity, such as water shortages and the continued shifting of seasons year after year. Adeniyi (2016) also notes the role of forestry in the sustainable management of the environment. However, Svubure *et al*. (2016) argue that sustainability can be enhanced through monitoring for efficient use of resource and constant provision of data. Thus, in Chadereka Ward 1 more extension services are needed to educate households in the proper use and management of their natural resources.

The sustainability status of the adaptation strategies to climate variability and change was also revealed through the quantity of production for both crops and livestock which was confirmed low and could not sustain the households from one rain season to the other. Generally, all the livelihoods assets (natural, physical, financial, human and social) were found not to be properly and adequately present to sustainably meet the requirements of the households in Chadereka Ward 1 (Table 5.30).

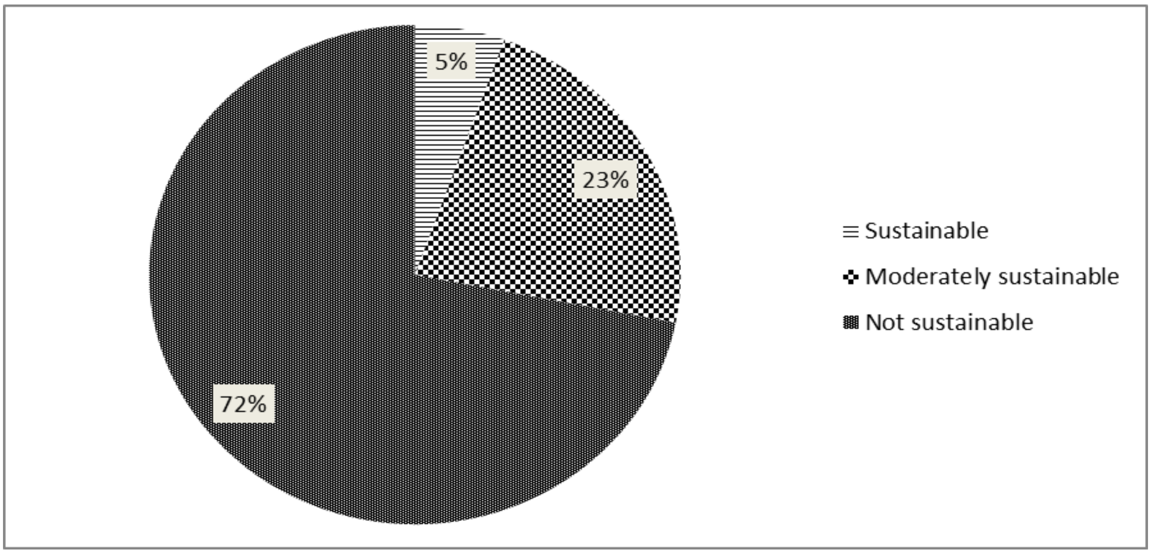


Figure 5.25: Respondents' comments on the sustainability of the adaptation strategies to climate variability and change (n=310)

Table 5.33 adopts key explanatory variables from the SRLF which show some deficits or challenges in most of the capital or assets available in Chadereka Ward 1. These have a bearing on the livelihoods strategies pursued by the community and how it is adapting to climate variability and change. It therefore calls for a holistic focus when dealing with climate variability and change issues, were a combination of the human and the biophysical environmental systems (see Figure 3.4) promote the well-being, sustainability and resilience of the practices in the face of climate variability and change. These assets have been presented and Table 5.33 provides a summary.

Table 5.33: Capital or assets and livelihood strategies resultant of the analyzed data

Capital or Asset	Description in relation to Chadereka Ward 1	Livelihood strategy promoted
Natural Asset	Availability of land (1-5 hectares), little rainfall, wild fruit (*Ziziphus mauritiana* and *adansonia digitata* berries), scarce water (from wells, inland ponds, boreholes, sand scooping and rivers when raining), mopane trees and other vegetation species, wild animals, solar system.	Farming, petty trade, brick molding, honey extraction, commercialization of wood and grass, hunting, craft work, wild fruit gathering, building of shelter, solar energy generation for lighting and powering radios. Selectively done by a few.
Physical Asset	Donated boreholes, poor roads and bridges, inadequate schools, clinic, service centers, Chadereka police base, household shelter/houses, granaries, scotch carts, wheel barrows and farm equipment, domestic generators, solar panels.	Farming, market gardening, service provision (transporting domestic goods and trade wares, teaching, attending to patients, maintaining security and safety), watering livestock, repairing farm equipment. All these are generally inadequate.
Social Asset	Marital status, donations of food, sanitary wares, shelter, gifts from government and NGOs, remittances, communication on weather and climate issues and disaster risk reduction associations or committees, intra-household relations.	Money transfers, exchanging gifts, social communication systems, processing and sharing climate information, intra-household borrowing and lending. All these are inadequate.
Financial Asset	Beasts (livestock), petty trade, and few individual savings, remittances, little income from hired labor, brick molding and construction, farm output in monetary terms.	Selling of livestock and wild fruit, acquiring farming equipment and household tools, buying staple food. All these are inadequate.
Human Asset	High literacy rate (availability of primary and secondary schools), varied and less skilled labor force (few qualified teachers, nurses, Agritex officers, business people), no training institutions, varied age groups, average household size and educational level.	Acquisition and transfer of knowledge on best practices from few extension officers, teachers and relevant authorities, spraying mosquitoes, providing labor for various livelihood strategies, treating patients, repairing infrastructure. Selectively adequate.

5.10 CONCLUSION

The Chapter presented, analyzed and discussed the results from respondents who identified the main rural livelihoods and adaptation strategies to climate variability and change in Chadereka Ward 1. The sustainability of the rural livelihoods was assessed given the awareness levels to the phenomena, the livelihood assets available at household level and how the adaptation strategies were being affected by the identified challenges in the Ward. An assessment of the stakeholders' roles was also considered useful in determining the sustainability of the livelihoods and the adaptation strategies to climate variability and change, the thrust of this research. The study revealed an over-reliance on farming which was under threat from the increased variations in climatic conditions. All the assets in the Ward (natural, physical, financial, human and social) were negatively affected by the changing climatic conditions thereby limiting the sustainability of the rural livelihoods and the adaptation strategies. Overall, the reliance mainly on natural resources (land, water and vegetation) which were found to be highly susceptable to climatic variations made the situation more complex. Hence, for increased resilience, well-being and sustainability; full community awareness and involvement in issues in relation to climate variability and change in their local area should be enhanced and supported.

CHAPTER SIX

CONCLUSION

6.1 INTRODUCTION

The study focused on assessing the sustainability of rural livelihood and adaptation strategies to climate variability and change in a case study, Chadereka Ward 1 in Muzarabani Rural District in Zimbabwe. The assessment was based on the contributions by household participant responses to the research tools generated for the purpose of soliciting data during THE household surveys conducted. Specifically, the research identified the rural livelihood practices in the Ward together with their governance and sustainability. Household respondents' awareness levels to climate variability and change issues were established in addition to the socio-economic and biophysical impacts posed by the climatic phenomena. The study further examined the adaptation strategies to climate variability and change practiced in the Ward. Finally, it established the challenges faced by the households as they adapt to climate variability and change and evaluated stakeholder roles in rural livelihood adaptation to the climatic problem. The outcomes from the research are summarized as per the objectives in the following sub-sections which culminate in the provision of recommendations and conclusions.

6.2: SUMMARY OF KEY FINDINGS

The summary of the research outcomes is presented considering the objectives in line with the research questions asked. The findings were based on the salient issues expressed in the combination of the SRLF and the CHES frameworks considered relevant and essential in this research. Basically, the results exposed the critical linkage between the human and the natural facets in fostering resilience, well-being and sustainability in this era of climate variability and change. The human-nature relationship formed the basis for the analysis and the discussion regarding the rural livelihood sustainability issue which occupied the center stage in this research. While advocacy for household livelihood practices which promote sustainable adaptation strategies is mounting, their vulnerability to climate variability and change would remain unabated if livelihood malpractices continue unchecked. This implies the need for the development of more resilient policy frameworks. The following summary of results includes critical reviews as to how they contribute to the sealing of the knowledge gap identified by this research.

6.2.1. Objective One: Rural livelihood practices and their governance in Chadereka Ward 1

The focus for this objective was to identify the current rural livelihoods being practiced by households in Chadereka Ward 1 in the face of climate variability and change. The rules and regulations governing their execution were also established. However, before these were presented, some demographic and social characteristics of household participants in the survey were established for they had a bearing on the responses analyzed and presented. For the demographic and social characteristics, attention was given to gender, age group, marital status, educational level, household sizes, religion, birth place and duration of stay, language and respondent’s household status. The influence of such characteristics on some rural livelihoods and adaptation strategies were statistically tested using the MLRM and found to be statistically significant.

The research identified farming, gathering of wild fruit and service provision as the main current livelihoods being practiced in Chadereka Ward 1 in the order of significance. A MLRM statistical analysis of how some of the socio-demographic characteristics influence the uptake of these current rural livelihood practices by household respondents in Chadereka Ward 1 in the face of climate variability and change was done and the majority of the characteristics were found significant. The results were comparatively similar to the research undertaken by Balama *et al*. (2016), Debela *et al*. (2015), Jiri *et al*. (2015a), Kima *et al*. (2015), Mudzonga (2012), Ncube *et al*. (2016), Wheeler *et al*. (2013) and Yegbemey *et al*. (2014).

In Chadereka Ward 1, household respondents revealed that farming was done as a permanent activity though seasonality was also a common practice. Yields depended on time spent by farmers on each livelihood. Thus, more yields were obtained by full time farmers. The rural livelihoods were also aided by the status of the household capital assets in the Ward. Generally, the Ward experiences deficiencies in all the five presented assets, namely, natural capital, physical capital, financial capital, social capital and human capital.

In relation to the natural capital, the household respondents identified land, vegetation and water as critical for their livelihoods in Chadereka Ward 1. These supported their livelihoods such as farming, gathering, crafting, building and energy provision. The resources were used almost on a daily basis. However, important to note is the severe water shortages as the place receives low rainfall in most cases. There is little grass such that browsing livestock rely on mopane leaves. Farm sizes are not a major issue as the majority had an average of 1.99 hectares with communal ownership.

Physical assets found in the Ward or owned by the households also contributed to the sustainability status of the rural livelihoods in the face of climate variability and change. The research noted that most of the households resided in their own built houses made frome locally available material. Some of the structures are damaged during flooding hence the need for building codes to safe guard the destruction of infrastructure which includes bridges and roads. Thus, physical assets have been considered by the households as an area which needs attention to enhance the sustainability of their livelihoods. Infrastructure like roads connecting the Ward with other places was found to not be maintained and poorly developed with broken bridges. Household physical assets (tools) for use like ploughs and hand tools were insufficient. Despite the assistance offered by some NGOs on physical assets, these remained inadequate and critical in fostering sustainable livelihoods in the Ward.

Households also confirmed the inadequacy of social networking to support the livelihoods in the area. The Ward lacked communication devices to warn people of pending or looming weather disasters. There were no weather stations in the area. However, the established Chadereka Early Warning Committee needed financial and material support to be effective in networking activities.

Financial assets were generally reported to be supported by the sale of livestock which was not frequently done. This practice also increased vulnerability of households to climate variability and change. In fact, livestock and crop production were found to be declining, perpetuating food insecurity in the Ward. Thus, financial capital was in short supply. However, livelihood diversification like petty trading was commended to buffer the financial crisis of households in the Ward.

Though there were reportedly high literacy rates in the Ward, the majority of the households were not skilled and their activities were done spontaneously. Qualified personnel to assist the households like the Agritex officers were in short supply as the Ward was reported to be ignored by highly qualified personnel given its remoteness and vulnerability to climate variability and change calamities. These conditions compromised the sustainability of the rural livelihood adaptation strategies to climate variability and change in Chadereka Ward 1.

Thus, human capital in the Ward was not fully utilized given the deficiencies in terms of skills. There is need for capacity building in various fields of critical need in the Ward.

The existing regulations, according to household respondents, in rural livelihood resource or environmental management in Chadereka Ward 1 included land conservation measures which are minimum tillage, land furrowing for the regeneration of vegetation, destocking, contour ploughing, prohibition of pulling of logs, ploughing at least 30 m from the river banks and resettlement. For vegetation conservation, households were encouraged to use dry fuelwood, prohibited from starting veld fires and deforestation, and there was the expropriation of the indigenous natural fruit trees like *Ziziphus mauritiana*. As for water, the watering points like wells, boreholes and sand scooped wells were protected by branches and logs against animals. Water recycling was employed to water animals and households also practiced mulching during market gardening.

For minerals and wild animal protection there were published laws which prohibited poaching and mining without having acquired a license. These regulations have been considered ineffective by the households as the custodians (counselor and kraal heads) were the ones who started flouting them by ploughing on river banks. While Wright (2016) upheld improved local community attitudes and perceptions towards conservation of the natural resources and mutual cooperation between resource users and the law enforcers as the best strategy in dealing with the problem of natural resource management. In Chadereka Ward 1 resource conservation issues were a source of conflict and discontentment given the irregularities in relation to resource usage. According to household respondents, the elderly and the local leadership strategically positioned themselves and did not follow the regulations as prescribed. Thus, the rule on stream bank cultivation for instance was never followed.

It can be noted that livelihood options are locality specific thus, adaptation strategies and management practices should be locally based. The Chadereka Ward 1 experiences highlight the need for revisiting legislation, policies and principles regarding natural resource use and management. This is critical as the number of rural areas becoming more vulnerable to the impacts of climate variability and change are increasing. The negative impacts of human activities on the natural environment in Zimbabwe are increasing as people have become more reliant on natural resources than before due to the socio-economic and political environment in the country.

6.2.2. Objective two: The degree of awareness of climate variability and change by the households in Chadereka Ward 1 in Muzarabani Rural District

This objective was set to establish the level of awareness of climate variability and change issues by the household respondents in Chadereka Ward 1 in Muzarabani Rural District. In this research, awareness levels of the issues were deduced through percentage responses on information regarding the reception, type and provider of climatic data, household assessment of climatic conditions in Chadereka Ward 1 and climate variability and change awareness campaigns conducted in the area. It emerged from the household respondents they had generally not received any information on climate variability and change in the Ward. A few who received the information comprised of the local leadership like the Chief, Councilor and the kraal heads who normally attended to workshops and conferences where the issues were discussed in towns. The majority of the households interpreted climatic conditions through their IKS as also revealed by Adetayo (2013), Betzold (2015) and Ogunleye and Yekinni (2012). Knowledge on climate change issues had not been disseminated properly in the Ward though some NGOs had tried to do so.

Further, the majority did not receive climatic information from anyone while a few confirmed to have been informed by the government organs comprising of the Agritex officer, teachers, EMA officers or CPU officials and the ZMSD officials. Others got the information from the NGOs. Media was not an effective source as the households rarely received newspapers or had access to the television. It became clear that the remoteness of the area hindered the dissemination of climatic information making it low and limited among the household respondents. Thus, methods of disseminating climatic information need to be developed and increased.

Of the few who received climatic information, they confirmed that it was mainly on weather conditions and not much to do with climate variability and change. The information received also lacked depth and clarity leading to the low level of understanding of these climatic issues by the households. Lin (2011) and Shemdoe *et al*. (2015) also confirmed low level of understanding of climatic issues by the general public in another study. Further probing the awareness level on climatic issues by the households, awareness campaigns mainly done by the NGOs in the Ward were confirmed. This supports the outcomes of other research in Zimbabwe like the one by Madobi (2014).

Household perceptions and views regarding climatic conditions in Chadereka Ward 1 were also obtained. The rest of the household respondents agreed that the climate had changed as they were experiencing more strong winds, heat waves, excessive floods and drought than before, a situation also confirmed in various literature (Balama *et al*., 2016; Chitende, 2013; Kashaigili, *et al*. 2014; Mudzonga, 2012; Ogunleye and Yekinni, 2012; Umunakwe *et al*., 2014). Generally, households indicated increased temperatures and reduced rainfall. Despite the low scientific knowledge on climatic issues, the household respondents' experiences and IKS confirmed increased aridity and change in climate in the Ward in agreement with studies by Chifamba and Mashavira (2011), Dube *et al*. (2016), Jiri *et al*. (2015b), Madobi (2014), Mazvimavi (2010), Pinto *et al*. (2016) and Sango and Godwell (2015a).

Awareness levels of climate variability and change are closely linked to the media of dissemination. Also, climate variability and change vocabulary is technical. The implication is to have climate change information printed in the vernacular language to be accessed and understood by all the people since the majority of residents in rural areas do not understand English, the official language. Various forms of communicating the information should be promoted.

6.2.3. Objective three: Impacts of climate variability and change on biophysical and socio-economic environment in Chadereka Ward 1

The biophysical and socio-economic impacts of climate variability and change have been over publicized in different countries of the world in general and other parts of Zimbabwe in particular. In the case of Chadereka Ward 1, data on such impacts is still scarce. Thus, this research noted the impacts on natural resources used by the households and their rural livelihoods strategies. In fact, this objective revealed the impacts as experienced by the households in the study area. Using the five point likert scale, the impacts on natural resources were classified as 'no impact', 'minor impact', 'moderate impact', 'severe impact' and 'neutral' as adopted by Belachew and Zuberi (2015).

Generally, the household respondents noted as moderate and severe the impacts of climate variability and change on the three mainly used natural resources in the Ward which are land, vegetation and water. This is in agreement with other research such as Aberman *et al*. (2015), Basak *et al*. (2015), Belachew and Zuberi (2015) and Huq *et al*. (2015).

The research also noted the changes observed on the natural resources resulting from climate variability and change in Chadereka Ward 1. The three mainly used natural resources (land, vegetation and water) were assessed as 'degraded and greatly degraded' by the household respondents. Sustainable management of these resources was not confirmed. Such observations tallied with Huq *et al*. (2016). The climatic variables that affected the rural livelihoods of the households in the Ward for the past ten or more years were identified as mainly droughts and floods. This also matches with the outcomes on research undertaken by Farai *et al*. (2012), Madobi (2014) and Muzari *et al*. (2014).

The research also established the impact of climate variability and change on the rural livelihoods pursued at the household level. The impact was assessed considering the observed changes such as 'no change', 'neutral', 'reduced or decreased variety', 'greatly reduced or decreased variety', 'increased variety', 'greatly increased variety' and 'changes in calendar of activities'. The majority of the respondetns noted that the rural livelihoods had reduced and decreased in terms of variety. This is in agreement with research conducted by Balama *et al*. (2015), Dube *et al*. (2016), Jiri *et al*. (2015a) and Zimmerer and Vanek (2016).

Specifically, the quantity for both crops and livestock production varied as a result of climate variability and change in combination with other factors. Crop yields for instance, were reported barely enough for the households to take them from one season to the other. ZimVac (2010) even confirmed food insecurity in the Northern Zambezi Valley where Chadereka Ward 1 lies. However, households also confirmed the production of drought tolerant cultivars like sorghum bicolor which was rated as slightly increased by the respondents. Cotton which was popular in the Ward had been affected by the marketing systems in Zimbabwe and declined considerably. In fact, supporting and improving the marketing conditions for the production of cotton could be an important strategy in Chadereka Ward 1 whose livelihood portifolios had declined due to climate variability and change. Thus, crop production had decreased since the past ten or more years, according to the household respondents. Generally, the level of crop production was considered unsustainable due to its rain-fed nature, a view which was also shared by Svubure *et al*. (2016).

The production of livestock was rated as a positive livelihood practice in the Ward, especially the keeping of the smaller livestock like chicken or guinea fowls. Cattle, goats and sheep were also kept though their average quantities remain small per household. The number for the livestock is considered low due to sales in meeting other financial or food necessities, an observation also noted by Chikodzi *et al*. (2013) and Msomba *et al*. (2016). Thus, this practice could increase vulnerability of households if not properly monitored. The sale times for the livestock therefore vary depending of the type of livestock. Smaller livestock were being sold more frequently than larger livestock. Livestock production was reported to be suitable in areas such as Chadereka Ward 1 with increased aridity while crops often failed due to water scarcity. Climate variability and change is having great impacts on the socio-economic conditions in the Ward. Financial assets were inadequate, strongly affecting the sustainability of the livelihood strategies. However, what could be noted was the abundant unskilled labor in the Ward. Sustainability could be attained if more innovations are explored in livelihood diversification. This could be enhanced by formulating policies which are favorable to collaboration and partnerships.

6.2.4. Objective Four: The livelihood adaptation strategies to climate variability and change impact reduction in Chadereka Ward 1

The aim of this objective was to examine the adaptation strategies employed in reducing the impacts of climate variability and change on livelihoods in Chadereka Ward 1. In this quest, after identifying the adaptation strategies, the statistical significance level of socio-demographic factors influencing the adaptation strategies was determined through computing a MLRM. Further, a Pearson's Product Moment Correlation (PPMC) statistical analysis was computed to determine if there existed a statistically significant relationship between sustainability of the adaptation strategies to climate variability and change and the duration of the practices in Chadereka Ward 1. This section culminated by focusing on the coping strategies to drought and flood, the two critical climatic variables in the Ward as provided by the household respondents.

The growing of crops and keeping of animals which were drought tolerant was acknowledged as an effective adaptation strategy in the Ward by the majority of the household respondents. From the previous objective, livestock had been observed as of great significance in arid areas like that of Chadereka Ward 1. Further, conservation farming and changing of crop calendar and pattern were suggested to be equally important. The household respondents also noted the significance of livelihood diversification (on and off-farm activities) and flood recession cultivation. The adaptation strategies acknowledged by relatively fewer household respondents were irrigation, agroforestry (carbon projects) and climate insurance cover including food rationing. All these were directly affected by water availability status in the Ward. It can be noted that sustainability status also depends on the quantity of livelihood portfolios promoting a diversity of adaptation strategies. All these are anchored on farming which had been noted to be rain-fed. Hence, this compromises the sustainability of the livelihoods.

A strong positive correlation was noted between sustainability of the adaptation strategies to climate variability and change and the duration of the practices in Chadereka Ward 1. That is, the longer the duration in practice of an adaptation strategy, the more sustainable it becomes. For instance, the production of drought tolerant crops and livestock was noted to be positive in sustaining the lives of the majority in the Ward though the production levels were reported to be decreasing of late. Significant proportions of the household respondents confirmed that there had been in the Ward for a shorter time and needed more time to assess the sustainabilioty of the strategies. Those who had stayed long confirmed their practice of a wide variety of the strategies which include flood recession cultivation. Practices like flood recession cultivation had increased siltation and reduced the water holding capacities of the local rivers, increasing the vulnerability of the Ward to climate variability and change. The environment continues to deteriorate because of such malpractices leading to reduced vegetation cover.

Finally, the copying strategies to major climatic variables (drought and floods) in the Ward were discussed. The household respondents acknowledged remittances, production of drought or flood tolerant crops or livestock, grants or donations from the government or NGOs, consumption of less food and selling of household assets as the coping strategies. Generally, these coping strategies continue into long-term adaptation strategies as the climatic phenomena get prolonged as also observed by Dube *et al*. (2016) and Ansell *et al*. (2016). Thus, the research established that coping and adaptation strategies are critical to climate variability and change in developing countries in general and marginal areas like Chadereka Ward 1 in particular.

While a variety of coping and adaptation startegies were noted, the lack of proper management in their execution increases the vulnerability of the households in the Ward. This implies that engagement of agents to educate and advise the households on good management and practices in livelihoods to promote sustainability and reduce vulnerability. Thus, material support and equitable allocation are needed in the Ward.

6.2.5. Objective Five: Challenges encountered by the households in Chadereka Ward 1 in Muzarabani Rural District in adapting to climate variability and change

The fifth objective was set to establish the challenges faced by the households in Chadereka Ward 1 in adapting to climate variability and change. Focus was given to socio-economic, political or institutional and biophysical constraints. For the purpose of their presentation and discussion, the constraints were crosstabulated with the adaptation strategies provided by the household respondents.

The challenges faced in relation to adaptation to climate variability and change indicated by the household respondents in Chadereka Ward 1 were natural disasters, lack of capital, lack of institutional support, lack of alternative sources of fuel, poor infrastructure, lack of market, lack of knowledge and labor shortage. These challenges influence adaptation in the study area in varying degrees. For instance, while natural disasters, knowledge level, fuel sources, institutional and financial challenges were highly influential on almost all the identified adaptation strategies, poor infrastructure and marketing issues were other setbacks to sustainable adaptation to climate variability and change in the Ward.

Knowledge is a critical resource in an attempt to sustainably adapt to climate variability and change in Chadereka Ward 1. Despite the acquisition of basic primary and secondary education by most household respondents, the current climatic challenges require practical solutions in the adaptation endeavor. Other possible ways of harnessing water in Chadereka are needed. Lack of knowledge has been emphasized by some researchers like Anandhi *et al*. (2016) and Shemdoe *et al*. (2015). This calls for more research into this area regarding water in particular.

It emerged from the analysis that most of the adaptation strategies in Chadereka Ward 1 required external services which were facilitated by good transport network and well serviced electrical grid system and water supply. In this regard, the state of infrastructure (poor road and broken bridges) was a cause of concern and negatively affected the adaptation strategies to climate variability and change in the Ward. For instance, lack of an electricity grid system was directly hindering the livelihood diversification strategies such as welding and sewing.

Unbalanced petty trade, especially involving livestock had been noted by household respondents in the study area. They were short changed by their petty trade partners from towns and cities. For instance, the growing of cotton, a suitable crop in the area had been strongly affected by marketing forces. Production cost has surpassed the marketing price for the commodity and some people have abandoned its production.

On another note, labor shortage was reported as not a major issue by the respondents. What was more critical was that labor with requisite skills for specialized adaptation strategies was almost non-existent. However, at the household level due to labor demanding livelihoods like flood recession cultivation and conservation farming in an average family size of 4, labor inadequacy had been reported.

The challenges are of institutional nature and the solution lies in improving the governance and management of livelihoods from the national to the local level. Rural development should be priotitized as it is generally the source of raw materials for manufacturing processes done in urban areas. Attention should be given to infrastructural development to make rural areas easily accessible, and make use of energy sources which do not degrade the environment such as the use of fuelwood. Efficient use of resource should also be promoted.

6.2.6. Objective Six: Stakeholders' participation in sustainable rural livelihood adaptation to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District

The last objective for this study focused on the participation of different stakeholders in sustainable rural livelihood adaptation to climate variability and change. It also considered household perceptions on the effectiveness of stakeholders in promoting sustainable adaptation strategies. The level of participation by household respondents in policy formulation processes was determined together with their involvement status. Further, the study identified the type of training received by the household respondents. It concluded by considering the provider of the training.
The research identified the government through its various organs like those in the Ministry of Environment, Water and Climate, Health and Child Welfare, educationists including

academics, Agritex officers, officers from the CPU or EMA and the ZMSD, the NGOs, local authorities such as the District Administrator, the Chief, Ward counselor, kraal heads and the local community members as key stakeholders in climate variability and change matters in Chadereka Ward 1. These had been considered in similar research by Dilling and Berggren, (2015), Haque *et al*. (2016), Mafongoya *et al*. (2016), Prokopy *et al*. (2015) and Sango and Godwell (2015a), among others. The identified roles ranged from agricultural inputs provisionto human capacity development support, though with they own challenges. Among the key roles performed by the government, these included the formulation of policies which guides the execution of the livelihood adaptation strategies as well as the setting of relevant boards to look into the issues of adaptation to climate variability and change. The governance structure or framework of how to deal with climate change issues in Zimbabwe has been illustrated in the Zimbabwe's National Climate Change Response Strategy (Government of Zimbabwe, 2015). Household respondents during the focus group discussion expressed that community consultations with government on issues to deal with climate change in the area were lacking and usually the government implemented whatever policies and programs it developed without consideration and involvement of local communities. Thus, the persistent problems of water and poor infrastructure which affect the accessibility of the Ward among other unresolved challenges resulted in the household respondents perceiving the effort by the government as less effective together with other government organs like the ZMSD, the Agritex Department and the CPU or EMA.

The NGOs, given their multifaceted roles in the Ward, were rated as effective by the household respondents. They were found to assist the households in various ways such as distributing food and some agricultural inputs and mending damaged infrastructure. They also supported human capacity building where some households are trained on disaster risk reduction skills and other sustainable ways of living in such a disaster vulnerable environment. The training was generally considered to be empowering and the one by the Red Cross Society in Zimbabwe, in June 2016, culminated in the setting up of a Chadereka Early Warning Committee which helped the community in health and disaster management issues.

According to the household respondents, the Chief provided feedback from any meeting attended. In addition, the Chief acted as the representive for the households who were not fully in contact with the higher authorities. Other officials such as the Ward counselor and the kraal heads oversaw the maintenance of the environmental regulations as stipulated by EMA at village and household levels. Their roles were rated less effective as they compromised their performance by failing to curtail stream bank cultivation and deforestation in the area. In fact, household respondents admitted that the local leadership were generally the ones who had fields along rivers where flood recession was mainly practised.

The household respondents confirmed that as the local community level, they participate in whatever task was asked of them within their capacity, a situation commended by Few *et al*. (2006) and Muchanga (2012). They usually provided labor and gathered locally available material for mending flood destroyed infrastructure like classroom blocks and other buildings. During the survey they confirmed that they cooperated with NGOs and some government organs whenever there were programs for their Ward. However, they had forwarded suggestions to address the needs of their community in some cases but these take a considerable amount of time to be implemented or are still not addressed. The focus group discussants even pointed out that some bridges that were washed away during cyclone Elena of 2000 to 2001 season were still not mended.

The research further established the level of participation by household respondents in policy formulation processes linked to sustainable rural livelihood adaptation to climate variability and change. The majority greatly participated in the implementation of the resolutions passed elsewhere but only a few were involved in the planning or decision-making stage. It became clear that the locals do not effectively participate in decision-making, a situation which contradicts what was stressed by Belachew and Zuberi (2015).

Finally, the research considered human capacity building promotion. A sizeable number of household respondents acknowledged having received some form of training on awareness and life skills in Chadereka Ward 1. Among those who were trained, this was mainly on sustainable natural resource use and management, and on community disaster survival education, especially floods and droughts which were prevalent in the Ward. The providers for the training were mainly the NGOs and, on few occasions, the government organs and local leadership.

It can be noted that in any development endeavor such as dealing with climate variability and change, collaboration among stakeholders such as government, NGOs, the private sector and the local community should be promoted. The local community should be assisted in training the trainer programs on good management of their livelihoods at the local level so that more people can be capacitated and knowledge shared more extensively.

6.2.7 Reflections in relation to the conceptual framework used

The research which focused on the sustainability of rural livelihoods and their adaptation to climate variability and change was guided by a combination of the SRLF and the CHES. The combined framework directed a clearer understanding and exposure of the important factors or determinants which work towards the development of sustainable livelihoods in Chadereka Ward 1 as also noted by Liu *et al*. (2016). The livelihoods in rural areas are natural resource based, hence, it was critical for the study to follow a human-nature conceptualization framework. From the onset, it was clarified that the framework would serve as an analytical tool to examine the state at which the components of the framework were found within the area of study as proposed by Masud *et al*. (2016. Further, it also noted the human interference with nature in increasing vulnerability to climate variability and change. That is, some livelihood practices negatively affected the biophysical environment.

From the analytical tool point of view for the framework, the respondents made it clear that Chadereka Ward 1 was vulnerable to climate variability and change. In trying to understand the sustainability of their livelihoods in the vunerability context of the Ward, the human issues (objectives of the study) in relation to the livelihood capitals (natural, physical, financial, human and social) were analyzed and discussed. The outcomes revealed the status quo of the Ward regarding the sustainability of household livelihood practices, their well-being and resilience in the prevailing conditions. Further, this created an informative ground for policy-makers guiding them towards efficient provision and monitoring of legislation for sustainable development in rural areas.

Specifically, the study examined the livelihood practices in the Ward which emerged to be mainly farming which was rain-fed. All the livelihood assets were evaluated in Chadereka Ward 1 following the proposed framework. The aspects analyzed in each relation to asset were used as indicators to assess the level of sustainability depending on how they supported the well-being of the household and their resilience or adaptation level to climate variability and change. A similar process was done for all the objectives for the study and a list of indicators used is presented in Table 6.1.

Table 6.1: Summarized dimensions of sustainability and their corresponding livelihood capital and indicators for sustainability assessment in Chadereka Ward 1, Muzarabani Rural District, Zimbabwe

Dimension of sustainability	**Livelihood capital**	**Indicators assessed**
Biophysical (Environmntal)	Natural capital	Land characteristics, vegetation characteristics, water characteristics, wild animal characteristics, mineral characteristics and natural disasters characteristics.
Economic	Physical capital	Household shelter characteristics, household implements and state of infrastructure (roads and bridges).
	Financial capital	Financial sources available, crop and animal production values, livelihood portfolio values, labor values, adaptation strategies pursued and market chracteristics.
Social	Social capital	Scientific and IKS available, social amenities available, stakeholder roles and their effectiveness, and household perceptions on sustainability.
	Human capital	Labor and demographic chracteristics, including the levels of education and skills.
Governance	Institutional processes	Existence of legislation, livelihood management systems, institutional characteristics and governance structure for climate change in Zimbabwe.

The combined framework used in this research allowed the participation of households in the sustainability assessment process considering the dimensions of sustainability and the status of selected indicators in the Ward, similar to that proposed by Svubure *et al*. (2016). As pointed out by Sharma *et al*. (2014), changes in any of the household capitals would directly or indirectly affect the other capitals thereby affecting the sustainability status of the household. The framework facilitated the integration of the two frameworks (SRLF and CHES) making the analysis of the data more flexible, clear and comprehensive (Huai, 2016).

Through the use of this combined framework, the most functional systems for rural livelihood adaptation to climate variability and change were identified. For instance, the role played by the NGOs was found to be significant and plausible which is similar to Wright *et al*.'s (2016) findings. The framework is participatory and empowering since it mainly focuses on the households, especially their assets and roles in solving their emerging problems. Therefore, it fostered the development of planning, managerial and organizational skills among the households, which is critical in relation to the sustainable development agenda. Althoughollaboration among the stakeholders was noted, the participation by government organs was limited in the Ward and needed improvement.

The issue of governance, particularly the impact of the the economic and political situation in Zimbabwe had a greater bearing on the sustainability of livelihoods from the national to the local levels. The macro-economic trend characterized by inflation and political uncertainty in the country negatively impacted on the sustainability of the strategies under discussion. Allocation of both material and financial resources for livelihood development in marginal areas is affected by the lack of transparency, accountability and corrupt tendencies which are hindering socio-economic development in the country as a whole. Hence, the gap is left to be filled by humanitarian agencies such as the NGOs who set their parameters with limited flexibility. Marginal areas, like Chadereka Ward 1, find it difficult to implement the recommended adaptation strategies due to resource, infrastructural, institutional and service provision constraints. The biophysical, socio-economic and political dimensions are critical in relation to the sustainability of adaptation to climate variability and change, hence, the need to adequatelyconsider them in rural livelihoods analysis. The research suggests the use of geographical information systems in coming up with spatial differences within the Ward for a more informed position in dealing with livelihoods and adaptation strategies to climate variability and change. Institutional considerations also need improvement.

6.3 RECOMMENDATIONS

This section provides some recommendations, including policy implications, for consideration in local communities when dealing with issues of rural livelihood sustainability in the context of adaptation to climate variability and change. The presented suggestions are based on the outcomes of the research summarized in the preceding section. Principally, the aim is to expose more intervening measures or strategies which could be explored to reduce or eliminate the vulnerability of marginal communities like Chadereka Ward 1 to the negative impacts of climate change. The findings can be translated into lessons for wider scale learning on the challenges of rural adaptation strategies and possible solutions.

6.3.1 Enhancing rural livelihoods through sound and appropriate natural resource governance

While farming emerged as the main rural livelihood in Chadereka Ward 1 in Muzarabani Rural District, its governance and execution were reported to be affected by management issues with regards to the natural resources in the area. Land degradation is accentuating leading to deforestation and siltation of the two main rivers, Hoya and Nzoumvunda. Water scarcity has become a major issue. Given that, more water harvesting and management technologies need to be a top priority in the area.

Flood recession cultivation has been reportedly linked to the problem of stream bank cultivation in the Ward. Curtailing the problem is being made difficult by influential leadership and elderly households who were allocated fields which stretch into the river. Thus, it is recommended in this study that the government through its organs such as the EMA, CPU and the Agritex officers scale up their visits to and awareness meetings with the households in the Ward to discuss the consequences of such practices and their sustainable management. Various methods of disseminating information on the best practices and repercussions of malpractices in these times of climate variability and change should be enforced. These include the production of pamphlets, use of mass media, literature on livelihood execution and other devices accessible by the households taking advantage of globalization through the use of information and communication technologies (ICT). Some households are not even aware of the existence of legitimate laws governing the use of the natural resources and this should be reinforced during the meetings. Such meetings or awareness platforms improve relations with the community as pointed out by Wright (2016).

In dealing with water crisis in Chadereka Ward 1, besides ensuring that the community properly maintains and use the boreholes sunk by the NGOs and government, dam construction on the upper parts of the rivers should be considered by all the stakeholders, including the government, civil society organizations, the private sector, NGOs and the local people. Artificial water storage mechanisms like constructed water tanks and other water harvesting technologies are also recommended. Construction of contour ridges by individual households which hold back soils from water and wind erosion could be enforced by the Agritex officers in collaboration with the households. Households could preserve some crop stalks made up of plant residues to supplement feed for their livestock.

Given that some homesteads succumb to floods whenever they occur, building codes for such areas could be established and followed like the granary built on top of deeply inserted logs. A government directive should enforce the resettlement of households on high ground away from flood plains and adequate support should be provided to ensure that the relocation does not result in the households becoming more vulnerable. The reconstruction of roads and bridges should be considered in order to mend or raise them in areas where these are low and easily eroded by flowing water. The tarred road which ends at Muzarabani Growth Point could be extended to link to the border with Mozambique via Chadereka Ward 1. This could promote development in the area as marketing boards could be set up and services of various kinds provided. Material for the construction could be sourced from Mavhuradonha Mountain Range which is approximately 36 kilometers away. Such development projects could also incorporate the rural electrification program which has since benefited the majority of Zimbabwean rural communities elsewhere (Government of Zimbabwe, 2015). Electricity grid could be extended from Muzarabani Growth Point to the Ward. Large solar projects could be set in the area given the high solar insolation experienced in the area and could feed into the national grid as well. This would also promote livelihood diversification as the households can engage in other income generating projects which make use of electricity.

Human capital is noted to be in abundance but is of concern regarding the lack of relevant and specific skills despite the literacy levels being relatively high. As such, most of the households were found to be engaged in extractive livelihoods which include farming and gathering of wild berries. Capacity building in different fields involving value addition could be promoted. Similar to what has been done in other rural Districts, a vocational training center could be established at Chadereka Business Center which would focus on training school leavers, in line with improving livelihoods using the locally available resources. Instead of selling the natural fruit raw such as *Ziziphus mauritiana* and *adansonia digitata* berries, the inhabitants could process them into finished goods like jam, wine and natural soft drinks. This could create job opportunities for young men and women who are unemployed. Once people find more value from the local natural resources, their sustainability would be enhanced through protection, conservation and proper management. The wild fruit trees would increase and improve carbon sequestration, a mitigatory measure to greenhouse gases. Soil erosion would be minimized by increased vegetation cover. Income generated from the sale of produced natural products would see the households acquiring other physical assets reported to be currently inadequate.

On the issue of social networking which has been reported as being inadequate due to the remoteness and inaccessibility of the Ward, commitment to infrastructure development (including network connections) needs to be prioritized as highlighted in the preceding paragraphs. Most of the drawbacks are linked to the lack of communication infrastructure which should be prioritized. Some development committees like the Chadereka Early Warning Committee could be set up to spearhead these issues in collaboration with the local leadership and other partners like the civil society groups, the NGOs and the private sector.

While the sale of livestock and wild berries supported the financial capital in the area, these were generally seasonal and inadequate. Livelihood diversification could be encouraged as households engage in both farm and non-farm activities. Apiculture could be promoted due to the favorable climatic conditions. Petty trading with other areas, even cross border trading with Mozambique in form of labor provision and the sale of local products could be scaled up. Food security would then be improved.

6.3.2 Enhancing high awareness levels to climate variability and change in Chadereka Ward 1

Having noted the low level of scientific knowledge on climate variability and change issues in Chadereka Ward 1, the research recommends the diversification of information dissemination methods to ensure improved awareness which will enhance local capacity and promote better responses to climate variability and change. The scaling up and use of ICT in the form of cellphones, televisions, print media and other forms possible should complement the IKS prevalent in the area in conscientizing households on climate variability and change. School curriculum at primary, secondary and up to University level should infuse climate variability and change material in the quest to increase awareness. This is in agreement with Musarurwa (2012) who noted the need for integrating or mainstreaming climate change into the University curriculum, thus cementing university-community relations.

This issue is also linked to capacity building, Universities and other knowledgeable organizations should train the trainers on climatology and meteorological matters. The remoteness of the area should not be a barrier to climate change information dissemination. It is time the climate change dissemination material be produced in vernacular languages prevalent in the local areas in order to make it clear and successfully convey the message. The use of awareness campaigns cannot be overemphasized for this should be considered seriously and their frequency scaled up in the Ward. The government organs should show commitment to ensure that households are reached when disseminating climate variability and change information by increasing the frequency of their visits to the area.

6.3.3. Reducing the impacts of climate variability and change on biophysical and socio-economic conditions in Chadereka Ward 1

The research noted the impact of climate variability and change as moderate and severe on the biophysical environment and on the socio-economic environment, specifically they caused a decrease in both crop and animal varieties, according to the household respondents. The assessment informs that the impact is generally negative, a situation also revealed by Belachew and Zuberi (2015) in a separate study in Ethiopia. Thus, various ways of dealing with and reducing the impacts of the phenomena on the human–nature environment considered in this research are recommended.

Natural resource management policies logged with the EMA of Zimbabwe should be enforced to ensure that households sustainably use the land, vegetation and water which are said to be moderately and severely affected. The local community should also be involved and be engaged whenever decisions are made regarding their resources. With the assistance from the government organs, NGOs and interested civil society organizations; households in Chadereka Ward 1 could set up committees similar to the Chadereka Early Warning Committee which deals with natural disasters. These committees can monitor the usage of natural resources and advise the community on their state from time to time. Firewood extraction, which is the main cause of deforestation, could be reduced if solar and wind energy devices are made available and accessible to the community through development schemes in the area. Strictly dry wood should be used and cutting of trees should not be permitted. As for land and water conservation and management, measures were recommended earlier.

Climate variability and change was noted to be threatening food security in Chadereka Ward 1 through the assessment of production levels of selected commodities by this research. For instance, crop production was confirmed by household respondents to have decreased or greatly decreased since the past ten or more years. This has been compounded by water scarcity since the production is mainly rain-fed. In view of this, the research recommends the diversification of livelihoods into non-farm activities which include petty trade and sale of labor in needy areas, among other activities. Suitable varieties of small grains which are drought tolerant and not edible by quelea birds could be grown. Some crop fields could be left furrow for vegetation regeneration and turned into safari areas for wild life so that tourism can bepromoted in the area. The community can also acquire revenue through the sale of carbon credits which accrue through protecting the forests which sequestrate carbon and mitigate climate change. The area would be converted into a tourist resort once accessibility is improved.

Market gardening, for the production of vegetables, only flourishes during the rainy season since during the greater part of the year there is no or limited surface water. It is recommended that households preserve their vegetables including wild fruit by drying them up for later use during the eight months of no or limited rainfall as well as when prolonged drough is experienced. Crop and fruit preservation by drying for use off-season is thus recommended. They could also process the commodities for trade with other regions or urban areas and earn much needed cash income.

Cotton production should be revived and depots reopened at Muzarabani Growth Point. This was a commercial crop which flourished well in the Ward as it tolerates drought. The crop was referred to as ‘white gold’ (ZimVac, 2010). It fetched more money for households during the 1980s and 1990s and caused many people to migrate from Masvingo to Muzarabani where they further increased the population in the area through marriages. Instead of exporting lint, the government should support the acquisition of textile machinery and makes clothes of various types for exportation which can bring inforeign currency. Value addition should be considered seriously. Reinstating cotton into the local market would promote the livelihoods in Chadereka Ward 1 in particular and in Muzarabani Rural District in general.

Livestock production was reported favorable by households though the quantity remains low due to sales in meeting financial needs. However, due to increased aridity small livestock like goats, sheep, chickens and guinea fowls could be increased in place of cattle which can easily be affected by water and food shortages when drought intensifies which occurred in the Southeastern Lowveld of Zimbabwe as discussed by Chikodzi *et al*. (2013). Measures should also be put in place to improve the veterinary services in the area as numerous animal diseases are found resulting from the high temperatures experienced. The area is tsetse infested, hence cattle can be subject to infection by *trypanosomiasis*, an animal disease. However, no cattle deaths due to food shortages had been reported in the Ward yet. During extreme drought, households usually herd their cattle along the Hoya River to the confluence with the Musengezi

River where they get water. During the summer season households should make hay for their livestock. It is further recommended that a market place for cattle be set up and be regulated at Chadereka Business Center in order to avoid households being exploited by individual buyers from major cities.

To reduce the impacts of climate variability and change on the socio-economic environment, households confirmed adaptation mechanisms practised in the Ward. These, in addition to the growing of crops and keeping of animals which are drought tolerant, include conservation farming and changing of crop calendar and pattern, livelihood diversification (on and off-farm activities), flood recession cultivation, irrigation, agroforestry (carbon projects), climate insurance cover and others like mulching and food rationing. In addition to what has been raised and recommended in earlier sections, this research suggests that households need to pay particular attention to the changing onset of rainfall which affects the crop calendar and pattern. They should integrate their IKS and scientific reports on weather forecasts from the ZMSD as they execute their farming activities. Other strategies like irrigation, conservation farming and mulching require the availability of water which is scarce in the Ward. However, mechanisms to have water available should be intensified by all stakeholders. Water harvesting still remains key. Climate insurance cover still needs publicity and details of how it could be operationalized shared in the community. Agroforestry or maintaining forested areas is highly recommended for this is remunerated through the payment of carbon credits once an assessment is done and amount of carbon sequestrated deduced. All malpractices which increase siltation of rivers and reduce vegetation cover should be identified and dealt with vigorously to deter would be culprits. Coping strategies should also be promoted in the Ward since these may turn into adaptation strategies as already established.

6.3.4. Management of challenges encountered by the households in Chadereka Ward 1 in Muzarabani Rural District in adapting to climate variability and change

Household respondents in Chadereka Ward 1 confirmed natural disasters, lack of capital, lack of institutional support, lack of alternative sources of fuel, poor infrastructure, lack of market, lack of knowledge and labor shortage as challenges faced in adapting to climate variability and change. Some recommendations or measures to consider these challenges have already been presented in earlier sections. Here additional suggestions are offered.

For natural disasters which normally affect the Ward like floods and droughts, this research recommends that households adopt a proactive stance rather than be reactive given the lack of response capacity prevalent in most developing countries in general and marginal local areas in particular. Both structural and non-structural measures should be considered. Given that Chadereka Ward 1 is far from weather stations (Map 2.1), the government of Zimbabwe through its ZMSD organ could procure and install an automated weather station at Chadereka Business Center. This could be used to compliment the IKS in the area in forecasting weather and advising the households through the established Chadereka Early Warning System Committee. Infrastructural development in the Ward could be made climate proof through adopting building codes which raise structures from the ground in the case of flooding as indicated earlier. Water harvesting technologies already alluded to could be useful in cases of drought. Food preservation and storage mechanisms could be improved considering the kind of disasters which normally affect the area.

The household respondents also cited lack of financial capital as a hindrance to sustainable adaptation to climate variability and change. This research recommends households to come up with small income generating projects like micro-finance schemes '*mukando*' which would buffer their day-to-day livelihoods. They could also set up community marketing associations or groups which would help them market their commodities without being exploited. They could also venture into group livestock projects which could result in a reduction of marketing travel costs and the pooling of resources.

On the issue of lack of institutional support, this research recommends the government of Zimbabwe through its organs to increase development efforts in neglect rural communities in marginal areas like Chadereka Ward 1. Qualified and adequate personnel to help in educating and advising the community on best practices in relation to climate variability and change should be provided. Incentivizing those officers who would want to work in remote areas could be considered. Thus, extension workers should be increased and practical training enhanced. These should include the veterinary surgeon, Agritex officers, teachers and nurses since the area has only one clinic with one qualified nurse. Universities in the province, on the other hand, should be supported to develop research centers in the area to examine problems being faced by the community and providing solutions thereafter.

Attached to the preceding constraint, poor or inadequate infrastructure is also another setback. This refers to the weather (flood) damaged roads, bridges and public buildings like schools. The government together with interested organizations like the NGOs and civil society groups could assist with construction material not found locally (reinforcements, cement and expert labor) while the community would provide casual labor and locally available material. Generally, what is required is to use rubbles and gravel to raise the roads and ensure that the bridges are not undercut on the edges by flowing water due to poor drainage. Siting of other infrastructure like schools on high ground which is not inundated by floods should be considered. More footbridges should also be constructed in the area to ensure school programs are not disrupted as they are currently whenever there is flooding. The other challenges like lack of alternative sources of fuel, lack of market, lack of knowledge and labor shortage have been discussed in the previous sections. What is needed is commitment on the part of the Zimbabwean government and its organs to ensure resources are allocated during the national budget for the development of such marginal areas. Such areas are sources of raw materials for the development of industries and employment creation which has remained unresolved in the country as a whole.

Emanating from the research are also practical recommendations for the application of climate finance instruments available for Zimbabwe and other developing countries who are signatory countries within the UNFCCC. It is important to expand the financing for climate change, especially in vulnerable communities such as Chadereka Ward 1. It is imperative to ensure that there are clear roles and responsibilities among government departments and institutions to address climate change challenges. Furthermore, it is important to monitor the impact and budgets of current financial instruments in Zimbabwe and the extent to which they address the concerns of poor communities. This may require current climate financial management systems to be reviewed and revised as suggested by Tirpak *et al*. (2014) as well as sourcing new funding streams, especially from the private sector to support initiatives at the local level.

6.3.5. Enhancing stakeholder participation in sustainable rural livelihood adaptation to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District

Given that the issues of climate variability and change have taken the center stage the world over, the participation by everyone in reducing or eliminating the negative impacts is considered positive in this crisis. Thus, in Chadereka Ward 1, the government through its various organs, the NGOs, local authorities such as the MRDA, the Chief, Ward counselor, kraal heads and the local community members were identified as the key stakeholders on any issues pertaining to the Ward including climate variability and change. The government through its organs is yet to come up with climate variability and change policy. This has been long overdue and the present research recommends prompt action to be taken. Human capacity building to facilitate this policy formulation process could be promoted to keep abreast with events pertaining to the issue from the local to the international levels.

The general household rated ineffectiveness of government participation stemmed from its prolonged and delayed implementation of expected services by the local community. This is exemplified by the unrepaired infrastructure (for example, bridges and roads) damaged by cyclone Elena in 2000. The present research therefore recommends that the government should safeguard its reputation by seriously and promptly considering the welfare of the vulnerable communities like that of Chadereka Ward 1. In fact, priority should be given to the most vulnerable groups of people who are socially and economically incapacitated by climatic events. The government could also spearhead community empowerment through capacity building of the locals in self-help value addition projects. This would reduce their over-reliance on donations and foster creativity and innovation.

In trying to strengthen adaptation endeavors among the local community, the government should continue lobbying for the relaxation of the conditions for the global climate change funds so as to qualify as a country to access and also meaningfully benefit from the development and implementation of adaptation strategies like other developing countries. Once the money is made available, the government should ensure that these funds are directed to projects which benefit the affected communities.

On the part of educationists and academics this research recommends the generation of up to date data on climate change issues in order to promote meaningful debates at international fora. Researchers have lamented the ill funding of research related to climate variability and change in marginalized communities (Donner *et al*., 2016; Shisanya and Mafongoya, 2016). Thus, the present research stresses that in the interest of the generation of better data sets on climate variability and change, the government including the private sector and the NGOs should come up with mechanisms of funding research. On this issue, strengthening collaboration among the government, NGOs, the private sector, the local community and academics could reinforce sustainable adaptation to climate variability and change. Thus, climate change governance in

Zimbabwe should consider meaningfully and equally all the stakeholders starting from the grassroots level.

6.3.6 Recommendations for further study

This study was an assessment of the sustainability of rural livelihoods and adaptation to climate variability and change in Chadereka Ward 1 in Muzarabani Rural District in Zimbabwe. From the outcomes of the research there is the need to further conduct similar studies in marginal areas so as to generate more data essential for national planning. The issues of climate variability and change are all inclusive hence the provision of its knowledge to everyone is paramount. There is need to generate more statistical data through research on these issues to assist in the proportional allocation of resources for adaptation to and mitigation of the phenomena.

With more research into this field, policy formulation needs to be treated with urgency to guide the socio-economic operations within the country. In a way, lobbying for external assistance in adaptation mechanisms requires facts and figures which in most cases the country is found wanting. Thus, the impacts of climate change in all the sectors of the economy need to be statistically authenticated and exposed, together with the responses at sectoral level through research. Not much has been done in support of climate change research in the country and this can only be realized through publications of how this phenomenon is impacting on the livelihoods of people in different contexts. Actions by the country towards the achievement of the sustainable development goal number thirteen lie in proper presentation of research facts and ideas. Climate change governance needs transparency, accountability, innovatoon and collaboration by all stakeholders disregarding the issues of gender, ethnicity, political affiliation and other social strata which can only be achieved through rigorous and scientific research.

6.4 CONCLUSION

This research assessed rural livelihoods in terms of their sustainability and adaptation to climate variability and change in Chadereka Ward 1. In the process, it identified the main rural livelihoods, established households' levels of awareness to the issues of climate variability and change as well as their impacts on the biophysical and socio-economic environments in the

Ward. The study was also significant in examining the livelihood adaptation strategies to climate variability and change as well as establishing the challenges faced by households in adapting to the phenomena. Furthermore, it performed a household evaluation of stakeholder participation in the promotion of sustainable rural livelihoods and adaptation to climate variability and change. Such data is critical in the formulation process of a climate change policy which is still pending in Zimbabwe.

In Chadereka Ward 1 the research discussed rural livelihoods which included farming, wild fruit gathering, service provision, mining and hunting, among others. This was significant in that all the identified traditional livelihoods need support and transformation since their sustainability is being threatened by climate variability and change. Hence, other livelihood portfolios not popular in the Ward such as remittances from emigrant relatives, honey extraction, brick moulding, grass and firewood sales, and craft work need more consideration. Of the common livelihoods, value addition through processing the products which is the thrust for the current ZimAsset should be promoted and pursued.

These rural livelihoods show the levels of interaction involving the natural system (climate variability and change), human system (household issues explored), household assets (capitals) and the livelihood outcomes which influence sustainability, resilience and well-being status discussed in the research. The present research revealed the status of the capitals which support the rural livelihoods in the area and regulations governing their execution. The research suggests the implementation of a variety of initiatives such as livelihood diversification and human capacity building in order to reduce or eliminate the shortcomings of the capitals. Thus, the policy-makers are advised to consider the proposals so as to reduce the negative impacts of climate variability and change.

The outcomes of the research further demonstrated the multidisciplinary nature of climate variability and change issues as postulated by Adu-Boateng (2015), Arfanuzzaman *et al*. (2016) and Liu *et al*. (2016). Using the MLRM, the research also revealed that age, education, household size and marital status were statistically significant at the 95% confidence level in influencing households' choices of some rural livelihood strategies in Chadereka Ward 1. Notwithstanding this computation result, the research significantly notes that a combination of socio-economic, political and environmental factors is critical to understand climate variability and change in marginalized rural communities in Zimbabwe that are already adversely impacted by floods and droughts. As such, some deficiencies noted in all the five capitals or assets which compromised the sustainability of the household livelihoods require a multifaceted approach. These should be dealt with collectively to improve the quality of lives and livelihoods in Chadereka Ward 1.

This research significantly calls for the effective implementation of environmental policies governing the use of resources in the area. Structural and non-structural responses to the impacts of climate variability and change were recommended in this research as adaptive strategies. These range from building codes, timeous restoration of damaged infrastructure with the participation of the community concerned to climatic knowledge dissemination. Effective organizational structures could be setup within the Ward to inform and direct appropriate actions and policies in response to the impacts of the natural phenomena. Without this it becomes difficult to implement sustainable adaptation strategies to climate variability and change. Some livelihoods were noted as sources of controversy in the Ward such as flood recession cultivation. The regularization and effective monitoring of these practices is noted as being critical and should be prioritized in the Ward.

The research further noted that the issues of climate variability and change is of universal concern. Hence, their amelioration requires complex approaches. In this vein, the households in Chadereka Ward 1 are encouraged to execute strategies which befit their general climatic conditions taking cognizance of their IKS. Thus, this research is significant in that it encourages the marrying of scientific and societal knowledge in dealing with emerging issues like climate variability and change.

The research in a way serves to contribute to addressing the knoweldge gap in relation to inadequate data and information regarding climate variability and change among households in marginal and vulnerable areas like Chadereka Ward 1 as revealed by Government of Zimbabwe (2013). It also challenges and exposes the need for different institutions to financially support research into this area and build capacity to deal with the climate variability and change problem.

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Appendix A

HUMAN SUBJECTS RESEARCH CONSENT LETTER

University of KwaZulu-Natal
Letter of Informed Consent

Date: 15 July 2014

I, Mr Albert Manyani (Reg. No. 213573232) am a PhD Geography student registered at the University of KwaZulu-Natal. I am conducting research on Rural Livelihoods and Adaptation to Climate variability and change in Muzarabani Rural District, Zimbabwe. The information collected will be used solely for the purposes of completing my thesis and future papers, journal articles and books that will be written by the researcher.

Since the validity of the results of the study depends on a high response rate, your participation is crucial to the success of this study. The questionnaire interview will take approximately one hour. Your cooperation will contribute to the growing body of knowledge aimed at assessing the rural livelihoods in terms of their sustainability in the face of climate variability and change in Muzarabani Rural District with a thrust to explore the best practices.
Please be assured that your responses will be held strictly confidential and no identity will be used in the results of the study. Your anonymity and confidentiality will be preserved at all times. Your personal details are not required for this study and in under no circumstances will your personal details be disclosed or referenced. Furthermore, your participation is entirely voluntary and you may withdraw your permission without any negative consequences to participate in this study without explanation at any time. I will also provide feedback on the results of the study to the community leaders.

I thank you for your time in completing this questionnaire. Do not hesitate to contact me or my supervisor if you have any questions or concerns about the questionnaire or any aspect of this study. My contact details are +263773099436 (cell) or albertoshezhu@gmail.com (email). My supervisor is Professor Urmilla Bob and her contact details are 027731330147 (cell) or bobu@ukzn.ac.za (email). Additionally, the contact details of the Human and Social Sciences Ethics Committee at the University of KwaZulu-Natal is Ms P Ximba at 027312603587 (telephone) or ximbap@ukzn.ac.za.

Yours sincerely,

____

Albert Manyani

Declaration Section

I have understood the information about the project and I agree to participate in the study	
Signature:	**Date:**

TSAMBA YEMVUMO PATSVAGURUDZO

University of KwaZulu-Natal
Tsamba yemvumo patsvagurudzo
Date: 15 July 2014

Ini, Albert Manyani (Reg. No. 213573232) ndiri kuita chidzidzo chePhD Geography ne Yunivesiti ye KwaZulu-Natal. Parizvino ndiri kuita tsvagurudzo pamusoro pe **ZVINORARAMISA VANHU UYE ZVAVANGAITA KUTI VARARAME MUDUNHU REMUZARABANI MUZIMBABWE PANGUVA INO YEKUSHANDUKASHANDU KWEMAMIRIRO EKUNZE (Rural Livelihoods and Adaptation to Climate variability and change in Muzarabani District).** Zvamuchanditaurira zvichashandiswa pazvinyorwa zve chidzidzo chandirikuita ichi bedzi.

Minduro dzenyu pamibvunzo chamucha pindura kanamuchitenda kundibatsira inokosha zvikuru kuti ndigova ndichabudirira pachidzidzo ichi. Saka ivaimakasununguka zvenyu uye muchireva chokwadi chenyu pazviri. Zvichatora nguva ingasvike awa rimwechete kupindura mibvunzo yese. Mhinduro yenyu ichabatsira kuunganidzwa kwezivo pamusoro pemararamiro arikuita vorunjizhi panguvaino yekushanduka shanduka kwekunzem uye zvingakuridzirwa kuti zvitwe zvichichengetedza zviwanikwa zvenharaunda yeMuzarabani kuitira nhaka yeramangwana redu.

Ndinokuvimbisai kuti zvamuchapindura hazvina pamwe pazvichashandiswa kunze kwechidzidzo ichi chete. Hapanazve pandichanyora zitarenyu muzvinyorwa izvi. Kutenda kwenyu kundibatsira chido chenyu chisina kugombedzerwa. Makasununguka kurega kupindura mibvunzo iyi pamunodira. Ndicha uyisa zvandinenge ndawana mutsvagurudzo iyi kuvatungamiriri venzvimbo ino.

Ndinokutendai nenguva yenyu yamuchatora muchipindura mibvunzo iyi. Kana paine zvamungade kunzwisisa pachidzidzo ichi ivaimakasununguka kundibvunza pafoni inoti +263773099436 (cell) kana paemail inoti albertoshezhu@gmail.com. Uyewo sunungukai kubvunza muongorori wechidzidzo changu ichi anova Professor Urmilla Bob anowanika pafoni inoti 0027731330147 (cell) kana paemail inoti bobu@ukzn.ac.za. Mungava nemubvunzo here parizvino? Kana mukazovanayo munguva yekupamhinduro yenyu, sunungukai kundibvunza. Pamusoro pazvo vanotungamirira bvumo yetsvagurudzo iyi pa Univesiti ye KwaZulu Natal ndiva Ms P Ximba vachiwanika pa foni inoti 027312603587 kana pa ximbap@ukzn.ac.za.

Wenyu anovimbika,

____

Albert Manyani

Tenderano

Ndanzwisisa zvirimaererano netsvagurudzo iyi uye ndinobvuma kuita namuzvina tsvagurudzo.	
Kunyo:	**Zuva:**

Appendix B

Enumerator's Name ______ **Questionnaire number:** ______

Questionnaire-Interview Survey for Households in Chadereka Ward 1 in Muzarabani Rural District in Zimbabwe

(Tick in the box your correct answer and/or provide written responses where applicable)

A. Demographic Data

1. Gender of respondent.

1. Male		2. Female	

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2. Age of the respondent.

1. <20 yrs		2. 21-30 yrs		3. 31-40 yrs	
4. 41-50 yrs		5. 51-60 yrs		6. >61 yrs (specify)	

3. Indicate you marital status.

1 Single		2.Married		3. Separated	
4. Divorced		5. Widowed		6.Other (Specify)	

4. Indicate the size of your household. ☐

5. What is your level of education in the following?

1.None		2. Primary (Grade 1-7)		3. Secondary (Form 1-6)		4.Tertiary (college/university)	

6. Indicate your religion

1.Christianity		2.Muslim		3.Traditional		4.None		5.Other (specify)	

7. What is your original or birth place?

1.Muzarabani Rural District		2.Other (Specify)	

8. Indicate the number of years you have stayed in this ward. ☐

9. Which language(s) do you speak?

1. English		2.Shona		3. Ndebele		4. Other(Specify	

10. If not the head of house, indicate your relationship to the household head or go to question 12.

1.Spouse		2. Child		3. Sibling		4. Other (Specify)	

B. Livelihoods (activities for a living) and Assets

11. Of the following, what do you do for your living? Number them in order of importance in your household.

1.Farming		2. Wild fruit gathering		3. Mining	
4.Fishing/hunting		5. Vending/Providing Services		6. Other(specify)	

12. **How do you rate your participation time in these livelihoods/activities for your living?**

Activity	**Time Taken on the Activity**			
	1. Permanent	**2. Seasonal**	**3. Temporary**	**4. Not Involved**
1. Farming				
2. Wild fruit gathering				
3. Mining				
4. Fishing/hunting				
5. Vending/Providing Services				
6. Other (specify)				

13. **If your answer to question 12 includes farming, which crops do you grow? Quantify in terms of 50Kg bags or buckets.**

1.Maize		2. Pearl Millet		3. Sorghum Bicolor	
4. Cotton		5. Vegetables of all kinds		6. Sugar beans	
7. Cowpeas		8. Finger Millet		9. Other (specify)	

14. **If your answer to question 12 includes farming, which livestock do you keep in your household? Give quantity.**

1. Cattle		2. Goats		3. Sheep	
4. Chicken/Guinea fowls		5. Pigs		6. Other (Specify)	

15. **What is the size of the farm where you do the farming activities?**

1. <1ha		3. 1-5ha		5. 6-10ha	
2. 11-15ha		4. 16-20ha		6. >20ha (Specify)	

16. **Who is the owner of the land where you practice your farming activities?**

1. Community		3. State		5. Cooperative	
2. Self		4. Private		6. Other (specify)	

17. **How did you acquire the land?**

1. Inherited		2. Given by Chief		3.Land reform		4.Borrowed		5. Other (Specify)	

19. **How much do you benefit in monetary value from your household livelihoods per month?**

Livelihood	**Amount in US$**					
	1.Nil	**2. <50**	**3. 51-100**	**4.101-150**	**5. 151-200**	**6. >200**
1.Farming						
4. Fishing/hunting						
2. Wild fruit gathering						
5.Vending/Service Provision						
3. Mining						
6. Other (specify)						

20. **How much do you receive, in monetary value, from individual(s) outside the household per month? (Remittances)**

1. Nil		2. <25		3. 25-50		4. 50-75		5. >75 (Specify)	

21. **What donations or grants, in monetary value, from government, NGO and/or other institutions do you receive in your household per month?**

	1.HIV/ AIDS	2.Retirement/Old age package	3.Drought/ flood Relief/ Food Aid	4.Agricultural inputs	5.Water System	**Total Amount**
Government						
NGO						
Other institutions						

22. How do you rate the quantity of your crop harvests since the past 10 or more years in your household?)

Crop	**1. Greatly Increased**	**2. Increased**	**3. Neutral**	**4. Greatly Decreased**	**5. Decreased**
1. Maize					
2. Pearl Millet					
3. Sorghum Bicolor					
4. Cotton					
5. Vegetables of all kinds					
6. Sugar beans					
7. Cowpeas					
8. Finger Millet					
9. Other (Specified)					

23. What can be the reasons for your answers in question 22?

………
………

24. How do you rate the quantity of the livestock you keep since the past 10 or more years in your household?

Livestock	**1. Greatly Increased**	**2. Increased**	**3.Neutral**	**4. Greatly Decreased**	**5. Decreased**
1. Cattle					
2.Goats					
3. Sheep					
4. Chicken/guinea fowls					
5. Pigs					
6.Other (Specified)					

25. What can be the reasons for your answers in question 24?

………
………

26. How often do you sell your livestock?

Livestock	**1. Every week**	**2. Every month**	**3. Seasonally**	**4. Yearly**	**5. Do not sell**
1. Cattle					
2. Goats					
3. Sheep					
4. Chicken/guinea fowls					
5. Pigs					
6. Other (Specified)					

27. Who provide(s) labor in most of your activities?

1. Household members		2. Hired labor		3. Community Cooperative		4. Other (Specify)	

28. How did you acquire the main house in which you are living?

1. Own built		2. Renting		3. Donation		4. Other (specify)	

29. Does the household own or often use any other building/structure besides this one?

1. Yes		2. No	

30. If yes, what is its use? If no move to question 32.

1. Store room		2. Field shelter		3. Flood shelter		4. Other (specify)	

31. Where is it located?

1. In the field		2. At service center		3. Another ward		4.In town	

32. What material has been used to construct the house(s)?

…………………………………………………………………………………………………

33. What physical assets do you own as a household? Number them in the order of importance to your livelihoods.

1. Plough		2. Scotchcart		3. Hand tools (Hoes, axes, etc)		4. Energy Generators (eg Solar)		5. Radio	
6. Bicycle		7. Wheel barrow		8. Irrigation Equipment		9. Television		10. Others (specify)	

34. Which natural resources are available for your livelihoods in your local area? Number them in the order of availability to your household.

1. Land		2. Vegetation (trees and grass)		3. Water	
4. Minerals		5. Wild animals		6. Other (specify)	

35. How often do you use the natural resources?

Natural Resources	**Time of use**				
	1. Everyday	**2. Once per week**	**3. Once per Month**	**4. Once per year**	**5. Not at all**
1. Land					
2. Minerals					
3. Vegetation (trees and grass)					
4. Wild animals					
5. Water					
6. Other (specify)					

36. Indicate the livelihoods/activities supported by the following tabulated natural resources as found in your ward.

Natural Resources	**Livelihood(s)/Activities**					
	1. Farming	**2. Crafting**	**3. Domestic use**	**4. Energy (fuel)**	**5. Material for Building**	**6. Other (specify)**
1. Land						
2. Minerals						
3.Vegetation (trees and grass)						
4. Wild animals						
5. Water						
6. Other (specify)						

37. Which climatic variables have affected your household livelihoods in the past 10 or more years? Indicate them in the order of severity.

1. Drought		2. Floods		3. Hailstorm		4. Other (Specify)	

38. How do you rate the impact of climate variability and change from the past 10 or more years on the natural resources mentioned in 34?

Natural Resource	**1. No impact**	**2. Minor Impact**	**3. Moderate Impact**	**4. Severe Impact**	**5. Neutral**
1. Land					
2. Vegetation					
3. Water					
4. Minerals					
5. Wild animals					
6. Other (specified)					

39. Which financial assets do you own?

1. Saving Account		**2. Pension Account**		**3. Cash at home**		**4. Other (specify)**	

40. Describe your calendar of activities throughout the year.

……
…………………………………………………………………………………………….…………

41. How have you managed the following natural resources in the current scenario of climate variability and change at household level?

Natural Resources	**Management strategy in the face of climate variability and change**
1. Land	
2. Minerals	
3. Vegetation (trees and grass)	
4. Wild animals	
5. Water	
6. Other (specify)	

C. Awareness of climate issues at household level.

42. Do you receive any climatic data in your local area?

1. Yes		2. No	

If 'yes' to question 42, proceed to question 43 and 44 and if 'no' leave out questions 43 and 44.

43. Who provides you with the data?

……………………………………………………………………………………………………….

44. What kind of data are you given?

……………………………………………………………………………………………………….
……………………………………………………………………………………………………….

45. What have you heard (if anything) about climate variability and change?

……………………………………………………………………………………………………….
……………………………………………………………………………………………………….

46. Please indicate your observations on the climatic conditions in your local area since the past 10 or more years.

1. Slightly changed		2. Changed		3. Greatly changed		4. Not changed		5. Neutral	

47. What changes on climatic conditions (if any) have you observed?

Climatic Condition	**Observed Change**				
	1. Greatly Increased	**2. Increased**	**3. No Change**	**4. Greatly Decreased**	**5. Decreased**
1. Temperature (^{0}C)					
2. Rainfall (mm)					

48. What are the changes (if any) in relation to your livelihoods regarding the observed climatic conditions?

……
……

49. What are the changes (if any) to the following natural resources regarding the observed climatic conditions?

Natural Resources	**Changes observed due to climatic conditions**
1. Land	
2. Minerals	
3. Vegetation (trees and grass)	
4. Wild animals	
5. Water	
6. Other (specify)	

50. **Have there been any climate change awareness campaign(s) in your local area?**

1. Yes		2. No	

51. **Who provided the campaign(s) if your answer to question 33 is yes?**
……………………………………………………………………………………………………..

52. **Are policy or regulation systems (laws) in relation to the following operating in your local area to promote sustainable adaptation to drought regarding?**

	Yes	**No**
Water management		
Vegetation management		
Crop production		
Livestock management		

53. **Are policy or regulation systems (laws) in relation to the following operating in your local area to promote sustainable adaptation to flood regarding**

	Yes	**No**
Water management		
Vegetation management		
Crop production		
Livestock management		

54. **What is your level of participation in the policy or regulation systems (laws) on the promotion of sustainable rural livelihoods adaptation to climate variability and change?**

1. No participation		2. Less participation		3. Greatly participate		4. Neutral	

55. **In what ways if any are you involved in the policy or regulation systems (laws) on the promotion of sustainable rural livelihoods adaptation to climate variability and change in your local area?**

1.Provision of ideas in planning		2.Implementation of the policy		3.Not involved	

56. **What is your assessment of the following policy or regulatory systems (laws) governing the sustainability of rural livelihoods adaptation to climate variability and change in Muzarabani?**

Policy Maker	**Assessment Criteria**			
	1. Not effective	**2. Effective**	**3. Very effective**	**4. Neutral**
Government				
Traditional				

C. Adaptation issues

57. **Which of the following adaptation strategies to climate variability and change do you practice at household level in their order of importance? Number them from 1 to 9.**

1.Agroforestry (carbon projects)		2. Conservation farming		3.Irrigation	
4. Use of drought tolerant crop and animal varieties		5. Livelihood diversification (on-farm and off-farm)		6. Climate risk insurance cover	
7. Flood recession cultivation		7. Changing cropping calendar and pattern		9. Other (specify)	

58. **What are your coping or survival strategies in times of the following major climatic variance in your local area?**

CLIMATIC VARIANT	**SURVIVAL STRATEGY**				
	1. Remittances from abroad	**2. Growing drought/ flood tolerant crops**	**3. Grant/ loans/ donations**	**4. Consumed less food**	**5. Sold assets**
1. Drought					
2. Floods					

59. **For how long have you practiced adaptive strategies in question 51 at your household level?**

1.<1yr		2. 2-5yrs		3. 6-10yrs		4. 11-15yrs		5. 16-20yrs		6. >21yrs	

60. **What challenges are you facing in practicing the adaptation strategies to climate variability and change listed in the following table?**

Adaptation strategy	**Challenges Faced**							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
1. Agroforestry (carbon projects)								
2. Use of drought tolerant crop and animal varieties								
3. Flood recession cultivation								
4. Conservation farming								
5. Livelihood diversification (on-farm and off-farm)								
6. Changing cropping calendar and pattern								
7. Irrigation								
8. Climate risk insurance cover								
9. Other (specify)								

Key: A - Labor shortage; B - Lack of knowledge; C - Lack of capital; D - Lack of institutional support; E - Lack of alternative source of energy, F - Lack of market; G - Transport problems, H - Natural disasters

61. **Comment on the sustainability of your adaptive strategies to climate variability and change at household level in your Ward.**
………
………
………

D. Stakeholder Participation

62. **What is the role played by the following stakeholders in promoting sustainable rural livelihood adaptation to climate variability and change in your area?**

Stakeholder	**Role(s) in promoting sustainable rural livelihood adaptation**
1.Government (Agritex Officer/s, Education staff, Health staff)	
2. Non-Governmental Organizations (provide name(s))	
3. Chiefs	
4. Kraal heads	
5. Meteorological Service Department	
6. Civil Protection Unit	
7. Ward Councilor(s)	
8. Other (Specify)	

63. **What training (if any) have you received to enhance your livelihoods or survival strategies?**
………
………
………

64. **Who provided the training?**
……..

Once more, **Thank you** **Siyabonga** **Ndatenda**

Appendix C

Guide for Focus Group Discussions

Introduction

Good morning / afternoon. I am ……………………. a PhD student at the University of KwaZulu-Natal in Durban, South Africa. I am carrying out a research study on Rural Livelihoods and Adaptation to Climate variability and change in Muzarabani District specifically in Chadereka Ward 1. As part of my studies I am required to gather data from various stakeholders about the rural livelihood practices in the area. The research also intends to help the community, the various stakeholders and policy-makers with information on best practices in this time of climatic variability and change. You are kindly asked to freely participate in this study. The information you provide is strictly confidential and your personal details will remain anonymous and protected. You are free to withdraw your participation from this interview at any time when you so wish. May I ask you some few discursive questions?

1. **Ward name and number ……………………………………………………………………..**

2. **What are your current livelihood practices (activities for a living) in Muzarabani District especially in your Chadereka Ward 1?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   …………………………………………………………………………………….

3. **On agriculture, which crops do you grow and which animals do you rear in the area?**

<u>Crops Grown</u>	**<u>Livestock kept</u>**
…………………………………….	**………………………………………**
……………………………………….	**………………………………………**
……………………………………	**………………………………………**
……………………………………	**………………………………………**

4. **Which natural resources are dominant in the area from which you get your living?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

5. **What laws or management strategies are operational in the area governing the use of the natural resources?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………..………………
   ……………………………………………………………………………………………………….

6. **What have you heard or do you know about climate variability and change? From who/where?**
   …………………………………………………………………………………………………..……
   …………………………………………………………………………………………..…………
   …………………………………………………………………………………………….

7. **How have these affected the natural resources and the livelihoods you practice in your Chadereka Ward 1 in Muzarabani?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

8. **What do you understand by or know about climate variability and change? …… …… ……**

9. **What similarities and differences (if any) exist between the livelihoods you practiced in the past 20 or more years and those you are doing now in Chadereka Ward 1? …… …… …… ……**

10. **What do you suggest are the reasons for the similarities and /or differences? …… …… ……**

11. **How do you survive during drought and/or floods in your area?**

Survival strategies during Drought	**Survival strategies during floods**
……………………………………….	**……………………………………………**
………………………………………	**…………………………………………….**
………………………………………	**…………………………………………….**
………………………………………	**……………………………………………**

12. **Which cooperatives or associations are operational in your Chadereka Ward 1? …… …… ……**

13. **Which ones are doing well, if any? ……………………………………………………………………………………………**

14. **What are the adaptation strategies to reduce the impacts of climate variability and change on your livelihoods practices.? ……………………………………………………………………… …… …… …… ……**

15. **What is your assessment on the sustainability of the adaptation strategies you mentioned in question 14? …… …… ……**

16. **What challenges (if any) are you facing in adapting to climate variability and change? …… …… ……**

17. **What roles are played by the various stakeholders in your area in promoting sustainable rural livelihood adaptation to climate variability and change?**

Stakeholder	Role(s) in promoting sustainable rural livelihood adaptation
1. Government (District Administrator)	
2. Non-Governmental organization (provide name(s))	
3. Chief	
4. Kraal head	
5. Meteorological Service Department	
6. Agritex Officer(s)	
7. Ward Councilor(s)	
8. Civil Protection Unit	
9. Other (Specify)	

18. **What is your assessment on each stake holder? Are the roles effective of not effective? Eate.**
……
……
……
……

19. **Is/ was there any training of some sort given to you regarding sustainable livelihoods practices in this time of climate variability and change? Who provided it?**
……
……
……

20. **What else do you want noted regarding this research on rural livelihoods practices and adaptation to climate variability and change?**
……
……
……

Once more, Thank you Siyabonga Ndatenda

Appendix D

An Interview Guide for the Chief/ Ward Councilor(s)/ Agritex Officer(s)/ Kraal head/ Meteorological Service Department Official/ District Authority/ Non-Governmental Organization Official, Civil Protection Unit Official

Dear Participant

Good morning / afternoon. I am …………………….. a PhD student at the University of KwaZulu-Natal in Durban, South Africa. I am carrying out a research study on Rural Livelihoods and Adaptation to Climate variability and change in Muzarabani District specifically in Chadereka Ward 1. As part of my studies I am required to gather data from various stakeholders about the rural livelihood practices in the area. The research also intends to help the community, the various stakeholders and policy-makers with information on best practices in this time of climatic variability and change. You are kindly asked to freely participate in this study. The information you provide is strictly confidential and your personal details will remain anonymous and protected. You are free to withdraw your participation from this interview at any time when you so wish. May I ask you some few questions?

1. **For how long have you been involved in the socio-economic affairs in Muzarabani District? ....**

2. **What are the current livelihood practices done by the people in Muzarabani District especially in Chadereka Ward 1?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

3. **On agriculture, which crops are grown and which animals are reared in the area?**

<u>Crops Grown</u>	**<u>Livestock kept</u>**
…………………………………	…………………………………
…………………………………	…………………………………
…………………………………	…………………………………
…………………………………	…………………………………

4. **Which natural resources are dominant in the area from which the inhabitants get their living?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

5. **What laws or management strategies are operational in the area governing the use of the natural resources?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

6. **What have you heard or do you know about climate variability and change? From who/where?**
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………
   ……………………………………………………………………………………………………

7. **How have these affected the natural resources and the livelihoods practices by the inhabitants in Chadereka Ward 1 in Muzarabani?**
……
……
……

8. **According to your observations or perception, do the inhabitants in the area know about climate variability and change? Why do you think so?**
……
……
……

9. **What similarities and differences (if any) exist between the livelihoods practices in the past 20 or more years and those being done now by the people in Chadereka Ward 1?**
……
……
……
……

10. **What do you suggest are the reasons for the similarities and /or differences?**
……
……
……

11. **How do people in the area under study survive during drought and/or floods?**

Survival strategies during Drought	**Survival strategies during floods**
………………………………………..	**……………………………………………**
…………………………………………	**…………………………………………….**
…………………………………………	**…………………………………………….**
…………………………………………	**……………………………………………**

12. **Which cooperatives or associations are operational for the inhabitants in Chadereka Ward 1?**
……
……
……

13. **What are the adaptation strategies to reduce the impacts of climate variability and change on the livelihoods practices of the people of the areas in question?**
……
……
……
……

14. **What is your assessment on the sustainability of the adaptation strategies you mentioned in question 11?**
……
……
……

15. **What challenges (if any) are faced by the inhabitants in Muzarabani District (Chadereka Ward 1) in adapting to climate variability and change?**
……
……
……

16. **What roles are played by the various stakeholders in the area in promoting sustainable rural livelihood adaptation to climate variability and change?**

Stakeholder	Role(s) in promoting sustainable rural livelihood adaptation
1. Government (District Administrator)	
2. Non-Governmental organiszation (provide name(s))	
3. Chief	
4. Kraal head	
5. Meteorological Service Department	
6. Agritex Officer(s)	
7. Ward Councilor(s)	
8. Other (Specify)	

17. **What is your assessment on each stake holder? Are the roles effective of not effective? Eate.**
………
………
………
………
………
………
………

18. **Is/ was there any training of some sort given to the inhabitants of the area regarding sustainable livelihoods practices in this time of climate variability and change? Who provided it?**
………
………
………

19. **What else do you want noted regarding this research on rural livelihoods practices and adaptation to climate variability and change?**
………
………
………

Once more, Thank you Siyabonga Ndatenda

Appendix E

Observation Guide/ Guide for photography visioning

Introduction

Good morning / afternoon. I am …………………….. a PhD student at the University of KwaZulu-Natal in Durban, South Africa. I am carrying out a research study on Rural Livelihoods and Adaptation to Climate variability and change in Muzarabani District specifically in Chadereka Ward 1. As part of my studies, I am required to gather data about various rural livelihoods practices in the area. The research once completed also intends to help the community, the various stakeholders and policy-makers with vital information on best practices in this time of climatic variability and change. You are kindly asked to freely participate in this study. May I take some photographs of the activities you are doing if you would not mind. The information you provide shall serve as illustrations in the document. Your personal particulars will remain anonymous and protected. You are free to decide before I proceed with photographing. Thank you.

The Researcher notes down the following observations in the field and where granted permission takes illustrative photographs.

1. Current livelihoods practices in Chadereka Ward 1 in different seasons of the year.
2. On agriculture, types of crops grown and the different type of livestock kept.
3. Visible natural resources dominant in the area from which the inhabitants get their living?
4. Evidence of natural resource management strategies operational in the wards.
5. Evidence of climate variability and change and their impact on natural resources, socio-economic aspects and the livelihoods in general Chadereka Ward 1 in Muzarabani Rural District.
6. Evidence of possible explanations to the state of natural resources, socio-economic aspects and some livelihoods practiced in the wards.
7. Evidence of survival strategies used during drought and/ or floods in the area?
8. Attend and observe meetings of cooperatives or associations that are operational in Chadereka Ward 1, including what the members do.
9. Observe challenges (if any) faced by the inhabitants in Chadereka Ward 1 in adapting to climate variability and change.