COMMUNITY ADAPTATION AND MITIGATION STRATEGIES TO CLIMATE CHANGE IN SEMI-ARID AREAS OF DODOMA REGION, TANZANIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF ENVIRONMENTAL STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENVIRONMENTAL STUDIES, UNIVERSITY OF ELDORET, KENYA

SEPTEMBER 2015

DECLARATION

Declaration by the student

This thesis is my original work and has not been presented for degree in any other University. No part of this thesis may be reproduced without the prior written permission from the author and/or University of Eldoret

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DEDICATION

To my grandparents, the late Mgini & Nyafulu Mungururu; my wife Jane Mchakama; my daughters Janet Nkwaya, Adelaida Ng'aeda and Awaki; and my son Hansel Mgini for your immeasurable love, encouragement and support.

ABSTRACT

Climate change is one of the global environmental problems that affect human livelihoods. Extreme events such as rainfall and temperature changes have led to severe economic and livelihood impacts hence prompting both international and national efforts to deal with climate change. However, such efforts face serious financial, technical, political and human capacity challenges. This underscores the need for examining local community adaptation and mitigation strategies as one of the attempts towards using local solutions in addressing the problem of climate change and hence the quest of this study. In particular, the study focused on assessing the impacts of climate change on livelihoods; determining adaptation and mitigation strategies used in addressing impacts of climate change; examining the status of mainstreaming issues into government policies; and examining the role and contribution of actors in facilitating local community adaptation and mitigation practices. The study used a household survey of 398 randomly sampled household respondents, focus group discussions, key informant interviews, analysis of meteorological data and documentary review. Quantitative data were analysed using SPSS (ver. 16) and Microsoft Excel 2007 programs using descriptive statistics, multiple responses, principal component analysis, t-test of independence, chi-square test of independence, and time series analysis as statistical techniques. Content analysis was used to analyse qualitative data from focus group discussions and reviewed documents. The analysis of meteorological data of 30 years indicated an increasing trend in temperature and wind speed and declining mean annual rainfall trend. Some of the major climate change impacts on livelihoods revealed by the study were reduced agricultural productivity, alteration of the planting season, water shortage and reduced livestock pasture. In response, various agricultural practices, income diversification, water management techniques, communal pooling, migration, tree planting and forest conservation were used as local community adaptations and mitigation strategies. However, their implementations were hindered by factors such as lack of resources, weak institutional support and high cost of adaptation and mitigation technologies. The study also revealed that efforts to mainstream climate change initiatives are still at the infancy stage. Furthermore, most actors involved in facilitating community initiatives lack institutional objectives and resources for guiding the process of climate change management. The study concluded that climate change has severe effects on the key livelihood sources and activities in the study area. Despite lack of support and coordination from public and private actors and an absence of concrete objectives on climate change amongst most actors, the local communities in the area were using various initiatives do deal with climate change. This study recommends the strengthening of the collection and dissemination of weather forecast information to help in planning for effective adaptation and mitigation practices; development of clear objective(s) to guide in facilitating local communities' adaptation and mitigation efforts; mainstreaming climate change issues to government levels and sectors; and strengthening the agricultural support system by recruiting adequate number of extension officers.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

ADP	Area Development Programme
ARI	Agriculture Research Institute
BAENET	Bahi Environmental Network
CBD	Convention on Biodiversity
CBOs	Community Based Organizations
CDM	Clean Development Mechanism
DONET	Dodoma Environmental Network
DRR	Disaster Risk Reduction
EAC	East African Community
EOs	Extension Officers
FGD	Focus Group Discussion
FMNR	Farmers Managed Natural Regeneration
FYDP	Five Years Development Plan
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GLCA	Global Leadership on Climate Change
HEP	Hydroelectric Power
HFCs	Hydro Fluorocarbons
HIPC	Heavily Indebted Poor Countries
IFTz	INADES Formation Tanzania
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
KONET	Kongwa Environmental Network
LDCs	Least Developed Countries
LEAP	Local Environmental Action Plan
LGAs	Local Government Authorities
LTPP	Long Term Perspective Plans
LWR	Lutheran World Relief
MDAs	Ministries, Departments and Agencies
MDGs	Millennium Development Goals
MTEF	Medium Term Expenditure Framework
MTEFs	Medium term Expenditure Frameworks
NAPA	National Adaptation Programme of Action
NBS	National Bureau of Statistics
NCCFP	National Climate Change Focal Point
NCCSE	National Climate Change Steering Committee

NCCTC	National Climate Change Technical Committee
NCF	National Climate Change Fund
NEAP	National Environmental Action Plan
NESP	National Economic Survival Programme
NGOs	Non Governmental Organizations
NSGRP	National Strategy for Growth and Reduction of Poverty
NSGRP	National Strategy for Growth and Reduction of Poverty
ODA	Official Development Assistance
PBGs	Plan and Budget Guidelines
PCA	Principle Component Analysis
PFCs	Per Fluorocarbons
PMO-RALG	Prime Ministers' Office –Regional Administration and Local Government
PRS	Poverty Reduction Strategies
PRSP	Poverty Reduction Strategy Paper
RLDC	Rural Livelihood Development Company
RVF	Rift Valley Fever
SACCOS	Saving and Credit Cooperatives
SPILL	Strategic Plan for the Implementation of Land Laws
SPSS	Statistical Packages for Social Sciences
STT	Sunseed Tanzania Technologies
TALIRI	Tanzania Livestock Research Institute
TDV 2025	Tanzania Development Vision 2025
TMA	Tanzania Meteorological Agency
TOAM	Tanzania Organic Agriculture Movement
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
VPO-DoE	Vice Presidents' Office – Division of Environment
WVT	World Vision Tanzania

ACKNOWLEDGEMENTS

The accomplishment of this work would have been impossible without intellectual and moral support from different people. Although it is difficult to mention all those who have supported the accomplishment of this piece of work, I am deeply thankful to all of you for your support.

Special thanks go to my supervisors Prof. Grephas P. Opata and Eng. Prof. Emmanuel C. Kipkorir; your constructive critiques, guidance and support have made this work to be accomplished. The discussion we had in different stages of this study has added something very valuable to my work and my teaching profession, indeed I'm very proud to be supervised by you. In the same note, I am also thankful to Dr. Jeremiah Ayonga for his professional and academic advices during research proposal development stage.

I am also grateful to my employer, The Institute of Rural Development Planning, for sponsoring my study and providing me with a paid leave to pursue my PhD studies. In particular, I am indebted to Mr. C. Lifuliro, Prof. I. J. Zilihona, Mr. T. Mdendemi, Prof. I. Katega and Dr. B. Sebyiga, Dr. F. Hawassi and Dr. V. Timothy for your leadership, support and encouragement. Am also thankful to Dr. F. B. Njau, Mr. A Zagar and Mrs. R. Uheche for welcoming me in your offices for advice and facilitation on various matters during my study.

I am thankful to the people and institutions of Kongwa and Bahi Districts and Dodoma region at large for your willingness to participate in this study during the period of data collection. In a special way, I am also indebted to Charles Chesang, Elsie Cheruiyot, Joyce Maiyo, Nancy Koech, Christine Jesang, Robert Tanui, Samuel Komen, Daudi Chumo, Mary Murei, Jared Ruttoh, Samuel Rotich, Gladys Cherono, Oliver Mandila and many others from Moi University for your immeasurable support. Only God knows how I am grateful to you and your families and indeed I will not forget your kindness.

Thanks also are due to Hamad Mshana, Levina Kasese, Annamaria Gerome, and Salumu Said. Without you, the process of data collection for this study would have been very difficult. Your support, willingness to walk long distances, your ability to introduce me to different stakeholders we visited and exchange of ideas made collection of the data possible.

Studying at the University of Eldoret needs both social and academic support. In this regard, I would like to extend my thanks to Prof. V. Sudoi, Dr. B. Mwasi, Dr. G. Simiyu, Dr. D. Fatuma, Ms. Beatrice Kageni and Mrs. Mutai for encouragement and always responding positively wherever I approached your offices seeking for advice. Further, I would like to extend my appreciation to all staff members and students in

the School of Environmental Studies, University of Eldoret; I will always remember you for your social and moral support.

Special thanks are also due to my parents and the families of Mr. & Mrs. Lukwila Wilson Mayaya, Mr. & Mrs. Said Rajabu and Mr. & Mrs. Thobias Mahenda. Without your support in different stages of my academic life, reaching this level would have been an unfulfilled dream. I lack words to explain how deeply I appreciate your support; indeed your support, kindness and signature hearts will never fade away from my memories.

This part will be incomplete without mentioning my beloved wife Jane S. Mchakama, my daughters Janeth Nkwaya, Adelaida Ng'aeda and Awaki, and my son Hansel Mgini. I appreciate your ability to bear with my absence during the whole period of my study at the University of Eldoret. Jane, thanks very much for taking care of our family during my absence.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Prior to industrial and green revolutions, the climate was relatively stable (URT, 2008a). For the past millennium, the average temperature varied within the range of less that 0.7^0C (World Bank, 2010a). However, recent analysis of the world average temperature records over the period 1861 – 1989, indicate that the earth as a whole has warmed up by about 0.3 – 0.6^0C over the past century making it higher than at any time ever recorded (URT, 2008a). This rise is due to human activities associated with greenhouse gases emission. It is estimated that for the next 100 years, the planet could possibly warm to 5^0C relative to pre-industrial period (World Bank, 2010a).

Such a rise in temperature has been termed as global warming that consequently leads to climate change. According to the United Nations Framework on Climate Change of 1992, climate change means a change of climate which is attributed directly or indirectly to human activity that alters the composition of global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UN, 1992). Currently, climate change is one of the most challenging global problems facing humanity. Its adverse impacts are already being experienced globally and locally on the environment, human health, food security, tourism, natural resources, physical infrastructure and many other economic activities. As noted by the World Bank (2010a), developing countries are the most vulnerable and it is estimated that they will bear some 75 to 80 percent of the costs of damages caused by the changing climate. This is due to the fact that developing countries lack financial and

technical capacities to manage increasing climate risk and also depend more directly on climate sensitive natural resources for income and well being (World Bank, 2010a).

Worldwide, there are inequities in the distribution of responsibility for the causes of climate change and the distribution of its impacts (UNDP, 2007). According to Mearns and Andrew (2010), poor people in developing countries bear the brunt of its impacts while contributing very little (25 percent) as compared to developed countries. In addition, vulnerability to climate change impacts varies by sector and regions mainly due to disparities in adaptive capacity. Among the most vulnerable sectors are agriculture and human health due to reduced water availability and low adaptive capacity respectively. Africa is among the most vulnerable regions, especially the sub-Saharan region because of low adaptive capacity and projected changes in rainfall (Mearns & Andrew, 2010). Therefore, it is important to undertake various initiatives to mitigate and adapt to climate change-related disasters which severely threaten the well-being of people as well as causing severe economic loss. For instance, in 2005, approximately 40 percent of weather-related disasters were attributed to climate change. Such disasters are expected to rise to 50 percent in 2030 (Global Humanitarian Forum, 2009). Furthermore, economic losses from climate change worldwide amount to $ 125 billion per year, roughly equivalent to flow of 2008 Official Development Assistance (ODA) from developed to developing countries (Mearns & Andrew, 2010). In Namibia for instance, it is expected that, for the coming 20 years annual economic losses could be up to 6 percent of the Gross Domestic Product (GDP) due to the impact that climate change will have on natural resources alone (Reid et al., 2007).

According to IPCC (2007), many impacts can be avoided, reduced, or delayed by mitigation. In addition, adaptation to impacts resulting from the warming that already is unavoidable because of past emission requires new initiatives to compliment the existing and potential mitigation strategies. Among the adaptation measures, as suggested by Mearns and Andrew (2010), are long term plan for infrastructure, land use, agriculture diversification, streamlining legislation, planning for ex-ante disaster risk reduction and ex-post disaster response and recovery and social policy measures. Some of these adaptation measures are purely technical while others are societal-based. However, when addressing climate change, it is important to consider the role of different levels of government, individuals, households, and civil society organizations (Moser & David, 2010).

In Tanzania, almost 70 percent of the total population live in rural areas. Their survival depends on the utilization of natural resources such as forest, water, soil and pasture. However, natural resources endowment, its utilization and sustainability depends on the needs of the people as well as their capacity to manage the same. Taking an example of forest resources, more than 90 percent of rural community and their urban counterparts depend on firewood and charcoal as major sources of energy. Furthermore, the country has 88.6 million hectares of land suitable for agricultural production, including 60 million hectares of rangelands suitable for livestock grazing (NIDOS, 2009). It should be noted that agriculture accounts for about 45.6 percent of GDP and about 50 percent of foreign exchange earnings (URT, 2008a). Other important sectors responsible for economic and livelihoods needs in Tanzania are tourism sector, water sector, fisheries sector and energy sector. Taking a quick glance of all the mentioned sectors above, it is a matter of fact that they all depend on the

quality of the environment. Therefore, any slight changes in the environmental status due to natural or anthropogenic activities can be detrimental to the economy and livelihoods of people of which majority are in rural areas.

Despite the importance of environmental resources to the economy and livelihoods of people, climate change mostly associated with changes in rainfall pattern and continuous increase in temperature poses overwhelming threats to their sustainability. Changes in temperature and rainfall distribution will change patterns of wildlife habitat and migrations, farmland and aquaculture facilities, public health, wetlands qualities which are already under stress and agriculture in arid areas (URT, 2008a). Consequently, such changes will threaten the livelihood of fast growing population (2.7 percent) and the already struggling economic growth of the country. As indicated by the World Bank (2010a), the GDP per capital growth of the country in 2007 was 4.4 percent.

Climate change, being a global problem, requires global effort and international consensus (World Bank, 2010a) if at all the problem is to be addressed. It is from that perspective whereby international effort has resulted into formulation of the United Nations Framework Convention on Climate Change of 1992 (UN, 1992), the Kyoto Protocol of 1997 (UN, 1998) which was ratified in 2005, and the Bali Action Plan of 2007 which acts as a road map towards addressing the problem of climate change (Fletcher & Larry, 2008). In addition, given the financial problems in developing countries (Global Humanitarian Forum, 2009), countries have been urged to develop National Adaptation Programme of Action (NAPA) prior to receiving funds for adaptation and Clean Development Mechanism (CDM).

Despite the above international efforts which seems to promise a green future in relation to climate change adaptation and mitigation strategies, the problem still exists and the results are somehow frustrating in the sense that: some developed countries leading in emitting Greenhouse Gases (GHGs) such as United States of America (USA) have never ratified the Kyoto Protocol on the basis of equity and scientific uncertainty (Fletrcher & Larry, 2008; Layfield, 2010); failure to reach agreement in the ongoing international climate change negotiations forums such as the Copenhagen (Christoff, 2010); the inefficiencies surrounding the CDM process and its efficiency as a financing instrument (Wolrd Bank, 2010); and failure of developed countries that have already ratified the Kyoto protocol to meet the specified targets of reducing GHG within the stipulated period due to lack of a legally binding agreement (Christoff, 2010). This means that the problem of climate change will remain unresolved for a long while and the only option at the moment should be how to mitigate and adapt at a local level as an attempt geared towards finding local solutions to the problem.

Previous studies on climate change in Tanzania focused on the effects of climate change on coastal areas (URT, 2008a), around major river basins (Kangalawe et al, 2011) and areas of tourism attractions such as Kilimanjaro Mountains (Agrawala et al, 2003).. In addition, other studies focused on the role of forest and land use sectors in climate change mitigation (CEEST et al, 1999). In arid and semi arid areas, most of the studies focus on the effects of climate change, stakeholders' understanding on climate change, and highlights the general adaptation strategies particularly those supported by the government or humanitarian aids (Sewando & Yohana, 2012; Anderson et al., 2010; Paavola, 2003; Mongi et al., 2010). This study therefore

intends to focus on local community adaptation and mitigation measures in semi arid areas of Tanzania with special attention on the local community responses, supporting institutions or actors and mainstreaming of local community adaptation and mitigation strategies into policies, plans, programmes and budgets. The focus of this study is still a quite new area of research (Aakre & Rubbelke, 2010; UNFCCC, 2010) and also the fact that adaptation is highly local and its success depends on the effectiveness of the available institutions (Agrawal, 2010; Measham et al., 2011; Mannke, 2011).

1.2. Statement of the Problem

Climate change is one of the worst problems of our time since it interferes with human livelihood opportunities. In Tanzania, different regions and sectors suffer severely due to the persistent variability in rainfall and temperature (URT, 2006; URT, 2008a). Among the consequences associated with climate change in Tanzania include, but not limited to, melting of glacier, the rise of sea level, food insecurity, water shortage, loss of biodiversity, loss of pasture due to prolonged drought, and drop of water levels in major rivers, lakes and reservoirs (Agrawala et al., 2003; NIDOS, 2009; URT, 2006; URT, 2008a).

In semi arid areas of Tanzania, such as Dodoma region the problem is even more challenging as major sources of livelihood in the region are heavily rainfed dependent. However, the quantity of rainfall in the region has reduced over years due to climate change (URT, 2006; URT, 2008a). For instance, the average rainfall has reduced from 558 mm in the period 1922 to 1999 to almost 480 mm in the period 2000 to 2006. In addition, Dodoma region experiences an increase in annual reference evapotranspiration from 2000 mm per annum to 2100 mm per annum (Rwebugisa,

2008) indicating changes in radiation, air temperature, humidity, and wind speed as the principal weather parameters affecting the evapotranspiration.

As a result, agricultural production as the major source of food and income in the region is severely suffering the consequences due to its high vulnerability to climate change and variability. For instance, due to reduced rainfall amount and increased variability in rainfall, the average yield of maize in Tanzania decreased by 33 percent countrywide while in Dodoma region, the production of the same crop has decreased by 84 percent (URT, 2006). Moreover, residents in the region are currently experiencing livestock and human deaths as a result of floods and drought (WHO, 2007; IRDP & Mpwapwa DC, 2010) indicating an increase of climate extreme events in the area. In addition, being a semi arid area Dodoma region's ecosystem is very fragile and susceptible to climate changes impacts particularly the problem of food insecurity and other environmental degradations which tend to manifest themselves very fast, therefore failing to support the population that is on the increase.

The aforementioned issues are a cause for alarm and therefore form the basis for this study. So far, different efforts with different options in addressing the problem of climate change particularly in developing countries have been put in place. However, most of the past solutions to address the problem of climate change are rather reactive than proactive and their sustainability questionable (Mearns & Andrew, 2010). In addition, the international and government capacity to effectively implement adaptation and mitigation measures in terms of financial, technical and human capacity is inadequate and sometimes lacks political will (World Bank, 2010a; URT, 1997; Global Humanitarian Forum, 2009). This entails finding local solutions as one

of attempts in addressing climate change challenges. The study therefore aims at analysing the local community adaptation and mitigation strategies to climate change in semi arid areas of Dodoma region in Tanzania in the pursuit of developing appropriate local strategies and solutions towards addressing the problem of climate change.

1.3. Research Objectives

1.3.1. Main Objective

To analyse the local community adaptation and mitigation strategies to climate change in semi arid areas of Dodoma region in Tanzania with a view of developing an appropriate climate change adaptation and mitigation strategy.

1.3.2. Specific Objectives

1. To assess the impacts of climate change experienced by the local community in the semi arid area of Dodoma region in Tanzania.
2. To determine strategies used by the local community in adapting to and mitigating impacts of climate change.
3. To examine the extent to which climate change adaptation and mitigation issues are mainstreamed into government policies, plans and strategies.
4. To examine the role and contribution of various institutions/actors in facilitating local community adaptation and mitigation practices.

1.4. Research Questions

1. What are impacts of climate change experienced by the local community in the semi arid area of Dodoma region?

2. How climate change impacts are manifested in the semi arid area of Dodoma region?
3. What are the adaptation practices used by the local community in responding to climate change impacts?
4. What are the mitigation practices used by the local community in responding to climate change?
5. To what extent are climate change adaptation and mitigation issues mainstreamed into government policies, plans and programmes?
6. What are the roles and contributions of institutions/actors in facilitating local community adaptation and mitigation practices?

1.5. Significance and Justification of the Study

The information (on adaptation and mitigation strategies) obtained from this study is very useful in highlighting and consequently strengthening the hidden potential of the vulnerable local community in addressing the problem of climate change. This is due to the fact that addressing the problem of climate change is very challenging particularly in developing countries where technical (e.g. development of effective early warning systems), financial and human resource capacity are severely inadequate, expensive and sometimes missing altogether. Therefore, the information generated in this thesis is expected to help the government, international community, development partners, NGOs, CBOs, the local community and other interested stakeholders to come up with new policies or reorienting the existing policies and institutions to focus on empowering the vulnerable local communities to cope, adapt and mitigate climate change challenges. As highlighted by the Global Humanitarian Forum (2009), funding for adaptation in developing countries is not even one percent

of what is needed and majority, particularly the, poor do not have the capacity to deal with the impact of climate change. This makes local community adaptation and mitigation strategies to be the sole cost effective way of reducing human impacts resulting from climate change and hence complement the existing government, international community, NGOs and CBOs adaptation and mitigation efforts, and hence, the need for this study. As argued by Agrawal (2010), adaptation to climate change is highly local and its effectiveness depends on local and extra-local institutions through which incentives for individual and collective action are structured. This follows the slow progress of the international and national efforts in addressing climate change challenges (Measham et al., 2011).

1.6. Structure of the thesis

This thesis is divided into six chapters. The first chapter introduces the study with special focus on the background, problem statement, objectives, research questions and significance and justification of the study. Literature review and theoretical and conceptual foundation of the study are presented in Chapter Two. The methodology adopted for the study is presented in Chapter Three. Chapters Four and Five present the findings and discussion, respectively, as an attempt to empirically providing answers to the research objectives and questions. The conclusions and recommendations are presented in Chapter Six. Chapter Six further proposes the climate change adaptation and mitigation strategy and identifies areas for further research critical for bridging the knowledge gap on the local community adaptation and mitigation strategies in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter surveys the conceptual and theoretical foundation of the study. In particular, the chapter highlights the concept of climate change, climate change adaptation, mitigation measures to climate change and mainstreaming of climate change adaptation and mitigation strategies as a window of opportunity towards effective climate change management. Furthermore, provides an overview of climate change institutional arrangement in Tanzania and institutional involvement in facilitating local community adaptation and mitigation practices. Lastly, the chapter presents the theoretical and conceptual framework that guide the study followed by a summary that highlights the key lessons learned from literature review.

2.2. Climate Change

Climate change is defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (IPCC, 2007). According to IPCC (1996), human activities increases the concentration of aerosols and greenhouse gases such as Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydro Fluorocarbons (HFCs), Per Fluorocarbons (PFCs) and Sulphur Hexafluoride (SF_6) in the atmosphere. Aerosols are responsible for cooling of the atmosphere. A combination of aerosols and greenhouse gases especially Carbon Dioxide resulting from burning of fossil fuel

contribute significantly in changing the climate parameters such as temperature, precipitation, and soil moisture among others (IPCC, 1996).

Changes in climate parameters are best manifested by the increase of climate-related extreme events including but not limited to extreme high temperature or heat waves, heavy precipitation, floods and drought. Consequently, such extreme events affect both the natural and human systems by interfering with the primary productivity, health, ecological and socio-economic systems (IPCC, 2014). In particular, changes in climate parameters are likely to affect the availability of water, shift in the growing season, flooding pattern, soil erosion, rise in sea levels, and distributions of disease vectors (UNFCCC, 2007). However, the effects resulting from climate change are not evenly distributed and tend to affect various regions in the world differently. For instance, some parts of USA and Europe are severely affected by heat waves while most parts of Africa especially areas along the horn of Africa and Australia are interchangeably affected by drought and floods (Global Humanitarian Forum, 2009; Warner & Afifi, 2014).

Unfortunately, changes in climate parameters can never be reversed within a few days or a year. Evidence suggests that stabilization of the atmospheric concentrations of greenhouse gases, equilibration of climate system given a stable level of greenhouse emissions and concentrations respectively will take decades to centuries (IPCC, 1996). The same time frame is required for the restoration or/and rehabilitation of the damaged or disturbed ecological systems. The above is based on the fact that, even if the emission of greenhouse gases was to cease immediately, the earth will continue to warm as a result of the already existing concentrations of greenhouse gases in the

atmosphere (UNFCCC, 2007). For instance, prior to industrial revolution, the concentration of carbon dioxide was 278 parts per million (ppm). However, the current concentration of carbon dioxide is about 387 ppm which is "higher than the highest point in at least the past 800,000 years" (World Bank, 2010a). Furthermore, the average global temperature rose by 0.74^0C between the same period (UNFCCC, 2007).

According to Tompkins and Adger (2004), slow changes in mean climatic conditions, increased inter-annual and seasonal variability, increased frequency of extreme events, and rapid climate changes causing catastrophic shifts in ecosystems are the major ways on which climate changes are manifested. Such changes strongly call for the need for adaptation and mitigation strategies to deal with climate change impacts of which some of them are melting of ice sheets, increase of climate-related extreme events which adversely affect the well-being of people particularly the poor in developing countries (Mearns & Andrew, 2010). It should be noted that the distribution of responsibility for the causes of climate change and of impacts differ widely among nations and people (UNDP, 2007). Whereas poor people, majority living in developing countries, contribute very little to the causes of climate change (25 percent) as compared to their counterpart in developed countries, they are the ones severely affected socially and economically by climate change-related impacts. Among the most affected sectors in developing countries are agriculture and human health as a result of reduced water availability and low adaptive capacity.

Worldwide, economic losses caused by climate change-related disasters amount to $ 125 billion per year, roughly equivalent to the flow of 2008 Official Development

Assistance (ODA) from developed to developing countries (Mearns & Andrew, 2010). According to Global Humanitarian Forum (2009), climate change-related disasters are expected to rise to 50 percent worldwide in 2030. Using severe drought as an example of a climate change-related disaster, Australia has experienced drought for almost more than a decade (Global Humanitarian Forum, 2009). In Tanzania, climate change related disasters have been of critical concern due to their recurrence and severe social and economic effects (Appendix I, II and III).

Despite the challenges posed by climate change impacts, most of them can be avoided, reduced, or delayed by mitigation (IPCC, 2007). For the already unavoidable climate change impacts, the most viable option is the use of various adaptation strategies such as planning for infrastructure, land use, agricultural diversification, and streamlining legislation (Mearns & Andrew, 2010). Worldwide, various international, regional and national efforts to address climate change are underway. Some of such efforts involve multilateral agreements and regional and national policies. For instance, through negotiations and conferences, international and regional communities have made a breakthrough by coming up with policy documents such as United Nations Framework Convention on Climate Change(UNFCCC), the Kyoto Protocol and other regional initiatives such as the East African Policy on Climate Change.

In 1992, the United Nations came up with the United Nations Framework Convention on Climate Change (UNFCCC) as the first non-legal binding treaty to address climate change. The treaty entered into force in 1994 after being signed by involved parties including the USA under voluntary commitment or pledge in establishing action plans

for reducing greenhouse emissions. Nevertheless, in 1995 parties decided that it would be necessary to move from voluntary measures to mandatory reduction of the major GHGs after the realization that USA and Japan would not be able to reduce their GHGs emissions (Fletcher & Larry, 2008). The above decision led to the formulation of the Kyoto protocol which officially entered into force in 2005. However, USA is not bound to the Kyoto Protocol provisions since it has not ratified it since its completion in 1997. The protocol specifies emission trading, Clean Development Mechanism (CDM), Joint Implementation (JI) and carbon sinks as the four flexible mechanisms for the implementation of the protocol (UN, 1998).

Regional-wise, the East African Community (EAC) completed the formulation of its policy on climate change in 2010. The policy complements the national, sub-region development policies, plans, programmes and other multilateral agreements of which EAC is part of. In its wider perspective, the East African policy on climate change aims at promoting public awareness, disseminating information on socio-economic importance of climate change, facilitating resource mobilization, promoting capacity building (technology transfer, training and information sharing) efforts, development of predictive models, facilitating preparedness for strategic responses, and establishing a regional framework as a guide to harmonize and co-ordinate implementation of climate change actions amongst partner states (EAC, 2010).

At national level, various efforts geared towards addressing the problem of climate change are in place taking into consideration that Tanzania is one of the twenty (20) most vulnerable countries worldwide (Global Humanitarian Forum, 2009). Among such efforts include preparation of the National Adaptation Programme of Action

(NAPA) and establishment of CDM projects as per the requirement of the Kyoto Protocol. According to URT (2006), the critical priority areas under NAPA involve improving food security in drought-prone areas by promoting drought tolerant crops; improving water availability to drought-prone communities especially in central Tanzania; shifting of shallow water wells affected by inundation of coastal regions of Tanzania mainland and Zanzibar; and combating the malaria epidemic in newly malaria infested areas. Other efforts involve development of drought resistant crops in arid and semi arid areas, shallow and deep wells drilling programmes, construction of dams, and use of natural gas for electricity production (URT, 2008a). The above efforts are further complemented by conservation efforts particularly in measures to avoid deforestation so as to facilitate the process of carbon sequestration and protection of water catchment areas as part of adaptation and mitigation strategies. It should be noted that Tanzania has reserved more than 20 percent of its territory as forest reserves, game reserves and national parks (URT, 2008a).

2.3. Climate change adaptation

Adaptation is defined as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effect, which moderates harm or exploits beneficial opportunities (UNFCCC, 2010). Adaptation to climate change is further defined by Aakre and Rubbelke (2010) as responding to the impacts of climate change by moderating or offsetting potential damages or taking advantages of such changes through changing processes, practices, or structures. The need for adaptations to climate change is based on the fact that majority, especially the poor, depend on climate sensitive sectors such as agriculture and forestry for their livelihoods (Mearns & Andrew, 2010). In addition, dealing with the problem of climate change through

stabilization of GHGs concentration in the atmosphere, equilibration of the climate systems given a stable level of GHGs, and restoration or rehabilitation of the damaged or disturbed ecological systems will take years to realize positive results or reverse the current situations (IPCC, 1996; Global Humanitarian Forum, 2009). Nevertheless, pledges made by developed countries to address the problem of climate change are one of the unfulfilled dreams (Global Humanitarian Forum, 2009). Therefore, adaptation strategies are very crucial in reducing vulnerability and negative consequences of climate change as well as increasing resilience to future impacts.

Categorically, adaptations are classified into two major types - planned and autonomous adaptations. Whereas planned adaptations are implemented prior to manifestation of climate change, autonomous adaptations are influenced by actual changes in the natural and human systems and usually occur at the community and local level (UNFCCC, 2010). However, autonomous adaptations should be supported by government, international organizations and other stakeholder (e.g. donors) policies, legislations, regulations, and socio-economic environment of actions for effective realization of their goals (Aakre & Rubbelke, 2010).

Although adaptation strategies can fall between the two categories of adaptations as aforementioned, the role of local communities in addressing climate change can not be underestimated. Their traditional agricultural methods, natural resources management, social solidarity networks, innovation and other traditional mechanisms are very important in adapting or coping with climatic changes and variability (UNFCCC, 2010). In developing countries like Tanzania, effective adaptations strategies are the ones that address environmental stress, enhance food security and

water availability, aim at alleviating poverty, reduce loss of biodiversity, enhance ecosystems services, and address the problem of land degradation (UNFCCC, 2007). However, availability of resources (human and financial), technological advances, information exchange, institutional arrangements, and knowledge are important in building the capability of local communities to adapt to climatic change impacts (IPCC, 1996).

Adaptation strategies worldwide vary depending on the nature of activities undertaken by the community or the nature of the most commonly occurring events. Communities practicing agriculture have different adaptations strategies as compared to those mostly affected by floods, storms and heat waves. In Ethiopia, where drought is common, improved management of land uses such as planting of multipurpose trees, reorientation of agricultural practices, environmental rehabilitation and conservation, and promotions and use of alternative energy sources are among climate change adaptation strategies. Other specific adaptation practices with special focus to agricultural crops include crop selection, land rehabilitation, adjustments of planting dates, use of drought resistant and early maturing crops, and improved water resource management (World Bank, 2010b).

Experience from The Netherlands shows that adaptation strategies for dealing with the impacts of climate change involve the use of regulatory instruments such as land use planning and legal instruments; technical measures such as construction of dykes and river regulation; financial instruments such as financial compensation and insurance; and preparatory measures such as evacuation plans, communicative measures, forecasting, and monitoring (Veraart et al., 2010).

Other adaptation incidences from India, Maldives, Peru, Philippines, Samoa, South Africa, United Kingdom and Vietnam show that dealing with climate change and the associated disasters require political commitment and involvement of all stakeholders (ISDR, 2009). In this case, political commitment is revealed through willingness to enact and implement climate change legislations and preparation of climate change adaptations strategy. For instance, while Philippines have enacted the climate change Act of 2009 to facilitate the integration of disaster risk reduction measures into climate change adaptation plans, development and poverty reduction programmes, the United Kingdom, in particular the city of London, has prepared a comprehensive adaptation strategy to prevent, prepare, respond and recover from risks associated with climate change (ISDR, 2009). Such legislations and strategies are paramount in mainstreaming climate change adaptation into policies, programmes, plans and budgets.

In dealing with the problem of climate change, Tanzania has been launching various national adaptation strategies. One of the national adaptation strategies is the preparation of the National Adaptation Programme of Action (NAPA) as per the requirement of the Kyoto Protocol. Other efforts involve development of drought resistant crops in arid and semi arid areas, shallow and deep wells drilling programmes, construction of dams, and use of natural gas for electricity production (URT, 2008a). Indeed, the above effort though different in nature and approach are in line with NAPA priority areas, According to URT (2006), the critical priority areas under NAPA involve improving food security in drought prone areas by promoting drought tolerant crops; improving water availability to drought prone communities especially in central Tanzania; shifting of shallow water wells affected by inundation

of coastal regions of Tanzania mainland and Zanzibar; and combating the malaria epidemic in newly malaria infested areas.

2.4. Mitigation measures to climate change

Given the overwhelming challenges posed by climate change, one of the efforts to address the problem involves the use of mitigation measures. In this case, mitigation refers to the anthropogenic efforts aimed at reducing the causes of a given impact through taking precautions and attitude change so as to reduce the associated risks to a minimum level. According to IPCC (2007), mitigation effort includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. Hence, mitigation measures help in reducing the rate and magnitude of climate change impacts (Aakre & Rubbelke, 2010).

Globally, mitigation measures differ widely depending on the level of financial capability, technology and knowledge; all of which define the course of mitigation measures. According to the World Bank (2010a), the major tracks for mitigation efforts are the target and policy tracks of which the target tract is widely used in developed countries as compared to developing countries due to financial and technical capability of the former. In the case of policy-based track, countries implement policies and actions with potentials of reducing the emissions or limiting the GHGs. Such policies or actions may include energy efficient standards, renewable energy targets, fiscal measures and land use policies (World Bank, 2010a).

Based on the principle of common but differentiated responsibility and respective capability (UN, 1998), different countries have the duty of taking various actions with the general aim of reducing the emissions and growth of GHGs. Such efforts are very

crucial in stabilizing the concentration of greenhouse concentration in the atmosphere to an acceptable level. However, some mitigation options such as carbon capture and storage, and switching from oil to other sources of energy among others are more technical as compared to those associated with land management such as afforestation.

Worldwide experience shows that both technical and management measures are currently used in different places. For instance, developed and industrialized countries such as USA, United Kingdom, China, and Russia are currently using mechanisms like setting performance standards, use of renewable energy, setting vehicle emission standards, setting energy conservation standards, carbon taxation, setting building standards, and retiring inefficient power plants and industrial enterprises as part of efforts to reduce the emissions of GHGs (UNDP, 2007). Other projects aiming at stabilizing GHGs emissions are afforestation and rehabilitation of wasteland in Sudan and carbon capture and storage in the Salah project implemented by BP Company in Algeria (Tolba & Najib, 2009). At community level, the Kuyasa low-cost housing energy upgrade project aiming at heat retention and energy efficiency in South Africa and the Nhambita Community carbon project (practicing agro forestry system) are some of the best mitigation practices in Africa (Ehrhart & Michelle, 2006).

Based on the above examples, both developed and developing countries have a role to play in reducing the emissions and limiting the growth of GHGs as well as reducing disaster risks. However, some of the measures require highly sophisticated technology and financial capacity and hence their implementations are limited to developed countries. Examples of such measures are the floating houses in Maasbommel and

construction of dykes in the Netherlands and the Thames Barrier (flood defence structure to protect London) in United Kingdom (UNDP, 2007; ISDR, 2009).

On the other hand, Least Developed Countries (LDCs) are very keen in limiting the growth of GHGs and hence minimizing the overall impacts of climate change by implementing various measures according to their capability despite the fact that their contribution to GHGs emissions is very minimal. In East Africa, among the mitigation measures of priority as per the East Africa climate change policy include promotion of energy efficiency, afforestation, reforestation, efficient transport system, efficient crop and livestock production systems, waste management, and capturing opportunities in emission reductions (EAC, 2010). At the national level in east African countries, renewable energy sources such as geothermal, wind, Hydroelectric Power (HEP), solar energy, and use of natural gases; forestry; and waste management are some of the potential mitigation measures (EAC, 2010).

In Tanzania, use of renewable energy, and land use management practices offer high potential in mitigating against GHGs emissions and limiting the growth of GHGs concentration in the atmosphere. The above efforts are further complemented by conservation efforts and measures to avoid deforestation so as to facilitate the process of carbon sequestration and protection of water catchment areas as part of adaptation and mitigation strategies. It should be noted that, Tanzania has reserved more than 20 percent of its territory as forest reserves, game reserves and national parks (URT, 2008a). According to World Bank (2010a), land use management practises such as forest management offer high mitigation potential through their role of carbon dioxide uptake (carbon sequestration) and hence carbon sink.

2.5. Mainstreaming Climate Change Adaptation and Mitigation Strategies

Taking into consideration the potential and actual socio-economic and environmental challenges, mainstreaming of climate change long term adaptation and mitigation practices into policies and national visions, development plans, strategies and programmes is a matter of priority. In this case, mainstreaming refers to the process of integrating climate change adaptation and mitigation activities into development policies, development programs and plans, budgeting, implementation and monitoring (URT, 2008b; UNDP-UNEP, 2010).

In the course of mainstreaming, adaptation and mitigation activities should be integrated into development plans and budgets both at strategic and operational levels (CARE International, 2009). The above levels entail the integration of adaptation and mitigation practices at national, sector, and sub-national levels as well as the need for cooperation between government and non governmental actors (UNDP-UNEP, 2010). However, it is important to note that any decision at the strategic level can influence decisions and actions at the operational level through its ability to determine national priorities and guiding policy framework.

The process of mainstreaming adaptation and mitigation strategies is vital in dealing with climate change. Among its benefits include assisting vulnerable people to better adapt (i.e. adaptive capacity) and mitigate climate-related changes. In addition, it plays a very critical role in reducing implementation hurdles associated with financial capability or budgets, technical capacity and human resources and hence improving institutional performance and infrastructures (CARE International, 2009; UNDP-UNEP, 2010).

At the international level, the entry points for mainstreaming adaptation and mitigation strategies are global policy frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC), Convention on Biodiversity (CBD), Convention on desertification, and the Millennium Development Goals (MDGs) among others. However, the entry points at the national to sub-national levels include but not limited to poverty reductions strategy paper, development plans, budget allocations guidelines and other core national policies (UNFCCC, 2010; UNDP-UNEP, 2010). Table 2.1 highlights the possible entry points for mainstreaming adaptation into national development planning.

Table 2.1: Possible Entry Points for Mainstreaming Adaptation into National Development Planning

Planning Level	Entry Points
National government and cross sector ministries	• Poverty reduction strategy paper • National development plan • MDG – based national development strategy • National budget allocation process or review
Sector Ministries	• Sector strategies, plans and policies • Preparation of sector budgets • Public expenditure reviews
Sub-national Authorities	• Decentralization policies • District plans • Preparation of sub-national budgets

Source: UNDP-UNEP (2010)

As per Table 2.1, mainstreaming adaptation and mitigation strategies to climate change at national level assists in ensuring that national priorities and guiding policy frameworks take on board climate change management issues. At sectoral level, mainstreaming of adaptation and mitigation strategies is also very important as sectors

such as agriculture, forestry, health and energy are climate sensitive sectors. In addition, these are the sectors of which most poor people in developing countries depend on for their livelihood (Mearns & Andrew, 2010). Furthermore, mainstreaming at the subnational level in particular through development plans is very important since climate change impacts the local level (UNDP-UNEP, 2010).

In general, mainstreaming of adaptation and mitigation strategies into various policies, programmes and plans is very important for effective tackling of climate change-related challenges. However, it should be noted that efforts at mainstreaming adaptation and mitigation strategies are hampered by limited awareness, lack of mechanisms for information sharing and management, poor data on adaptation options, and low staff capacity for planning (UNFCCC, 2007). Hence, addressing the above challenges requires raising public awareness, participation of various actors, and capacity building (URT, 2008b) - all of which can be achieved through effective institutions.

2.6. Historical Background of Climate Change Mainstreaming in Tanzania

2.6.1. Pre-Colonial Period (Prior to 1884)

During the pre-colonial period, the area was characterized by minimal exploitation of natural resources as a result of low population whom among others perceived nature as a granary, pharmacy, butchery, and source of energy and construction materials (Zahabu et al., 2009; Kwashirai, *undated*). The local population also lacked technological capacity and intensive markets, hence limiting their ability to overexploit natural resources. Furthermore, the pre-colonial period was not incorporated into the world economy that is characterised by high consumptive

behaviours and patterns, hence contributing to severe global environmental consequences such as climate changes (World Bank, 2010a). According to Zahabu et al. (2009), the main anthropogenic impact was the modification of land in particular the Savannah areas by fire. Other activities such as shifting cultivation and grazing had minimal and quite limited impacts on the environment.

Moreover, the management of natural resources in Tanzania, as elsewhere in Africa during the pre-colonial period, were vested in the hands of the community through their traditional institutions (Zahabu et al., 2009). The conservation of natural resources was based on community rules, beliefs and taboos using their indigenous or customary institutions under the leadership of kings and chiefs. Such institutions were responsible for coordinating and structuring the access and utilization of natural resources and thus playing a critical role in dealing with potential environmental challenges (Kwashirai, *undated;* Zahabu et al., 2009).

In general, during the pre-colonial period, human activities were limited in scale and thus not a threat to the environment. The period was characterised by an absence of formal state institutions and plans to address environmental challenges which were also quite limited mainly to the modification of land by fire and well coordinated shifting cultivation. Likewise, climate change was not a problem of environmental concern.

2.6.2. The Colonial Period (1884 – 1961)

In Tanzania (the then Tanganyika), the history of colonialism comprises the period of 1884 to 1961. The colonial period in Tanzania is subdivided into two phases namely the German colonial period (1884 – 1917) and the British colonial period (1920 –

1961). Regardless of the named phases, the colonial period in Tanzania like in other countries was characterised by land alienation, voracious harvesting of natural forests for timber exports, forced migration of local communities, establishment of conservation areas, and introductions of cash crops in various parts of the country (Kjekshus, 1996; Neumann, 1997). Land alienation involved grabbing the most productive lands for European farmers thus forcing the local communities to marginalised land (Neumann, 1997). According to Anderson (1984), the desire of the colonial master was to increase African production and exploitation of natural resources as a way of meeting difficulties caused by economic depression in their countries.

In order to achieve their goal, the colonial masters nullified the local systems and institutions for managing the accessibility and use of natural resources leading to fundamental alteration of the society and natural resources interactions (Neumann, 1997; Zahabu et al., 2009). They further systematically introduced cultivation of cash crops to the local communities in their marginal lands as a way of earning money to pay for the colonial hut tax (Swai, *undated*). Consequently, the colonial land alienation practices, utilization of resources, production systems guided by high technological use (overproduction), disregard of local institutions and mechanisms later on led to environmental consequences (Anderson, 1984; Voss, 2001).

Experience from America and other African countries under colonial rule indicate that the white settlers were not environmental conscious as their activities led to soil erosion as a result of soil exhaustion, declining soil fertility, and overcrowding of local communities into unproductive land (Kwashirai, *undated;* Anderson, 1984;

Swai, *undated*). Environmental challenges were further aggravated by unchecked extraction of raw materials that led to ecological catastrophes manifested through deforestation, extinction of some animal species, soil infertility, drought, and disappearance of water sources (Kjekshus, 1996; Anderson, 1984; Zahabu et al., 2009). It is due to such environmental irresponsible behaviour of the colonial masters, that some authors have branded the colonial era as the period of overtaxing the land and gross environmental neglect (Voss, 2001; Anderson, 1984).

Based on the analysis of the colonial period, it suffices to conclude that the emphasis of the colonial authorities was on extraction of raw materials for export and exploitation of national resources. Less emphasis was put on solving socio-economic and environmental problems leading to the emergence of soil erosion as the first global environmental problem in the 1930s (Anderson, 1984). Furthermore, the local population and their customary institutions were undermined and neglected whereby their actions were viewed as detrimental to the environment (Zahabu et al., 2009).

2.6.3. Post Colonial Period (from 1961 to date)

Soon after independence in 1961, Tanzania declared war against three development enemies namely poverty, ignorance and diseases in order to reduce economic and social inequalities in resource distribution and control (URT, 1998). In achieving that goal, the country formulated two long term perspective plans (LTPP) to take over the three year development plan (1961 -1964) adopted immediately after the independence of Tanganyika. The first LTPP (1964 – 1980) was not implemented in three phases of five year development plans of 1964 – 1969, 1969 – 1974, and 1975 – 1980 as planned. This was due to the fact that, the second (1969 – 1974) and third

(1975 – 1980) five year development plans were not implemented as a result of economic crisis caused by drought (1973 – 1975), oil price shocks in 1970s, breakup of the East Africa Community in 1977, and war between Tanzania and Uganda from October 1978 to April 1980 (URT, 2011a; Kayunze et al, 2010). In addition, the implementation of the first (1964 – 1969) five year development plan was interfered by the Arusha declaration of 1967 that led to the nationalisation of all major means of production and social services (Ngowi, 2009).

The government also prepared the second LTPP (1981 -2000) that was supposed to be implemented in four phases of successive five year development plans. However, the LTPP (1981 – 2000) never took off as a result of the escalated economic crisis and other challenges experienced in 1970s forcing the government to resort to short term plans such as the National Economic Survival Programme (NESP) (1981 – 1982) as an emergence programme to contain the economic crisis. Altogether, the government abandoned the implementation of envisaged five year development plans for the implementation of LTPP (1981 – 2000). According to URT (2011a), the NESP was immediately followed by the implementation of three consecutive three-year economic stabilization programmes namely the Structural Adjustment Programme (1982-1985) for stabilising the crisis, Economic Recovery Programme I (1986 – 1989), and Economic Recovery Programme II (1989 – 1992).

The post-colonial period, in particular the period between 1961 – 1990, saw the country experience the formulation of LTPP and medium term plans (five year development plans) most of which were not implemented as a result of economic and political crisis. As a result, the country adopted short term plans (one to three years)

hence compromising long term aspiration and targets. As noted in URT (2011a, p.2), "the planning process became ad-hoc, frequently interrupted in order to revert to crisis management, thus losing focus on strategic investments targeting long-term growth". In general, the planning process during this period focused on economic reforms, poverty reduction, and food production as a way of dealing with the crisis. Environmental management was then not a top priority to the government (Zahabu et al., 2009). Likewise, climate change was not a major problem of concern and therefore neither national nor international policies were formulated to address it.

Another development regarding the issue of climate change is noted during the post 1990s. During this post colonial period (1990s to date) a long term Tanzania Development Vision 2025 (TDV 2025) was formulated based on the experience that the pre-1990s plans failed to produce satisfactory results due to the absence of a guiding development philosophy (URT, 2011a). The TDV 2025 focuses on transforming the national economy and development to achieve middle income status by 2025. According to URT (2011a), the TDV 2025 was designed to be implemented through a series of five year development plans. However, the adoption of the TDV 2025 coincided with the implementation of far-reaching policy and institutional reforms, under the auspice of Heavily Indebted Poor Countries (HIPC) for the country to qualify for the debt relief initiative. As a result, the country, with the help of development partners, implemented the three years (2000 – 2003) Poverty Reduction Strategies (PRS) followed by the National Strategy for Growth and Reduction of Poverty I (NSGRP I: 2005-2010). The two (PRS 2000 – 2003 and NSGRP I 2005 – 2010) became the framework for the implementation of the TDV 2025 in the absence of the five years development plans. However, Tanzania embarked once again on the

implementation of the first five year development plan 2011/2012 – 2015/16 (FYDP I: 2011/12 – 2015/16) in 2011/2012 alongside the NSGRP II (2010 -2015) following the failure of NSGRP I to prioritize development issues and lay out specific strategic interventions to realize the objectives of Vision 2025 (URT, 2011a).

It was during the post 1990s when climate change gained both global and national recognitions as a threat to human well-being. Thus, post 1990s saw various international and national efforts to mainstream climate change adaptation and mitigation initiatives in policy and development institutions. Among the international attempt to address climate change include the formulation of the United Nations Framework Convention on Climate Change (UNFCCC) of 1992 (UN, 1992), the Kyoto Protocol of 1997 (UN, 1998) which was ratified in 2005, and the Bali Action Plan of 2007 as a road map towards addressing the problem of climate change (Fletcher & Larry, 2008). It is within this period whereby developing countries were urged to develop and implement their National Adaptation Programme of Action (NAPA) with the help of financial support from the international community (Global Humanitarian Forum, 2009) alongside other financial mechanisms (World Bank, 2010a).

Likewise, it is during the post 1990s when Tanzania started to respond to climate change as a way of both responding to the national impacts and complimenting global efforts on the issue of climate change. Thus post 1990s witnessed emergence of attempts to mainstream climate change adaptation and mitigation into various development policies and institutions as a way of responding to climate change challenges and fulfilling the international obligations stipulated in the UNFCCC and

the Kyoto protocol. For instance, in article 3 of the UNFCCC, countries are urged to integrate policies and measures to protect the climate system with national development programmes (UN, 1992). Such attempts are crucial in guiding and supporting climate change efforts that are necessary for avoiding, reducing, or delaying the impacts of climate change (Burton et al., 2006; IPCC, 2007). According to UNFCCC (2010), climate change impacts have the potential to push developing countries back into the poverty trap, and to undo many achievements that have been made towards attaining development goals (UNFCCC, 2010). However, the country is just in the initial stages of implementing measures, thus necessitating a need for studies to contribute towards this endeavour.

Given the historical background in the pre-colonial, colonial, and postcolonial periods, it is evident that climate change mainstreaming is a post 1990s attempt at both national and international levels. In view of this, the following sections review various national development policies, plans, strategies, and sectoral policies of post 1990s to establish the extent of climate change mainstreaming in Tanzania.

2.7. Climate Change Institutional Arrangement in Tanzania

According Young et al. (1999), institutions encompasses rules, decision making procedures and programs that define social practices, assign roles to the participants of such practices, and govern the interactions of those roles. In this regard, institutions are very important in facilitating the implementation of climate change initiatives by setting out procedures, roles and code of practices among actors involved in addressing climate change challenges. It is from this perspective that institutional arrangements are regarded as tools that structure risks and sensitivity to climate

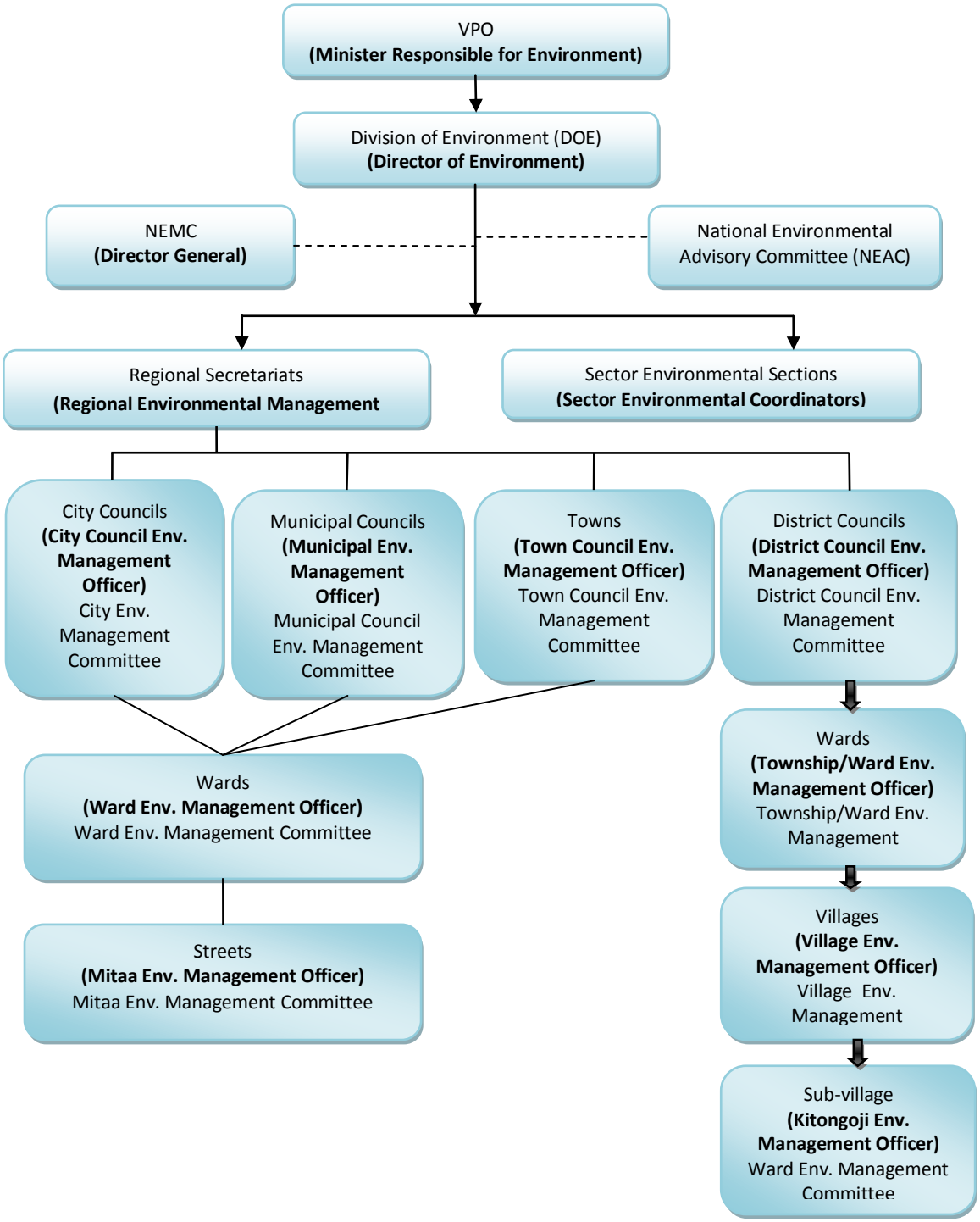
hazards, facilitate or impede individual and collective responses, and shape the outcomes of such responses (Agrawal, 2010:174). In this regard, Agrawal (2010) underscores the importance of understanding how institutions function so as to help in designing effective interventions to climate change of which its impacts continues to be uncertain.

The effectiveness of climate change institutions varies across different levels depending on the level of institutional development. Well developed institutions lead to greater adaptive capacity to climate change challenges as compared to less effective institutional arrangements (Smit & Pilifosova, 2007). Consequently, this implies that the ability to effectively deal with climate change challenges at a global, regional, nation and subnational level depends strongly on how the institutional arrangements facilitate the implementation of climate change policy options and strategies. Experience from developed countries indicate that climate change institutions facilitate the management of climate change risks and provide the institutional capacity to help deal with risks associated with future climate change (ibid.). Nevertheless, institutions are not stand alone arrangements; they operate in a complex way with other forces such as economic, political, technological and social settings; hence influencing the institutional outcomes (Young et al., 1999; Koch et al., 2007).

In Tanzania, the institutional arrangements for the implementation of climate change initiatives operates across the national, sectoral, regional and local government authorities as stipulated by the Environmental Management Act (Cap 191) of 2004. At the national level, the Vice President's Office – Division of Environment (VPO-DoE) is the National Climate Change Focal Point (NCCFP) responsible for

coordinating all climate related activities. Among the key roles of the NCCFP include the preparation of the national climate change frameworks and guidelines. In executing its mandate, the NCCFP is assisted by various committees established at both national and local levels. At the national level, there are two committees namely the National Climate Change Steering Committee (NCCSC) and the National Climate Change Technical Committee (NCCTC). The NCCSC chaired by the Permanent Secretary and NCCTC chaired by the Director of Environment provide policy guidance and technical advice, respectively, to the NCCFP. Other responsibilities for the NCCTC include stimulating coordinated actions of actors and broadening their participation in addressing climate change. At the local level, various committees responsible for addressing climate change are at the district, wards, streets, villages and sub-village levels (Figure 2.1).

MDAs are responsible for implementing climate change strategies at the sectoral level while the PMO-RALG in collaboration with LGAs and lined sector ministries are responsible for implementing climate change strategic interventions at the local level. The NCCSC and NCCTC are responsible in facilitating the implementation of cross-sectoral climate change interventions. Moreover, the National Bureau of Statistics (NBS) is responsible for keeping and updating track records on climate change. Specific responsibilities of different actors in the implementation of climate change strategies in Tanzania are as summarized in Table 2.2.



Source: URT (2004)

Figure 2.1: Institutional Arrangement for Environmental Management in Tanzania

Table 2.2: Actor's Responsibilities in Implementing Climate Change Strategies

Actor(s)	Responsibilities
VPO-DoE	• Overseeing all climate change activities • Providing policy guidance in relation to climate change activities • Coordinating actions and participation within various sectors, institutions and actors • Facilitating the implementation of cross-sectoral climate change interventions • Monitoring, evaluating, receiving reports and communicating on climate change issues • Awareness raising
MDAs	• Preparing climate change projects, programmes, actions plans and costing sector specific strategic interventions • Preparing budgets through MTEF to facilitate the implementation of their plans • Reporting the implementation status to the NCCFP on annual basis • Awareness raising
PMO-RALG	• Collaborate with LGAs and line ministries to implement the strategic interventions at local level
LGAs	• Preparing climate change projects, programmes, actions plans and costing local level specific climate change interventions • Preparing budgets through MTEF to facilitate the implementation of their plans • Reporting the implementation status of their Environmental Action Plans to the NCCFP on annual basis • Awareness raising
NBS	• Keeping and updating track records on climate change
Development Partners	• Providing financial and technical support to the government in implementing climate change strategies • Providing capacity building • Facilitating technology development and transfer to various stakeholders
Non Governmental Actors	• Cooperate with the government under Public Private Partnership (PPP) to implement various climate change projects and/or programmes such as CDM project activities and REDD+ initiatives • Facilitating the implementation of specific adaptation and mitigation projects at a community level • Awareness raising

Source: Extracted from URT (2012a) by the author

Therefore, the responsibility for implementation, coordination, monitoring and evaluation, keeping records, and dissemination of climate change activities in Tanzania are vested into various institutions. These comprise governmental (VOP-DoE, MDAs, PMO-RALG, LGAs and NBS) and nongovernmental (NGOs, Civil Society Organisations, religious institutions etc) institutions. On the other hand, development partners are critical in capacity building, providing financial and technical support, and facilitating technological development and transfer to governmental and nongovernmental actors.

In terms of financing climate change activities, resources can be solicited from a number of sources such as government budget, international funds and commitments related to UNFCCC and Kyoto Protocol, private sectors, as well as from individual contributions. Proposals are underway to establish a National Climate Change Fund (NCF) and climate change window under Basket Fund to ensure sustainability in financing climate change projects and programmes. This is of critical importance in strengthening climate change institutional support and capacity in Tanzania. As noted by Smit and Pilifosova (2007), inadequate institutional support weakens the institutions' ability to ease the hardship resulting from climate change.

In general, climate change initiatives in Tanzania are coordinated by the VPO-DoE as the national climate change focal point. The unit is responsible for streamlining international, national, sectoral and subnational climate change related efforts. According to Oulu and Emmanuel (2011), a designated high level strategic unit for coordinating climate change activities is vital in dealing with climate change challenges successfully. At the national level, the institutional arrangements as

provided in Figure 2.1 show linkages between different levels namely national, regional, sectoral, and subnational levels. This provides room for the interactions of a wide range of institutions and actors dealing with climate change challenges. According to Koch et al. (2007), addressing climate change requires collective actions and effective interactions of actors across various levels.

Indeed, climate change institutional arrangements in Tanzania meet the criteria of being linked to various levels and actors; necessary for addressing climate change (Koch et al., 2007, Measham et al., 2011). At the subnational level, the institutional arrangements indicate that the focal point at subnational levels is the environmental management officers at the district, wards and village/*mtaa* levels. On the other hand, the regional environmental management experts and the sector environment coordinators are responsible for coordinating environmental matters at the regional and sectoral levels. However, the sector environmental sections are not interlinked to the subnational levels where climate change impacts are strongly felt. This is contrary to the fact that climate change impacts affect a number of development sectors at the national and subnational levels (Koch et al., 2007).

The failure to have a clear linkage among institutions (in this case, environmental sections at subnational levels and sectors) is strongly criticised on the basis that assigning climate change adaptation and mitigation to the environmental section at subnational levels does not reflect the reality that climate change is a cross cutting issue (Measham et al., 2011). Furthermore, the effectiveness of subnational authorities in dealing with climate changes strongly depends on the commitments at the national level. As a matter of fact, the operations and decisions of local government authorities

are defined by the central government through various national policies and strategies. Therefore, the commitment at the national level influences the performance of climate change adaptation and mitigation initiatives at the subnational level (Measham et al., 2011). It is on this basis that Bierbaum et al. (2013) call for continuous review of climate change institutions and legal arrangements so as to curb climate change implementation challenges across various sectors and actors.

2.8. Role of Institutions in Facilitating Adaptations and Mitigation Practices

Adaptation to climate change usually takes place in a local context (Agrawal, 2010) and hence tends to vary from one place to another. This is based on the fact that different localities have varied adaptation practices depending on their livelihoods sources, activities, and the nature of climate change-related impacts. Likewise, climate change mitigation strategies are localized despite the fact that their impacts are usually transboundary in nature. However, the success of both adaptation and mitigation strategies depends on direct or indirect support from the institutions facilitating their implementations for the purpose of building resilience and reducing vulnerability (GLCA, 2009).

The fundamental roles of institutions in this aspect include creation of awareness, capacity building, strengthening knowledge base, and creation of an enabling environment for designing and implementing adaptation and mitigation practices. Furthermore, institutions are vital in mainstreaming adaptation and mitigation efforts and practices into development planning (UNFCCC, 2010). However, the effectiveness of the above highlighted institutional roles depends on availability of resources, technological capability, education and knowledge, and governance

(Christoplos et al., 2009). Nevertheless, it is worth noting that adaptation and mitigation strategies to climate change are generally influenced by international, national, and local institutions. International institutions include the United Nations through its various multilateral agreements and mechanisms, regional cooperation such as the East African Community, international NGOs, and the donor community. Such international institutions usually collaborate with national institutions in awareness creation, resource mobilization and capacity building among others. As noted in GLCA (2009), viable institutions and effective policy framework at the global and national levels are paramount in realizing climate change adaptation and mitigation goals.

On the other hand, local institutions in collaboration with the local communities are responsible for dealing with climate change challenges at the local level. According to Agrawal et al., (2008) there are three types of local institutions namely:

- Local public institutions which comprise local governments and local agencies such as extension services and other arms of higher levels of government operating at local level;
- Civic society institutions such as rural producer organizations, cooperatives, and saving and loan groups; and
- Private institutions such as service organizations (e.g. NGOs and charities) and private businesses that provide insurance or loans.

The major responsibility for the local institutions involves building resilience and reducing vulnerability of the most vulnerable social groups by buffering the costs (through financial support) of implementing relevant and effective adaptation and

mitigation options. In addition, local institutions are also responsible for strengthening local communities' adaptive capacity through their technical input, leadership, policy interventions, skills development and dissemination of relevant information (Agrawal & Nicolas, 2008; Agrawal et al., 2008; Gupta et al., 2010). It should be noted that poor people are not capable of meeting high costs and other challenges involved in adoption of some adaptation and mitigation options.

2.9. Theoretical Framework

For in-depth understanding of local community adaptation and mitigation strategies or practices to climate change, this study uses two prominent theories namely the adaptation (also known as survival of the fittest theory) and the system theory in particular the open system theory as advocated by biologists Charles Darwin in 1859 and Ludwig von Bertalanffy in 1950 respectively . On one hand, the adaptation theory borrows from organisms' adaptation and applies the same in exploring the current human adaptation strategies to climate change. On the other hand, the study uses the open system theory to address the issue of climate change adaptation and mitigation strategies as a system characterised by many components. It is through such understanding whereby the problem of climate change can best be addressed in a holistic view.

2.9.1. Adaptation Theory

Adaptation to climate change has its origin in adaptation theory also known as survival of the fittest theory as put forward by Charles Darwin in 1859 following an establishment of the relationship between organisms and their habitats in the Galapagos Islands. From biological definitions, adaptation is an evolutionary process

involving an adaptive trait which enables organisms to better survive in their ecological niches. The adaptive traits may be structural (physical features of organisms), behavioural, and (or) physiological. These traits lead to three types of biological adaptations namely changes in habitat, habitat tracking, and genetic change. Habitat change may lead to habitat tracking, genetic change or extinction. On one hand, habitat tracking implies the movement of population to another suitable locale following habitat change. On the other hand, genetic change occurs in a population when natural selection acts on the genetic variability of the population. In the situation when the population fails to move or change sufficiently to preserve its long term viability, its extinction is inevitable at least in that locale.

Based on the structural, behavioural, and physiological adaptive traits, the key issues for biological adaptation are flexibility, learning, and acclimatization all of which aims at improving the performance of individuals to their habitats. Flexibility implies the capacity of an organism to maintain themselves in different habitats. In addition, learning and acclimatization implies improvement in behavioural performance and automatic physiological adjustments during life respectively. From the above, it is clear that adaptation theory focus on the organism's ability to adapt to changes in their environment and adjust accordingly overtime following long or short term exposure to extreme conditions of their habitat. In this context, extreme conditions may be environmental pollution, environmental degradation, and climatic-related events among others. In addition, such extreme conditions can best be regarded as risks that mainly lead to disasters and hence the need for disaster response.

Although the founder of adaptation theory aimed to use the theory in explaining how organisms are able to adapt when exposed to new conditions, the theory is still relevant in explaining human adaptation to climatic change impacts. The significance of the theory is based on the reality that the persistence of climatic-related events such as drought, floods and heat waves has led to detrimental effects to the well-being of people especially the poor following their exposure and vulnerability to such events. It is an inevitable fact that, climate change effects are long term in nature and thus the need for adaptation if at all surviving the impacts is a viable option. According to UNFCCC (2010), adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effect; which moderates harm or exploits beneficial opportunities. Consequently, adaptation to adverse effects of climate change is vital in order to reduce the impacts of climate change that are happening now and also to increase resilience to future impacts.

In the perspective of human adaptation, the concept needs to be explained as a system especially when responding to environmental risks and hazards occurring to the natural systems and human systems (Smith, 1996). In human system, human populations are most vulnerable to hazards such as extreme climatic change events particularly floods and drought which substantially increases water insecurity, health risks, changes in livelihoods, effects on the wider economy and changes in agricultural productivity among others (Mearns & Andrew, 2010). Such impacts call for quick behavioural and structural responses to the situation. According to Smith (1996), behavioural response involves monitoring and scientific explanation of the geophysical process, physical and managerial control, and formulation of disaster plans and emergency response. Furthermore, structural response insists on changing

human exploitation to natural resources, availability of adequate resources to deal with the event, increase of choices (diversification) and reliance to local knowledge.

Although adaptation theory is very strong in explaining organisms' adaptation to their habitat, the theory falls short in explaining climate change as a system made up of various components which interact in a complex way. In addition, the theory fails to explain the concept of mitigation strategies as an important element for dealing with the problem of climate change. Hence the need for the open system theory to explaining the complex nature of climate changes adaptation and mitigation strategies with special attention on the roles and interactions among and between various components. In this case it is assumed that climate change adaptation and mitigation strategies as a system is not well understood and most likely those giving solutions to climate change only address part of the system (component) known to them while leaving other components unattended.

2.9.2. Open Systems Theory

The system theory is based on the work of Ludwig von Bertalanffy. According to Bertalanffy (1950), open systems are "capable of maintaining themselves in exchange of materials with the environment, and in continuous building up and breaking down of their components". Such views as put forward by Bertalanffy imply that systems are complex and dynamic in nature allowing for changes to take place within their components. Their complexity is based on the fact that the system allows the flow of materials from within and outside of its components (sub-systems), comprises independent but interdependent components, and the capability of the system to re-

establish after disturbance (Bertalanffy, 1950; McLoughlin, 1969). The latter is facilitated by its ability to import and export resources from and to the environment.

Therefore, the open system theory offers an important opportunity to address various environmental challenges holistically. The above argument can best be explained by key fundamental issues as raised by Bertalanffy (1950) and McLoughlin (1969). According to them, its dynamic nature, capability to exchange materials within and outside the system, capability to break down the components, and ability to continuously build up makes this theory to be more applicable in analysing community adaptation and mitigation practices to climate change hazards.

The dynamic nature of the system allows the system to change as per the needs or as caused by the current situation. Such phenomenon is crucial for the system to absorb shocks of which in this case are the shocks resulting from climate change hazards. Furthermore, the capability of the system to exchange materials within the subsystems allows the movement of resources from one subsystem to the other hence making the theory capable of explaining the interdependencies among various components of the system. For instance, the current efforts in addressing the problem of climate change involves the international community, regional blocks, national actors, various institutions, NGOs and the local community at large. In this case, the above mentioned organisations and institutions are considered important environmental factors which can influence the system to function properly as the phenomenon allows the movement (importation and exportation) of resources among and within components of the system.

On the other hand, the system has the ability to rebuild or to continuously build up in order to deal with the changing situation no matter how complex the situation is. This is based on the fact that the system and its sub-system tend to come up with new mechanisms suitable to the changing situation or for the re-establishment subsequent to turbulence. The process is facilitated by the flow of materials from within and outside of its components. All the above makes this theory more relevant in exploring the interactions between and within components of which in this case the major components are the climatic change hazards as well as adaptation and mitigation practices.

Considering the complexity surrounding the issue of climate change, the use of the system approach offers an imperative opportunity for analysing various components and their interdependence within the system. It should be noted that, the problem of climate change signifies a very complex system comprising components such as driving factors for climate change, its manifestation and impacts, adaptation, and mitigation all of which impacts the environment, economy and socio-cultural issues. Therefore, the open system approach helps in understanding the roles and relationships between and among various components in relation to climate change adaptation and mitigation strategies. In this case, the operationalisation of the system requires a strong collaboration of various actors and coordination from the local community, government (governance) in the form of policies and laws, strong local institutions and external support.

Conclusively, dealing with climatic change challenges requires involvement of local communities, governance, taking proactive approach, and technological approach all

of which form the backbone of sustainability issues. The concept of sustainability is well reflected in the Brundtland report on sustainable development whereby it aims at meeting the needs of the present without compromising the ability of the future generations to meet their own needs (WECD, 1987). It is an inevitable fact that human development significantly alters the natural systems leading to various detrimental environmental effects such as global warming which consequently affects agricultural production, raises sea levels, and disrupts the national economy at large. Sustainable developments therefore call for equity and reorientation of economic growth aiming at reducing environmental stresses. Consequently, such efforts can significantly reduce human vulnerability to climate change impacts and other catastrophes. This means that, realizing sustainable development entails adjustments and changes in development strategies through the use of appropriate technologies, institutional reorientation and promotion of equity among others. Such strategies will on one hand effectively reduce vulnerability and on the other hand increase resilience of the marginalized who severely suffer from the impacts of climate change.

Nevertheless, the above mentioned strategies require strong local institutions, good governance, and external interventions or support (GLCA, 2009). Strong institutions are very critical in dissemination of information, building knowledge, articulating needs, ensuring accountability, and transferring resources needed for adaptation. In addition, despite the fact that adaptation to climate change is highly local, external interventions through financial assistance, training, technologies, information, and meeting other costs of adaptation is necessary for helping the poor and vulnerable communities in building resilience and reducing vulnerability. Governance on the other hand is a very challenging concept in terms of its definition (UN, 2006; Al-

Marhubi, 2005). However, it simply implies the process in which the state plays a leading role, making priorities and defining objectives (Pierre & Peters, 2000). Others consider governance as the manner in which authority is exercised thus including the norms defining political action, the institutional framework in which public policies are designed, implemented and sustained (Al-marhubi, 2005). It is in this state-centric approach whereby Meadowcroft (2009) points out that climate change governance tasks governments to take an active role in favour of maintaining adaptation and mitigation regime. However, external intervention or support is important in realizing local adaptation and mitigation strategies as shown in the conceptual framework (section 2.10).

2.10. Conceptual Framework

Effective local community adaptation and mitigation strategies to climate change involve various issues or factors. Among the critical issues include the nature of climate change impacts and their manifestation, governance, local institutions and external interventions (Figure 2.2). All the above influence the community strategies in terms of adaptation and mitigation responses to climate change impacts. Therefore in assessing the community adaptation and mitigation strategies to climate change in semi arid areas of Dodoma region, a conceptual framework as indicated in Figure 2.2 was used.

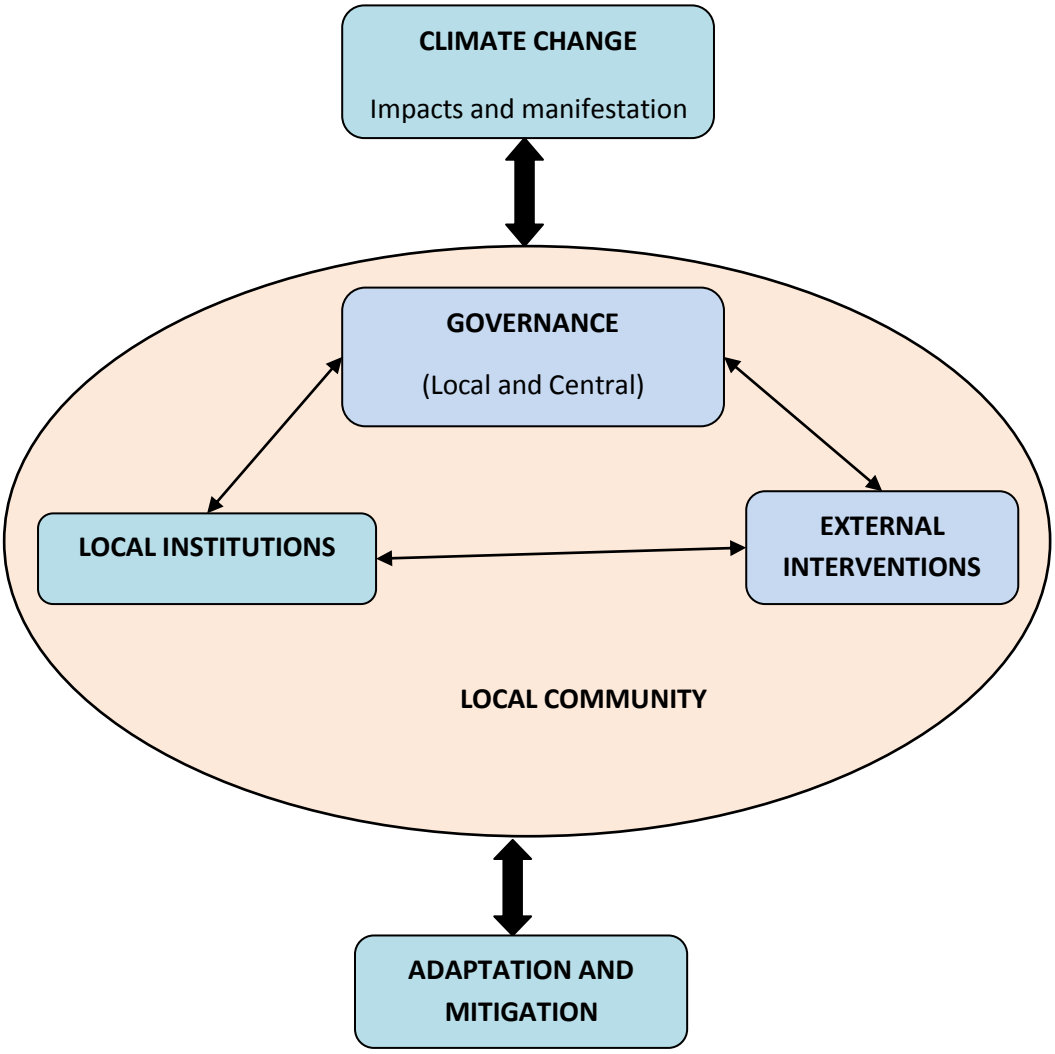


Figure 2.2: Conceptual Framework

The climate change impacts and its manifestation are critical in understanding the kind of adaptation and mitigation strategies. Worldwide, the major impacts of climate change are the extreme events such as droughts and floods, increased variability in rainfall and temperature, and shift in average temperature and rainfall (Anderson et al., 2010). These impacts are further manifested through reduced crop yields, increased wildfire risks, damage to crops resulting from disruption in crop development, disruption of water supplies leading to increase in water stress, land

degradation (e.g. soil erosion and encroachment of forest resources), livestock deaths and emergence of new livestock and human diseases such as rift valley fever and waterborne diseases. All the above impacts severely affect the livelihood of people taking into consideration that most residents in the study area depend on rain-fed agriculture and natural resources for their livelihood needs.

Generally, people living in semi arid areas are more vulnerable to the impacts of climate change therefore calling for the need to strengthen their adaptive capacity. Adaptive capacity in this case is the ability of the government (countries), communities and individuals to adjust in order to reduce vulnerability to climate change, moderate potential damage, cope with and recover from consequences. Adaptive capacity depends on availability of resources for adaptation, capability to adapt, education and knowledge, and governance (Christoplos et al., 2009; Gupta et al., 2010). All the above determinants for adaptive capacity can strongly be influenced by local institutions, governance and external interventions all of which are interlinked to one another.

According to Agrawal and Nicolas (2008), institutions are humanly created formal and informal mechanisms that shape social and individual expectations and behaviour. The major types of institutions are public (bureaucratic and administrative units and elected local government), civic (membership and cooperative organizations), and private sectors (service and business organizations). In terms of adaptation and mitigation strategies to climate change, local institutions play critical roles in structuring and distribution of climate risk impacts, constitute and organize the incentive structure for household and community level adaptation responses which

shape the nature of these responses, and mediate external interventions and governance issues. Therefore, of much interest in this study is to explore the way local institutions facilitates the implementation of local community adaptation and mitigation strategies.

Furthermore, external interventions are very instrumental in addressing climate change impacts. Usually, external interventions are in the form of policy instruments implemented through the use of various mechanisms. Among the external interventions as put forward by Agrawal and Nicolas (2008) are finance, knowledge and information, skills training, new institutional inputs, and technological support into local contexts. However, such external interventions are highly influenced and mediated by governance and local institutions respectively in facilitating local community adaptation and mitigations strategies. It is due to the above facts; an assessment of the local community adaptation should factor in the aspect of external interventions.

In facilitating adaptation and mitigation strategies to climate change at local level, the concept of governance involves the integration and mainstreaming of local community adaptation and mitigation options into policies, plans, and strategies. This can only be achieved through the use of regulations, provision of information, funding, partnership and other resources necessary for effective implementation of local adaptation and mitigation options to climate change impacts.

Adaptation and mitigation strategies to climate change have so many different faces depending on resource endowments. In dry areas, the major adaptations strategies include mobility, storage, diversification, and communal pooling. On the other hand,

agricultural methods, natural resource management, social networks and innovations that play critical roles in enhancing local adaptation and mitigation strategies depend on effective governance, local institutions and external interventions all of which are dynamic and interlinked to each other, to climate change impacts and to climate change adaptation and mitigation strategies.

2.11. Summary

In this chapter, issues on climate change, climate change adaptation and mitigation strategies, mainstreaming of climate change adaptation and mitigation strategies, and the role of institutions in facilitating adaptation and mitigation practices have been reviewed. However, in the course of the review it has been revealed that climate change is attributed by human activities. Nevertheless, various efforts are underway at international, national and local levels to address climate change challenges. The review has further established that climate change management requires a multifaceted approach such as the use of regulatory instruments, mainstreaming of climate change issues into policies, plans and strategies, institutional support and specific interventions to the affected activities. Such approach is critical in ensuring long term sustainability in dealing with climate change challenges and increasing resilience to climate change impacts. In particular, interventions to climate change should focus on creating awareness on climate change management issues, capacity building, strengthening knowledge base and creation of enabling environment for designing and implementing adaptation and mitigation practices.

CHAPTER THREE

METHODOLOGY

3.1. Description of the Study Area

This study was conducted in Dodoma region in Tanzania. Dodoma region is located in the central part of Tanzania (Figure 3.1) at 4^0 to 7^0 S and 35^0-37^0 E. The region, with an area of 41,310 km^2, 1,698,996 inhabitants and a total of 450,305 households (census of 2012), is bordered by four other regions: Manyara in the North, Morogoro in the East, Iringa in the South and Singida in the West. Administratively, the region is subdivided into seven districts namely Dodoma Municipal, Kongwa, Bahi, Mpwapwa, Bahi, Kondoa, Chemba, and Chamwino (URT, 2010a).

The climatic condition of Dodoma region is predominately characterized by long drought conditions (late April- early December) and short wet season with an average rainfall of 570 mm of which almost 85% falls between December and April. The average maximum and minimum temperature are 31^0 C and 18^0 C respectively (URT, 2010a). Based on the climatic conditions above, Dodoma region is an arid and semi arid area particularly in its eastern and central part respectively (URT, 2006).

The major economic activities for rural residents in the area are agriculture and livestock keeping. However, these activities are severely affected by relatively low, unpredictable and unreliable rainfall (URT, 2010a). As reported by Ehrhart and Michelle (2006), farmers in Dodoma region have experienced 80 percent fall in expected yields due to late or/and poor rains aggravated by rise in temperature. For instance, maize yield has declined by 84 percent in Dodoma as compared to the 33 percent of national average (URT, 2006).

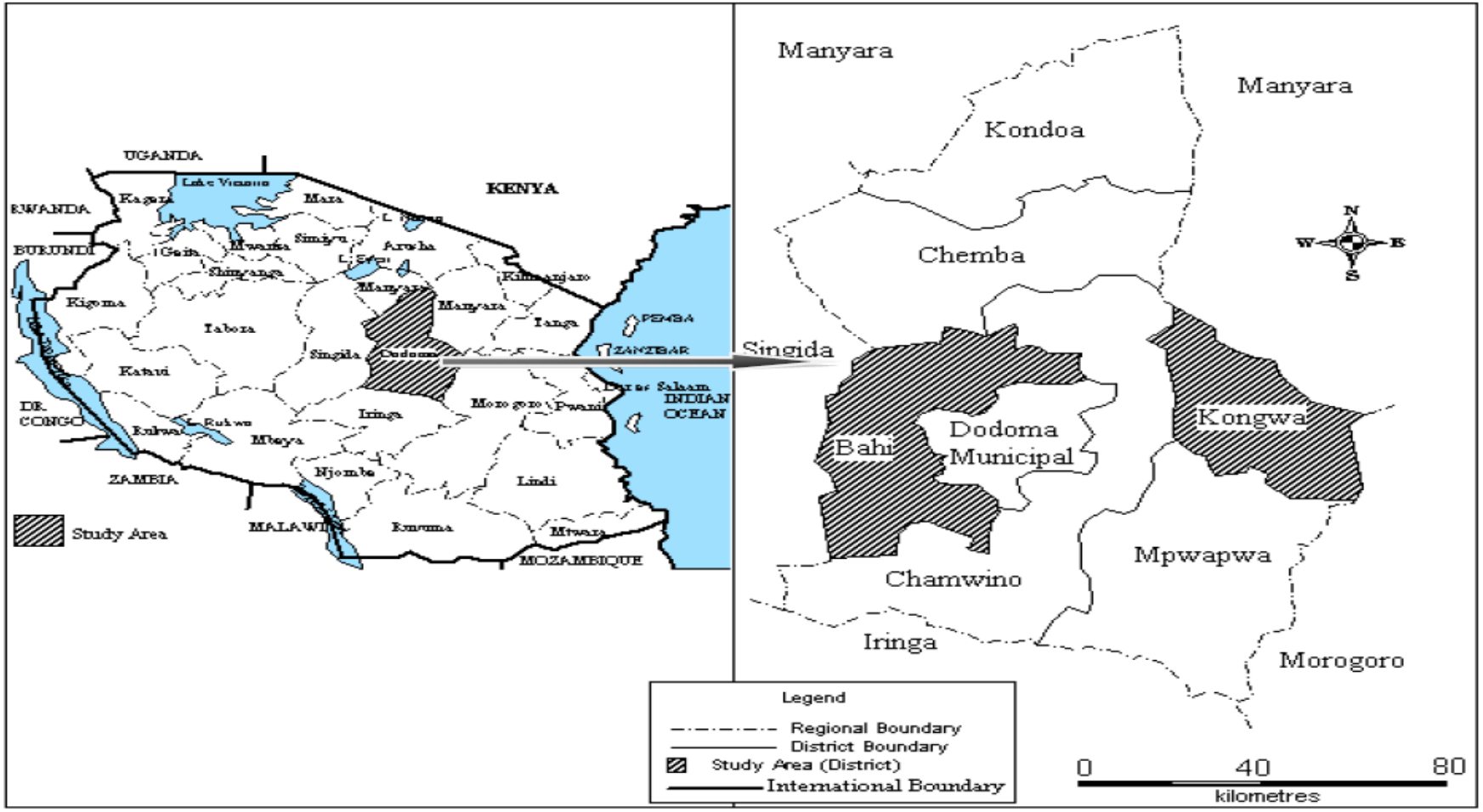


Figure 3.1: Map of Administrative Region in Tanzania and Districts of Dodoma Region as the Study Area (modified from URT, 2013a)

3.2. Types of Data Collected

This study aimed at exploring the local community adaptation and mitigation strategies to climate change in the semi arid areas of Dodoma region. In particular, the study focused on assessing the impacts of climate change on the livelihoods of the local community; determining the local community adaptation and mitigation strategies to climate change; mainstreaming of climate change issues in government policies, plans and strategies; and examining the role and contribution of local institutions in facilitating local community adaptation and mitigation practices. In realizing the study objectives both primary and secondary data were collected as indicated in section 3.2.1 and 3.2.2 and summarized in the data matrix (Appendix IV).

3.2.1. Types of Primary Data Collected

The types of primary data collected (categorical and continuous) were of socio-economic characteristics of respondents, climate change (extreme events) witnessed, local causes of climate change, effects of climate change on livelihood activities and sources, food and cash crop production overtime, factors affecting crop production, livelihood sources lost as result of climate change, and extent to which climate change affects livelihood sources and activities. Also, data on the local community adaptation and mitigation strategies with special focus on the type of strategies currently used by the local community, their usefulness in addressing climate change impacts, and challenges affecting their implementation were collected. Furthermore, primary data focusing on the role of actors in facilitating local community adaptation and mitigation strategies were also collected. The focuses on the role of actors were their objectives, interests, roles, and challenges in relation to climate change management.

3.2.2. Types of Secondary Data Collected

On the other hand, secondary data were also collected to compliment primary data. In the process of triangulation and complementing primary data, secondary data on climatic parameters (rainfall, temperature, and wind speed) for 30 years to depict changes associated with climate change; production trends of major crops; expenditure and relevant socio-economic and institutional data; status of climate change mainstreaming at different levels; and challenges affecting local community climate change initiatives were collected.

3.3. Research Design and Sampling Procedure

A cross sectional research design whereby the data was collected at a single point in time without repetition from the target population was applied. In this case, a number of data collection methods (section 3.6) such as interview, Focus Group Discussions (FGDs), observation, and review of various documents including reports were used in soliciting the required data.

In terms of sampling, both probability and non probability sampling were applied. Probability sampling was used in sampling households who were the unit of analysis in this study. In addition, non probability in particular purposive sampling was used to sample specific groups of respondents such as government officials and other interested stakeholders such as NGOs.

Taking into consideration the vast area of Dodoma region (41,310 km^2) and the fact that the region is subdivided into seven administrative districts (Dodoma municipal, Kongwa, Mpwapwa, Bahi, Kondoa, Chemba and Chamwino), multi-stage sampling was used as a sampling procedure. This is a sampling procedure whereby the

sampling process is carried out in phases and usually involves more than one sampling method and mainly used in the case of very large and diverse populations (Kothari, 2004). In this study therefore, two districts namely Kongwa and Bahi were purposively selected so as to establish a trend on matters pertaining to climate change impacts, adaptation and mitigation strategies as the two districts are severely affected by climate change extreme events such as drought, floods, and rainfall variability (URT, 2006; 2010b).

The next stage was to purposively sample 10 wards (5 wards from Kongwa District and 5 from Bahi District) on the basis of various selection criteria. In this case, the selection criterion used was representativeness (Vallee et al, 2007) on the basis of rainfall amount (400 - 650mm to represent semi aridity climatic conditions); economic activities (with both farming and livestock keeping all of which are rainfall dependent); areas with irrigation potentials (to facilitate intervention of climate change impacts in particular impacts resulting from rainfall shortage); areas with acute to moderate food shortage; areas receiving various institutional support in dealing with the effects of climate change hazards; areas of high potential of being affected with climatic hazards such as drought and floods). On the basis of the above criteria, five wards selected from Kongwa District were Kongwa, Sagara, Mtanana, Chamkoroma and Mlali (URT, 2010b; KDC, 2009; KDC, 2010a). On the other hand, Bahi, Mpamantwa, Chali, Mtitaa, and Chipanga wards were selected from Bahi District as they met the above selection criteria as indicated in URT (2010c).

One village meeting the criteria used in the selection of wards was selected from each of the selected wards. The villages selected from Kongwa District were Mnyakongo

(Kongwa Ward), Mtanana B (Mtanana Ward), Mlali Bondeni (Mlali Ward), Sagara B (Sagara Ward), and Chamkoroma (Chamkoroma Ward). On the other hand, the villages selected from Bahi District were Mpamantwa (Mpamantwa Ward), Chipanga A (Chipanga Ward), Chali (Chali Ward), Mtitaa (Mtitaa Ward), and Sanduli/Bahi Sokoni (Bahi Ward).

Thereafter, random selection of household respondents was undertaken. The use of random selection of household members was based on the fact that in order to obtain a reliable sample, both statistically and spatially, respondents need to be selected randomly (Varkevisser et al., 2003; Vallee et al, 2007). However, at the village level, same numbers of individual household were selected so that comparison could be done with the same precision (Vallee et al., 2007).

3.4. Sampling Frame

The target population for this study compromised all households found in both Kongwa and Bahi Districts in Dodoma region. According to the 2002 population census, the total number of households in Kongwa and Bahi districts was 94,188 of which 50,877 and 43,311 households were from Kongwa and Bahi districts, respectively (URT, 2002). In this case, a total of 94,188 households formed the target population of this study.

3.5. Sample Size

As the study population was too big (94,188 households), only a representative sample of households was included in the study. It should be noted that either household heads or an older person found at the household during the survey was

interviewed (Varkevisser et al, 2003). The following formula as provided by Yamane (1967) was used to determine the sample size.

$$n = \frac{N}{1 + N(e)^2} \quad \text{………………………………………………………} (3.1)$$

Where n is the sample size, N is the population size and *e* is the precision level which in this study is 0.05. Based on this formula, the sample size for this study was 398 households from the two districts as shown below.

$$n = \frac{94{,}188}{1 + 94{,}188(0.05)^2} = 398 Households$$

However, taking into consideration the number of households in each of the two districts, a proportionate approach as calculated below was used to select 215 and 183 households from Kongwa and Bahi districts, respectively.

Given

Number of households in Kongwa District (HHK) = 50,877

Number of household in Bahi District (HHB) = 43,311

Total number of Households in Kongwa and Bahi districts (THHKB) =94,188

Total sample size (TSS) = 398 households

Formula

Sample size as per the district = $(HHK or HHB / THHB) \times TSS$ ………....... (3.2)

Therefore

$$\text{The sample size for Kongwa District} = (HHK/THHB)\times TSS$$

$$= (50{,}877/94{,}188)\times 398 = 215 households$$

$$\text{The sample size for Bahi District} = (HHB/THHB)\times TSS$$

$$= (43{,}311/94{,}188)\times 398 = 183 households$$

In order to ensure that the sample size was representative, 215 household heads or elders (in case the household head is not available) from Kongwa District were selected from 5 villages of the selected 5 wards. In addition, 183 households' heads or elders from Bahi District were selected from 5 villages of the selected wards. The selection of villages and wards was based on the selection criteria as indicated in section 3.3.

3.6. Data Collection Methods

In soliciting the required information for this study, both primary and secondary data (specific types of data collected are indicated in section 3.6) were collected. Primary data was collected using data collection methods such as Focus Group Discussion (FGD), interview and observation.

3.6.1. Focus Group Discussions

Two Focus Group Discussions (FGDs) each with 12 participants (males, females, crop farmers and livestock keepers) were conducted in Kongwa and Bahi districts. The purpose of this approach was to obtain in-depth information on the manifestation, impacts and local community institutions and adaptation strategies to climate change.

In addition, the method was also intended to explore information on the challenges facing local adaptation and mitigation strategies. However, it should be noted that, in order to facilitate the process of FGD among different groups as mentioned above, a guide with series of open ended questions was developed and consequently used to guide the discussion. In this case, the questions in a guide for the FGD were designed based on issues stipulated in the Climate Vulnerability and Capacity Analysis (CVCA) and Community-based Risk Screening tool – Adaptation and Livelihood (CRiSTAL) as standardised tools among others for analysing climate change issues (Sterrett, 2011).

3.6.2. Interview

Furthermore, interviews were used to collect data from households, government officials, NGOs, CBOs representatives and other key informants through the use of structured questionnaires and checklists. Specifically, structured interview was used to collect information on climate change adaptation and mitigation strategies from households in the study area (see section 3.2). In addition, key informants interviews were conducted to government officials, NGOs/CBOs and few local leaders through the use of checklists. Key informant's interviews were aimed at supplementing information collected from households. According to Kothari (2004), key informants interviews help to recognize the views and perspectives of key informants such as government officials and NGOs/CBOs representatives involved or responsible in facilitating local community adaptation and mitigation strategies to climate change.

3.6.3. Observation

Observation, in particular non participant observation, as a method of data collection was used to collect primary data in the study area. The data collected with this method

were those related to observable adaptation and mitigation to climate change strategies such as water storage infrastructures, storage facilities, diversification strategies, conservation efforts, sustainable land uses and effects of droughts (e.g. crop failure) and floods (e.g. Infrastructural damages) among others. The information collected through observation was systematically documented in the form of text. At its core, this method was used to complement the information by other data collection methods such as interviews and FGDs.

3.6.4. Documentary review

On the other hand, documentary review was used in colleting secondary data. Secondary data were collected from various published and unpublished government, NGOs, CBOs documents such as policies, plans, and strategies; assessment, implementation and monitoring and evaluation reports; District and Regional Medium Term Expenditure Frameworks (MTEF); MDGs implementation reports; and the National Strategy for Growth and Reduction of Poverty (NSGRP) reports among others. In particular, documentary review was instrumental in collecting information on climatic data (rainfall, temperature and wind speed), production trends of major crops produced, expenditure in facilitating local community-related adaptation and mitigation strategies, and relevant socio-economic and institutional data.

3.7. Data Processing and Analysis

3.7.1. Data Processing

The data collected using various data collection methods were processed prior to analysis. Data processing especially for quantitative data involved checking for errors mainly through editing/cleaning with the purpose of looking for completeness of

responses, removing logical inconsistencies, and combining similar responses. These processes were followed by categorization of data, coding and data entry in the computer programme (in this case SPSS version 16) and verification that aims at removing entry errors. On the other hand, meteorological data on rainfall, temperature and wind speed were processed using Microsoft Office Excel 2007.

3.7.2. Data Analysis

The collected data were analyzed using both qualitative and quantitative approaches.

3.7.2.1. Analysis of Qualitative Data

The analysis of qualitative data was done by using content analysis approach. According to Kothari (2004), content analysis consists of analyzing the content of documentary and verbal materials. In this regard, the data obtained through documentary review and FGDs were both analysed by using content analysis. The data analyzed using qualitative approach include information on the status of climate change mainstreaming, government expenditure on adaptation and mitigation initiatives and challenges affecting local community efforts in dealing with climate change challenges.

3.7.2.2. Analysis of Quantitative Data

Information collected using questionnaires was analyzed using the Statistical Packages for Social Sciences (SPSS) version 16. This involved the production and interpretation of frequencies, tables and graphs that describe the data. In addition, both descriptive and analytic cross tabulation so as to describe or provide explanations that requires a combination of information on two or more variables was also employed. Whereas descriptive cross tabulation aimed at describing the problem

under study, analytic cross tabulation involves comparing groups in order to determine differences and relationships between variables (Varkevisser et al., 2003). The major test statistic approaches used in analysing quantitative data were Chi-square test of independence, t-test of independence, and the Principal Component Analysis. Effect size for the t-test was determined by Eta squared and for chi-square by phi and Cramer's V coefficients. The details for quantitative analysis are given below.

Chi- square Test of Independence

The chi-square test for independence was used to explore the relationship between categorical variables (see chapter 4). According to Field (2009), chi-square is used to explore the relationship or association between two categorical variables by comparing the observed frequencies of cases that occur in each of the categories with expected values. The results on the relationship between categorical various were considered significant if $p < 0.05$. Below is an equation for chi-square.

$$\chi^2 = \sum \frac{(O-E)^2}{E} \qquad \text{..... (3.3)}$$

Where by x^2 = Chi-square, O = Observed frequency, E = Expected frequency

Determination of the Magnitude of Association when using Chi-Square Test of Independence

In determining the magnitude of association between two variables, phi statistics and Cramer's V coefficient were used whereby phi statistics was used for 2 x 2 contingency table and Cramer's V coefficient for contingency table with number of rows and columns greater than 2. The equations for phi statistics and Cramer's V are given below:

The Phi coefficient (ϕ)equation is $\phi = \sqrt{\frac{\chi^2}{N}}$ ……..... (3.4)

Where χ^2 = Chi-square; N = Sample size

The Cramer's V equation for Cramer's is $C = \sqrt{\frac{\chi^2}{n(k-1)}}$ …… (3.5)

Where χ^2 = is derived from chi-square test; n = sample size (grand total of observations); k = the smaller number between the number of rows and number of columns is used in for k.

According to Pallant (2011), the interpretation of Cramer's V as a statistic for measuring the effect size (values 0 to 1 with higher values indicating a stronger association between the two variables) is for two categories (small = 0.01, medium = 0.30 and Large = 0.50), for three categories (small = 0.07, medium = 0.21 and large = 0.35), and for four categories (small = 0.06, medium = 0.17 and large = 0.29)

T-test of Independence

The t-test of independence is used in comparing the mean score of continuous variable for two different groups of participants (Field, 2009). The equation for the t-test of independence is given below:

The t-test equation when population variances are different is $$t = \frac{\left(\bar{x}_1 - \bar{x}_2\right)}{\sqrt{\frac{s_1^{\,2}}{n_1} + \frac{s_2^{\,2}}{n_2}}} \quad (3.6)$$

The t-test equation when population variances are equal is $$t = \frac{\left(\bar{x}_1 - \bar{x}_2\right)}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad \ldots\ldots (3.7)$$

Where $\bar{x}$ = mean; s = standard deviation; and n = sample size

During the analysis, the Levene's test for equality of variance was used. In the case where the significance value for the Levene's test was less than 0.05 in the SPSS, then the assumption of homogeneity of variance has been broken and the values for t-test was read from the row labelled equal variance not assumed. For the case where the significance value of Levene's test was bigger than 0.05, then the values for t-test was read from the row labelled equal variances assumed.

Determination of Effect Size when using t-test of Independence

The determination of the effect size for the t-test of independence was calculated using the Eta squared values. The effect size provides an indication of the magnitude of the difference between groups (not just whether the difference could have occurred by chance).

The equation for the Eta squared is $$\frac{t^2}{t^2 + \left(N_1 + N_2\right) - 2)} \quad \ldots\ldots\ldots\ldots\ldots (3.8)$$

Whereby t = *t* value; N_1 and N_2 = sample size; and (N1 + N2) – 2 = degree of freedom

According to Pallant (2011), Eta squared is an effect size statistics that provide an indication of the magnitude of the differences between groups. Eta squared can range from 0

to 1 and represents the proportion of variance in the dependent variable that is explained by the independent (group) variable. Its interpretation is based on the guidelines proposed by Cohen in 1988 whereby 0.01 = small effect size, 0.06 = moderate effect size, and 0.14 = large effect size (Pallant, 2011).

Principal Component Analysis

The Principal Component Analysis (PCA) was used to analyse the twelve (12) items considered as key in explaining the extent to which climate change affects households' livelihood activities using SPSS version 16. These items were effects on household income, effects on agricultural productivity, effects on water availability, effects on planting season, destruction of crops, size of land cultivated, effects on water availability for livestock, effects on the number of livestock, reduced pasture for livestock, destruction of settlements, effects on socioeconomic activities, and natural resources degradation.

Prior to performing PCA, the suitability of data for PCA was assessed. Inspection of the correlation matrix (Appendix V) revealed the presence of many coefficients of 0.3 and above. The Kaiser-Meyer-Olkin value (a measure of sampling adequacy) was 0.84, exceeding the recommended value of 0.6 and Bartlett's test of sphericity reached statistic significance ($x^2(398) = 2089.23$, $p < 0.001$), supporting the factorability of the correlation matrix. Principle component analysis using the Kaiser's criterion revealed the presence and hence accepted three eigenvalues exceeding 1. The Kaiser's criterion requires the inclusion of factors with eigenvalue of 1.0 or more for PCA (Field, 2009; Pallant, 2011). In this regard, only three components with eigenvalues more than 1 were accepted for further analysis (Table

3.1). An inspection of the Scree plot *(*Appendix V*)* also slightly showed an inflection between both the second and third components. Consequently, a decision was made to use three components during PCA on the basis of Kaiser's criterion, adequate sample size (N= 398) and scree plot (Field, 2009).

Table 3.1: Selection of Components using Eigenvalues from PCA and Kaiser's criterion

Component number	Decision based on Kaiser's criterion	
	Eigenvalue from PCA	**Decision**
1	4.993	**Accept**
2	1.621	**Accept**
3	1.069	**Accept**
4	0.931	Reject
5	0.727	Reject
6	0.613	Reject
7	0.464	Reject
8	0.405	Reject
9	0.346	Reject
10	0.313	Reject
11	0.286	Reject
12	0.232	Reject

An analysis of the three components explained a total of 64.03% of the variance, with component 1 contributing 41.61%, component 2 contributing 13.51 and component 3 contributing 8.91%. Thereafter, Oblimin rotation for revealing pattern and structure coefficients was performed in order to aid in the interpretation of three components by indicating the factor loading of each of the variables and the correlation between variables and factors (Pallant, 2011). The rotated solutions revealed both components showing a number of strong loadings in the three components. However, only

variables with factor loading greater than 0.40 were used in naming the three components as suggested by Ozor et al. (2010).

Analysis of Meteorological Data

Meteorological data obtained from Tanzania Meteorological Agency (TMA) for rainfall, temperature and wind speed for Dodoma region were analysed to determine the trends of the named weather elements. The climatic data were analysed using time series analysis (Mudelsee, 2010; Shumway & Stoffer, 2010; Witt, 2013). Prior to analysis, the anomalies of actual climatic data for rainfall, temperature and wind speed were normalised (Tesso et al., 2012) using the formula indicated in equation 3.9.

The equation for normalisation of climatic data is $= \frac{(x - mean)}{SD}$ …… (3.9)

Whereby x = actual value for climatic parameter; and SD = standard deviation

Thereafter, the normalised data were subject to the XY scatter plot in MS Excel that produced linear trend lines and equations indicating rainfall, temperature and wind speed trends for Dodoma region. The outcomes of the analysis showing the trends on climatic parameters are given in chapter 4.

Descriptive and Multiple Responses Analysis

Other analyses used in this study by using SPSS version 16 were descriptive analysis (sometimes cross tabulated) and multiple responses (sometimes cross tabulated) in the case of multiple answers from respondents per question.

CHAPTER FOUR

RESULTS

4.1. Introduction

This chapter presents the results from the field. The chapter focuses on climate change driven impacts, local community adaptation and mitigation strategies, mainstreaming of climate change in government policies, plans and strategies, and the role of actors in facilitating local community adaptation and mitigation strategies in the study area.

In this regard, the chapter explores the nature, impacts, responses and challenges of climate change to the local community. This is undertaken with a view of increasing awareness of risks associated with climate change alongside the fact that climate change impacts are local and efforts to address such challenges should be place-based and informed by the understanding of the local context.

4.2. Respondents' Characteristics

Despite the fact that the study examined climate change adaptation and mitigation strategies in local community in Dodoma, before looking at the adaptation and mitigation measures, it was considered important to have a glimpse of the characteristic of the people affected. In this regard, the study examined key respondents characteristics such as sex, age, marital status, education level and number of years living in the area. Other characteristics were organisational membership, source of income and assets owned by households. The results of the characteristics of respondents are presented in section 4.2.1 – 4.2.8.

4.2.1. Sex of Respondents

Results in Table 4.1 show that male respondents in the study area were 61.1% while females were 38.9%. This implies that both male and females were involved in this study. The number of male respondents is bigger as compared to the number of females due to the fact that the study earmarked heads of households of which majority of households were male-headed. In the case where the head of households were not available for interview the study interviewed their wives.

4.2.2. Age of Respondents

Results in Table 4.1 indicate that all interviewees were aged between 15 years and above implying that respondents were mature and hence capable of understanding the phenomenon of climate change. The findings imply that most respondents were in the economically active group (lower, middle and higher category of labour force). In addition, respondents at the age bracket 65+ years were 20.6% of the total respondents. The age distribution of respondents into various age brackets signifies that there is a good mix of people with various ages in the study area and hence capable of capturing information on climate change challenges and measures from different community groups.

4.2.3. Marital Status of Respondents

Results in Table 4.1 indicate that married respondents accounted for 87.2% of the total respondents as compared to single (4.5%), widowed (6.8%), and divorced (1.5%). Based on the results, the study has established that majority of respondents have family responsibilities and therefore involved in various socio-economic activities such as agriculture, livestock keeping, businesses, and formal employment

among others. Their involvement in various livelihood activities is of critical importance in understanding the effects and measures used in addressing climate-related events in such activities.

Table 4.1: Distribution of Respondents Based on Characteristics of Respondents by Respondents' District of Residence (N = 398)

Variables	Characteristics	District of residence		Total
		Bahi	Kongwa	
Sex	Male	96 (24.1)	147 (36.9)	243 (61.1)
	Female	87 (21.9)	68 (17.1)	155 (38.9)
Age	Below 34 years	45 (11.3)	17 (4.3)	62 (15.6)
	35 – 50 years	55 (13.8)	72 (18.1)	127 (31.9)
	51 – 64 years	62 (15.6)	65 (16.3)	127 (31.9)
	65+ years	21 (5.3)	61 (15.3)	82 (20.6)
Marital status	Married	155 (38.9)	192 (48.2)	347 (87.2)
	Single	10 (2.5)	8 (2.0)	18 (4.5)
	Widowed	16 (4.0)	11 (2.8)	27 (6.8)
	Divorced	2 (0.5)	4 (1.0)	6 (1.5)
Education level	Primary	120 (30.2)	169 (42.5)	289 (72.6)
	Secondary	12 (3.0)	13 (3.3)	25 (6.3)
	Tertiary	0 (0.0)	6 (1.5)	6 (1.5)
	Adult education	7 (1.8)	18 (4.5)	25 (6.3)
	Illiterate	44 (11.1)	9 (2.3)	53 (13.3)
Years living in the area	1 – 5 years	17 (4.3)	4 (1.0)	21 (5.3)
	6 – 10 years	17 (4.3)	11 (2.8)	28 (7.0)
	11 – 15 years	27 (6.8)	9 (2.3)	36 (9.0)
	> 15 years	122 (30.7)	191 (48.0)	313 (78.6)
Organisational Membership	Member	15 (3.8)	81 (20.4)	96 (24.1)
	Not a member	168 (42.2)	134 (33.7)	302 (75.9)
Source of household income*	Farming	158 (39.7)	213 (53.5)	371 (93.2)
	Sale of livestock	70 (17.6)	69 (17.3)	139 (34.9)
	Charcoal burning	34 (8.5)	14 (3.5)	48 (12.1)
	Formal employment	11 (2.8)	3 (0.8)	14 (3.5)
	Business	34 (8.5)	65 (16.3)	99 (24.9)
	Part time jobs	5 (1.3)	8 (2.0)	13 (3.3)
	Brewing local beer	6 (1.5)	10 (2.5)	16 (4.0)
	Others	21 (5.3)	5 (1.3)	26 (6.5)

Note: Dataset based on multiple responses; values in parentheses are percentages

4.2.4. Education Level of Respondents

Another factor of interest examined was the education level of respondents whereby the results in Table 4.1 indicate that 72.6% of respondents have primary school education. Other respondents have secondary education (6.3%), tertiary education (1.5%), and adult education (6.3) while the remaining 13.3% are illiterate. Compared to the findings from the study area on level of education, the findings from URT (2014) indicate that majority of Tanzanians (81.7%) has primary education as their highest level of education. From these findings, the study has established that most respondents had low level of education. This low level of education which is a characteristic of most rural Tanzanian has various disadvantages in relation to local communities' ability to adapt and mitigate climate change challenges.

Among the disadvantages of low education in the area include denying them opportunities to undertake other economic activities such as formal employment in both public and private sectors, and failure to adopt good agricultural practices and innovations through learning from various sources of information. The findings further suggest the need for effective extension services and outreach programmes in improving climate change adaptation and mitigation practices in the area. These findings are consistent with NBS (2006) and Salau et al (2012) who consider high literacy and quality education as a way of increasing productive capability by enhancing the capacity of people to understand, ability of accessing accurate information, and managing and harnessing the environment through increased knowledge and adoption of science and technology in the process of production.

4.2.5. Number of Years Living in the Area

The findings in Table 4.1 show the number of years under which respondents have been living in the study area. The findings indicate that 78.6% of the total respondents have lived in the area for above 15 years. The remaining 5.3%, 7.0%, and 9.0% have lived in the area for 1 – 5 years, 6 – 10 years and 11 – 15 years respectively. From these findings it has been established that majority of respondents have lived in the area for more than 10 years (a decade) and therefore they were better placed to understand and explain the dynamics and impacts of climate change overtime in the area of study. Similar findings were also noted by Ugokwe et al (2012) and Oluwasusi and Sangotegbe (2012) in Nigeria.

4.2.6. Organisational Membership

With regard to organisational membership, most respondents (75.9%) were not members of any organisation (Table 4.1). However, membership-based organisations such as Savings and Credit Cooperatives (SACCOS) play an important role in facilitating climate change adaptation and mitigation practices. As revealed during FGDs, such organisations are crucial in pooling community resources and knowledge sharing among community members. The findings are in tandem with Rodima-Taylor (2012) and Makanya et al (2010) who by using experiences from Tanzania and Kenya argue that community organisation can play a pivotal role in empowering the local community in responding to climate change impacts through shared knowledge such as on new cultivation techniques, crop varieties, markets, and provision of social support for their members.

4.2.7. Source of Household Income

Results in Table 4.1 shows that the main sources of income at household level in the study area are crop farming (93.5%), sale of livestock (34.2%), business (24.4) while others include charcoal burning (12.1%), formal employment (6.3%), brewing local beer (4.0%), and part time jobs (2.5%). Based on these findings the major sources of household income are farming, sale of livestock and business. Nevertheless, the major sources for household income are also exposed to the vagaries of climate variability, hence calling for the need for diversification of livelihood activities. In addition, charcoal burning and brewing of local beer poses threats to vegetation resources and food storage; therefore affecting the quality of forests in carbon sequestration and food security, respectively. The effects of climate change on major sources of household income such crop farming and livestock keeping are also experienced in other places (Ozor & Cynthia, 2010; Njau et al., 2014).

4.2.8. Assets Owned by Households

The findings in Table 4.2 show that the assets owned by respondents are farmland (98.5%), house (64.6%), livestock (38.7%) and woodlot (0.8%). The findings in Table 4.2 partly imply that most respondents own land and their main activities as indicated in previous sections are farming and livestock keeping. Crop and livestock farming being the main activities, the findings suggest for the need of proper land use management for sustainable livelihood in the area taking into consideration that land is the main asset owned by majority of households. In addition, the findings shows that just a small number of responds (0.8%) own woodlots.

Table 4.2: Assets Owned by Households (N = 398)

Assets owned by households	N	Percent
Farmland	392	98.5
Livestock	154	38.7
House	257	64.6
Woodlot	3	0.8
Others	3	0.8

Note: Dataset based on multiple responses

Given the findings, a majority of respondents depends on natural or village forests for firewood and other forest-related products. In the long run, this leads to forest degradation and therefore reducing the ability of the forest as a carbon sink. Furthermore, taking into consideration the nature of assets owned at household levels in the study area, the management of rangelands; soil conservation strategies; and establishment of woodlots at local levels can play a great role in strengthening local communities' adaptive capacity to climate changes. In general, assets and their proper management and protection are of paramount importance in building local community resilience to climate change hazards. These findings are in tandem with Rodima-Taylor (2012) and Heltberg et al. (2010) who call for proper management of livelihood assets as a way of building community resilience to climate change.

Land being the major asset owned by households in the study area, respondents were asked to identify the size owned and cultivated by their households. The findings in Table 4.3 indicate that majority of households (58.0%) owned farm size between 1 to 5 hectares followed by 29.6% of households owning between 6 to 10 hectares. Only few households (6.5%) own 16 hectares or above. With regard to the farm size cultivated, the findings show that majority of households (66.1%) cultivates between

1 to 5 hectares followed by 24.9% who cultivates between 6 to 10 hectares. Only 4.8% of households cultivates between 16 hectares and above.

Table 4.3: Farm Size Owned and Cultivated (ha) within Respondents' District of Residence (N = 398)

Status	Farm size (in Ha)	Respondents district of residence		Total
		Bahi	Kongwa	
Farm size owned	1 – 5 ha	131 (71.6)	100 (46.5)	231 (58.0)
	6 – 10 ha	31 (16.9)	87 (40.5)	118 (29.6)
	11 – 15 ha	12 (6.6)	11 (5.1)	23 (5.8)
	16 + ha	9 (4.9)	17 (7.9)	26 (6.5)
Farm size cultivated	Below 1 ha	1 (0.5)	1 (0.5)	2 (0.5)
	1 – 5 ha	139 (76.0)	124 (57.7)	263 (66.1)
	6 – 10 ha	35 (19.1)	64 (29.8)	99 (24.9)
	11 – 15 ha	4 (2.2)	11 (5.1)	15 (3.8)
	16 + ha	4 (2.2)	15 (7.0)	19 (4.8)

Note: Values in parentheses are percentages

Furthermore, an independent sample t-test was conducted to compare the households' farm size owned (ha) and cultivated (ha) by using continuous data for Kongwa and Bahi districts (Table 4.4). On average, households in Kongwa District owned larger farms *(M = 7.74, SD = 7.73)* than households in Bahi District *(M = 6.08, SD = 8.5)*. This difference was significant (*t (396) = -2.05, p value = 0.04*, two tailed). The magnitude of the differences in the means (mean difference = -1.67, 95% Confidence interval (CI): -3.27 to -0.07) was small (eta squared = 0.01). With regard to the farm size cultivated, households in Kongwa District cultivated larger farms *(M = 6.9, SD = 6.7)* than households in Bahi District *(M = 4.48, SD = 3.6)*. This difference was significant *t (340) = -4.64, p value = 0.000*, two tailed. The magnitude of the differences in the means (mean difference = -2.45, 95% Confidence interval (CI): -3.49 to -1.41) was small (eta squared = 0.05).

Table 4.4: Mean Values for Farm Size Owned and Cultivated (ha) by Bahi and Kongwa Districts' Households

Farm size (ha)	Mean ± SD		t-value	df	Sign. (2-tailed)	Mean Difference	95% CI of the Difference	
	Bahi	Kongwa					Lower	Upper
Owned	6.08 ± 8.5	7.74 ± 7.73	- 2.05	396	0.041	-1.67	-3.27	-0.07
Cultivated	4.48 ± 3.6	6.9 ± 6.7	- 4.64	340	0.000	2.45	- 3.49	- 1.41

4.3. The Impacts of Climate Change in Dodoma Region

One of the key aims of the study was to establish the impacts of climate change on livelihoods of the local community in the semi arid areas of Dodoma region in Tanzania. To achieve this, changes associated with climate change with special focus on trends of meteorological data on rainfall, temperature and wind speed and views from respondents on such trends in the study area were established. In addition, challenges faced by the local community as a result of climate change driven impacts were also examined.

4.3.1. Trends in Climatic Parameters: Rainfall, Temperature and Wind Speed

The study sought to establish nature of climate change and variability in Dodoma region. This was done by analysing meteorological data collected from Tanzania Meteorological Agency (TMA). This is based on the fact that the exposure to climate change can be interpreted as the changes in a location's climate variables such as temperature, precipitation and wind speed.

The analysis of annual rainfall data for the period 1980 - 2011 indicated a general declining trend on the amount of rainfall in Dodoma region (Figure 4.1). Further

analysis of the monthly rainfall trends for the same period taking into consideration of months (Appendix VI) with rainfall in the area showed a declining trend of actual mean monthly rainfall amount in the months of January, March, April, May and November in the same period. Further, the findings showed slight increasing rainfall trend in February, October, and December.

The findings suggest that the monthly rainfall amount is highly declining in April and shows a slight decline in January, March, November and May. Nevertheless, the increasing rainfall trend is most conspicuous in December with a slight increase in October and February. These findings have established a shifting trend in rainfall pattern towards October implying an early onset of rainfall than normal as also indicated in Figure 4.2. The trends also indicate an early end of rainfall as reflected in declining trend of rainfall in March and April which are critical months for the flowering and maturity of crops, consequently leading to low agricultural productivity. The likely reasons for the changing trends in rainfall amount in accordance to the local community views are as indicated in section 4.3.2.

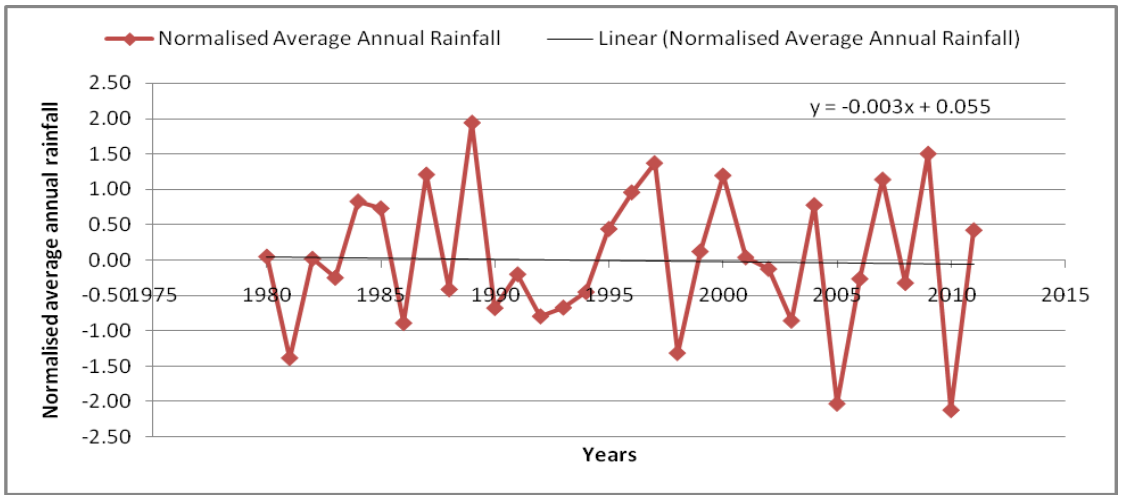
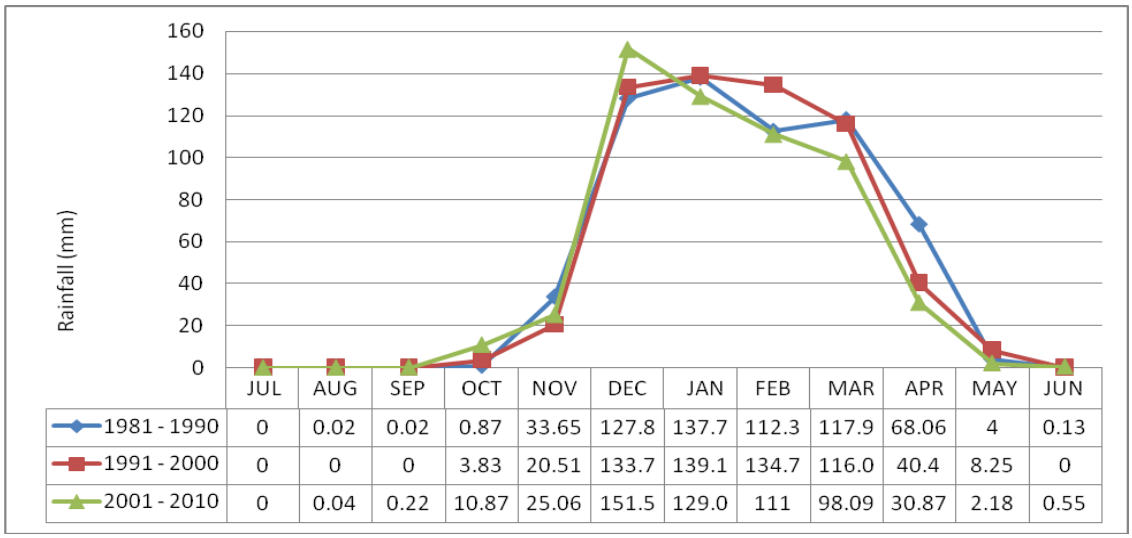


Figure 4.1: Trend of Annual Rainfall (mm) from 1980 – 2011 in Dodoma Region

Source of Data: TMA (2012)

Further analysis of rainfall trends for the three decades (1981 – 1990, 1991 – 2000 and 2001 – 2010) indicated the shift of rainfall pattern across different months (Figure 4.2). The rainfall trends showed a sharp increase of rainfall in December followed by a sharp decrease in January, February, March, and April for the period 2001 – 2010 as compared to the periods 1981 – 1990 and 1991 – 2000, respectively. The rainfall pattern for the three decades further indicates that, rains in Dodoma region now commences in October with slight increase in November to reach its peak in December before declining in the months of January, February, March, April and May.

These findings suggest that local communities in Dodoma region should reorient their farming calendar to suit the current changes in rainfall trends so as to avoid severe decrease in agricultural productivity. The finding also suggests that the most appropriate time for planting is December following high amount of rainfall that can influence optimum germination of seeds. The findings on rainfall trends in the study area are similar to other places with the same climatic characteristics (Mongi et al., 2010; Tesso et al., 2012).



	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1981 - 1990	0	0.02	0.02	0.87	33.65	127.8	137.7	112.3	117.9	68.06	4	0.13
1991 - 2000	0	0	0	3.83	20.51	133.7	139.1	134.7	116.0	40.4	8.25	0
2001 - 2010	0	0.04	0.22	10.87	25.06	151.5	129.0	111	98.09	30.87	2.18	0.55

Figure 4.2: Trends in Monthly Rainfall for the Period 1981 - 2010 in Dodoma Region

Source of Data: TMA (2012)

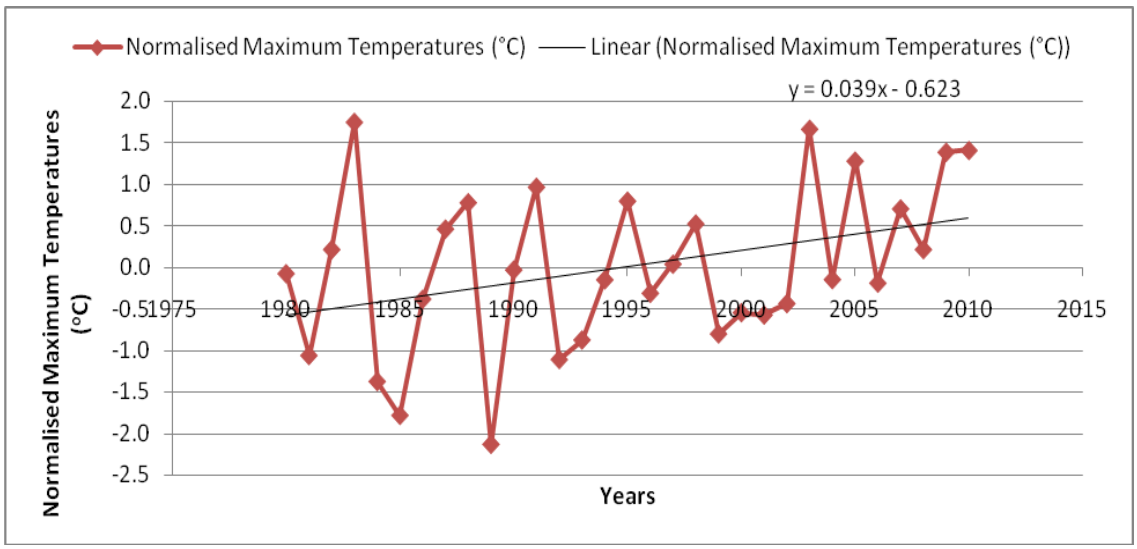


Figure 4.3: Trend in Mean Annual Maximum Temperature (^{O}C) from 1980 – 2011 in Dodoma Region

Source of Data: TMA (2012)

Regarding the trends in temperature, the analysis of the mean annual maximum and minimum temperatures for the period 1980 – 2011 showed an increasing trend (Figures 4.3 and 4.4). Nevertheless, the rate of increase for the minimum temperature

in the region was faster than the rate of change for the mean annual maximum temperature. The findings indicate that the temperature in the region is gradually increasing, and hence the climatic condition in the area is also changing.

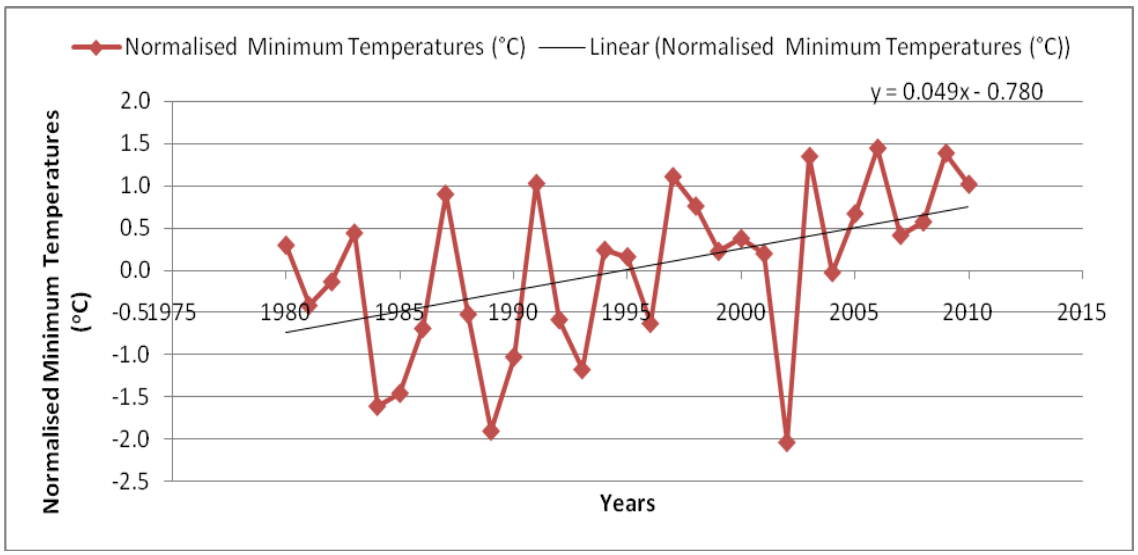


Figure 4.4: Trend in Mean Annual minimum Temperature (^{O}C) from 1980 – 2011 in Dodoma Region

Source of Data: TMA (2012)

The findings on temperature in Dodoma region are similar to trends experienced in other places. Experience from Kenya indicates an increasing maximum and minimum temperature trends in Kisumu, Lodwar and Dagoretti (Nairobi) signifying a warming pattern (GoK, 2009). Other African countries and regions that have experienced similar temperature trends are South Africa, Ethiopia and Southern and Western Africa (Yanda & Mubaya, 2011). Consequently, such changes may lead to detrimental effects to the local community livelihoods. According to IPCC (2014), an increase in temperature of up to 1^{o}C will substantially affect crop production alongside spread of human and animal diseases.

Furthermore, the analysis of wind speed in Dodoma region from 1980 to 2009 as one of the climatic parameters analysed also showed changing trends. The findings indicated that the actual wind speed for the period 1980 – 2009 recorded at 0600 GMT and 1200 GMT (Figures 4.5 and 4.6) showed a clear case of steadily increasing trends. The likely causes for the increase of wind speed are changes of the climatic conditions (e.g. weather related parameters) and haphazard cutting of trees in the study area. These findings are similar to the projections made by various studies that the global mean tropical cyclone maximum wind speed is likely to increase (IPCC, 2014). This has already been experienced through the occurrences of wind storms and increases in wind speeds in different places of the world (Knippertz et al., 2000; Webster et al., 2005; Young et al., 2011).

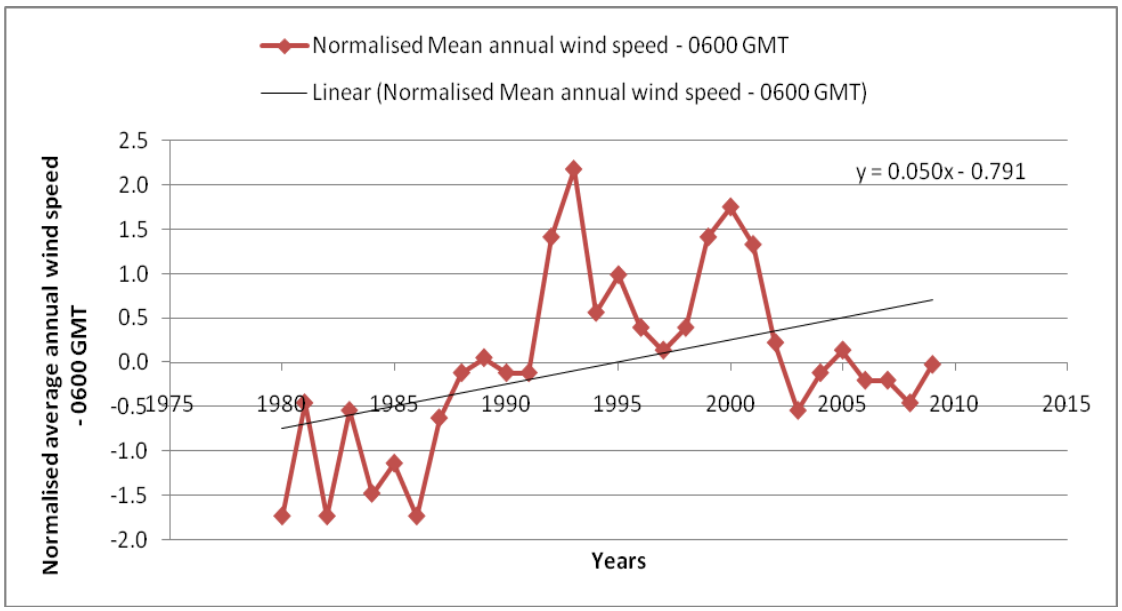


Figure 4.5: Trend of Wind Speed (Knots) Recorded at 0600 GMT from 1980 to 2009 in Dodoma Region

Source of Data: TMA (2012)

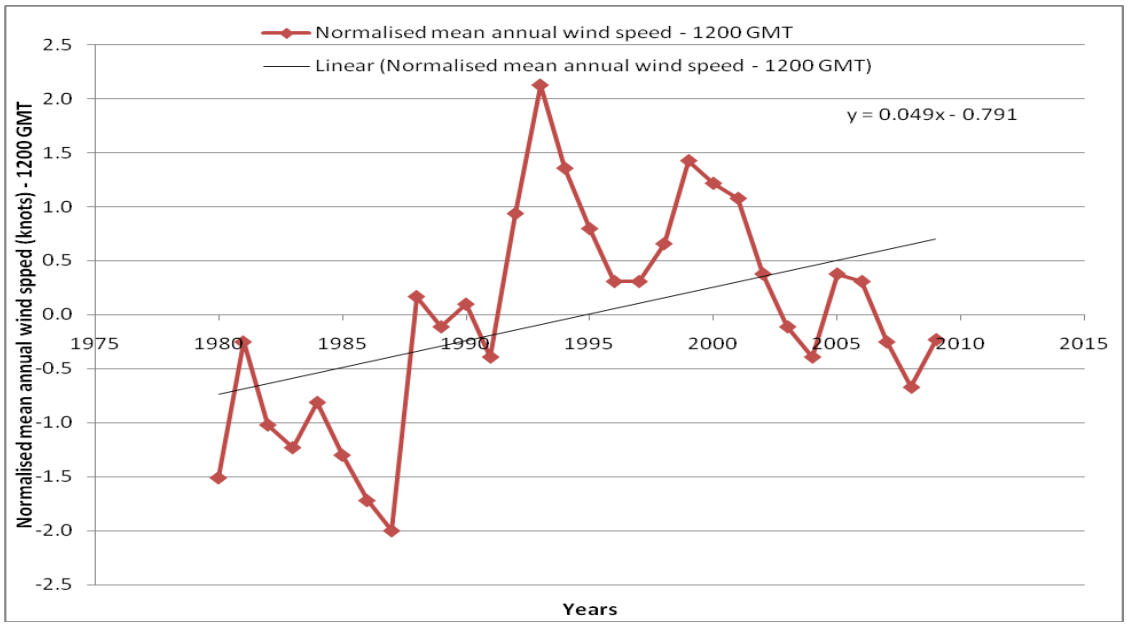


Figure 4.6: Trend of Wind Speed (Knots) Recorded at 1200 GMT from 1980 to 2009 in Dodoma Region

Source of Data: TMA (2012)

4.3.2. Climate Change Extreme Events as Witnessed by the Local Community

In ascertaining the results analysed from meteorological data, respondents were asked to identify climatic related changes they have witnessed in the past ten years. Majority of respondents (90.5%) as shown in Table 4.5 seem to have noticed decrease in rainfall, unpredictable rainfall (75.9%) and droughts (62.6%) as major climatic related changes. In addition, some respondents noticed temperature increase (46.5%), more intense storm (25.9%), temperature decrease (18.6%) and floods (13.3%).

These results were similar to the results analysed from meteorological data whereby rainfall amount showed a declining trend (as depicted by decrease in rainfall, unpredictable rainfall and droughts) while both temperature and wind speed showed an increasing trends. Of all the changes noticed by the local community, the top three changes (decrease in rainfall, unpredictable rainfall and drought) are related to rainfall amount in the area as compared to other climatic related changes. Probably this is due

to the direct influence of rainfall in their major economic and livelihood activities namely crop cultivation and livestock keeping all of which depend on rainfall for their productivity. These findings are similar to the experience noted from different places in Africa and elsewhere as a result of climate change whereby the decline in rainfall, increasing average temperature, variable rainfall pattern were also noted in Southern African region and Kenya (Yanda & Mubaya, 2011; Okoba et al., 2011; Mtambanengwe et al., 2012; Moyo et al., 2012).

Table 4.5: Changes Witnessed by Local Community as a Result of Climate Change (N = 398)

Changes witnessed	N	Percent*
Decrease in rainfall	360	90.5
Unpredictable rainfall	302	75.9
Droughts	246	62.6
Temperature increase	185	46.5
More intense storms	103	25.9
Temperature decrease	74	18.6
Floods	53	13.3

Note: Dataset based on multiple responses

4.3.3. Local Community Perception on the Causes of Climate Change

Respondents were further asked to identify the causes for climatic related changes that have been witnessed in their area. The findings in Table 4.6 show that the perceived causes of climatic related changes or extreme events as per the local community knowledge in Dodoma region include changes in climatic conditions (79.1%), haphazard cutting of trees (52.5%), environmental degradation (50.5%), destruction of natural vegetation (34.2%) and lack of conservation education (28.6%). However, few respondents (3.8%) indicated that they were not aware of the causes of climate related changes despite noticing some changes resulting from climate change. In

particular, more female respondents (5.8%) did not know the causes of climate change as compared to 2.5% of male respondents.

A critical analysis of the findings suggests that most of the causes of climate changes in Dodoma region are related to poor environmental management and lack of conservation education. Although the problem of climate change is global and transboundary in nature, these findings signify that any intervention to deal with climate change should focus on addressing environmental management failures that have led to environmental degradation, destruction of natural vegetation and haphazard cutting of trees. These should be taken concurrently with awareness creation on conservation issues in order to deal with poor conservation education at the local level. Furthermore, given the fact that changes in climatic conditions is a major perceived cause of climate change in the area, its complexity calls for collaborative efforts at international, regional, national and local levels.

Table 4.6: The Perception of Local Community on Causes of Climate Change (n = 398)

Causes of climate change	Responses and percentages within sex of respondents		Total
	Male	Female	
Changes in climatic conditions	191 (78.6)	124 (80.0)	315 (79.1)
Environmental degradation	134 (55.1)	67 (43.2)	201 (50.5)
Lack of conservation education	83 (34.2)	31 (20.0)	114 (28.6)
Destruction of natural vegetation	93 (38.3)	43 (27.7)	136 (34.2)
Haphazard cutting of trees	139 (57.2)	70 (45.2)	209 (52.5)
Don't know	6 (2.5)	9 (5.8)	15 (3.8)
Others	1 (0.4)	1 (0.6)	2 (0.5)

Note: Dataset based on multiple responses; values in parentheses are percentages

4.3.4. Impacts of Climatic Changes on Livelihood Activities

As part of understanding the effects of climate change on livelihood activities and sources, the study sought to establish the impacts of climatic related changes to the livelihoods of people in Dodoma region. The findings (Table 4.7) indicate that the major effects associated with climate changes in the region were reduced agricultural productivity (89.2%) and alteration of the planting season (83.2%). Other effects include reduced livestock pasture (34.2%), reduced water availability (33.7%) and reduced household income (30.4%). In addition, few respondents identified reduced amount of land cultivated (21.4%), effects on the number of livestock (19.1%), destruction of settlements (17.3%) and reduced water availability for livestock (12.6%) among others as livelihood effects associated with climate change.

Table 4.7: Effects of Climatic Changes on Livelihood Activities within Sex of Respondents (N = 398)

Effects of changes on livelihood activities	Responses and percentages within sex of respondents		Total
	Male	Female	
Reduces agricultural productivity	223 (91.8)	132 (85.2)	355 (89.2)
Affects planting season	208 (85.6)	123 (79.4)	331 (83.2)
Reduces livestock pasture	104 (42.8)	32 (20.6)	136 (34.2)
Reduces water availability	94 (38.7)	40 (25.8)	134 (33.7)
Reduces income	66 (27.2)	55 (35.5)	121 (30.4)
Reduces the amount of land cultivated	63 (25.9)	22 (14.2)	85 (21.4)
Affects the number of livestock	60 (24.7)	16 (10.3)	76 (19.1)
Destruction of settlements	39 (16.0)	30 (19.4)	69 (17.3)
Reduces water availability for livestock	26 (10.7)	24 (15.5)	50 (12.6)
Affects socioeconomic activities	18 (7.4)	19 (12.3)	37 (9.3)
Destruction of crops	16 (6.6)	15 (9.7)	31 (7.8)
Leads to natural resources degradation	13 (5.3)	14 (9.0)	27 (6.8)

Note: Dataset based on multiple responses; values in parentheses are percentages

Based on the findings, the key livelihood activities heavily impacted by climate change were crop farming and livestock keeping. For instance, a decrease in average yield of maize by 84 percent was reported in Dodoma region as compared to 33 percent decrease nationally following reduced rainfall amount and increasing variability in rainfall (URT, 2006). However, these are the major livelihood activities that form the socio-economic base for the local communities in the region. As established by this study (Table 4.1), crop and livestock farming accounts for 98.7% and 50.3% respectively of residents' occupations in the study area. Climate change extreme events also affect the availability and productivity of critical livelihood resources including water, land, natural resources, and pasture among others. Consequently, this leads to reduced agricultural productivity, affecting the planting season, destruction of settlements, destruction of farms, affecting socio-economic activities, and reducing local communities' income.

Further analysis to establish the extent to which climate change affects local livelihood sources and activities as identified in Table 4.7. An analysis of the information using principal component analysis with Oblimin rotation categorized the effects of climate change hazards into three major components (Table 4.8) namely water and crop farming (Component 1), livestock keeping (Component 2), and non agricultural activities (Component 3) as indicated by numbers 1, 2 and 3. It is important to note that the pattern and structure coefficients as indicated in Table 4.16 show the factors loadings of each of the 12 variables and information about the correlation between variables and factors (components) respectively.

Table 4.8: Pattern and Structure Matrix for PCA with Oblimin Rotation of Three Factor Solution of Effects of Climate Change on Household's Livelihoods

Item	Components[a] and Rotated factor loadings						Communalities
	Pattern coefficients[b]			Structure coefficients[c]			
	1	2	3	1	2	3	
Affect water availability	**0.82**	-0.11	-0.20	**0.81**	-0.47	0.13	0.69
Affect agricultural productivity	**0.76**	-0.001	-0.03	**0.75**	-0.36	0.25	0.56
Affects planting season	**0.73**	-0.08	0.03	**0.78**	-0.43	0.32	0.61
Lead to destruction of crops	**0.71**	0.06	0.17	**0.74**	-0.31	0.42	0.58
Affects the size of land cultivated	**0.70**	-0.10	0.10	**0.79**	-0.45	0.38	0.64
Affect water avail. for livestock	-0.01	**-0.88**	-0.11	0.41	**-0.87**	0.14	0.76
Affect pasture avail. for livestock	0.06	**-0.86**	-0.08	0.44	**-0.87**	0.09	0.77
Affect the number of livestock	0.01	**-0.84**	0.11	0.45	**-0.86**	0.26	0.75
Destruction of settlements	0.22	**-0.35**	0.06	0.41	-0.46	0.20	*0.26*
Affects socioeconomic activities	0.12	0.14	**0.86**	0.38	-0.07	**0.88**	0.80
Natural resources degradation	-0.13	-0.24	**0.83**	0.29	-0.33	**0.83**	0.73
Affect household income	0.41	0.05	**0.49**	0.57	-0.23	**0.63**	0.53

[a]1= Water and farming; 2= livestock keeping; and 3= non agricultural activities

[b] Pattern matrix shows the factor loading of each of the variables

[c] Structure matrix provides information about correlation between variables and factors

Component 1: Water and Crop Farming

In this component, specific issues of interest include the larger impact of climate change on water availability (0.82), reduction in agricultural productivity (0.76), effects of climate change on planting season (0.73), destruction of crops (0.71) and effect of climate change on the size of land cultivated (0.70). In fact these are the main challenges affecting the livelihoods of local communities in the area. In general, these issues strongly influence production activities in Dodoma region. For instance, effects on water availability limit women and children to engage in other matters related to production including diversification of income generating activities. In Tanzania, house chores such as fetching water and collection of firewood are the responsibilities of women and children. Climate change also strongly affects agricultural related activities and outcomes as it reduces agricultural productivity, destroys crops especially during the critical period of growth e.g. at the flowering

stage or harvesting as a result of rainfall unpredictability in the area, and also influences the amount of land to be cultivated. Considering the role of water in agricultural production, climate change strongly affects water availability for irrigation purposes. This was ascertained by FGDs' participants who opined that most water sources have dried up and others become seasonal, hence reducing the irrigation potential in the area.

Component 2: Livestock Keeping

In this component, the variables that loaded high regarding the effects of climate change on the livelihoods of local communities in Dodoma region were reduced availability of water for livestock (-0.88), reduced pasture for livestock (-0.86), the effects of climate change on the number of livestock (-0.84), and destruction of settlements (-0.35). From the findings, the livelihood of local communities in the aspect of livestock keeping is strongly affected by water and pasture that in turn affects the contribution of livestock in promoting the social and economic well being of the local communities. Consequently, water and pasture availability also affects the number of livestock in Dodoma region. During the focus group discussion, it emerged that during the time of water and pasture scarcity caused by drought and low rainfall, local residents' treks long distance and sometimes have to temporarily migrate in search of water and pasture for livestock.

Although the issue of settlement was also loaded high (more that 0.3), its loading was generally lower when compared to the loadings of issues related to livestock keeping. The implication is that the effect of climate change on local community settlements is not strongly felt by the local as an issue of concern when compared to other

livelihoods aspects. The lower importance accorded to settlement destruction can further be observed on its communality value (0.26) which is tremendously low as compared to communality values for other household livelihood aspects considered in the PCA.

Component 3: Non Agricultural Livelihoods Activities

Regarding this component (non agricultural livelihood activities), the variables that loaded higher were the effects of climate change on socio-economic activities (0.86), natural resources degradation (0.84) and households income (0.49). The findings signify that climate change severely affects socio-economic activities in the area. This is based on the fact that for other activities, in particular the diversification of income generating activities, to flourish and for the community to effectively engage in other social activities requires stability in the aspect of food security particularly on food production and accessibility. However, in the study area the issue of food security is a matter of concern following reduced agricultural productivity on the one hand and poverty that impedes local community to access food among other social needs on the other. Another emerging aspect revealed is that the effects of climate change on household income is not of high concern (factor loading of 0.49) in the area as compared to socio-economic activities (0.86) and natural resources degradation (0.84). This is supported by the fact that majority of residents are actively engaging in subsistence agricultural activities as indicated by their small farm size. On average, households own and cultivate 6.98ha and 5.8ha respectively.

4.3.5. Ranking of Climate Change Hazards Based on the Level of Importance/Effects

Respondents were also asked to rank climate change hazards based on their level of importance to the household livelihoods and the results are as indicated in Table 4.9.

Table 4.9: Ranking Climate Change Related Hazards based on the Level of their Importance (Effects) on Household Livelihoods (N = 398)

Climate related hazards	Frequency on the Level of Importance[a]			Score[b]	Mean score[c]	Rank
	Less important	Important	More important			
Recurrent drought	20	49	329	1105	2.78	1
Unusual rainfall trend	36	132	230	990	2.49	2
Drought due to less rainfall in what would be rainy season	61	130	207	942	2.37	3
Early end of rainy season	69	161	168	895	2.25	4
Prolonged drought during what would be rainy season	84	141	173	885	2.22	5
Increased temperature	138	155	105	763	1.92	6
More intense storms	192	133	73	677	1.70	7
Crop diseases	261	66	71	606	1.52	8
Decreased temperature	246	129	23	573	1.44	9
Damage due to heavy showers	268	99	31	559	1.40	10
Floods	293	65	40	543	1.36	11
Animal diseases	276	108	14	534	1.34	12

[a] The level of importance and ranking was assessed in relation to climate change hazards that mostly affect households.
[b] 'Score' calculated as: (Freq. 'Less important' *1) + (freq. 'Important' *2) + (freq. 'Most important' *3).
[c] 'Mean score' calculated as : (Score/Sample size).

The findings in Table 4.9 indicate that the top five (5) climatic related hazards affecting the households are related to rainfall variations and trends. These include recurrent drought (mean score: 2.78, rank: 1); unusual rainfall trend (mean score: 2.49, rank: 2); drought due to less rainfall during what would be rainy season (mean score: 2.37, rank: 3); early end of rainy season (mean score: 2.25, rank: 4); and prolonged drought during what would be rainy season (mean score: 2.22, rank: 5).

The findings further indicate that climate change related hazards in particular increased temperature (mean score: 1.92, rank: 6); more intense storms (mean score: 1.70, rank: 7); crop diseases (mean score: 1.52, rank: 8); decreased temperature (mean score: 1.44, rank: 9); damage due to heavy showers (mean score: 1.40, rank 10); floods (mean score: 1.36, rank: 11); and animal diseases (mean score: 1.34, rank: 12) were of less importance in terms of their effects on local community livelihoods.

These results further confirm that climate change related hazards, especially rainfall variability, cause great damage to rainfall dependent livelihood activities. This is of particular importance to local communities whom their livelihood security, food security, household income, and capacity to access various social services are highly determined by the performance of farming and livestock keeping activities in Dodoma region. These findings are similar to the findings by Warner and Afifi (2014) and Yanda and Mubaya (2011) who also noted devastating effects of changing rainfall trends on agricultural activities in Ghana, Guatemala, Bangladesh, India, Vietnam, Peru, Thailand and Kenya.

Further analysis on assessing the difference in ranking climate related hazards based on the effects on household livelihoods was done using t-test of independence. This was done after manipulating the ranked responses as suggested by calculating the respondents' cumulative score and then the mean score for each of the respondents (Pallant, 2011). Of interest was to understand if there were differences in ranking the effects of climate related hazards between male and females; households that some of their member(s) have migrated and not migrated; households that have received or not received assistance from different actors/institutions in adapting to or mitigating

climate change driven impacts; and households that have received or not received support from agricultural extension worker(s) in the past five (5) years (2007 – 2011). The result indicated that there was a significant difference in ranking of the importance of climate change related hazards for households who were assisted by different actors in adapting to or mitigating climate change driven impacts *(M = 7.12, SD = 0.63)* and those without assistance *(M = 8.07, SD = 1.06); t(398) = -10.83, p = 0.000, two tailed*. The magnitude of the difference in means *(mean difference = -0.95, 95% CI: -1.12 to -0.77)* was very small *(eta squared = 0.003)*. In addition, there was a significant difference in ranking the importance of climate change related hazards for households who have received support from an agricultural extension worker *(M = 7.34, SD = 0.76)* and those not received *(M = 7.99, SD = 1.17)* during the past five years (2007 – 2011); *t(398) = -6.127, p = 0.000, two tailed*. However, the magnitude of the difference in means *(mean difference = -0.65, 95% CI: -0.85 to -0.439)* was very small *(eta squared = 0.003)*.

Nevertheless, there was no significant difference in raking the importance of climate related hazards for males *(M = 7.59, SD = 0.91)* and females *(M = 7.60, SD = 1.11); t(398) = -0.097, p = 0.95, two tailed* as also indicated by a very small magnitude of the differences *(eta squared = 0.003)* in the mean *(mean difference = -0.01, 95% CI: -0.22 to 0.20)*. Furthermore, there was no significant difference in ranking the importance of climate change related hazards for households who some of their members have migrated due to climate related hazards *(M = 7.68, SD = 1.19)* and not migrated *(M = 7.55, SD = 0.87); t(398) = 1.147, p = 0.25, two tailed*. The magnitude of the difference in the means *(mean difference = 0.13, 95% CI: -0.094 to 0.355)* was very small *(eta squared = 0.003)*.

From these findings on households ranking of climate change related hazards, it is evident that interventions to deal with climate change impacts on livelihood activities should involve strategies that reduces or addresses rainfall variability challenges. Such interventions may involve developing community rainwater harvesting, establishment of irrigation schemes, in-situ rainwater water harvesting, and use of agricultural techniques that minimize moisture loss among others. Furthermore, these findings suggest that the effects of climate related hazards affects all households in the study area more or less equally as it has been revealed by t-test analysis between male and females on one hand and between households with some member(s) who have migrated and not migrated because of climate change impacts.

The findings further underscore the need for provisions of extensive extensions services to the local community in the area so as to better adapt to and mitigate climate related hazards. This is based on the fact that households that received extension workers' or different actors' support were less affected by the impacts of climate related hazards as compared to their counterparts. In general, extensions services are of critical importance in empowering the local community with good agricultural practices and necessary skills for climate change adaptation and mitigation planning. The importance for the need of extension services in dealing with climate change challenges have also been underscored in Vietnam, Kenya, Nigeria and Nepal (Hoang et al., 2014; Khatri et al., 2013; Ozor & Cynthia, 2010).

4.4. Manifestation of Climate Change Impacts in Dodoma Region

The study also sought to try and establish some of the manifestation of climate change driven impacts. This was done by examining the status of food crops production over time, cash crops production over time, loss of livelihood sources as a result of climate hazards, and effects experienced on livestock as a result of climatic related changes. In the case of reduced food and cash crop production, the study also sought to establish the reasons for the reduced productivity.

4.4.1. Effects of Climate Change on Food Crop Production

As part of the quest to understand the effects of climate change driven impacts in Dodoma region, respondents were asked to indicate the status of food production for the past five years (2007 – 2011). The study findings as indicated in Table 4.10 show that in all five years more than 70% of households failed to produce adequate food crops. The proportion of households who produced enough food crops were 22.6% in 2007, 25.6% in 2008, 26.1% in 2009, 27.6% in 2010, and 25.1% in 2011. From these findings, majority of households suffer from inadequate production of food crops hence becoming vulnerable to challenges associated with food insecurity.

A similar trend on the decline in food crop production was also noted in various agricultural production reports in the region (KDC, 2010a; 2010b). In fact, majority of respondents indicated that they are facing difficulties in feeding household members as a result of inadequate production of food crops. The challenges on feeding household members in Dodoma region as a result of climate change are in tandem with the findings from other studies undertaken in Kenya, Ghana and

elsewhere (Mongi et al., 2010; Songok et al., 2011a; Afifi et al., 2014; Radamacher-Schulz et al., 2014; Warner & Afifi, 2014).

Table 4.10: The distribution of respondents by production of enough food within district of respondents from 2007 - 2011

Year	Status in production of food crops at household level (2007 – 2011)	Responses and percentages within district of respondents		Total	X^2 ***value***	***df***	***p value***
		Bahi	Kongwa				
2007	Produced enough food	26 (14.2)	64 (29.8)	90 (22.6)	25.07	2	0.000
	Didn't produced enough food	143 (78.1)	150 (69.8)	293 (73.6)			
	Don't remember	14 (7.7)	1 (0.5)	15 (3.8)			
2008	Produced enough food	29 (15.8)	73 (34.0)	102 (25.6)	23.72	2	0.000
	Didn't produced enough food	142 (77.6)	140 (65.1)	282 (70.9)			
	Don't remember	12 (6.6)	2 (0.9)	14 (3.5)			
2009	Produced enough food	34 (18.6)	70 (32.6)	104 (26.1)	9.30	1	0.02
	Didn't produced enough food	149 (81.4)	145 (67.4)	294 (73.9)			
2010	Produced enough food	31 (16.9)	79 (36.7)	110 (27.6)	18.41	1	0.000
	Didn't produced enough food	152 (83.1)	136 (63.3)	288 (72.4)			
2011	Produced enough food	23 (12.6)	77 (35.8)	100 (25.1)	27.17	1	0.000
	Didn't produced enough food	160 (87.4)	138 (64.2)	298 (74.9)			

Note: Values in parentheses are percentages

It is worth to note that more households in Kongwa District produced enough food compared to their counterparts in Bahi District. Nevertheless, the proportion of households which failed to produce enough food was higher in all districts as compared to those who produced enough food in the two districts. The differences in food production among the two districts is attributed to the fact that residents in Kongwa District usually cultivate in Kiteto District where the productivity especially of maize is high as compared to their counterparts in Bahi District. Also, the

differences in food production in the two districts is explained by the size of farm cultivated at household level in the two districts whereby households in Kongwa District cultivated larger farms *(M = 6.9, SD = 6.7)* than households in Bahi District *(M = 4.48, SD = 3.6*. The differences in farm size cultivated by households in the two districts was significant *t (340) = -4.64, p value = 0.000*, two tailed *(see Table 4.4).*

Further analysis on the production status of food at household level in the cumulative five years from 2007 to 2011 (Table 4.11) shows significant association between the status in food production (whether households produced enough food or not) in relation to respondent's district of residence $x^2(2, n = 398) = 25.45, p = 0.000,$ *Cramer's V = 0.25;* migration of some household members $x^2(2, n = 398) = 13.31, p = 0.001,$ *Cramer's V = 0.18;* assistance from various actors and institutions in assisting the local communities in adapting and mitigating climate change impacts $x^2(2, n = 398) = 29.89, p = 0.000,$ *Cramer's V = 0.27*. In all cases, Cramer's V statistics were significant at $p = 0.000$ for districts of respondents; $p = 0.001$ for migration of some household members; and $p = 0.000$ for actors and institutions assisting local communities in adapting and mitigating to climate change impacts. These results for Cramer's V indicate that values of the x^2 - tests on the named variables were unlikely to have happened by chance and therefore, the strength of the relationships was significant.

On the other hand, there were no associations between the status of food production (whether enough or not) for past cumulative five years (2007 – 2011) and sex of respondents $x^2(2, n = 398) = 0.03, p = 0.985,$ *Cramer's V = 0.01*; and support from extension workers $x^2(2, n = 398) = 1.426, p = 0.490,$ *Cramer's V = 0.06*. In all cases,

Cramer's V statistics were not significant *(p > 0.05)* so confirming that the strength of the relationship was not significant as also reflected in the chi-square test for sex, organization membership, and extension workers' support.

Table 4.11: The Distribution of Respondents by Production of Enough Food at their Household in Five Years (2007/2011)

Variable		Produced enough food in all 5 years	Did not produce enough food in all 5 years	Produced enough food in some years	Total	χ^2 value	df	p value
District of respondents	Bahi	8 (14.5)	127(51.4)	48 (50.0)	18 (46.0)	25.5	2	0.000
	Kongwa	47 (85.5)	120(48.6)	48 (50.0)	215(54.0)			
Sex of respondents	Male	34 (61.8)	150(60.7)	59 (61.5)	243(61.1)	0.03	2	0.985
	Female	21 (38.2)	97(39.3)	37 (38.5)	155(38.9)			
Organization membership	Member	11 (20.0)	59(23.9)	26 (27.1)	96(24.1)	0.98	2	0.613
	Not member	44 (80.0)	18 (76.1)	70 (72.9)	302(75.9)			
Migration of some HH members	Migrated	12 (21.8)	103(41.7)	24 (25.0)	139(34.9)	13.3	2	0.001
	Not migrated	43 (78.2)	144(58.3)	72 (65.1)	259(65.1)			
Assistance from actors / institutions	Assisted	45 (81.8)	102(41.3)	50 (52.1)	197(49.5)	29.9	2	0.000
	Not Assisted	10 (18.2)	145(58.7)	46 (47.9)	201(50.5)			
Extension workers support	Supported	37 (67.3)	145(58.7)	59 (61.5)	241(60.6)	1.43	2	0.490
	Not supported	18 (32.7)	102(41.3)	37 (38.5)	157(39.4)			

Note: Values in parentheses are percentages

From these findings it has been established that most households in Dodoma region did not produce enough food to cater for household needs in the five years (2007 – 2011). In addition, the findings also have established that majority of households who produced enough foods were resilient to climate change impacts leading to migration of fewer members from such households as compared to their counterparts. The findings have further established that majority of households receiving assistance from various actors and institutions produced enough food in the past five years as compared to their counterparts.

This calls for the need to undertake strong measures that are critical in enhancing the production of adequate food crops among local community members in the region. Among such measures include diversification of agricultural and non agricultural activities, adoption of good agricultural practices, natural resources management, strengthening extension services and agricultural support systems, and use of irrigation techniques among others. Furthermore, assistance to the local community experiencing various climatic change vagaries can enhance their coping strategies (Hoang et al., 2014; Milan & Ruano, 2014; Page et al., 2010).

According to the FGDs conducted in Kongwa and Bahi districts, the major reasons for not producing enough food crops were increased drought and unpredictable rainfall. Other reasons for not producing enough food crops were crop diseases and poor quality of seeds. From these findings, food production in Dodoma region is heavily impacted by prolonged drought and unpredictable rainfall. However, this could have been addressed by development of irrigation infrastructures which are scantly developed in the study area and assisting farmers on accessing and using drought resistant varieties.

Based on the reviewed official documents at the district level, 71.2% and 95% of the total potential area for irrigation in Bahi and Kongwa districts respectively were not developed during the period at which this study was undertaken**.** This is despite the fact that irrigation schemes can play a big role in boosting food and cash crop productivity by mitigating the effects of drought and rainfall unpredictability. However, government and other actors' efforts are needed in order to realize the full irrigation potential in the study area. This is based on the fact that the income levels of

the local community in the study were very low (with an average of Tshs. 105, 570/= for Bahi District and Tshs. 122,810/= for Kongwa District per household per month) signifying lack resources at community level to invest on irrigation technologies.

4.4.2. Effects of Climate Change on Cash Crop Production

The findings in Table 4.12 shows that the production of cash crops in the area from 2007 to 2011 was very low as only 19.7% of respondents produced enough cash crops in 2007, 19.3% in 2008; 22.7% in 2009; 27.7% in 2010; and 23.8% in 2011.

Table 4.12: The Distribution of Respondents by Production of Enough Cash Crops from 2007 - 2011

Year	Status in cash crop production at household level	Responses and percentages
2007	Produced enough cash crops	77 (19.7)
	Did not produced enough cash crops	300 (76.9)
	Don't remember	13 (3.3)
2008	Produced enough cash crops	75 (19.3)
	Did not produced enough cash crops	303 (77.9)
	Don't remember	11 (2.8)
2009	Produced enough cash crops	88 (22.7)
	Did not produced enough cash crops	297 (76.5)
	Don't remember	3 (0.8)
2010	Produced enough cash crops	88 (27.7)
	Did not produced enough cash crops	295 (76.2)
	Don't remember	4 (1.0)
2011	Produced enough cash crops	92 (23.8)
	Did not produced enough cash crops	292 (75.5)
	Don't remember	3 (0.8)

Note: Values in parentheses are percentages

In general, the findings indicate that throughout five years (2007 – 2011) majority of residents (more than 70% in each year) in the study area failed to produce enough cash crops. Taking into consideration that the local communities in the study area

depend on crop farming as the major source of income (see Table 4.1), it is evident that their failure to produce enough cash crops severely impacts the household economy and income levels.

A number of reasons were identified by the local community in relation to low production of cash crops in Dodoma region. Among such reasons (Table 4.13) include increased drought (89.5%) and unpredictable rainfall (72.4%). Other reasons include crop diseases (31.1%), small farm size (24.7%), poor quality seeds (24.7%), increased floods (18.3%), damage due to storm (4.9%), and damage due to heavy showers (1.2%).

Table 4.13: Reasons for not Producing Enough Cash Crops (N = 344)

Reasons for not producing enough cash crops	N	Percent
Increased drought	308	89.5
Unpredictable rainfall	249	72.4
Crop diseases	107	31.1
Small farm size	85	24.7
Poor quality seeds	85	24.7
Increased floods	63	18.3
Damage due to strong storms	17	4.9
Damage due to heavy showers	4	1.2

Note: Dataset based on multiple responses

From these findings, climatic related extreme events such as drought and unpredictable rainfall top the reasons for not producing enough cash crops in the areas. Other climatic related elements such as damage caused by heavy showers, strong storms, and floods have little influence on the production of cash crops as compared to drought and unpredictable rainfall. Nevertheless, crop diseases and poor quality seeds were also regarded by the local community as some of the factors leading to low production of cash crops. These findings underscore the need to

address drought and rainfall unpredictability challenges. This can be done by adopting good agricultural practices such as agroforestry, use of manure and in-situ rain water harvesting techniques that are critical in reducing soil moisture loss. In addition, the problems related to crop diseases and poor quality seeds calls for a strong agricultural support system and extension services to support farmers in dealing with such challenges in the area.

4.4.3. Loss of Livelihood Sources as a Result of Climate Hazards

As already established in the previous sections, the main climatic changes hazards in Dodoma region are the decrease in rainfall, unpredictable rainfall, droughts, temperature increase, more intense storms and floods. These hazards have negative effects on the local community livelihoods including the loss of household livelihood resources. Among the livelihood resources lost as a result of climatic related hazards (Table 4.14) as identified by households who have already experienced the loss (N = 164) were agricultural land (82.9%), crops (64.0%), water sources (54.9%), forest (50.6%), livestock (36.6%), and pastureland (35.4%).

Table 4.14: Distribution of Respondents based on Type of Livelihood Resource Lost as a Result of Climate Hazards (N = 164)

Type of livelihood resource lost	N	Percent
Agricultural land	136	82.9
Crops	105	64.0
Water sources	90	54.9
Forest	83	50.6
Livestock	60	36.6
Pastureland	58	35.4

Note: Dataset based on multiple responses

Among the major reasons for the loss of household livelihood resources, as it was revealed during FGDs and local level key informants' interviews, were climatic condition variations such as recurrent drought, rainfall unpredictability, intense storms, increased temperature and floods. Consequently, such variations led to second order consequences namely haphazard cutting of trees, water scarcity, reduced land productivity, shortage of pasture, soil erosion, loss of crops, stunted growth of crops and livestock, declining soil fertility, famine, settlements destructions, destruction of infrastructure, and livestock and human diseases. Other livelihoods effects attributed by climatic related hazards in the area were loss of income spent on purchasing agricultural inputs and labour hiring following crop failure caused by climate change hazards, and poor performance of entrepreneurial activities such as businesses as a way of diversifying household's income generating activities.

A chi-square test for independence was undertaken to determine whether there is an association between household status on loss of livelihood sources and district of residence and sex of respondents. The findings (Table 4.15) indicate that there was a significant relationship between household's loss of livelihood sources and respondents' districts $x^2(1, n = 398) = 41.68, p = 0.000, Phi = 0.324$ in which most households in Bahi District had lost livelihood sources compared to households in Kongwa District. In this case the Phi statistic was significant (p = 0.000) indicating that the relationship between the variables was unlikely to occur by chance. The results further indicate that there was no relationship between household's loss of livelihood sources and sex of respondents $x^2(1, n = 398) = 1.50, p = 0.220, Phi = 0.061$ implying that both male and females were more or less equally experiencing loss of livelihood sources as a result of climate change hazards. The Phi statistic was

also not significant hence confirming the absence of relationship between household's losses of livelihood sources and sex of respondents.

The significant relationship between household's district of residence and loss of livelihood sources can be explained by the fact that Kongwa District is strategically located close to agricultural and livestock research institutions hence benefit from extension services provided by the institutions through cooperate social responsibility mechanisms. In addition, Kongwa District has many town centres such as Mbande, Kibaigwa and Kongwa all equipped with a good business infrastructure hence capable of buffering the impacts of climate change hazards as compared to their counterparts in Bahi District. Furthermore, Kongwa District residents have the benefit of farming in an agricultural productive area in Kiteto District in Manyara region (KDC, 2010a).

Table 4.15: Distribution of Respondents based on Loss of Household Livelihood Sources due to Climate Change Hazards (N = 398)

Variables		HH status on loss of livelihood sources		**Total**	χ^2 ***value***	***df***	***p value***
		Lost	Not lost				
District of residence	Bahi	107(65.2)	76(32.5)	183(46.0)	41.68	1	0.000
	Kongwa	57(34.8)	158(67.5)	215(54.0)			
Sex of respondents	Male	106(64.6)	137(58.5)	243(61.1)	1.50	1	0.220
	female	58(35.4)	97(41.5)	155(38.9)			

Note: Numbers in parentheses are percentages

4.5. Local Community Adaptation Practices to Climate Change Impacts

As noted in the previous sections, the effects of climate change hazards in Dodoma region include decline in agricultural productivity, effect on planting season, reduced water availability, reduced livestock pasture, decline in household income, destruction of settlements and natural resources degradation. This is attributed to the fact that most livelihood activities are rainfall dependent and hence unpredictability of rainfall

and recurrent drought negatively affects the livelihood of the local community. Climate change impacts being local in nature, efforts to address them should be grounded in the local context. This calls for the need of analysing local climate change adaptation approaches as a way of understanding the involved dynamics in addressing climate change challenges. It is on the basis of the need for local action towards climate change impacts that this study sought to establish the local community adaptation strategies as a result of climate change impacts in Dodoma region. This was done by examining the key adaptation strategies, their usefulness and implementation challenges of which in the context of this study were categorised into agricultural techniques, water management techniques, communal pooling techniques, and migration of some household members as proposed by Agrawal (2010).

4.5.1. Agricultural Adaptation Strategies

As established in the previous sections, agriculture that is threatened by recurrent drought and declining and unpredictable rainfall is the major livelihood activity in Dodoma region. Such changes have led to a decline in agricultural productivity which has, therefore, necessitated the local communities to devise agricultural adaptation strategies to deal with the challenge. It is on this basis that respondents were asked to identify various agricultural adaptation strategies used in their areas. The findings (Table 4.16) indicate that the major agricultural adaptation strategies used by the local community in Dodoma region were crop type selection (57.0%), use of manure (41.5%), use of drought resistant crops (37.4%), adjusting planting dates (34.9%), and changing of tillage practises (34.7%). Other agriculture adaptation strategies used by local residents were; adapt crop plant densities (20.1%), crop rotation (15.6%), intercropping (9.0%), agroforestry (6.3%), fertilizer application (3.5%), and control of

water loss (3.5%). To a small extent (0.5%), improved storage facilities were also used by the local communities as an agricultural adaptation strategy.

Table 4.16: Distribution of Respondents based on Agricultural Adaptation Strategies (N = 398)

Agricultural adaptation strategies	N	Percent
Crop type selection	227	57.0
Use manure	165	41.5
Use drought resistant crops	149	37..4
Adjusting planting dates	139	34.9
Adapt tillage practices	138	34.7
Adapt crop plant densities	80	20.1
Crop rotation	62	15.6
Intercropping	36	9.0
Agroforestry	25	6.3
Fertilizer application	14	3.5
Control water loss	14	3.5
Apply different feed techniques (e.g. zero grazing)	9	2.3
Change herd composition	7	1.8
Change from pastoral to sedentary agricultural systems	5	1.3
Improve storage facilities	2	0.5
Change of pastoral system (distance and mobility)	2	0.5
None	10	2.5

Note: Dataset based on multiple responses

In terms of livestock, change of pastoral systems involving walking long distances and migration (0.5%); change of herd composition (1.8%); applying different feed techniques such as zero grazing (2.3%); and change from pastoral to sedentary agriculture (1.3%) were some of the common adaptation practices. The issues of livestock mobility to other places in search for pasture and water was also ascertained during focus group discussions held in Bahi and Kongwa districts. Nevertheless, local

communities were not ready to reduce the number of livestock due to cultural reasons particularly the fear of being regarded as poor by the community.

Furthermore, respondents (N = 388) using various agricultural adaptation strategies in the area were asked to identify the usefulness of such strategies in dealing with climate change impacts in the study area. The findings established that such strategies help in increasing agricultural productivity (64.2%), reducing the impacts of drought (39.4%) and soil conservation (33.2%). Other benefits of agricultural adaptation strategies as identified by the local communities were controlling soil erosion (20.1%), income generation (19.8%), reducing water loss (14.2%), reducing the impacts of intense storms (11.9%), increasing climate change resilience (10.8%), stabilizing climatic conditions (6.4%), good management of pastureland (3.1%), and reducing floods impacts (1.0%).

Nevertheless, the implementation of agricultural adaptation strategies as identified by households' respondents (N = 388) was hampered by a number of challenges. The challenges for agricultural adaptation strategies in the Dodoma region include poor knowledge on good agricultural practice (51.8%), difficulties in obtaining improved seeds (50.5%), crop diseases (42.0%), climatic condition uncertainties (37.1%) and lack of environmental awareness (26.0%). Other challenges to agricultural adaptation strategies were based on the cost of adaptation technologies (21.1%), challenges such as high price of purchasing tree seedlings, absence of tree nurseries and lack of seedlings encountered during tree planting process (10.9%), taboo (2.6%), absence of dams for irrigation (2.3%), and financial constraints (1.5%).

On the basis of the findings, the uses of agricultural strategies for climate change adaptation in the area were very instrumental in increasing local community resilience to climate change impacts. Nevertheless, lack of knowledge on good agricultural practices, difficulties in obtaining improved seeds, crop diseases, and climatic conditions were among the factors affecting the performance of local community agricultural adaptation strategies in the area. The findings on challenges to agricultural adaptation strategies in Dodoma region are more or less similar to those of Ozor et al (2010) who cited poor climate information and agricultural extension services, high costs of farm inputs, high costs of irrigation facilities, credit constraints, and income constraints as among constraints affecting local adaptation among farming households in Nigeria.

Given the findings, it is evident that local community agricultural adaptation strategies, however much important, are not effective enough to deal with climate change challenges in the long run. This is due to the weak agricultural support system manifested through lack of knowledge on good agricultural practices among community members, difficulties in obtaining agricultural inputs such as improved seeds, crop diseases and the uncertain climatic conditions. On the basis of such hindrances, most adaptations strategies are considered far from sustainable as they are just reactive rather than focusing on reducing risks of climate change, strengthening the local community adaptive capacity, and addressing the causes of vulnerability among the local community (Brown, 2011; Eriksen & Brown, 2011; Mannke, 2011).

4.5.2. Income Diversification Strategies

Income diversification is one of the basic adaptation strategies for climate change and other environmental risks to livelihoods. In this regard, household respondents were asked to identify various income diversification strategies used in the area. The major income diversification strategies identified by respondents in Dodoma region (Table 4.17) were temporal migration to other rural areas (33.1%) and intensification of off-farm income generating activities (33.1%). Other income diversification strategies identified by the local community were home garden agriculture (29.9%), reducing expenses by changing number of meals (28.5%), temporary migration to urban areas (24.0%), permanent migration to other areas (19.8%), and reducing expenses by changing type of food (18.4%). Furthermore, commercialization of non timber forest products (14.4%), draw down on livestock, surpluses or savings (12.7%), handcrafts (12.4%), and charcoal selling (10.7%) were also considered as income diversification strategies necessary for climate change adaptation.

Table 4.17: Distribution of Respondents based on Income Diversification Strategies (N = 354)

Income diversification strategies	N	Percent
Temporal migration to other rural areas	117	33.1
Intensification of off-farm income generating activities	117	33.1
Home garden agriculture	106	29.9
Reducing expenses by changing number of meals	101	28.5
Temporal migration to urban areas	85	24.0
Permanent migration to other areas	70	19.8
Reduce expenses by changing type of food	65	18.4
Non timber forest product commercialization	51	14.4
Draw down on livestock, surpluses or savings	45	12.7
Handcrafts	44	12.4
Charcoal selling	38	10.7

Note: Dataset based on multiple responses

Respondents were further asked to identify the usefulness of income diversification strategies as a climate adaptation strategy. Given the findings in Table 4.18, the usefulness of income diversification strategies in addressing climate change challenges in the area include increasing household income (78.8%), increasing household ability to purchase food (48.9%), increasing household resilience to climate change impacts (36.7%), and increasing household ability to purchase improved seeds (8.2%).

Table 4.18: Distribution of Respondents based on Usefulness of Income Diversification Strategies (N = 354)

Usefulness of income diversification strategies	N	Percent
Increase of household income	279	78.8
Increased ability to purchase food	173	48.9
Increasing household resilience to climate change impacts	130	36.7
Increase household ability to purchase improved seeds	29	8.2

Note: Dataset based on multiple responses

Despite the importance of the strategies, various implementation challenges affect the use of income diversification strategies in adapting to climate change challenges. The findings (Table 4.19) suggest that the major challenges to income diversification strategies in Dodoma region were environmental degradation (33.3%), failure to eat minimum number of meals as a way of cutting expenses (28.0%), lack of capital (25.1%), and inability to get employment in areas of destination (24.6%). Other challenges include inability to send money and/or other resources back home (16.7%), nutritional status of some foods (15.0%), poor market (11.9%), climatic challenges in areas of destination (11.6%) and socio-economic challenges in areas of destination (11.6%). The least mentioned challenges to income diversification strategies were lack of environmental awareness (9.9%), lack of household assets such as livestock

(7.6%), fear of taking loans from financial institutions (7.6%) and absence of forest resources (4.0%).

The findings suggest that, in Dodoma region, income diversification strategies take the form of mobility, commercialization of natural resources in particular forest products, diversification of household income generating activities, and expenditure control. Nevertheless, human mobility in its varied forms (temporal and permanent migration) was the dominant (76.8%) form of income diversification strategies. In general, income diversification strategies increases households ability to deal with climate change impacts by strengthening the household food security, purchasing improved seeds capable of withstanding climate change dynamics such as droughts, and ability to meet other household needs. As noted by Agrawal (2010), income diversification strategies distribute climate change risks across household and/or community resources.

Table 4.19: Distribution of respondents based on implementation challenges to income diversification strategies (n = 354)

Implementation challenges to income diversification strategies	N	Percent
Environmental degradation	118	33.3
Failure to eat the minimum required number of meals	99	28.0
Lack of capital	89	25.1
Inability to get employment	87	24.6
Inability to send money or other resources back home	59	16.7
Nutritional status of some foods	53	15.0
Poor market	42	11.9
Climatic challenges in areas of destination	41	11.6
Socio-economic challenges in areas of destination	41	11.6
Lack of environmental awareness	35	9.9
Lack of household assets (e.g. livestock)	27	7.6
Fear of taking loans from financial institutions	27	7.6
Absence of forest resources	14	4.0

Note: Dataset based on multiple responses

Based on the findings, the study has established that the effectiveness of income diversification strategies are strongly determined by healthy environmental resources, ownership of assets, good and functional markets for various goods, good climatic and socio-economic conditions in areas of destination, and effective institutional support such as from financial institutions. A critical analysis of the income diversification strategies and the associated challenges signifies that diversification strategies as climate change adaptation mechanism are extensively anchored on utilization of natural resources in the area and the surrounding rural areas. The strategies are further characterised by lack of capital, poor market, high dependence on farming and livestock keeping, high dependence on migration, and lack of necessary skills for effective diversification hence rendering them ineffective and unsustainable. For instance, high dependence on natural resources has led to severe environmental degradation (*see* Table 4.19) in the area therefore threatening the future sustainability of the current income diversification strategies.

These findings are also in tandem with the experience of income diversification as observed by other authors. According to Paavola (2004), diversification to non agricultural activities such as charcoal production, timber harvesting, and burn brick productions have led to soil erosion and deforestation in Morogoro region in Tanzania. However, these are the common diversification strategies used by majority of local community for maintaining or increasing their income levels following a stable market of such products in the surrounding towns and urban centres. Nonetheless, diversification strategies depending highly on the use of natural resources are not sustainable since such resources are subject to degradation as is the

case for Dodoma region; hence jeopardizing the capacity of such resources to provide an escape route during the time of dearth.

In general, the use of income diversification strategies in adapting to climate change is not endemic to Dodoma region. Experiences from various places have indicated a diverse range of challenges to income diversification as it has also been observed in Dodoma region (Burke & Lobell, 2010, Macours et al., 2012, Ajan & Igbokwe, 2012). Some of the challenges affecting income diversification strategies include environmental degradation (33.3%, lack of capital (25.1%) and inability to get employment in areas of destination (24.6%). In that regard, a need for adoption of responsible and sustainable income diversification strategies that do not compromise the social and natural resource base should be central to local community undertaking. Nevertheless, public and private intervention is needed to streamline local community diversification efforts.

4.5.3. Water Management Techniques

As noted in the preceding sections, climate change challenges in the study area has led to shortage of water for domestic, livestock, and irrigation purposes; all of which affect livelihood security, food security and household income among others. Taking such challenges into consideration and the quest to improve livelihood, food and income security, the local communities in collaboration with government and nongovernmental organizations use various strategies to manage water resources in Dodoma region. The findings in Table 4.20 indicate that the key water management strategies in Dodoma region include the use of water harvesting techniques (43.0%), conservation of water catchment areas (33.7%), and improvement of watering sites in pastoral areas (21.1%). In some areas, residents (18.8%) use rainwater for irrigation

purposes. For instance, residents in Bahi Sokoni Ward in Bahi District in collaboration with the government are exploiting water flowing to the areas from other places through river channels for irrigation purposes. In addition, other residents (18.1%) manage water resources in the area through construction and improvement of terraces.

Table 4.20: Distribution of Respondents based on Water Management Strategies (N = 398)

Water management strategies	N	Percent
Use of water harvesting techniques	171	43.0
Conservation of water catchment areas	134	33.7
Improvement of watering sites in pastoral areas	84	21.1
Use of irrigation	75	18.8
Construction and improvement of terraces	72	18.1
None	57	14.3

Note: Dataset based on multiple responses

Furthermore, respondents were also asked to identify the usefulness of water management strategies used in the area. The findings in Table 4.21 indicate that the major benefits of water management strategies at the community level were water conservation (60.1%), reducing the impacts of drought (30.2%), and increasing water availability and accessibility (26.1%). Other usefulness accrued from community water management strategies include reducing flood impacts (12.9%), soil conservation and management (10.0%), increasing agricultural productivity (5.0%), stabilizing climatic conditions (2.9%), and income generation (1.2%).

Table 4.21: Distribution of Respondents based on Usefulness of Water Management Strategies (N = 341)

Usefulness of water management strategies	N	Percent
Water conservation	205	60.1
Reducing the impacts of drought	103	30.2
Increasing water availability and accessibility	89	26.1
Reducing flood impacts	44	12.9
Soil conservation and management	34	10.0
Increase in agricultural productivity	17	5.0
Stabilizing climatic conditions	10	2.9
Income generation	4	1.2

Note: Dataset based on multiple responses

Despite the fact that water management strategies in the area are of critical importance in reducing the impacts of climate change, several challenges affect the implementation of water management strategies. Among the key implementation challenges to water management strategies in Dodoma region were lack of environmental awareness (33%), high costs of water harvesting technologies (31.3%), and absence of dams for irrigation (23.3%). Other challenges identified were climatic conditions uncertainties (11.4%), and tree planting and conservation along water sources or catchment related challenges (7.6%) such as lack of tree seedlings, high price of purchasing tree seedlings, haphazard cutting of trees, and absence of adequate tree nurseries.

Given the findings, it is evident that one of the key strategies in water management strategies in the study area is the use of water harvesting techniques. In general, different rainwater harvesting techniques were used in harvesting rainwater for agricultural and domestic uses. For agricultural purposes, rainwater was harvested through construction of dams and use of good agricultural techniques such as construction of terraces and deep ploughing. Among the dams constructed for

agricultural irrigation purposes in the area are Tubugwe Juu, Kongwa, Chamkoroma, Banyibanyi, Mseta, and Ibwaga in Kongwa District. On the other hand, irrigation schemes developed in Bahi District include Nguvumali, Bahi Sokoni, Matajira, Uhelela, Nagulo Bahi, Bahi Makulu, Chali Makulu, Chikopelo, Mtitaa and Chipanga irrigation schemes. Nevertheless, the area utilized for irrigation purposes is very small as compared to the total potential area. For instance, 71% (4470.6 ha) of the land suitable for irrigation in Bahi District is not utilized despite the fact that majority of residents in the area were affected by rainfall related hazards that consequently affect agricultural productivity.

Focusing on the aspect of rainwater harvesting at household level, the findings from the study area indicate that 306 (76.9%) respondents out of 398 interviewed reported being involved in rainwater harvesting. The harvested water was mainly used for domestic uses (88.4%), for livestock (9.6%), irrigation (1.6%), and other uses (0.3%).

Nonetheless, the use of harvested water barely lasted three months from the last day of rain. As indicated in Figure 4.7, 55.2% of respondents used harvested rainwater for less than a week, 33.7% for one week, 6.9% for two weeks, 1.3% for two months, and 2.0% for three months from the last day of rain. Considering the facilities used by households in the storage of harvested rainwater, respondents reported the use of buckets (59.2%), small containers (drums) (34.4%), water tanks (3.3%), temporary dams (2.0%), and temporary wells (1.1%).

These findings suggest that harvesting rainwater as a way of dealing with climate change challenges in the area is not fully exploited due to limited storage capacities. Therefore more effort is needed in mobilizing human and financial resources to

ensure that the existing potentials for rainwater harvesting for long lasting community use are effectively exploited. This may include the construction of community tanks and dams for water harvesting during the rainy season.

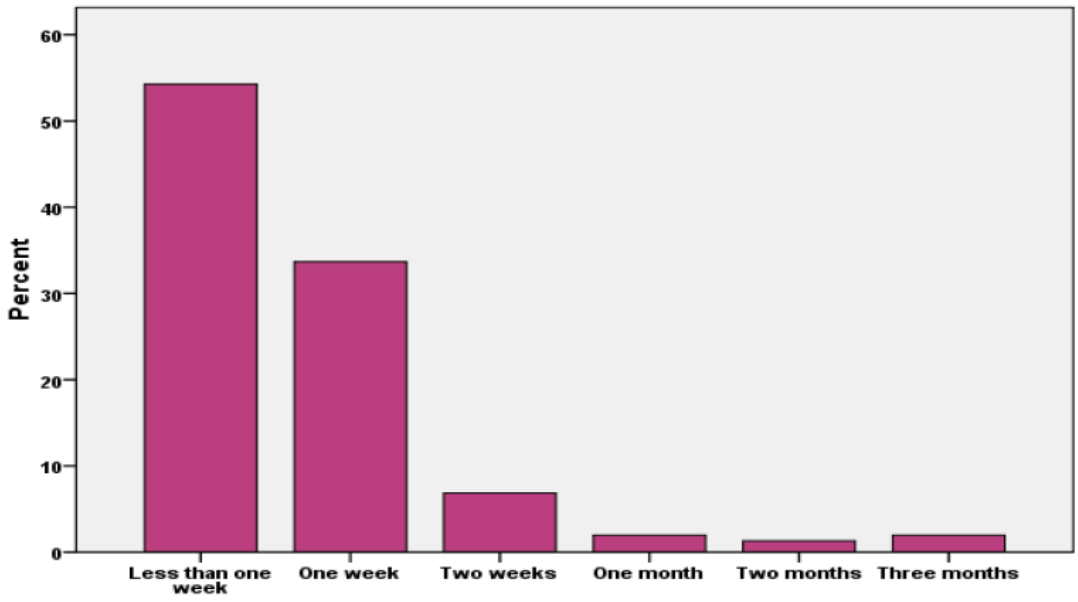


Figure 4.7: Period at which Household use Harvested Rainwater from the Last Day of Rain

The findings have further revealed that Dodoma region has high potential areas for irrigation purposes which are not exhaustively exploited. Despite efforts undertaken by district authorities in promoting irrigation, the unutilized area is more than 70% for Bahi District only. In light of recurring drought and unpredictable rainfall, development of irrigation schemes and infrastructures is of vital importance in improving local community resilience to climate change impacts. In this regard, a need to improve and expand irrigation schemes in the area cannot be underestimated in the quest for improving agricultural productivity.

Nevertheless, due to heavy investment costs involved in development of irrigation infrastructures, this task can barely be accomplished by the local community due to

lack of necessary resources. Hence, there is need for government intervention on establishing irrigation schemes in all areas with irrigation potential in Dodoma region. This will help in sustaining local community livelihoods currently threatened by increased frequency and severity of droughts as well as rainfall unpredictability. Alongside interventions in the aspect of irrigation, efforts are also needed to address water management challenges especially the degradation of water catchment areas in Dodoma region. In this regard, the focus should be on enforcing existing bylaws and regulations to control farming in unauthorized areas; and haphazard cutting of tree for charcoal making, firewood and building materials as key drivers for the degradation of water catchment areas in Dodoma region.

4.5.4. Communal Pooling Techniques

According to Agrawal (2010:184), communal pooling is a climate change adaptation strategy that involves joint ownership of assets and resources; sharing of wealth, labour or incomes from particular activities across households; and/or mobilization and use of resources that are held collectively during times of scarcity. With reference to Dodoma region (Table 4.22), the common communal pooling adaptation strategies to climate change were forest conservation (62.3%), soil conservation (37.7%), prevention of uncontrolled grazing (31.4%), soil erosion prevention programmes (20.9%) and reforestation (20.9%). Other communal pooling strategies identified by the local communities as important to climate change adaptation were preservation and restrictions of grazing area (17.1%), and control of overgrazing (14.3%). Furthermore, communal irrigation (2.3%) and communal water harvesting tanks (1.3%) were also considered by a small proportion of respondents as communal pooling adaptation strategies used in the area.

Table 4.22: Distribution of Respondents based on Communal Pooling Adaptation Strategies (N = 398)

Communal pooling strategies	N	Percent
Forest conservation	248	62.3
Soil conservation	150	37.7
Preventing uncontrolled grazing	125	31.4
Soil erosion prevention programmes	90	22.6
Reforestation	83	20.9
Preservation and restrictions of grazing area	68	17.1
Control overgrazing	57	14.3
Communal irrigation	9	2.3
Communal water harvesting tanks	5	1.3
None	31	7.8

Note: Dataset based on multiple responses

Another form of communal pooling adaptation strategy identified during FGDs and review of Medium Term Expenditure Framework (MTEF) was the formation of informal and formal small social groups for the purposes of pooling their financial and labour resources. In the informal small social groups, the financial resources are mobilized and shared in the form of *"Merry-go-round"*. The purpose of mobilizing and sharing of resources is to empower individual group members in the form of capital and other resources for diversifying households' activities that consequently addresses household climate change risks. The formal social groups on the other hand are supported by the government after mobilizing a certain percentage of capital to establish income generating activities of choice in order to improve their wellbeing.

The findings (Table 4.23) identified reduction of impacts of drought (77.7%), soil conservation (40.3%), and controlling soil erosion (35.4%) as major benefits of communal pooling adaptation strategy at community level. Other benefits were stabilizing climatic conditions (11.7%), reducing high temperature (6.0%), increasing

agricultural productivity (5.2%), reducing impacts of floods (3.0%) and reducing the impacts of intense storms (2.2%).

Table 4.23: Distribution of Respondents based on Usefulness of Communal Pooling Adaptation Strategies (N = 367)

Usefulness of communal pooling strategies	N	Percent
Reducing the impacts of drought	285	77.7
Soil conservation	148	40.3
Controlling soil erosion	130	35.4
Stabilizing climatic conditions	43	11.7
Reducing high temperature	22	6.0
Increase agricultural productivity	19	5.2
Reducing flood impacts	11	3.0
Reducing the impacts of intense storms	8	2.2

Note: Dataset based on multiple responses

The findings suggest that communal pooling adaptation strategies in addressing climate change impacts in the area are of importance. Nevertheless, various challenges threaten the effectiveness of communal pooling as an adaptation strategy to climate change impacts. The major identified challenges of the communal pooling (Table 4.24) were lack of environmental awareness (63.2%), poor enforcement of bylaws (43.1%), absence of adequate tree nurseries (30.3%), and high price of purchasing tree seedlings (24.8%). Other identified challenges were persistence of drought (17.7%), cost of adaptation technologies such as irrigation technologies (16.3%), inadequacy of dams for irrigation (4.6%) and financial constraints (2.7%).

Table 4.24: Distribution of Respondents based on Implementation Challenges for Communal Pooling Adaptation Strategies (N = 367)

Implementation challenges for communal pooling strategies	N	Percent
Lack of environmental awareness	232	63.2
Poor enforcement of bylaws	158	43.1
Absence of adequate tree nurseries	111	30.3
High price of purchasing tree seedlings	91	24.8
Persistent drought	65	17.7
Adaptation technologies are too expensive	60	16.3
Inadequacy of dams for irrigation	17	4.6
Financial constraints	10	2.7

Note: Dataset based on multiple responses

With regard to the communal pooling adaptation strategies used in Dodoma region, the findings have shown that the main focus is on management of natural resources such as forest, soil and pasture management. This is an indication that the livelihood of the local communities is strongly linked to the utilization of the named natural resources. As stated in the previous sections, agriculture (farming) and livestock keeping are the main forms of occupation, sources of income and sources of food production. Nevertheless, the findings have established that communal irrigation and communal water harvesting are not widely used by local communities in adapting to climate change. Probably this may be attributed to the low capacities for rain water storage that consequently leads to under utilization of a lager potential area for irrigation.

In addition, the findings also have shown that both informal and formal social groups are also engaging in pooling their resources in various forms so as to improve their well being. The findings have further established that the key challenges to communal pooling techniques are based on financial, institutional, climatic uncertainties, and

access to adaptation technologies. These challenges suggest that the effectiveness of communal pooling is determined by well functioning or vibrant local institutions. Such institutions are instrumental in awareness creation and law enforcement among others on matters pertaining to managing environmental resources.

From the findings, it has been established that some technologies necessary for the realization of the full potential of communal pooling adaptation strategies cannot be easily afforded by the local community. For instance, irrigation technologies which always transcend household capacity can easily be obtained with assistance from the government or development partners. In such a situation, government and other actors intervention is of vital importance in facilitating community joint action for climate change adaptation. Furthermore, the persistence of drought in the area also poses a threat to communal pooling adaptation strategies due to its ability to contravene the local community livelihood base and therefore affecting a larger segment of the community. Similar findings on the importance and the need for effective local institutions on the use of communal pooling as a local community adaptation strategy to climate change have also been observed in Tarime District in Tanzania (Rodima-Taylor, 2012).

4.5.5. Migration of some Household Member

In adapting to climate change challenges such as increased drought, human mobility is increasingly becoming an effective adaptation strategy. In the study area, the findings indicate that 139 (34.9%) of respondents reported permanent or temporary migration of some household (HH) member(s). Based on the percent of cases (Table 4.25), the reasons for migration were seeking for new livelihood opportunities

(48.9%), prolonged drought (33.1%), inadequate/unpredictable rainfall (32.4%), formal employment (21.6%), shortage of pasture (12.2%), and shortage of water for animals (10.8%). Others were temperature increase (2.2%) and floods (0.7%).

Table 4.25: Reasons for Migration of some Household Member(s) (N = 139)

Reasons for Migration of some HH member(s)	N	Percent
Seeking for new livelihood opportunities	68	48.9
Prolonged drought	46	33.1
Inadequate/unpredictable rainfall	45	32.4
Formal employment	30	21.6
Shortage of pasture	17	12.2
Shortage of water for animals	15	10.8
Temperature increase	3	2.2
Floods	1	0.7

Note: Dataset based on multiple responses

Further analysis using Chi-square test on the relationship between permanent or temporal migration of some household member(s) with respondents' district of residence, effects of climatic elements (drought, storms, floods, temperature, and rainfall) and status of food production for the past 5 years (2007 – 2011) was undertaken. The findings in Table 4.26 indicate a significant relationship between migration of some household member(s) and district of respondents $x^2(1, n = 398) = 43.02, p = 0.000, Phi = 0.329$ in which most member(s) from Bahi District migrated as compared to Kongwa District; effect of drought on household livelihood activities $x^2(1, n = 398) = 7.83, p = 0.005, Phi = -0.140$ whereby most households which reported being affected by drought some of their member(s) migrated as compared to those remained in their households; effect of unpredictable rainfall on the household activities $x^2(1, n = 398) = 7.17, p = 0.007, Phi = 0.134$ whereby most of households which reported being affected by unpredictable rainfall some of their household

member(s) migrated as compared to those who did not migrate; and the status of household food production in the past 5 years (2007 – 2011) $x^2(2, n = 398) = 13.31, p = 0.001$, *Cramer's V = 0.183* whereby most of households which reported inadequate production of food in all 5 years (2007 – 2011) some of their household member(s) migrated as compared to households which either produced enough food in all 5 years or in some years;. In all explained cases, Phi and Cramer's V statistics were significant $(p < 0.05)$ indicating that x^2 values of the named variables were unlikely to have happened by chance and therefore, the strength of the relationships was significant.

Furthermore, there were no associations between migration of some household member(s) and the effects of storms on household livelihood activities $x^2(1, n = 398) = 1.09, p = 0.296$, *Phi = 0.052*; effects of floods on household livelihood activities $x^2(1, n = 398) = 0.34, p = 0.560$, *Phi = -0.029*; effects of temperature decrease on household livelihood activities $x^2(1, n = 398) = 0.61, p = 0.436$, *Phi = 0.039*; effects of temperature increase on household livelihood activities $x^2(1, n = 398) = 2.27, p = 0.132$, *Phi = -0.076*; and effects of rainfall decrease on household livelihood activities $x^2(1, n = 398) = 0.48, p = 0.486$, *Phi = 0.035*. In all cases, Phi statistics were not significant $(p > 0.05)$ thus confirming that the strength of the relationship was not significant as already reflected in the chi-square test for the effects of storms, floods, temperature decrease, temperature increase, and rainfall decrease on household livelihood activities.

Table 4.26: Distribution of Respondents by Migration of Household Member(s)

Variable		Migration of HH member		**Total**	χ^2 ***value***	***df***	***p value***
		Yes	No				
District of residence	Bahi	95 (51.9)	88 (48.1)	183 (46.0)	43.02	1	0.000
	Kongwa	44 (20.5)	171 (79.5)	215 (54.0)			
Effect of drought on HH livelihood activities	Affected	102 (73.4)	37 (26.6)	139 (34.9)	7.83	1	0.005
	Not affected	220 (84.9)	39 (15.1)	259 (65.1)			
Effect of storms on HH livelihood activities	Affected	54 (38.8)	85 (61.2)	139 (34.9)	1.09	1	0.296
	Not affected	87 (33.6)	172 (64.4)	259 (65.1)			
Effect of floods on HH livelihood activities	Affected	22 (15.8)	117 (84.2)	139 (34.9)	0.34	1	0.560
	Not affected	47 (18.1)	212 (81.9)	259 (65.1)			
Effect of temperature decrease on HH livelihood activities	Affected	32 (23.0)	107 (77.0)	139 (34.9)	0.61	1	0.436
	Not affected	51 (19.7)	208 (80.3)	259 (65.1)			
Effect of temperature increase on HH livelihood activities	Affected	69 (49.6)	70 (50.4)	139 (34.9)	2.27	1	0.132
	Not affected	149 (57.5)	110 (42.5)	259 (65.1)			
Effect of rainfall decrease on HH livelihood activities	Affected	128 (92.1)	11 (7.9)	139 (34.9)	0.48	1	0.486
	Not affected	233 (90.0)	26 (10.0)	259 (65.1)			
Effect of unpredictable rainfall on HH livelihood activities	Affected	126 (90.6)	13 (9.4)	139 (34.9)	7.17	1	0.007
	Not affected	208 (80.3)	51 (19.7)	259 (65.1)			
Status of HH food production in the past 5 years (2007 – 2011)	Enough	12 (8.6)	43 (16.6)	55 (13.8)	13.31	2	0.001
	Not enough	103 (74.1)	144 (55.6)	247 (62.1)			
	Enough in some years	24 (17.3)	72 (27.8)	96 (24.1)			

Note: Numbers in parentheses are percentages

Based on the findings indicated in Table 4.26, the key factors leading to migration of household member(s) in the study area are drought, unpredictable rainfall and the status of food production. Nevertheless, such factors differently affect the extent of household migration in Bahi and Kongwa districts whereby majority of migrants were from Bahi District. This may be attributed to the fact that Kongwa District has a slightly higher number of households producing enough food, income and size of

farms cultivated hence ability to adapt to climate change effects using local resources. The findings from the study area are similar to the findings on migration of household member(s) as a result of climate change in Tanzania and elsewhere. Studies on rainfall induced crop failure, food insecurity and human mobility conducted in Same District in Tanzania, Ghana, India, Guetamala, and Bangladesh indicated a positive relationship between rainfall shortage and out-migration (Afifi et al., 2014; Radamacher-Schulz et al., 2014; Murali & Afifi, 2014; Milan & Ruano, 2014; Etzold et al., 2014). In all cases, variation in rainfall affected food production, water availability, and other community livelihood sources such as livestock keeping hence increasing household vulnerability to climate change.

Such losses prompt migration of some household member from farming and livestock keeping communities as a way of dealing with climate change associated risks. Following migration of some household member(s), the assistance provided to households back home in adapting to the effects of climate change hazards (Table 4.27) include remitting money for purchasing food (48.9%), sustaining access to basic needs (46.0%), sending food at home (38.8%), source of income for investing in other activities (29.5%), providing much needed economic support to the household (21.6%), and reducing the risks of animal deaths from shortage of pasture and water (20.1%) as the motive of migration in this aspect is to search pasture and water for their animals. However, some of the migrated household members (14.4%) do not provide any assistance to the household in adapting to the effects of climate change.

Table 4.27: Assistance from Migrated Household Member(s) to the Household in Adapting to the Effects of Climate Change Hazards (N = 139)

Assistance to the HH in adapting to climate change hazards	N	Percent
Remit money for purchasing food	68	48.9
Sustain access to basic needs	64	46.0
Sending food at home	54	38.8
Source of income for investing in other activities	41	29.5
Providing much needed economic support to the household	30	21.6
Reducing risks of animal deaths from shortage of pasture and water	28	20.1
None	20	14.4

Note: Dataset based on multiple responses

Based on the findings, the study has established that migration of some household member(s) in the study area was as a result prolonged drought, unpredictable rainfall and the need to seek for new livelihood opportunities as the current livelihood sources in the area are no longer predictable due to the wrath of climate change impacts. For those engaging in livestock keeping, shortage of pasture and water for animals motivates their migration particularly during the time of dearth. As further analysed, the findings also indicated a significant association between district of residence, status of food production, drought and unpredictable rainfall with migration of some household member(s) in the area. This indicates that the migration of household member(s) in Dodoma region is motivated by drought and unpredictable rainfall rather than floods, intense storms, decrease in temperate and increase in temperature as other forms of climate change extreme events. In addition, the findings imply that the traditional livelihood activities namely farming and livestock keeping are no longer capable of sustaining the lives of local communities in the area and hence the need to move out to seek for other new livelihood opportunities that could be of vital importance for the survival of households in the areas of origin.

It is from these outlook and the quest for improving the climatic affected livelihoods, that the migrants play critical roles in stabilizing livelihoods in their areas of origin via remittances for purchasing food, sustaining the households basic needs, providing support for investing in other activities as a way of diversifying livelihood sources, sending food at home, providing economic support, and also reducing the risks of animal deaths from shortage of pasture and water. The findings of this study reflect the fact that remittances from migrants play a critical role in improving household resilience to climate change impacts.

Nevertheless, migration as an adaptation strategy does not always help in achieving its intended goal for some households. Some of the migrants do not provide any support to their areas of origin for dealing with climatic related risks (Table 4.27). This was also raised by participants during focus group discussion (FGD) in Bahi and Kongwa districts in Dodoma region. For instance, during a FGD held in Bahi District on 3/10/2013, participants explained that some heads of households especially men usually stay for a long period in areas of destination while leaving women, children and elders struggling to take care of the family during the time of dearth. Sometimes they temporarily migrate in December (which is a critical time for cultivation in the area) and return in April when the family has already stabilized from shocks following the harvest of cultivated crops. The participants, especially women, further complained that on the return of their husbands sometimes they come with new wives and during their stay in the areas of destination they do not support their families back home (areas of origin). These findings are in tandem with the findings on human mobility established in Bangladesh, Tanzania and other countries (Warner & Afifi, 2014, Etzold et al., 2014; Rodima-Taylor, 2012).

4.6. Local Community Mitigation Practices to Climate Change

The study further sought to establish the local community mitigation strategies to climate change in Dodoma region. This was done by examining the adopted local community mitigation strategies and sources of energy for cooking and types of cooking stoves.

4.6.1. Adopted local Community Mitigation Strategies

Respondents were asked to identify the adopted local community mitigation strategies in their area. The findings in Table 4.28 indicate that out of 398 respondents, 70.1% were involved in tree planting at household level. Other local community members were involved in village forest conservation (43.0%), afforestation at community level (31.7%), preventing fire outbreak (30.9%), and reforestation at community level (17.8%). Very few respondents were participating in rangeland management (2.8%), use of alternative sources of energy (1.0%), and use of improved stoves. Nevertheless, 7.8% of the respondents were not involved in any of the adopted local community mitigation strategies.

Table 4.28: Adopted local Community Mitigation Strategies in Dodoma Region (N = 398)

Adopted community mitigation strategies	N	Percent
Tree planting at household level	279	70.1
Forest conservation	171	43.0
Afforestation at community level	126	31.7
Preventing haphazard fire outbreak	123	30.9
Reforestation at community level	71	17.8
Rangeland management	11	2.8
Use of alternative sources of energy	4	1.0
Use of improved stoves	3	0.8
None	31	7.8

Note: Dataset based on multiple responses

The finding signifies the presence of community level efforts that contribute to climate change mitigation. Activities such as tree planting, forest conservation, afforestation, prevention of haphazard fire outbreak and reforestation contribute significantly in reducing atmospheric GHGs concentration. Of particular importance for activities related to tree planting, is the role played by the forest in carbon sequestration (Yanda & Mubaya, 2011). Based on information collected from district officials responsible for environmental management, the process of tree planting at the community level is coordinated by the district councils with strong support from village leaders. For instance, in Kongwa District, every household is required to plant ten (10) trees per year in the land owned by the household and the district target is to plant 1,500,000 trees per year. However, such efforts are mostly affected by rainfall variation and recurrent drought that affects the survival rate of the planted trees.

The findings also suggest that the rate of tree cutting for energy use is very high. This is based on the fact that only 1% and 0.8% of respondents use alternative sources of energy and improved stoves, respectively. In addition, some respondents do not engage in any local community mitigation strategies despite the fact that they also use firewood and charcoal as their main source of energy for cooking at household level. It is therefore very paramount for the local community among themselves, through their community leaders, and the district authorities to take stern measures to ensure that households plants trees or establish woodlots at household level. Efforts should also be undertaken to promote the use of alternative sources of energy and energy saving stoves at household level. Such measures are critical in reducing local

community pressure to village forests in search for cooking energy *(see section 4.6.2),* building materials and other uses.

Despite its importance in reducing GHGs, the adopted local community mitigation strategies have both climate change adaptation and mitigation potentials to the local community. An interview with 367 respondents participating in implementation of various mitigation practices indicated that 78.7% of 367 respondents use local community mitigation strategies to reduce the impacts of drought. Other usefulness *(based on multiple responses - percentage of cases)* of adopted community mitigation strategies were soil conservation (32.2%), income generation (26.7%), stabilizing climatic conditions (26.4%), controlling soil erosion (20.7%), reducing high temperature (16.9%), reducing impacts of intense storms (15.0%), and reducing floods impacts (0.3%). These findings suggest that community level mitigation strategies have other roles such as stabilizing the climatic conditions, environmental management and income generation to the local community.

Nonetheless, the implementation of the local community mitigation strategies in the area is affected (Table 4.29) by lack of environmental awareness (86.4%), lack of tree seedlings (53.7%), high price of purchasing tree seedlings (31.3%), and climatic condition uncertainties (25.6%). Other implementation challenges include absence of tree nurseries (9.8%) and high costs involved in acquiring mitigation technologies (7.9%).

Table 4.29: Implementation Challenges for the Adopted Mitigation Strategies (N = 367)

Implementation challenges for mitigation strategies	N	Percent
Lack of environmental awareness	317	86.4
Lack of tree seedlings	197	53.7
High price of purchasing tree seedlings	115	31.3
Climatic conditions uncertainties	94	25.6
Absence of tree nurseries	36	9.8
Mitigation technologies are too expensive	29	7.9

Note: Dataset based on multiple responses

The findings suggest that majority of residents in the study area are not aware of environmental conservation and management issues leading to haphazard cutting of trees and failure to use environmental friendly technology such as improved stoves. The findings also suggest that activities related to tree planting in the area are affected by difficulties involved in obtaining tree seedlings and to a larger extent by the climatic condition uncertainties.

An interview with key informants, village leaders, and government officials at the district level also revealed that lack of environmental education, lack of funds to facilitate extension officer's activities, shortage of environmental officers at ward and village level and poverty affects the implementation of mitigation strategies in the area. Other challenges opined by key informants, village leaders and government officials were poor rangeland management mainly caused by the resistance of livestock keepers to reduce the number of livestock, high costs for climate change mitigation technologies, shifting cultivation, resistance of the local community to refrain from haphazard tree cutting since majority see it as a source of income, and social conflicts between farmers and livestock keepers.

Citing poverty as an example for the implementation of climate change mitigation strategies, the agricultural extension officer for Mpamantwa Ward in Bahi District categorically stated that it is difficult to prohibit the local communities from cutting trees for charcoal making as their survival depends on such activities following low agricultural productivity as a result of climate change. An informal conversation with a governmental official in Kongwa District revealed that one of the local residents in the district committed suicide after his charcoal (illegally made from protected forest) was confiscated by the natural resource management officers claiming that charcoal making was the only activity used to provide for the family needs including food, paying for school fees, and covering for medical bills among others.

In general, the local community in the study area was participating in the implementation of various climate change mitigation strategies mainly through tree planting related activities. However, local community efforts are hindered by a number of challenges such as lack of awareness in environmental issues and climatic uncertainties. In this regard, the issue of environmental education is considered by all actors as key in the quest for addressing climate change challenges through a mitigation window. Nevertheless, the local community in Dodoma region has not yet exploited the emerging climate change mitigation opportunities such as the Clean Development Mechanism (CDM) and "reducing Emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries" commonly known as REDD+. The two mechanisms offer both mitigation potential and ability for the local community to earn income.

4.6.2. Sources of Energy for Cooking and Types of Cooking Stoves

The findings in Table 4.30 indicate that firewood (95.7%) and charcoal (34.2%) are the main sources of energy for cooking. The use of other sources in particular kerosene (1.8%) is very low. The findings are similar to Boko et al. (2007) who place the use of wood for cooking in rural households in Kenya, Tanzania, Mozambique and Zambia among other sub-Saharan countries at more than 90%. Despite the fact that majority of residents in Dodoma region use charcoal and firewood as their main sources of cooking energy, the findings also revealed that majority of residents (88.4%) in the area use three stone open stove. Other types of cooking stoves used by households in the study area were traditional charcoal stove (31.4%), improved firewood stove (8.8%), improved charcoal stove (6.0%) and kerosene stove (1.8%).

Table 4.30: Distribution of Respondents based on Main Households' Sources of Energy for Cooking and Type of Cooking Stove (N = 398)

Variables	Sources of energy and type of cooking stove	N	Percent
Source of energy	Firewood	381	95.7
	Charcoal	136	34.2
	Kerosene	7	1.8
Type of cooking stove	Three stone open stove	352	88.4
	Traditional charcoal stove	125	31.4
	Improved firewood stove	35	8.8
	Improved charcoal stove	24	6.0
	Kerosene stove	7	1.8

Note: Dataset based on multiple responses

Further analysis using chi-square test of independence on the source of tree for fuel, households' woodlot ownership, and presence of bylaws or/and regulation used in managing village or community forests indicated (Table 4.31) that there was no

significant relationship between district of residence and where households obtain trees for fuel $x^2(1, n = 398) = 0.062, p = 0.804, Phi = -0.013$ as majority of residents from Bahi (94.5%) and Kongwa (95.1%) collects their fuel from village or community forests. The findings further indicated that there was no significant relationship between district of residence and presence of bylaws and/or regulations for managing forest in the area $x^2(2, n = 398) = 3.82, p = 0.148, Phi = 0.98$ with 75.4% and 69.3% of respondents from Bahi and Kongwa districts respectively confirming the presence of bylaws/regulations for forest management. In the two cases (where households obtain fuel and presence of bylaws/regulation), the Phi statistics were not significant $(p > 0.05)$ so confirming that the strength of the relationship was not significant as already reflected in the chi-square test. These findings suggest that bylaws and/or regulations for forest management in the area are not effectively enforced and some households are not even aware of their presence as most households depend on village forests for their sources of cooking energy. The findings also suggest that efforts to encourage households to have their own woodlots are minimal therefore creating a danger for the depletion of village/community forests in future.

Furthermore, the findings showed a significant association between household woodlot ownership and district of residence $x^2(1, n = 398) = 25.05, p = 0.000, Phi = -0.251$ with more households owning woodlots (15.3%) in Kongwa District as compared to 1.1% in Bahi District. In this case, the Phi statistic was significant $(p < 0.05)$ indicating that values of the x^2 - tests on household woodlot ownership and district of residence was unlikely to have happened by chance and therefore, the strength of the relationships was significant.

Table 4.31: Distribution of Respondents based on Source of Tree for Fuel, Households' Woodlot Ownership, and Presence of Bylaws/Regulation used in Managing Village or Community Forests

Variable		District of residence		**Total**	χ^2 *value*	*df*	*p value*
		Bahi	Kongwa				
Where do you obtain trees for fuel	Collecting from forest	171(94.5)	173(95.1)	344 (94.8)	0.06	1	0.804
	Buying	10 (5.5)	9 (4.9)	19 (5.2)			
Woodlot ownership	Own	2 (1.1)	33 (15.3)	35 (8.8)	25.1	1	0.000
	Not own	181(98.9)	182(84.7)	363(91.2)			
Presence of bylaws for managing forest	Yes	138(75.4)	149(69.3)	287(72.1)	3.82	2	0.148
	No	30 (16.4)	35 (16.3)	65 (16.3)			
	Don't know	15 (8.2)	31 (14.4)	46 (11.6)			

Note: Numbers in parentheses are percentages

Given the findings in Table 4.30 and 4.31; majority of households in the study area use fuelwood as the main source of cooking energy other than alternative energy sources such as biogas, solar energy and electricity. Unfortunately, the trees used for fuelwood are obtained from the village forests as only few households (8.8%) in the study area own woodlots. However, continuous cutting of trees from the village forests leads to more land degradation and reducing the forest potentials in the area to absorb GHGs. The finding has also shown that most households use three stone open and traditional charcoal stoves rather that improved firewood and charcoal stoves. The three open stone and traditional charcoal stoves consume more fuelwood in the cooking process as compared to the improved ones and therefore facilitate deforestation in the area. According to IRDP (2014), the use of improved stoves, in particular the improved fuelwood stove, cuts down fuelwood by 57 percent and reduces household CO_2 by 1.4 tons per year.

These findings suggest that the rate of cutting trees for fuelwood purposes in Dodoma region is high due to the fact that both major sources of energy for cooking and type

of cooking stoves used in the area involves cutting of trees mainly from the village or/and community forests. In this regard, the main source of energy for cooking and type of cooking stove used by households in the area facilitates deforestation. Nevertheless, deforestation severely impacts the multi-functional nature of forest in supporting and sustaining livelihoods; alleviating poverty; and supporting economic, social, and cultural environment development in rural areas (Adeola et al., 2001; Somorin, 2010).

4.6.3. The Role of Land Use Planning in Climate Change Mitigation

Regarding the role of land use planning in climate change mitigation in the study area, the findings, based on the review of various government documents and interview with government officials, established that the intention of the government on developing the land use plans to the village level is evident (URT, 2010d). Nevertheless, land use plans were not developed in the area hence leading to degradation of forests and generating conflict among different users.

The question of environmental degradation and conflicts among different users were established during FGDs whereby participants also faulted the government for her failure to facilitate the process of land use planning in their villages; therefore expressing the need for effective preparation and implementation of village land use plans. They also expressed concerns on minimal or absence of support from the village government and the district authority on enforcement of bylaws governing resource use in the villages.

According to FGDs participants, the preparation and effective implementation of the proposed village land use plans have the potential of controlling unsustainable use of

village land by pastoralists. At the same time, it offers an opportunity for livestock keepers to keep animals in accordance to the available village land and respective uses. Other expected benefits include addressing the recurring conflicts between livestock keepers and farmers.

Other FGDs participants complained of the failure of their villages to develop land use plans. In addition, participants requested for government assistance in developing village land use plans alongside issuance of land ownership rights. FGDs participants also believed that preparation of village land use plans and consequently their implementations can resolve the existing impasse whereby people destroying the environment are favoured by politicians under the umbrella of *"my voters"*. This indicates the tendency by politicians to achieve political mileage at the expense of the environmental and lack of political will in environmental management. It also signifies the political interference on the rule of law leading to poor enforcement of environmental laws, bylaws and regulations.

Supporting the views obtained during FGDs, key informants and government officials on the failure to develop village land use plans is the Strategic Plan for the Implementation of Land Laws (SPILL) that offers high priority in preparing integrated human settlements plans, surveys and gender balanced issuance of land titles at least in cities, municipalities and towns (URT, 2010d). This leaves the vast rural areas unplanned. As a result, some villages have rudimentary and rarely implemented land use plans developed by the respective village communities. It is on this basis that there are no cases for successful implementation of the village land use plans in Dodoma region.

In general, the absence of village land use plans has led to environmental degradation in the area, hence limiting the role of land use plans in climate change mitigation. These findings are consistent with IRDP (2014) that argues that the absence of village land use plans is the source of environmental degradation and conflicts in the use of environmental resources. Considering the importance of land use management, local communities/villages should develop their own land use plan in order to manage community resource use in a sustainable manner.

4.7. Mainstreaming Climate Change Issues into Government Policies, Plans and Strategies

Government is a key player in the development process of a developing country such as Tanzania. If climate change adaptation and mitigation programmes are to succeed, they must be fully integrated or rooted in government policy and institutional framework. It is against this background that in this section government policies, plans and strategies are critically reviewed with respect to climate change adaptation and mitigation. This is an attempt to establish the extent to which these measures have been mainstreamed in government plans, policies and strategies and if institutions exist for implementing the required measures.

4.7.1. Mainstreaming Climate Change into National Development

Using content analysis in analysing the process of climate change mainstreaming into national development, this study examined the national poverty reduction policies, national development plans, and national budget allocation process. Below are the findings.

Mainstreaming Climate Change in National Poverty Reduction Strategies

The review of the Poverty Reduction Strategy Paper (PRSP) and the National Strategy for Growth and Reduction of Poverty (NSGRP) in Tanzania established that climate change mainstreaming is just a new phenomenon. Prior to NSGRP II of 2010 (2010/11 – 2014/15), the PRSP of 2000 and its successor (the NSGRP I of 2005/06 – 2009/10) only focused on poverty reduction and economic development. Unlike the PRSP and NSGRP I, the NSGRP II apart from focusing on addressing the economic growth and poverty challenges it also offers measures to deal with climate change challenges (URT, 2000a; URT, 2005; URT, 2010d). The commitment of NSGRP II in addressing climate change challenges is reflected in its commitment in ensuring food and nutrition security and climate change adaptation and mitigation; enhancing the capacity to mitigate the adverse impacts of climate change and natural and human – made disasters; and for mitigating the adverse effects of climate change in the aspect of developing decent human settlement while sustaining environmental quality (URT, 2010d).

In achieving the above, NSRP II calls for community empowerment, supporting of research that focuses on reducing vulnerability to climate change; promotion of climate smart agriculture, water conservation and irrigation, strengthening weather projection and early warning systems, forest management, management of climatic related disasters, strengthening institutions dealing with early warning systems, risk management and preparedness, and disaster management and response. Other strategies highlighted in NSRP II include developing and instituting methods for adapting the adverse impacts brought about by climate change and disasters; revising laws, regulations and guidelines on risk management, protection, mitigation, and

reduction of effects of human made and natural disasters, developing regional and international collaboration on information sharing, and developing decent human settlement while sustaining environmental quality (URT, 2010d). With regard to the focuses of NSGPR II in climate change issues, it suffices to argue that NSGRP II, if well implemented, as a strategy, is well placed in addressing climate change adaptation and mitigation issues. Its strength is anchored on a wide coverage of climate change issues and the integration of solutions for addressing climate change challenges with technical, governance, financial, empowerment and partnership all geared towards promoting community well-being.

Some of the achievements of NSGRP II (2010/11 – 2014/15) in dealing with climate change challenges in the first two years of its implementation as reviewed from URT (2011b) and URT (2012b) were maintaining the Strategic Grain Reserve at least 4 months of national food requirement; to train government officers in early warning and natural disaster response and coordination during 2010/11; climate change awareness creation; formulation of climate change adaptation guideline, climate change communication strategy, and National climate change strategy in 2011/12 among others. Furthermore, based on a critical analysis of the achievements registered following the implementation of NSGRP II, it is evident that the impact of NSGRP II towards addressing climate change challenges at a national scale is still minimal. This is based on the fact that throughout its implementation period, the focus has been on institutional capacity development usually at a strategic level as compared to implementation of activities that directly reduce climate change vulnerability of the local communities. This situation has been compounded by various implementation challenges such as low budgetary allocation, delays and inadequate release of funds,

shortage of critical skills especially knowledgeable extension staff; and low capacity for planning, budgeting and project execution at LGA level (URT, 2011b; URT, 2012b).

Mainstreaming Climate Change into National Development Plans

The review of various national development plans since independence in 1961 has established that all national development plans prior to 2000 did not directly take into consideration the issues of climate change adaptation and mitigation. Their focuses were on economic reforms, poverty reduction, and food production. Nevertheless, almost all development plans were never implemented due to shortage of resources. It is likely that the pre 2000 national development plans did not take into consideration the issue of climate change as it was not a major environmental problem of concern until 1992 when it received international recognition leading to the formulation of the United National Framework Convention on Climate Change (UNFCCC) of 1992.

The first development plans to categorically mainstream climate change were the long term Tanzania Development Vision 2025 (TDV 2025) unveiled in 2000 and the five year development plan (FYDP I: 2011/12 – 2015/16). As a strategic and major development policy in Tanzania, the TDV 2025 embraces the need for addressing current trends associated with environmental resources degradation and climate change in achieving fast economic growth (URT, 2000b). The findings are similar to those of Kok et al. (2008) who considered development that turns its back on climate change as unsustainable. In this case, the TDV 2025 accords high priority to environmental sustainability including the need to address climate change challenges for the purpose of building a strong and competitive economy.

Despite the fact that the TDV 2025 was unveiled over a decade ago, its achievements in relation to climate change adaptation and mitigation are still at the infancy stage. This is due to the fact that the frameworks adopted during the first ten years of its implementations (i.e. the PRSP: 2000 – 2003 and NSGRP I: 2005/06 – 2009/10) did not take into account the aspect of climate change. Among the achievements of TDV 2025 in relation to climate change adaptation and mitigation include the formulation of the national climate change strategy of 2012; the National Environmental Action Plan of 2013; guidelines for integrating climate change issues into development plans at local government and sector level; and awareness creation among various actors on climate change. In general, the achievements of TDV 2025 in relation to climate change adaptation and mitigation are still limited to a strategic rather than the operational level as it is also the case of NSGRP II.

On the other hand, the Five Year Development Plan 2011/12 – 2015/16 (FYDP I) is the first in a series of five year development plans aiming at implementing the TDV 2025. The remaining two (FYDP II and FYDP III) will be formulated and implemented in 2016/17 – 2020/21 and 2021/22 – 2024/25, respectively. In relation to climate change, the FYDP I recognizes that mitigating and adapting to climate change is paramount for sustainable growth (URT, 2011a). In dealing with climate change challenges, the FYDP I underscores the need for development of climate wise economic development policies and national framework for climate change for guiding measures to be taken in addressing climate change; development of national institutional framework that will oversee government efforts to seek global partnerships to environment and climate change finance; awareness creation among climate change actors; formulation of coherent national climate change strategy;

formulation of the national climate change policy by 2015; and creation of adequate institutions to deal with climate change. The named priority areas as advocated by the FYDP I imply that effective policy and institutional frameworks are of prime importance in coordinating climate change related activities among them being seeking global, regional and local partnership in terms of financial, technological and capacity building.

Among the achievements of the FYDP I (2011/12 – 2015/16) in relation to climate change management include the preparation of strategic climate change documents such as the national climate change strategy; national climate change communication strategy (2012 – 2017); monitoring and evaluation framework for climate change adaptation in Tanzania; and the guidelines for integration of climate change adaptation into national sectoral policies; plans and programmes of Tanzania, all of which were formulated in 2012. Furthermore, the country prepared the National Environmental Action Plan (NEAP) 2013 – 2018 in 2013. This is an indication that the country is making a step towards strengthening the policy and institutional capacity in dealing with climate change challenges. However, at the community level the impact of the named documents is still minimal as the implementation of climate change frameworks is just in its early stages.

Mainstreaming of Climate Change into National Budget Allocation Process

In Tanzania, the national budget allocation process is guided by the Plan and Budget Guidelines (PBGs). The guidelines direct Ministries, Departments and Agencies (MDAs), Regions, and Local government Authorities (LGAs) the procedures, considerations, priorities and later ceilings to abide when preparing their Medium Term Expenditure Frameworks (MTEFs). This justifies the need to review PBGs to

establish whether climate change adaptations and mitigations issues are also high in the planning and budgeting agenda. To that end PBGs for 2009, 2010, 2011 and 2012 were reviewed. The review of the named PBGs established that the matter was not of priority concern for the 2009 and 2010 PBGs (URT, 2009a and URT 2010b). These findings are in conformity with NSGRP I goals. The NSGRP I goals do not appreciate the need of addressing climate change issues. Therefore, absence of climate change issues in 2009 and 2010 PBGs is due to the fact that the two were formulated to reflect NSGRP I as one of the major guiding policies to national development.

However, matters on climate change adaptation and mitigation takes a new shape and recognition in the 2011 and 2012 PBGs. The two PBGs recognize climate change challenges on the health, agricultural, infrastructure, energy, and other economic sectors. It should be noted that the FYDP I (2011/2012 – 2015/2016) and NSGRP II (2010/11 - 2014/15) priorities and goals were taken into consideration in the formulation of 2011 and 2012 PBGs. The two national development policies at the strategic level recognize the importance of integrating climate change adaptation and mitigations issues as a way of unlocking the nation economic development potentials (URT, 2011c and URT, 2012c).

The key lesson learned from the PBGs used prior to 2010 and those used after 2010 is that climate change adaptation and mitigation issues must be mainstreamed in major development policies for the same to be allocated resources. This is due to the fact that all development plans formulated by MDAs, Regions, and LGAs in any financial year are required to conform to the directives provided by the PBGs as the latter

should also be in conformity to the major development guiding policies implemented at a particular time.

4.7.2. Mainstreaming Climate change into Sectoral Policies, Strategies and Plans

Using content analysis in analysing the process of climate change mainstreaming into sectoral policies, strategies and plans, this study examined various sectoral policies, strategies and plans. Below are the findings.

Mainstreaming Climate Change into Sectoral Policies

The review of the national environmental policy of 1997; national forest policy of 1998; the national human settlements development policy of 2000; national land policy of 1997; the energy policy of Tanzania of 1992; the food and nutrition policy for Tanzania of 1992; national tourism policy of 1999; the wildlife policy of Tanzania of 1998; agricultural and livestock policy of 1997; national livestock policy of 2006; national water policy of 2002; community development policy of 1996; and national beekeeping policy of 1998 generally established that these sectoral policies do not categorically recognize issues of climate change. This is despite the fact that the named sectors are prone to the impacts of climate change.

The findings have further established that only few policies such as the national water policy of 2002, the national environmental policy of 1997, the beekeeping policy of 1998, and the community development policy of 1996 recognize the need for environmental management hence offering an opportunity for climate change management. Nevertheless, absence of climate change management objectives in these sectoral policies may impede efforts geared towards addressing climate change challenges in these sectors. In this regard there is a need for reviewing the named

sectoral policies so as to accommodate issues related to climate change in their objectives.

Mainstreaming of Climate Change into Sectoral Strategies

With regard to the sector strategies, the agricultural development strategy of 2001; National Water Development Strategy (2006 – 2015); National Environmental Education and Communication Strategy (2006 – 2009); Rural Development Strategy, 2001; and the National Climate Change Strategy (2012 – 2017) recognize the need for climate change management. The key issues identified by these strategies are establishment of early warning on the prospective occurrences of climatic related disasters, intensifying public environmental awareness; instituting contingency plans, adaptation and mitigation measures, and procedures aimed at minimizing the impacts of extreme events resulting from climate change, accidental pollution and other disasters, and improving understanding of the economic and social consequences of atmospheric changes and of mitigation and response measures (URT, 2001a; URT, 2008b; URT, 2001b; URT, 2012d). On the other hand, the National Climate Change Strategy (NCCS) 2012 – 2017 aims at guiding the country to effectively adapt and participate in global efforts to mitigate climate change. Central to the attainment of the NCCS 2012 -2017 are capacity building to enhance both climate change adaptation and mitigation; accessibility and utilization of the available climate change opportunities; public awareness building; information management; strengthening institutional arrangements; and resource mobilization (URT, 2012a).

Mainstreaming of Climate Change into Sectoral Plans

Regarding mainstreaming of climate change adaptation and mitigation issues into sectoral plans, the National Environmental Management Action Plan (NEAP) 2013 –

2018 provides in-depth environmental analysis and guidelines for dealing with environmental management challenges among them being climate change at sectoral and LGAs levels within the national framework. It is on this basis that the NEAP (2013 – 2018) calls for assessment of climate change impacts, mainstreaming climate change adaptation into sectoral policies, strategies, programmes, plans and budgets, implementation of the national climate change strategy, enhancement of public awareness and understanding on climate change adaptation and mitigation, designing and implementing programmes and projects at LGAs level to address adaptation, and promoting and/or strengthening modern and traditional early warning systems as priority actions in addressing climate change adaptation and mitigation challenges (URT, 2013b). Generally, efforts to mainstream climate change into MDAs and LGAs operationalisation in Tanzania is taking a new positive turn as currently new guidelines and frameworks have been unveiled. For instance, the guidelines for integrating climate change adaptation into national sectoral policies, plans and programmes; and the monitoring and evaluation framework for climate change adaptation in Tanzania were released in 2012. The purposes of the named guidelines are to provide guidance to MDAs, LGAs and non state actors on the integration and tracking progress and results emanating from climate change adaptation initiatives (URT, 2012e; URT, 2012f).

4.7.3. Mainstreaming Climate Change into Sub-National Authorities

In Tanzanian context, sub-national authorities represent Local Government Authorities (LGAs) responsible for coordinating all development activities in their areas of jurisdiction. As such, the sub-national authorities present another opportunity for mainstreaming climate change issues in development planning. Therefore

mainstreaming climate change in LGAs is critical in creating attention to climate change adaptation and mitigation in local environmental plans. A review of various government documents has revealed that the LGAs responsibilities in climate change adaptation and mitigation has been consolidated in the National Environmental Action Plan (NEAP) 2013 – 2018. The NEAP calls for the preparation of the Local Environmental Action Plan (LEAP) aiming at mainstreaming various environmental challenges among them being climate change in local government planning.

Furthermore, the process of mainstreaming climate change adaptation and mitigations strategies in LGAs plans and budgets is guided by the PBGs. As guiding documents, PBGs offer a broad categorization of environmental consideration as a segment on cross cutting issues. However, through reviewing various PBGs, it is evident that climate change adaptation and mitigation elements are scantly acknowledged as compared to other environmental challenges. As a result, the funds allocated are insufficient and sometimes the funds are not allocated at all in efforts to address climate change adaptation and mitigation issues through the central government budget. According to URT (2009b), the failure to allocate funds from the central government is due to the fact that most climate change projects are funded by development partners. However, there is evidence of instances where development partners failed to honour their pledges on disbursing funds to the government for the purpose of implementing environmental projects prioritized in the PBGs (URT, 2010e). Probably this is due to the slow pace of Tanzania to capitalize on the existing international climate change financing opportunities hence making donors fail to align behind government priorities for climate change (Norrington-Davies & Thurnton, 2011). Moreover, LGAs are frustrated by inadequate resources to support the

implementation and mainstreaming of environmental challenges in their development activities (URT, 2012b).

Similar experiences from other countries show that local governments are characterised by lack of resources (technical, human and financial) to initiate and sustain climate change efforts and also understanding the science behind climate change and use in adaptation planning (Khatri et al., 2013; Measham et al., 2011; Bele et al., 2011; Bierbaum et al., 2013). Therefore, measures are required to ensure that climate change issues are explicitly high in the planning and budgeting agenda offered by the central government through PBGs. That can be achieved through implementation of the National Environmental Action Plan (NEAP) 2013 - 2018 and its subsequent guideline that guides the preparation of LEAP by LGAs.

4.7.4. Emerging Issues based on Climate Change Mainstreaming in Tanzania

After reviewing various policies, plans and strategies to ascertain the extent of mainstreaming climate change adaptation and mitigation issues, this study has established that the current policy framework and institutional arrangements in Tanzania offers a unique window of opportunity which remains untapped. The study has further established that, efforts to mainstream climate change adaptation and mitigation initiatives into the government policies and institutions are also still in the infancy stage, hence a need for thorough guidance on tackling emerging issues pertaining to climate change mainstreaming. Following a thorough review of the policy and institutional framework, challenges such as funding of climate change; weak sectoral policies and institutions; declining budget support; low awareness of climate change issues; slow pace on capitalizing on climate change funding; lack of

resources for implementing climate change at LGAs level; policy intervention being a recent phenomenon; and climate change being a major problem in Tanzania stand out as the main emerging issues which need to be addressed to enable successful mainstreaming of climate change issues into government policies, strategies, and plans at both strategic and operational levels.

4.8. The Role of Actors in Facilitating Local Community Climate Change Initiatives

Successful implementation or success of adaptation and mitigation measures will depend on the involvement and commitment of many stakeholders or actors. In this section, the main actors are identified alongside assessing their initiatives in facilitating local community adaptation and mitigation practices. The section draws a vast experience from local actors (governmental and nongovernmental) working with the local community in crafting local community adaptation and mitigation practices in Dodoma region. However, in the role of government, the section mainly focuses on the role of LGAs and research institutions as important stakeholders responsible for ensuring that the well being of local people in relation to climate change is well addressed.

4.8.1. Actors Involved in Facilitating Local Community Climate Change Initiatives

In Dodoma region. a wide range of actors are involved in facilitating local communities to craft adaptation and mitigation practices. Their activities towards facilitating local community adaptation vary according to their interests and organizational objectives. The major categories of actors identified in Dodoma region

were government departments, research institutions, non state actors (NGOs and private companies), and the local community.

The government actors interviewed during the process of data collection in the study area were Kongwa and Bahi district councils. In addition, various research institutions situated in Dodoma region were also interviewed. In particular, these were Agricultural Research Institutions namely the Pasture Research Centre - Kongwa, Tanzania Livestock Research Institute (TALIRI) – Mpwapwa and Agricultural research Institute (ARI) – Hombolo. On the other hand, non-state actors (NGOs and private non profit companies) interviewed were World Vision Tanzania, Rural Livelihood Development Company (RLDC), Lutheran World Relief (LWR), Kongwa Environmental Network (KONET), and Bahi Environmental Network (BAENET). Other non state actors interviewed were INADES Formation Tanzania (IFTz), Sunseed Tanzania Technologies (STT), Tanzania Organic Agriculture Movement (TOAM) and ST. Phillip Theological College. Further details on the interests, roles of different actors, and challenges in facilitating local community adaptation and mitigation strategies are given in the subsequent sections.

4.8.2. Objectives of Actors in Facilitating Local Community Climate Change Initiatives

The study also sought to establish whether actors facilitating the local community adaptation and mitigation practices in Dodoma region are guided by institutional objective(s) directly focusing on climate change issues. The findings (see appendix VII) have established, with exception to the World Vision Tanzania (WVT) and INADES Formation Tanzania (IFTz), that the remaining ten (10) actors interviewed had no direct objectives in addressing climate change issues. Instead they are

facilitating local community adaptation and mitigation practices just by the nature of their activities. In the case of WVT and IFTz, their climate change objectives were to improve the local community capacity for disaster risk reduction, climate change mitigation and adaptation and provide extension education and training support services on adaptation to climate change and management of dry land resources, respectively. In this regard, it is of utmost importance for other actors to develop objectives in line with climate change adaptation and mitigation for a climate change resilient community. Having an objective specifically focusing on climate change issues offers a window of opportunity for the actors to allocate resources for addressing climate change issues at the community level.

4.8.3. Role of Actors in Facilitating Adaptation and Mitigation Practices

Local actors are instrumental in assisting local communities' adaptation to and mitigation for climate change. According to Koch et al. (2007), local actors can encourage long term capacity development and strengthen knowledge and resource network of the local community in addressing the problem of climate change. In that regard, a number of actors are involved in capacitating the local community to become more resilient to the effects of climate change of which adaptation is critical in Dodoma region. Table 4.32 summarises the key roles of local actors in crafting local communities' adaptation and mitigation practices. Among such roles include capacity building, provision of extension services, provisioning of support services (food aid and drought resistant and early maturing seeds), construction of infrastructures (irrigation schemes), establishment of local community savings and credit cooperatives and microfinance services, improving rural marketing systems, and promoting environmental management practices.

Table 4.32: Interests and Roles of Actors in Facilitating Community Climate Change Adaptation and Mitigation Practices

Actors and their interests	Roles
Government (Central & Local) • Addressing climate change challenges • Capacity building • Ensuring food security • Disaster Risk Reduction (DRR)	• Formulating policies to address climate change issues • Providing early warning on the potential occurrences of climate change hazards • Facilitating farmers to form SACCOS and other economic oriented groups • Providing extension services to the local community • Disseminating drought resistant and early maturing crops • Investing in irrigation schemes • Facilitating environmental management activities • Formulation of environmental management bylaws • Awareness creation through training and meetings. • Supporting and providing technical backstopping to local communities initiatives • Providing logistical and technical support to other actors • Disseminating food aid and seeds to affected households
Non Governmental Actors (NGOs and Private Companies) • Improving livelihoods of rural communities through training and capacity building • Lobbying and advocacy • Environmental conservation • Sustainable rangeland management • Market facilitator for improving the welfare of the rural households by making the market work better for rural producers.	• Empowering local communities to access, use, and own resources legally for their development • Facilitating land use planning and environmental conservation (reducing deforestation, use of energy efficient stoves, and tree planting) • Providing extension services on various matters related to agriculture and climate change management • Facilitating marketing and microfinance services • Assisting community members in diversifying their income generating projects • Strengthening community linkages and networking • Facilitates capacity building to local, private sector and public service providers • Facilitating farmers to produce Quality Declared Seeds • Promoting conservation agriculture in particular on grapes • Tapping rain run-off for irrigation purposes • Assisting in restoration through Farmers Managed Natural Regeneration (FMNR)
Research Institutions • Undertaking research in the agricultural and livestock field	• Developing and disseminating technologies that reduces climate change impacts to livestock and crop production • Breeding and selection of harsh environment tolerant breeds of livestock, pasture and crops • Capacity building and awareness creation on issues related to climate change and its management • Capacity building and awareness creation to community members on good agricultural practices

The findings on the role of actors as summarised in Table 4.32 have established that actors are playing a pivotal role in facilitating local communities to adapt and mitigate climate change challenges in Dodoma region. This is through production of quality declared seeds in some areas of Dodoma region, provision of extension services that is critical in shaping local community practices, construction of key infrastructure such as dams and storage facilities, and empowering local communities through establishment of financial institutions from which local communities can easily access financial assistance for purchasing climate resilient farm inputs. The study further established that various actors are engaging in facilitating the marketing systems for the betterment of the local communities; environmental management activities among others. Experience from other places also underscores the pivotal role of actors in facilitating climate change management among community members (Amaru & Chhetri, 2013; Ozor et al., 2010; Ogunlade et al., 2014; Ibrahim et al., (2012).

4.8.4. The Contributions of Actors in Facilitating Community Adaptation and Mitigation Practices

The contributions made by various actors towards facilitating local community adaptation and mitigation practices in Dodoma vary in accordance to the type of actors involved as explained hereunder.

INADES Formation Tanzania

As a result of its various extension services and training to small scale farmers, IFTz has facilitated the adoption of environmental friendly activities in various areas of Dodoma region. Some of the major achievements of IFTz in facilitating local community adaptation and mitigation practices include increasing food security for those effectively implementing innovation; improving micro-climate in their areas

after planting trees; and identifying and developing a pool of resource farmers whom have been recognized by all stakeholders from village to international level. These farmers are being used by other stakeholders in training farmers on good agricultural practices and are also visited by people from all over the world.

World Vision Tanzania

Some of the achievements of WVT include assisting farmers to use the Farmers Managed Natural Regeneration (FMNR) approach in restoring trees in Kongwa District. Other WVT contributions towards facilitating local communities in adapting to and mitigating climate change include provision of insured capital through CEDA (a WVT microfinance institution) in Area Development Programme (ADP); improving and promoting eco-friendly activities such as tree planting; increasing agricultural productivity and hence increasing safety net; and promoting the use of drought resistance species.

Local Government Authorities

Local government authorities are also engaging directly or indirectly in addressing climate change challenges in their areas of jurisdiction. The term *"indirectly"* as used here underline the fact that climate change adaptation and mitigation have been recently mainstreamed in major development policies (NSGRP II, TDV 2025 and FYDP I), the national climate change strategy and NEAP 2013 -2018. In addition, LGAs have been addressing climate change issues through various development projects such as establishment of tree nurseries and production of quality declared seeds (QDS).

Lutheran World Relief

The main contribution of Lutheran World Relief (LWR) in facilitating households/local communities in adapting to and mitigating climate change is on training farmers on various technical issues related to good agricultural practices and soil and water conservation. In addition, the LWR is involved in Natural Resources Management whereby it works with local community Savings and Credit Cooperatives (SACCOS) in Mpwapwa (Matomondo) and Kongwa (Mlali) districts of Dodoma region to reduce community vulnerability to drought and flooding. Under this project, the LWR and its network of partners are using a watershed-based approach to natural resource management encourages community SACCOS to increase organizational capacity, promote sustainable natural resource management, and increase and diversify revenue sources. Such efforts help in improving the communities' resilience to climatic related natural disasters by increasing food security, income, and better management of natural resources.

Environmental Networks

In Dodoma region, environmental networks have been instrumental in implementing a number of environmental conservation initiatives at regional, district and village levels. In general, the contribution of environmental networks in addressing climate change challenges is insurmountable. Their efforts on environmental conservation and management; including the protection of indigenous trees, tree planting, and encouraging the use of alternative sources of energy such as energy saving stoves contributes significantly to climate change adaptation and mitigation. Furthermore, efforts on community capacity building to run environmental friendly income generating activities such as beekeeping and poultry projects so as to reduce human

pressure on forest resources offers an amazing window of opportunity to climate change adaptation and mitigation.

Sunseed Tanzania Technologies

The key contributions of Sunseed Tanzania Technologies (STT) in facilitating local community mitigation practices to climate change include the dissemination of the technology to targeted beneficiaries. The STT, in collaboration with other stakeholders in Dodoma region, has established tree nurseries in various areas of Dodoma region. They also offer practical experience on the role of efficient energy use and tree planting in curbing deforestation to students from various academic institutions.

Tanzania Organic Agriculture Movement

Among the key achievement of Tanzania Organic Agriculture Movement (TOAM) in facilitating local community adaptation and mitigation practices include creating awareness on climate change and its effects, and promoting and supporting context-specific innovations to combat adverse effects of climate change. This is achieved through introduction of new or improving locally adopted innovations such as application of farm yard manure, use of improved seeds, water harvesting, introducing superior livestock breeds to boost livestock production, introduction of new pasture species, processing animal skin and developing various leather products among others. In relation to mitigation for climate change, TOAM has played a critical role in promoting the use of alternative sources of energy and tree planting among community members in Dodoma region. Following the roles played by TOAM, some households have participated in climate change awareness raising events, training workshops, and project activities. These included rainwater harvesting and the

establishment of a school tree nursery where children are learning about climate change. In addition, through TOAM activities, local communities in areas where TOAM is working have tremendously increased their agricultural productivity. TOAM also provides institutional capacity building of farmers' organizations or local leadership.

Research Institutions

The central achievements of research institutions in facilitating households and local communities in adapting to and mitigating climate change have been in developing technologies, selecting and breeding animal and plants, conducting research on livestock and crop diseases, and in offering extension services to the rural communities in Dodoma region. Some of their research outcomes have been very useful in assisting farmers to adapt and mitigate climate change in the region. For instance, TALIRI has managed to breed and select harsh environment tolerant breeds of cattle (Mpwapwa breed) and goats (blended Malya goats) among other livestock. Also, they have managed to select and cultivate drought resistant breeds of grasses and legume pasture species in some of the villages in Dodoma region.

4.8.5. Challenges Facing Local Actors in Facilitating Community Adaptation and Mitigation Strategies

Evidence from Dodoma region indicates that local actors are doing overwhelming activities in their quest to facilitate local communities to adapt and mitigate the impacts of climate change. Therefore, the achievements registered by local actors in facilitating and/or empowering local communities to adapt and mitigate climate change impacts cannot be underestimated. Nevertheless, the role of such actors in facilitating local community adaptation and mitigation practices in the area is

hampered by inadequate number of extension officers consequently leading to inadequate coverage of extension services to local community members. The inadequacy in the number of extension officers especially to LGAs is very high based on the fact that almost half of the villages in the area do not have extension officers as demonstrated by the situation in Kongwa District for the period 2005/06 – 2009/10 (Table 4.33). Such a situation, coupled by budgetary limitations at LGAs, limits the provision of extension services and training to both farmers and extension officers (EOs) especially on the execution of training services and implementation of good agricultural practices in the area.

Table 4.33: Status on the Availability of Extension Officers at Village Level in Kongwa District 2005/06 – 2009/10 Cropping Season

Item	2005/06	2006/07	2007/08	2008/09	2009/10
Number of villages	67	67	67	67	74
Number of EOs at village level	28	30	30	30	37
Shortage of Eos	39	37	37	37	37
Number of trainings to EOs	2	3	2	4	2
Number of trainings to farmers	6	5	8	10	8

Source: Extracted from KDC, 2010b

Another key challenge facing local actors in facilitating local community adaptation and mitigation practices is lack of resources for implementing climate change initiatives. Taking an example of Kongwa District once again, the budgets focusing on community adaptation and mitigation practices was very small in comparison to the total LGAs budgets as indicated in Table 4.34.

Table 4.34: Climate Change (CC) Fund as Shares of the Total Budget and Disbursed (in Million Tshs) from 2004/05 to 2010/11 in Kongwa District Council

Financial Year	Total Budgeted	Budgeted for CC	% of CC as a share of total budget	Total disbursed	Disbursed for CC	% of CC as a share of total disbursed
2004/05	4,654.86	41.41	0.89	3,843.10	41.41	1.08
2005/06	8,045.85	64.17	0.80	4,821.19	63.97	1.33
2006/07	9,782	67.41	0.69	7,858.34	67.41	0.86
2008/09	9,009.12	1,006.07	11.83	9,744.44	1,076.80	11.05
2009/10	13,550.86	567.60	4.19	13,272.94	567.40	4.27
2010/11	15,777.83	248	1.57	13,741.20	244.03	1,78

Source: KDC (2007 & 2012b) and Author's calculations

Other challenges affecting the role of actors in facilitating local community adaptation and mitigation to climate change as established by this study were unsustainable utilization of natural resources resulting from lack of livelihood alternatives to local communities, lack of resources for effective implementation of climate change initiatives, cultural beliefs, failure to honour memorandum of understating among local actors, and slow adoption rate of climate change adaptation and mitigation initiatives. Furthermore, challenges such as inadequate awareness of environmental policies among community members, poor enforcement of environment related policies, lack of awareness on climate change issues, conflicts between farmers and livestock keepers, difficulties involved in development of land use plan in particular issues related to land ownership, and low education to majority of community members were also noted as hurdles for implementing climate smart innovations and managing the environment. The study also has established that temporal and spatial coverage of most actors in facilitating local community adaptation and mitigation practices is very limited.

4.9. Summary

Based on the findings, the study has generally established that climate change and its vagaries on local community livelihood in Dodoma region are real. As a result, various attempts are made by the community and other actors in order to address the challenge of climate change driven impacts. From the findings of this study, it is therefore suggested that, climate change policies, strategies and actors efforts at a local level should focus on addressing the questions of water availability for domestic and agricultural use; agricultural productivity; pasture for livestock mainly through sustainable livestock keeping and land use planning; promotion of socio-economic activities including diversification of income generating activities; and promotion of natural resources management. In addition, such efforts should be complemented by resolving local level conflicts among competing interests and groups (for instance, between farmers and livestock keepers) over the utilization of productive resources. As further noted during focus group discussion, land use planning and enforcement are critical parameters to conflict resolution among resource users of which for the case of Dodoma region are dominated by farmers and livestock keepers.

CHAPTER FIVE

DISCUSSION

5.1. Introduction

This chapter discusses the findings of this study and also sets the platform for raising the key issues in an attempt to develop a climate change adaptation and mitigation strategy in the study area. The chapter is subdivided based on the key issues as identified in the study objectives. In this regard, this chapter focuses on impacts of climatic change, local community adaptation and mitigation practices, and challenges faced by the local community as a result of climate change and in their attempt to address such challenges. The chapter further focuses on the status of mainstreaming climate change in Tanzania, and the role of actors in facilitating climate change initiatives at local level. Lastly, the chapter provides a conclusion with special attention to reorienting local community adaptation and mitigation practices for better results.

5.2. Impacts of Climate Change on Livelihoods in Dodoma Region

The current results have established that climate change in Dodoma region is real as it has been indicated through the analysis of meteorological data. The analysis of rainfall data has established that the amount of rainfall in the region is generally declining with a more conspicuous decline in April. Further, the analyses of rainfall trends have established an increase in rainfall amount in December. This was further supported by an analysis of rainfall trends in Dodoma region for three decades (1981 – 1990, 1991 – 2000, and 2001 – 2010). In general, the findings on rainfall trends in Dodoma region suggest the presence of early onset of rainfall, early end of rainfall, decline in rainfall amount and shifting of rainfall pattern. Consequently, such rainfall

variations over time lead to detrimental effects on local communities' livelihoods in particular crops as a result of pollination failure, stunted growth and wilting in the study area. Such changes, therefore, call for the need of realigning the farming calendar in line with the current changes in rainfall trends. The findings also suggest that the most appropriate time for planting is in December so as to avoid the problem of seed germination failure. Similar findings on early onset and end of rainfall and decrease in rainfall amount were also unveiled by Mongi et al. (2010).

An analysis of temperature and wind speed in the study area has indicated an increasing trend. Such changes create the possibility for more evaporation of water from the soil. With these changes on temperature and wind speed in the region, it is evident that the climatic condition in the study area is also changing. In general, the existence of changes in climatic parameters as revealed by the findings calls for good agricultural practices with high potentials for water and soil moisture conservation. This may entail the use of manure, mulching, and deep ploughing that offers an opportunity for in-situ rainwater harvesting. These further should be complemented by other methods for rainwater harvesting such as construction of dams for irrigation, livestock and domestic uses. Similar findings on temperature increase have also been established in Kenya, Ethiopia, southern and western Africa (GoK, 2009; Yanda & Mubaya, 2011). As for the changes in wind speed, the findings in Dodoma region are in tandem with projections made by various studies that wind speed is likely to increase as already experienced in various places worldwide (Knippertz et al., 2000; Webster et al., 2005; Young et al., 2011; Pereira et al., 2013). Nevertheless, such changes in wind speed affect other climatic parameters and economic activities (IPCC, 2014; Hoang et al., 2014).

The changes in climatic parameters as further ascertained by the local community (as presented in chapter four), have led to various livelihood effects of the local community in Dodoma region. Based on the findings of this study, the key effects of climate change include reduced agricultural productivity and alteration of the planting season of which 89.2 and 83.2 percent were reported by household respondents. Other effects as established by this study include reduced livestock pasture, water availability, and household income among others. A critical analysis of the above effects indicates that the key livelihood activities heavily impacted by climate change in the area are crop farming, livestock keeping, and other socio-economic activities. However, this study has also established that these are the major livelihood activities that form the socio-economic base in the study area.

Based on the findings the need for addressing climate change impacts with special target to various livelihoods activities in the region need not be gainsaid. This is based on the fact that climate change in the area has been a source of food and economic insecurity to most households; loss of livelihood sources such as agricultural land; water sources and environmental degradation in its multifaceted context in Dodoma region. Nevertheless, based on the findings, the study has shed light on the need for addressing climate change through reducing rainfall variability challenges, provision of extension services, strengthening local institutions such as SACCOS and other social groups; improving animal breeds; and use of improved seeds among other interventions. One of the interventions that can help in reducing the impacts resulting from rainfall variations in the area is to exploit potential areas of irrigation of which for the case of Dodoma region such areas are largely undeveloped. Other studies from

different countries also suggest the need for effective intervention on climate change driven impacts due to its devastating effects to peoples livelihoods and economic activities (Taylor, 2013; Milano & Ruano, 2014; Sakdapolrak et al., 2014). Nevertheless, such interventions should be well focused on local community pertinent livelihood issues (Below et al., 2012; Ozor et al., 2010; White et al., 2010).

5.3. Local Community Adaptation and Mitigation Strategies

The study also sought to establish the local community adaptation and mitigation practices used in addressing climate change challenges in the study area. The findings of this study have established that the local community in the area uses various agricultural, income diversification, communal pooling, migration, and water management as adaptation strategies. In addition, the study has also unveiled the local community mitigation strategies as already indicated in chapter four.

Regarding the use of agricultural adaptation strategies, the study has established that the local communities in Dodoma use a wide range of agricultural adaptation strategies of which the most commonly used were crop selection, farm yard manure, drought resistant seeds, changing of planting dates, and adapting tillage practices. In the livestock sub-sector, the strategies used were applying different feed techniques, changing of herd composition and change from pastoral to sedentary agriculture systems. The uses of such agricultural strategies for climate change adaptation in the area were very instrumental in increasing agricultural productivity, reducing the impacts of drought, and soil conservation among others. Nevertheless, this study has demonstrated that lack of knowledge on good agricultural practices, difficulties in obtaining improved seeds, crop diseases, and climatic conditions were among the factors affecting the performance of local community agricultural adaptation

strategies. The existence of such hurdles signifies that long term success in dealing with climate change through the use of agricultural adaptation practices needs strengthening of the agricultural support system. Consequently, an effective agricultural support system is vital in imparting the local community with good agricultural practices, skills and knowledge and ensuring timely availability of the required agricultural inputs.

Experience from other countries has demonstrated that the use of local agricultural adaptation practices is of critical importance in cushioning the local climate change impacts. Such strategies include timing in planting, mixed and staggered cropping, use of improved varieties, and changing the cropping patterns (Rusinga et al., 2014; Agbongiarhuoyi et al., 2013; Majule et al., 2013). In addition, the study findings have also established the need for governmental and others actors support for effective implementation of agricultural adaptation strategies used by the local community in the area. Such support may be in the form of developing areas with irrigation potentials in the region, subsidizing agricultural inputs and assisting the local community to utilize research findings undertaken by research institutions in the area. Such approaches are of critical importance in fostering the sustainability of the local adaptation strategies currently considered questioned on their long run ability on reducing risks of climate change, strengthening the local community adaptive capacity, and addressing the causes of vulnerability among the local community (Brown, 2011; Eriksen & Brown, 2011; Smit & Johanna, 2006).

Income diversification is also one of the adaptation strategies used in the study area in addressing climate change driven impacts. In Dodoma region, income diversification

strategies take the form of mobility, commercialization of natural resources in particular forest products, diversification of household income generating activities, and expenditure control. Nevertheless, the study has established that human mobility in its varied forms (temporal and permanent migration) was the dominant (76.8%) form of income diversification strategies.

Nevertheless, this study has indicated various challenges to effective income diversification strategies. Some of the challenges established include environmental degradation, lack of capital, inability to get employment in areas of destination, and climatic challenges in areas of destination among others. In this regard, the findings intimate that healthy environmental resources, ownership of assets, good and functional markets for various goods, good climatic and socio-economic conditions in areas of destination, and effective institutional support such as from financial institutions are critical in realizing the effectiveness of income diversification strategies in addressing climate change challenges. This is informed by the study findings that have demonstrated the high dependence of income diversification on natural resources from the study area and surrounding rural areas. The study has further demonstrated that income diversification strategies used in the area were characterised by lack of capital, poor market, high dependence on farming and livestock keeping, high dependence on migration, and lack of necessary skills for effective diversification hence rendering them ineffective and unsustainable. Similar findings have also been experienced in other more or less similar studies (Paavola, 2004; Burke & Lobell, 2010; Macours et al., 2012; Pinkse & Kolk, 2012). With regard to the findings demonstrated by this study, a need for adoption of responsible and sustainable income diversification strategies that does not compromise the social

and natural resource base should be central to local community undertaking. Nevertheless, public and private intervention is needed to streamline local community diversification efforts.

On the other hand, this study has established the use of various water management strategies in the area with the dominant ones being use of water harvesting techniques and conservation of water catchment areas. Nevertheless, the findings from this study have established that harvested water at community level was not long lasting from the last day of rain in the area. Some of the key challenges demonstrated by this study with regard to water management strategies were lack of environmental awareness as manifested through haphazard cutting of trees, high cost of water harvesting technologies and absence of dams for irrigation to mention just few. Despite various efforts for water management in the area such as formulation of bylaws, the findings have revealed that the existing bylaws are not effectively implemented as practices involving haphazard cutting of trees for charcoal making, firewood, and building materials were more pronounced in the area; hence contributing to the degradation of water catchment areas in Dodoma region.

Based on the findings of this study, it has also been established that different rainwater harvesting techniques were used in harvesting rainwater for agricultural and domestic uses. This includes the construction of dam for irrigation purposes. Nevertheless, the area utilized for irrigation purposes is very small as compared to the total potential area. For instance, 71% (4470.6 ha) of the land suitable for irrigation in Bahi District is not utilized despite the fact that majority of residents in the area were affected by rainfall related hazards that consequently affects agricultural productivity.

However, in the light of recurring drought and unpredictable rainfall, development of irrigation schemes and infrastructures is of vital importance in improving local community resilience to climate change impacts. In this regard, a need to improve and expand irrigation schemes in the area cannot be underestimated in the quest for improving agricultural productivity.

As demonstrated by Ozor et al. (2010), lack of resources limits the ability of the local community in investing in irrigation infrastructures. As deduced from the findings of this study, Dodoma region is not an exception. Therefore there is a need for the government and other actors' interventions on developing all areas with irrigation potential in region. This will help in sustaining local community livelihoods currently threatened by increased frequency and severity of droughts as well as rainfall unpredictability. Alongside interventions in the aspect of irrigation, efforts are also needed to address water management challenges especially the degradation of water catchment areas. In this regard, the focus should be on enforcing existing bylaws and regulations so as to control the key drivers for the degradation of water catchment areas. Such drivers include but not limited to farming in unauthorized areas, and haphazard cutting of trees for charcoal making, firewood and building materials.

With regard to the communal pooling adaptation strategies used in Dodoma region, the findings have established that the main focus is on management of natural resources such as forest, soil and pasture management. This is an indication that the livelihood of the local communities is strongly linked to the utilization of the named natural resources. Nevertheless, communal irrigation and communal water harvesting are not widely used by local communities in adapting to climate change. Probably this

may be attributed to under utilization of a lager potential area for irrigation. Given the findings of this study, it has further been established that both informal and formal social groups are also engaging in pooling their resources in various forms so as to improve their well being. The findings on formation of informal social groups are similar to those of Rodima-Taylor (2012) who argues that informal associations constitute a powerful communal pooling mechanism of local adaptation and mitigation to climate change.

The findings on communal pooling further established that the key challenges to communal pooling techniques are based on financial, institutional, climatic uncertainties, and access to adaptation technologies. These challenges suggest that the effectiveness of communal pooling is determined by well functioning or vibrant local institutions. Such institutions are instrumental in creating awareness and law enforcement among others on matters pertaining to managing environmental resources. In addition, the findings also signify that some technologies necessary for the realization of the full potential of communal pooling adaptation strategies cannot be easily afforded by the local community. For instance, irrigation technologies which always transcend household capacity can easily be obtained with assistance from the government or development partners. In such a situation, government and other actors intervention is of vital importance in facilitating community joint action for climate change adaptation. Furthermore, the persistence of drought in the area poses a threat to communal pooling adaptation strategies due to its ability to contravene the local community livelihood base and therefore affect a larger segment of the community. Similar findings were also noted by Agrawal (2010) who advocates for functioning

and viable institutions to coordinate communal activities across households for the purpose of enhancing their capacity to adapt to the impacts of future climate change.

Based on the findings, the study has established that migration of some household member(s) is one of the strategies used by the local community in adapting to climate change impacts. This has been demonstrated by a significant association between district of residence, status of food production, drought and unpredictable rainfall with migration of some household member(s) in the area. This indicates that climatic variations are central to the migration of household member(s) for the purposes of seeking new livelihood opportunities that could be of vital importance to the survival of households in the areas of origin. These findings on the assistance of migrants to their areas of origin are similar to the findings demonstrated by other scholars who consider assistance from migrants as a way through which some households manage to continue living in drought affected areas (Warner & Afifi, 2014; Raleigh & Jordan, 2010).

With regard to mitigation strategies, the findings from the study area have established that tree planting, forest conservation, afforestation at community level and preventing fire outbreaks were the key mitigation practices used in the study area. Nevertheless, such efforts are threatened by unsustainable use of forest resources thus degrading the capability for carbon sequestration. As suggested by the findings, the rate of tree cutting for energy among other uses is very high. Other challenges affecting local community mitigation efforts include lack of awareness, tree planting related challenges, high cost for mitigation technologies and climatic conditions uncertainties.

As such, there is a need for establishment of tree nurseries, use of improved cooking stove, establishment of woodlots at household level and community awareness creation. As established by the findings of this study, community awareness should focus on climate change issues (causes, impacts and responses), environmental conservation, tree planting, and the effects of haphazard cutting of trees among others. Other measures suggested include land use planning, rotational grazing and destocking, construction of dams for harvesting and storage of rain water, and effective enforcement of environmental bylaws and regulation. This may also involve the integration of the global mitigation initiatives such as REDD+ and CDM currently missing in the study area. Other studies have also called for proper management and utilization of forest so as to tap the benefits of multi-functional nature of forest in climate change adaptation and mitigation (Adeola et al., 2001; Somorin, 2010; Van Noordwijk et al., 2011; Palm et al., 2010).

5.4. Challenges Faced by the Local Community

Climate change as an emerging and devastating environmental challenge of our days causes different challenges to the local communities. In Tanzania and Dodoma region in particular, the local communities are facing a number of challenges as a result of climate change. Such challenges include decrease in crop production, failure to cultivate and plant on time, shortage of water from various water sources, the absence of quality seeds for planting, and shortage of pasture and water for livestock. Other challenges include environmental degradation, high price of farm inputs (e.g. drought resistant seeds), high price of plant seedlings, epidemic diseases, and damage from flooding especially damages to crops, farms and settlements.

The key household challenge as a result of climate change as established by this study during household interview, FGDs and review of various government documents is the decrease in crop production in the area. This decrease in crop productions is caused by rainfall unpredictability, distribution, intensity, heavy rainfall for a short period that sometimes leads to severe soil erosion, and prolonged droughts. Consequently, such climatic variations lead to the failure to cultivate and plant on time. For instance, the occurrence of drought in what would be a rainy period in Kongwa District led to destruction of 75% of crops in a flowering stage in 2009/10 cropping season, leading to crop pollination failure, stunting and wilting (KDC, 2010a; KDC, 2012b). The study has further established that the problem of decline in crop production is further aggravated by high price of agricultural inputs, shortage of extension officers, and shortage of working facilities. As noted during FGDs and review of various official documents, the decline in crop production has caused many residents to depend on government food aid, migrating to other areas and changing the number and type of meals among other strategies. Similar findings were also observed by Page et al. (2010) and IPCC (2014).

In particular, this study has established that efforts of the local community in dealing with climate change challenges are further threatened by shortage and high price of improved seeds. The shortage of improved seeds in the region was further ascertained by complaints given by farmers during FGDs and informal conversation that seeds for droughts resistant crops are not readily available when needed and sometimes when such seeds are available, they are highly priced and sometimes not to the required standard i.e. they are fake seeds. Such complaints were further supported by information extracted from various government documents as indicated in Table 5.1.

This underscores the need for strengthening the agricultural support system and collaboration among actors so as to increase the local community adaptive capacity (Smit & Johanna, 2006; Pinkse & Kolk, 2012; MAFAP, 2013).

Table 5.1: The Status on the Availability of Improved Seeds (in tons) in Kongwa District 2005/06 – 2009/10

Cropping season	Status on seed availability	Sorghum	Sunflower	Maize
2004/05	Requirement	20	49	175
	Available	16	46	23
	Shortage	4	3	152
2005/06	Requirement	25	49	180
	Available	15	40	34
	Shortage	10	9	146
2006/07	Requirement	75	55	180
	Available	60	35	60
	Shortage	15	20	120
2007/08	Requirement	147	60	218
	Available	86	52	-
	Shortage	61	8	218
2008/09	Requirement	165	98	290
	Available	98	75	186
	Shortage	67	23	104
2009/10	Requirement	254.4	98	295
	Available	107	88	189
	Shortage	147.4	10	106

Source: Extracted from KDC, 2010b by the author

Other challenges revealed in the study area were inadequate extension services to farmers, shortage of water from various sources, shortage of pasture for livestock, environmental degradation, high price of seedlings, and occurrences of diseases mainly caused by changes of weather condition and food insecurity. In particular, the lack of extension services is very high as demonstrated by the fact that almost half of the villages in the area do not have extension officers as demonstrated by the situation

in Kongwa District for the period 2005/06 – 2009/10 (See Chapter Four). Given the findings, the provision of extension services in Dodoma region is affected by inadequate number of extension officers. Based on the findings, this study calls for provisions of adequate extension services that should go hand in hand with hiring of adequate number of extension officers.

With regard to occurrence of diseases, household interview and FGDs cited malnutrition especially to households with low income, water borne diseases (diarrhoea and cholera) caused by floods, respiratory and eyes problem (trachoma) as key health challenges associated with extreme weather events such as drought and floods in the area. As it has also been shown by other studies, the prevalence of such health challenges caused by climate changes are further intensified by inadequate human and financial resources, inadequate public health and health care systems, insufficient access to safe water and improved sanitation, food insecurity and poor governance and more dependence on climate sensitive economies (Mboera et al., 2011; Bain et al., 2013; IPCC, 2014).

With regard to the challenges discussed in this section, there is need for the strengthening of the agricultural support systems for timely availability and use of appropriate seeds, and strengthening the health systems countrywide in order to effectively deal with emerging climate change related human health challenges. Other measures of significant importance include rainwater harvesting, use of good agricultural practices, proper storage of crops and timely food purchasing, and rangeland management, local production of quality declared seeds (QDS) diversification of income generating activities and tree planting alongside the use of

improved cooking stoves. The importance of food storage has also been highlighted in other studies. According to Songok et al. (2011a) and Owuor et al (2011), the need for food storage at household and community levels alongside government food strategic reserves in order to ensure food security at community level is paramount in increasing local community resilience to climate change challenges.

5.5. Mainstreaming Climate Change in Tanzania

From the findings of this study, it has been established that climate change mainstreaming in government policies, plans and strategies is a phenomenon that is still in its infancy stage. This has been demonstrated by the fact that climate change mainstreaming has taken place only in major national development policies and plans. At sectoral and LGAs level, most sectoral policies and LGAs plans have not yet directly embedded climate change adaptation and mitigation issues despite the fact that such policies should conform to the major national development policies and plans directives. This calls for immediate review of sectoral policies and LGAs plans in order to align them to the current national efforts on dealing with climate change challenges.

Furthermore, the EMA of 2004 as indicated in the previous chapters offers an exceptional institutional arrangement for addressing climate change issues in the country (Figure 2.1). However, the findings in this study have unearthed the existing disconnects resulting from absence of environmental committees and environmental officers at the ward level that consequently affects the implementation of climate change adaptation and mitigation measures. The problem is further aggravated by absence of environmental officers at village/*mtaa* levels leading to the failure of tapping the indigenous knowledge and innovations that has proved to be critical for

climate change adaptations as they are cost effective and can easily be adopted by majority at the grassroots.

Taking into consideration the issues raised above, it is evident that mainstreaming of climate change issues in major national development policies has not yet been felt by the local people majority being poor peasants. The failure of the sector ministries or MDAs and local governments to address climate change adaptation and mitigations in their plans and budgets has a stake on this. Nonetheless, the MDAs and LGAs are not to blame as they are not the controller of their own budgets in terms of prioritization. Furthermore, this study has established that some planning technocrats fail to incorporate environmental management issues as per the government requirement in local government plans and budgets. On one hand, this contravenes the PBGs Directives and the Local Government Act number 6 of 1999 as it limits the implementation of environmental management activities. On the other hand, it unearths the inadequate capacity of various planning units in the government since the approval of LGAs plan and budget is only done after being reviewed by the Regional Secretariat and PMO- RALG prior to its consolidation in the national budget. Similar experience on the challenges affecting mainstreaming environmental issues such as climate change in national development policies, plans and strategies were also noted by Dalal-Clyton and Bas (2009).

Conclusively, the quest and timing for mainstreaming climate change into government policies, plans and strategies is right – climate change is high at the international and national agenda following the severity of its impacts. In Tanzania, signs of closing the planning gap at the strategy level are evident following the

government's move towards climate smart development that led to the accommodation of climate change issues in the major development policies (TDV 2025, NSGRP II and FYDP I) and the National Environmental Action Plan (NEAP) 2013 -2018. However, the implementation gap both at the strategic and operational (MDAs and LGAs) levels is still wide mostly due to institutional disconnect, laxity in planning, and inadequate resources for dealing with climate change challenges. Similar experience on institutional disconnect and conflicting policies was also noted in Kenya (Kimani et al., 2011). Therefore there is need for undertaking thorough decisions on addressing climate change challenges at all levels including incorporating a climate change segment in the Plan and Budget Guidelines (PBGs) that guide the preparation of plan and budgets to both MDAs and LGAs. The need for integrating climate change initiatives with local development is critical for effective adaptation and mitigation measures (Paudel et al., 2013). Concurrently, the nation should capitalise in the emerging climate change funding opportunities to compliment local resources, initiatives and innovations as also proposed by White et al. (2010). This will be instrumental in narrowing the resource gap that cripples the implementation of climate change adaptation and mitigation initiatives.

5.6. Role of Actors in Facilitating Climate Change Initiatives

Given the findings, this study has established that local actors play an important role and contribution in facilitating local community adaptation and mitigation practices in Dodoma region. Their roles and contribution are anchored in capacity building, provision of extensions services, provisioning of support services (food aid and drought resistant and early maturing seeds), construction of infrastructure (irrigation schemes), establishment of Local Community Savings and Credit Cooperatives and

Microfinance Services, improving rural marketing systems, and promoting environmental management practices. In the aspect of promoting environmental management practices, the actors are involved in facilitating land use management and planning, afforestation, natural resources management, and use of improved cooking stoves; all of which are critical in improving access to natural resources and reducing pressure on forest reserves.

Nevertheless, the study has established that, in the course of facilitating local community adaptation and mitigation efforts, most of these actors do not have clear objectives related to climate change management to guide their efforts. For the government (both central and local), the study has established the presence of an institutional gap at the ward and village levels following the lack of environmental officers and committees (at a ward level) to facilitate climate change related initiatives. In this regard, this study calls for filling the existing institutional gap by recruiting environmental officers as required by the EMA 2004 so as to establish an effective linkage between the local and national institutions. This is very important for the realization of the major national development policies, climate change strategy (2012 -2017) and the NEAP 2013 – 2018 objectives in addressing climate change driven impacts at all levels.

The current study has also established that the area is characterised by inadequate extension officers. In addition, the spatial and temporal coverage of most local actors, especially the NGOs, is very limited. Nevertheless, extension services are vital in promoting good agricultural and environmental management practices to the community. In addition, extension services empower local communities to adapt and

mitigate climate change by facilitating land use management and planning. Furthermore, extension services are vital in supporting and disseminating agricultural innovations and information relevant to climate change adaptation. Other studies have also underscored the importance of effective extension services in promoting community understanding on the causes and consequences of climate change; the existence and need for effective adaptation and mitigation programmes; use of climate smart agricultural practices and inputs such as the use of alternative cultivation methods and drought tolerant seeds; and use of new technologies; and on sustaining agriculture production particularly under the current threats posed by climate change (White et al., 2010; Ozor & Cynthia, 2010; Ajan et al., 2013).

This study has also established that the government and other actors such as the World Vision Tanzania (WVT) are sometimes involved in the provision of food aid and seeds to the affected and vulnerable rural communities. However, this study unearthed, the distribution of drought resistance and early maturing seeds is sometimes not well synchronized with farmers' cultivation calendar due to late distribution of seeds. The situation is further aggravated by the high price of improved seeds. Given the findings, farmers usually decide to use unimproved seeds or plant at a time when rainfall amount and distribution does not assure maximum seed germination and maturity of crops. This leads to low agricultural productivity in the area as demonstrated by experience from Kongwa District in Dodoma region whereby the situation of crop failure is sometimes devastating as more than 75 percent of crops can be affected at once by a combination of floods followed by a long dry spell and use of unimproved seeds (KDC, 2010a). Similar results were also demonstrated by

Page et al. (2010) when exploring the underlying cause of the 2009 sorghum failure in Kongwa District.

Due to such challenges, some local actors such as the RLDC and district councils are currently capacitating local farmers to produce quality declared seeds. Such efforts are not only limited to local community members but also focus on improving the competence of extension officers working with local communities towards reducing the effects of climate change and sustaining the innovations. This is in tandem with proposals made by Amaru and Chhetri (2013) and Sangotegbe et al. (2012) who advocate for better training, educating and collaborating with local actors especially farmers for the purpose of sustaining the innovations. Therefore, facilitating small farmers to produce their own quality declared seeds is a good step towards sustainable climate change adaptive capacity as it gives local community members the skills and a laboratory to experiment and experience the innovations which can be used even in the absence of actors such as RLDC. In general, full realization of the potentials of local actors in facilitating local community adaptation and mitigation practices requires the government and other actors to train and recruit more extension officers and equip them with necessary facilities and skills. As argued by other authors, adequate numbers of well trained extension officers are capable of building the necessary capacity of farmers to deal with climate change challenges (Ozor & Cynthia, 2010; Ozor et al., 2010). Moreover, extension agents should provide their extensions services in a more innovative, participatory and pluralistic approach to ensure sustainability in adaptation to and mitigation of climate change (Urama & Ozor, 2011; Ogunlade et al., 2014).

5.7. Summary

Empirical evidence suggests that climate change and its impacts in Dodoma region are real. In dealing with such climate change challenges, various local adaptation and mitigation strategies to climate change were in place. Among such adaptation strategies include agricultural, income generating activities, human mobility, water management and communal pooling. Despite the use of various local community adaptation and mitigation practices, such strategies were not fully utilized to realize their full adaptation and mitigation potentials. Therefore, it is of vital importance to assist the local communities in their local efforts to address climate change challenges. In general, most climate change hazards affecting the local communities in Dodoma region were rainfall related hazards. Therefore, efforts should be focused on strengthening agricultural support system and development of irrigation infrastructures since areas with irrigation potentials in Dodoma region are not fully developed and utilized. Nonetheless, there is a need for government and other actors support in developing areas with irrigation potentials as local communities lack resources to invest in irrigation technologies and infrastructures.

As a matter of fact, climate change hazards affect almost all households in the area. Nevertheless, the findings have shown that households receiving support from extension workers and other actors were significantly less affected by the impacts of climate change hazards as compared to their counterparts. This further suggests the need for provision of adequate and reliable extension services and support in the quest for empowering the local communities and their institutions to effectively plan for and deal with climate change hazards. Also noted is the need for a collaborative approach among actors in order to maximize the effectiveness of climate change adaptation and

mitigation initiatives. The named initiatives should be implemented alongside development and implementation of village land use plans so as to tap the unique opportunity for sustainable utilization of village resources and promotion of land management systems.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

This study aimed at exploring the local community adaptation and mitigation strategies to climate change in the semi-arid areas of Dodoma region in Tanzania. The study was undertaken as an attempt towards finding local based solutions to climate change challenges that consequently requires an understanding of climate change in the local context and the associated local level climate change adaptation and mitigation dynamics. In this regard, this chapter presents the conclusions based on the study objectives, recommendations, the proposed climate change adaptation and adaptation strategy for Dodoma region, and areas proposed for further research.

6.2. Conclusions

6.2.1. Impacts of Climate Change on Livelihood

The trends based on the analysis of meteorological data provide evidence for the changing and variations climatic condition over time as it was also ascertained by most households' respondents in the study area. Such changes have severe effects on the key livelihood sources and activities. This calls for the need of immediate actions to contain the challenges caused by climate change in the area whereby climate change policies, strategies and actors' initiatives at local level should focus on addressing the challenges on water availability for domestic and agricultural use, agricultural productivity, pasture for livestock through sustainable livestock keeping and land use planning, promotion of socio-economic activities including

diversification of income generating activities, and promotion of natural resources management.

6.2.2. Local Community Adaptation and Mitigation Practices in Addressing the Impacts of Climate Change

Local communities are playing pivotal roles in adapting and mitigating climate change challenges. Nevertheless, they severely lack the needed support and coordination from public and private actors. This further underscores the importance of strong local institutions, strengthening the resources and assets of the local community and coordinating their climate change initiatives by providing them with technical assistance and training on how to undertake their activities to promote both adaptation and mitigation to climate change. Such strategies are of vital importance in strengthening their adaptive capacity so as to enable the local communities to effectively deal with climate change challenges.

6.2.3. Mainstreaming Climate Change Issues into Government Policies, Plans and Strategies

Climate change mainstreaming in government policies, plans and strategies is a new phenomenon in Tanzania. Based on the findings, most major national development policies, plans and strategies have only taken into consideration the issue of climate change management recently. This provides the window of opportunity for reviewing and subsequently mainstreaming climate change adaptation and mitigation issues into sectoral policies, MDAs and LGAs plans towards climate change resilient policies and plans. Such attempts are of critical importance in increasing the chances for

achieving sectoral, MDAs and LGAs objectives under the current climate change threats.

As also established by the findings, the institutional structure for climate change management in Tanzania is well structured from the national to the village level. Nevertheless, there are key emerging issues affecting effective mainstreaming of climate change issues. These include high dependence on external funding, failure to align sectoral policies to major national development policies and plans, low budgetary allocation, shortage of environmental officers especially at the ward and village levels, slow pace of capitalizing on climate change financing opportunities, and lack of resources for implementation of climate change adaptation and mitigation issues at LGAs and MDAs.

6.2.4. The Role and Contribution of Actors in Facilitating Climate Change Initiatives

The analysis of the role and contribution of actors towards climate smart strategies established that various actors are involved in facilitating local community adaptation and mitigation initiatives to climate change in Dodoma region. Nevertheless, actors' efforts are very limited in terms of spatial and temporal coverage due to limited resources and absence of concrete objectives dedicated in addressing climate change among others. In addition, most actors especially NGOs do not have own financial sources, hence depending on donors support for implementing their activities. As a result, the sustainability of their activities in relation to climate change adaptation and mitigation suffers implementation hurdles due to lack of climate change budget

segment and failure of donors to timely disburse and allocate adequate financial resources.

6.3. Recommendations

With regard to the findings, discussions, and conclusions, this study recommends the following measures to enhance local community adaptation and mitigation strategies to climate change in Dodoma region.

1. This study has revealed that one of the major climate change impacts in the study area is rainfall unpredictability. In this regard, this study calls for the strengthening of the collection and dissemination of weather forecast information so as to help in planning for local community adaptation and mitigation practices.
2. The analysis on the involvement of local actors in facilitating local community adaptation and mitigation efforts suggested that most activities undertaken by some local actors are not guided by concrete climate change objective(s). In this regard, it is imperative for actors to develop clear objective(s) on climate change that will assist in developing a budget segment on facilitating local community initiatives on climate change. Nevertheless, this should be implemented alongside actors' cooperation so as to reduce some challenges such as lack of resources currently constraining actors' innovations in managing climate change impacts.
3. Based on the emerging issues on policies and institutional framework in Tanzania, there is a need for strengthening the institutional capacity in LGAs; intensifying the use of local resources and innovation; aligning sectoral policies to the major national development and plans, national climate change

strategy 2012 -2017 and NEAP 2013 – 2018; strengthening and hastening cross sectoral coordination; promoting awareness creation and capacity building on climate change issues; improving climate change budgetary allocation; and timely disbursement of funds.

4. Some of the major challenges to local community adaptation identified by this study were difficulties involved in obtaining improved seeds and adequate extension services. This signifies the lack of committed agricultural support systems. This study therefore calls for the strengthening of the agricultural support system and recruitment of adequate number of well equipped agricultural extension officers. This will help in strengthening the provision of extension services to local community members in the areas so as to better adapt and mitigate climate change hazards. In addition, there is also the need for strengthening the production of Quality Declared Seeds (QDS) at community level to ensure that the communities have easy access to quality seeds at the right time.
5. Based on the findings, the top five climate change hazards in the area are related to rainfall variations. Therefore, interventions to deal with climate change impacts on livelihood activities in Dodoma region should involve strategies for reducing the impacts associated with rainfall variations. Such interventions should involve community rainwater harvesting and establishment of irrigation schemes among others.
6. The study has revealed unsustainable use of village forest resources through haphazard cutting of tress for various domestic and commercial uses hence degrading the forest. Thus, there is a need for proper management and

utilization of forest including the use of alternative energy and improved stoves so as to tap the benefits of forest in climate change adaptation and mitigation in the study area.

7. There is a need for development of a village land use plan which will take into account the unique characteristics of each village and ensure environmental sustainability.
8. Lastly, this study proposes the climate change local adaptation and mitigation strategy indicated in Table 6.1 on the basis of the major issues and that needs immediate attention. Such issues include the need for improving agricultural productivity; improving water availability for domestic, agriculture, and livestock; diversification (agriculture and non agriculture activities); controlling environmental degradation; and strengthening the performance of institutions and other actors in the area.

Table 6.1: Proposed climate change adaptation and mitigation strategy for Dodoma region

Goal	Objectives	Actions/strategies	Key actors	Implementation period
To enhance agricultural productivity	To promote farming productivity in the changing climate of Dodoma region	Timely supply of adequate improved seeds (drought tolerant, early maturing, and pest resistant crop varieties)	• LGAs • PMO-RALG • Ministry of Agriculture • The local community • Local actors • Research institutions • TMA	Short to medium term
		Strengthening extension services by recruiting and facilitating extension officers in their activities		
		Promoting good agricultural practices		
		Promoting irrigation activities in the area by developing potential areas for irrigation		
		Strengthening weather forecast information dissemination and/or sharing for farmers		
		Strengthening integrated pest management techniques		
	To promote livestock productivity	Promoting destocking of livestock for sustainable use of the available pasture and water resources	• LGAs • PMO-RALG • Ministry of Agriculture • The local community • Local actors • Research institutions • TMA	Short to medium term
		Improving the genetic potential of livestock in the area (to promote fast growth and productivity)		
		Promoting development and implementation of land use planning		
		Promoting improved traditional livestock keeping system		

Goal	Objectives	Actions/strategies	Key actors	Implementation period
To ensure water availability and accessibility for domestic, livestock and agricultural use in a changing climate	To improve water availability & accessibility for domestic, livestock and agricultural use in a changing climate	Promoting appropriate water management strategies such as management of catchment areas at community level	• LGAs • PMO-RALG • Village water management committees • Private sector • The local community • Ministry of water	Short to medium term
		Investing in rainwater harvesting technologies (in-situ water harvesting, dams construction, terracing, construction of community water tanks, construction of sand and sub-surface dams)		
		Strengthening water conservation and protection measures		
		Implementing the districts bylaws on water management		
To increase resilience and adaptive capacity of the local community through diversification of agricultural and non agricultural activities	To promote diversification of agricultural activities	Enhancing production of other crops tolerant to climate change	• LGAs • PMO-RALG • Local community leadership • The local community • Financial institutions • SACCOS • Private sector	Short term
		Encourage the use of intercropping to spread climate change risks across crops		
	To enhance diversification of non agricultural activities	Enhancing diversification of income generating sources		
		Promoting and strengthening rural market and marketing systems		
		Enhancing the establishment of financial services in rural areas to facilitate the availability of capital to the local community		
		Promote establishment of SACCOS and community		

Goal	Objectives	Actions/strategies	Key actors	Implementation period
		productive social groups for easy access of capital and pooling of resources	• Central government	
To enhance local community resilience and adaptive capacity through environmental conservation and management in the area	To strengthen environmental conservation and management issues in the area	Promoting the use of alternative energy sources and energy efficient stoves	• LGAs • PMO-RALG • Private sector • Education institutions • The local community	Short, Medium and long term
		Supporting diversification of sustainable income sources in rural areas rather than depending on charcoal making for household income.		
		Implementing the District Councils environmental management bylaws to protect the environment.		
		Encouraging the establishment of woodlots at household level, education institutions, and non academic institutions.		
		Strengthening village forest management		
		Controlling soil erosion and strengthening soil management practices		
		Integrating climate change issues (e.g. REDD+) in forest management at village and household level.		
		Promoting and supporting effective land use planning at all levels (e.g. urban and rural areas)		
		Promoting afforestation and reforestation		
		Promoting agro-forestry systems		
To strengthen the performance of public and private institutions in	To build effective public and private institutions for facilitating local	Reviewing and aligning sectoral policies by integrating climate change issues in such policies so as to conform to the major national development policies, NEAP 2013 – 2018, and National Climate Change Strategy	• Sector ministries • LGAs	Short, medium and long term

Goal	Objectives	Actions/strategies	Key actors	Implementation period
supporting the local community to better adapt and mitigate climate change impacts	adaptation and mitigation to climate change	2012 – 2017.	• PMO-RALG • Central Government • Private sector	
		Providing logistical and technical support to private institutions facilitating local community to adapt and mitigate climate change impacts.		
		Recruiting adequate number of extension and environmental officers to support the local community in their quest to adapt and mitigate climate change impacts		
		Allocating adequate funds and resources to facilitate the performance of institutions in facilitating local community adaptation and mitigation to climate change.		
		Integrating climate change adaptation and mitigations issues into Medium Term Expenditure Frameworks (MTEF).		
		Strengthening the collection and distribution of climate change (weather) related information (forecast information sharing)		

6.4. Areas for Further Research

6.4.1. Sustainability of Local Community Adaptation and Mitigation Strategies

Few studies have been carried out on local community adaptation; hence there is a need to undertake empirical research on sustainability of local community adaptation and mitigation strategies so as to determine whether local community adaptation and mitigation practices achieves both social and environmental goals in the study area. The findings of such research will be of critical importance in reorienting the local community adaptation and mitigation strategies towards more environmental and social friendly approaches. In addition, this study did not focus on understanding whether the current community adaptation and mitigation strategies facilitates or hinders long term climate change adaptation and mitigation. As such, there is a need for further research to determine the implications of the current local community adaptation and mitigation strategies to the future climate change management in the study area.

6.4.2. Climate Change Information Management and Dissemination Systems

The findings have established that one of the major climatic change challenges affecting the local community in the area is rainfall unpredictability. This suggests the possibility that the local communities were not well furnished with weather forecast information. In addition, this study did not address the question of climate change information managements and dissemination systems. In that regard, empirical research should be undertaken with special focus on climate change information management and dissemination systems and its implications to climate change impacts management at community level.

6.4.3. Sectoral and Inter-Sectoral Coordination

Based on the findings of this study, climate change mainstreaming, especially in major national development policies, some strategies and plans, in Tanzania is still in its infancy stage. This suggests that a lot needs to be done in the process of climate change adaptation and mitigation mainstreaming at national, sectoral and LGAs levels. Taking into considerations the complexities surrounding climate change management, the challenge of climate change coordination across sectors is imminent. In the quest for an inclusive approach for addressing climate change impacts across sectors, this study suggests the need for inter-sectoral coordination studies to determine the most effective way of coordinating different sectors in dealing with climate change challenges from national to local levels.

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APPENDICES

Appendix I: Top 10 Natural Disasters in Tanzania for the period 1992 to 2011 sorted by number of people affected

Disaster	Date	Number of people affected
Drought	2006	3,700,000
Drought	1996	3,000,000
Drought	August 2003	1,900,000
Drought	October 2004	254,000
Flood	12/2/1993	201,543
Flood	25/12/2009	50,000
Epidemic	1 January 1998	35,824
Epidemic	30January 1997	35,591
Flood	26/5/1995	20,000
Flood	9/5/2006	19,000

Source: EM-DAT (2011)

Appendix II: Top 10 Natural Disasters in Tanzania for the period 1900 to 2011 sorted by economic damage costs

Disaster	Date	Damage (000 US$
Flood	12 February 1993	3,510
Flood	May 1974	3,000
Flood	May 1968	1,000
Flood	3 April 1990	280

Source: EM-DAT (2011)

Appendix III: Top 10 Natural Disasters in Tanzania for the period 1982 to 2011 sorted by number of people affected

Disaster	Date	Number of people affected
Drought	2006	3,700,000
Drought	1996	3,000,000
Drought	1984	1,900,000
Drought	August 2003	1,900,000
Drought	1991	800,000
Drought	October 2004	254,000
Flood	12 February 1993	201,543
Flood	3 April 1990	162,000
Flood	7/4/1989	141,056
Flood	1988	110,00

Source: EM-DAT (2011)

Appendix IV: Data Matrix

Objective	Research question(s)	Data needs	Sources of data	Data collection methods	Data analysis	Data Presentation
To examine the nature, manifestation and magnitude of climatic change driven impacts	What are the changes associated with climate change in semi arid area of Dodoma region?	• Data on climatic parameters (rainfall, temperature and wind speed	• Weather stations • Office reports • Peoples' experience	• Reviewing of secondary data • Interview schedule • Focus Group Discussion (FGD)	• Content analysis (qualitative analysis) • SPSS (quantitative analysis)	• Charts • Graphs • Text • Tables
	How are climatic change driven impacts manifested in the semi arid area of Dodoma region?	• Reduced crop yields • Increased wildfire risks • Damage to crops (crop failure) • Water availability and/or water stress • Land degradation (soil erosion and forest encroachment)	**1. Reports from** • District Agricultural and livestock department • District Health department • District water department • District land and natural resource department • Any other relevant agency	• Reviewing of reports • Interview schedule administered to household heads • FGD with relevant Officials and Local people	• Content analysis (qualitative analysis) • SPSS (quantitative analysis)	• Charts • Graphs • Text • Tables

Objective	Research question(s)	Data needs	Sources of data	Data collection methods	Data analysis	Data Presentation
		• Livestock deaths (water and pasture) • Emergence of new diseases	2. **Local people** • Household heads			
To identify and analyse local community adaptation and mitigation practices in addressing the impacts of climate change	What are the adaptation and mitigation practices used in responding to climate change impacts?	• Adaptation practices (e.g. diversification, storage, migration, agricultural methods, natural resource management, social network, local innovations, changes in land use etc) • Mitigation practices (e.g. afforestation, reforestation, energy efficiency etc)	• Household heads • Government office	• Interview schedule • FGD • Review of various reports and other relevant secondary data	• Qualitative and quantitative analysis • Content analysis	• Charts • Graphs • Text • Tables
To examine the extent to which climate change	To what extent climate change adaptation and	• Integration of adaptation and mitigation issues into	• Government offices • Government reports	• interview schedule • Review of policies,	• Content analysis • Quantitative analysis	• Charts • Graphs • Text

Objective	Research question(s)	Data needs	Sources of data	Data collection methods	Data analysis	Data Presentation
adaptation and mitigation issues are mainstreamed into government policies, plans and programmes	mitigation issues are mainstreamed into government policies, plans and programmes?	government policies, plans and strategies (i.e. policies, programme and plans addressing climate change in the form of regulations, provision of information, training, funding, partnership and other necessary resources)	• Government policies (e.g. PRSP, vision 2025, and sectoral policies such as forest, agriculture, livestock, environment etc) • Government plans (e.g. National development plans, LGA plans and budgets etc)	programmes and plans (review of literature). For instance the review of MTEF[1] for budgetary allocations and review of implementation reports in determining the actual expenditure.	especially LGA budgets	• Tables
To examine the role and contribution of various actors and/or institutions in	What are the roles and contributions of various actors and/or institutions in	• Actors and institutions involved • Role of actors and institutions in facilitating adaptation and mitigation	• LGA Offices • Household heads for understanding institutions and actors operating in the study area • Offices of	• Interview schedule • FGD • Review of various reports and other relevant secondary data	• Qualitative data analysis • Quantitative data analysis • Content analysis	• Charts • Graphs • Text • Tables

[1] Medium Term Expenditure Framework

Objective	Research question(s)	Data needs	Sources of data	Data collection methods	Data analysis	Data Presentation
facilitating local community adaptation and mitigation practices	facilitating local community adaptation and mitigation practices?	practices • The contributions of various actors and institutions in facilitating adaptation and mitigation practices	relevant actors and institutions • Implementation reports of various institutions addressing climate change in the study area			

Appendix V: Correlation matrix, Component matrix and Scree plot for PCA

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	.574**	1.000										
3	.411**	.366**	1.000									
4	.463**	.516**	.406**	1.000								
5	.471**	.558**	.355**	.576**	1.000							
6	.351**	.396**	.719**	.369**	.454**	1.000						
7	.445**	.378**	.232**	.284**	.427**	.350**	1.000					
8	.378**	.459**	.273**	.585**	.499**	.284**	.395**	1.000				
9	.277**	.382**	.656**	.442**	.349**	.627**	.147*	.323**	1.000			
10	.209**	.327**	.172**	.198**	.325**	.268**	.326**	.318**	.294**	1.000		
11	.271**	.279**	.075	.187**	.334**	.178**	.496**	.410**	.068	.571**	1.000	
12	.176**	.298**	.262**	.344**	.403**	.275**	.222**	.248**	.357**	.262**	.094*	1.000

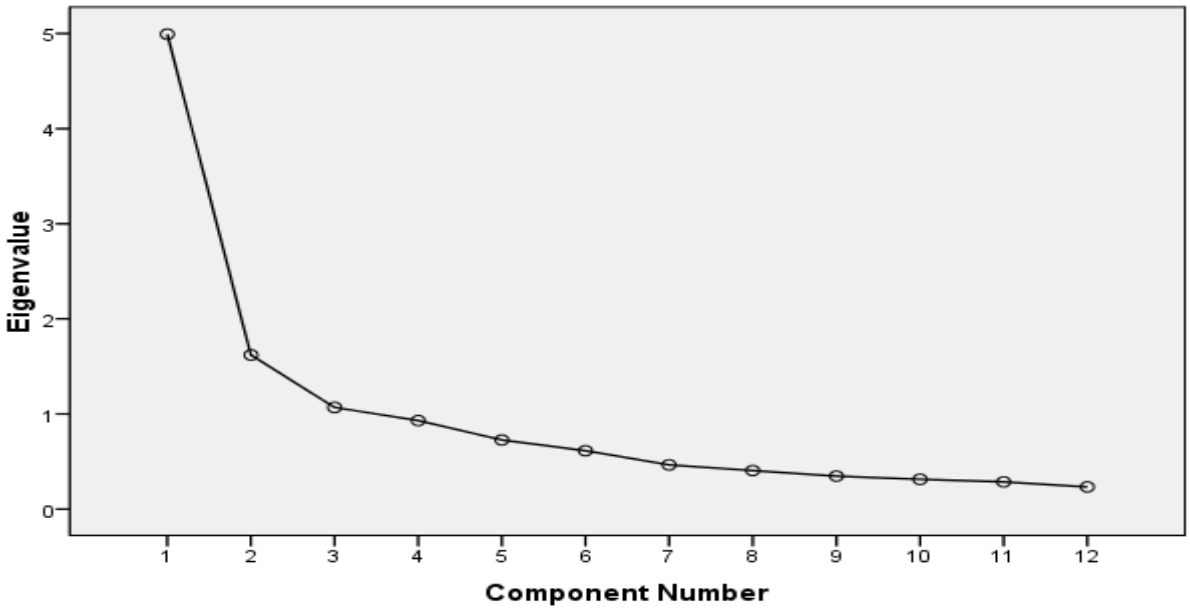
Note: **. Correlation is significant at the 0.01 level (2 – tailed); *. Correlation is significant at the 0.05 level (2 – tailed)

Variables: 1= Reduces agricultural productivity; 2 = affects planting season; 3 = reduces pasture for livestock; 4 = reduces water availability; 5 = affects the size of land cultivated; 6 = affects the number of livestock; 7 = reduces household income; 8 = lead to destruction of crops; 9 = reduces water availability for livestock; 10 = natural resources degradation; 11 = affects socio-economic activities; and 12 = Destruction of settlements.

Component matrix[2] for three components

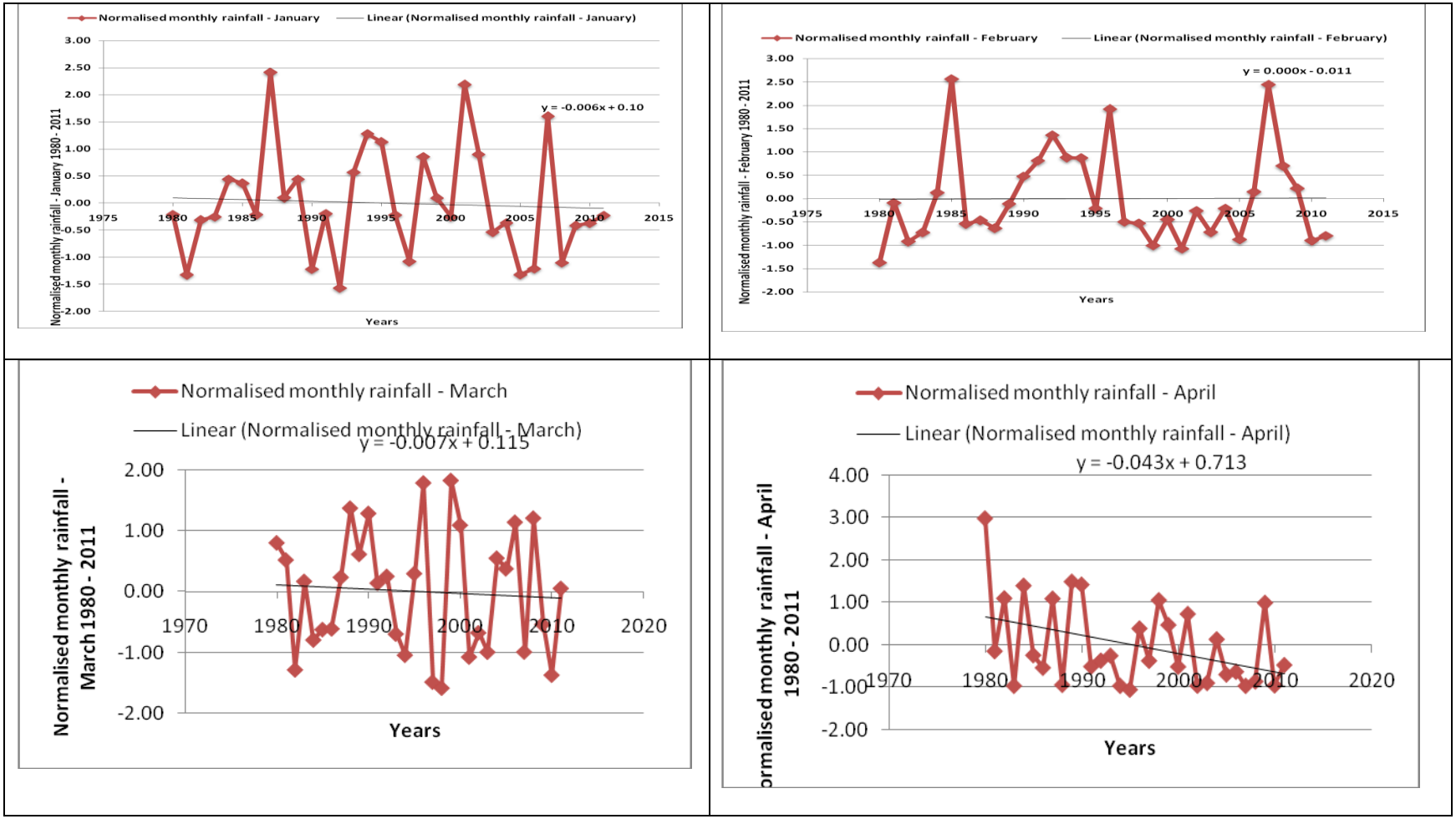
Item	Component		
	1	2	3
Affects the amount of land cultivated	.762	.091	-.213
Affecting planting season	.737	.061	-.267
Reduces water availability	.720	-.099	-.404
Affects the number of livestock	.697	-.403	.320
Lead to destruction of crops	.684	.230	-.235
Reduces agricultural productivity	.666	.072	-.331
Reduces pasture for livestock	.656	-.540	.209
Reduces water availability for livestock	.649	-.514	.277
Reduces income	.597	.414	.050
Lead to destruction of settlements	.493	-.132	.049
Affects socioeconomic activities	.479	.681	.326
Lead to natural resources degradation	.521	.412	.539

Scree plot showing eigenvalues for twelve components

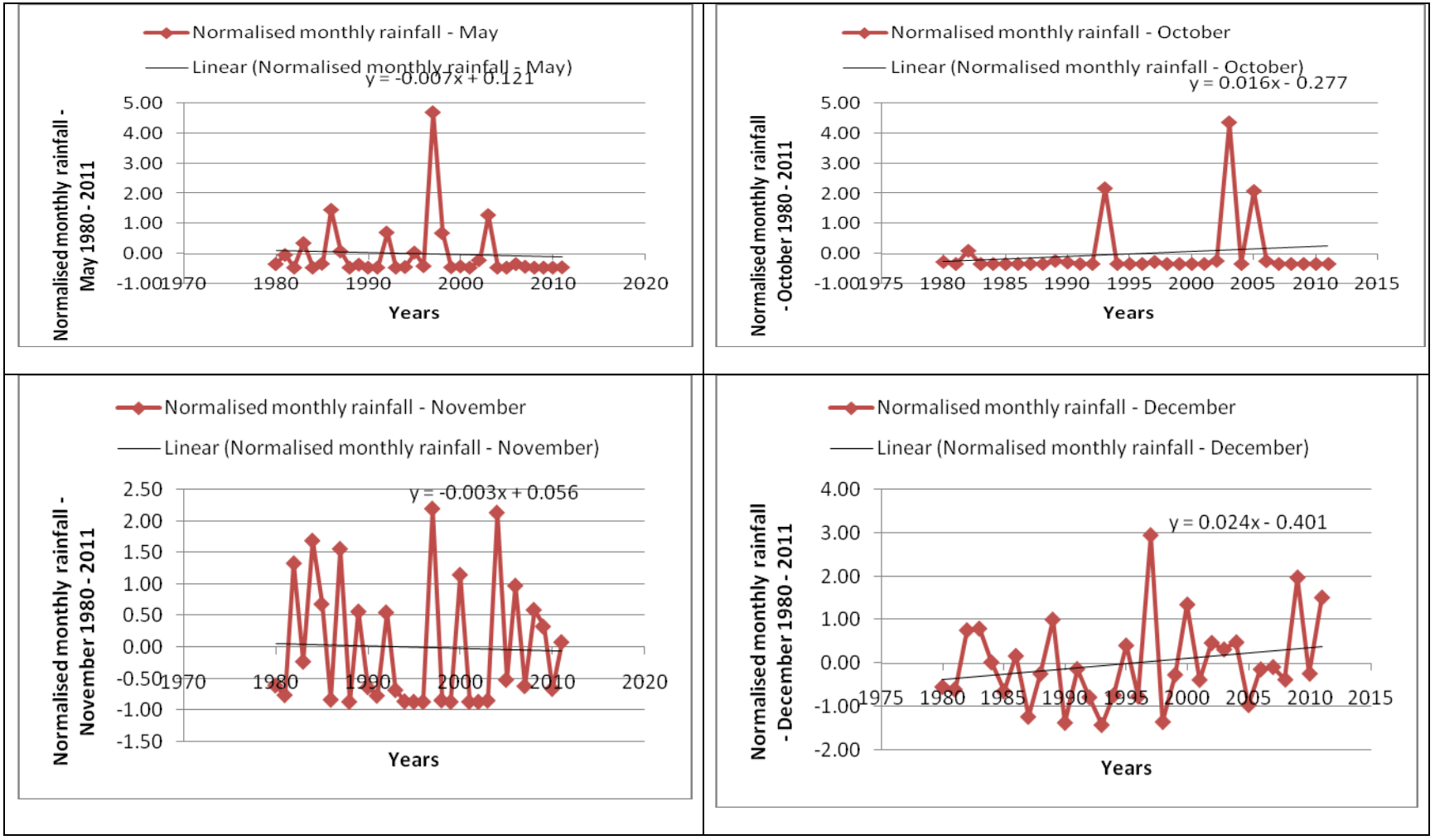


[2] Component matrix indicates the unrotated loadings of each of the items on the three components

Appendix VI: Monthly rainfall trends in Dodoma region



Appendix VI: Monthly rainfall trends in Dodoma region (cont……)



Appendix VII: Objectives of actors involved in facilitating local community adaptation and mitigation practices

In Dodoma region various actors are involved in facilitating local community adaptation and mitigation practices. The objectives of each of the actors interviewed in the region are as follows:-

1. **Sunseed Tanzania (STT)**
    - Improve the health, primarily of women and children by introducing new appropriate cooking approaches which reduce some and dangerous fumes
    - Reduce the financial, human resources (wood and Charcoal) used in tradition means of cooking and thus improve the livelihood of poor
    - Contribute to reducing the deforestation and desertification in the a rid region of Dodoma through the introduction of improved tree management and use
    - Embed the new approaches of cooking and tree management in culture and lifestyles of the communities and thus ensure their sustainability

2. **World Vision Tanzania (WVT)**
   In the aspect of ensuring households and communities are socio-economically empowered to sustainably assure the well being of children, WVT have the following objectives:-
    - Improved natural resources management and natural environmental resilience for sustained benefits to rural communities, households and children
    - Increased agricultural productivity and profitability of smallholder farmers for selected farm and non farm enterprises
    - Enhanced household and community resilience and social safety nets to support the well being of children and care for the environment
    - Improved capacity for disaster risk reduction, climate change mitigation and adaptation

3. **Rural Livelihood Development Company (RLDC)**
    - Improved welfare of the rural household in the central corridor of Tanzania by improving access to and availability of inputs; introducing good agronomic practices; creating income and employment opportunities; increasing gender and social equity interventions; and intervention on HIV/AIDS
    - Make market systems work better for rural producers to improve their welfare

4. **Kongwa Environmental Network (KONET)**
    - Ensure sustainability of natural regeneration/ecology to Kongwa district
    - Capacity building to local community on environmental management in the agricultural sector
    - Promote sustainable use of environmental resources

5. **Dodoma Environmental Network (DONET)**
    - To sensitize, educate and liaise with individual people, organizations, institutions community groups, government institutions and non governmental organizations in the conservation of the environment
    - To ensure sustainable management of natural resources of Tanzania in general through coordinated community plans of environmental management and conservation.

6. **Bahi Environmental Network (BAENET)**
    - Promote environmental conservation and management
    - Promote sustainable use of resources
    - Lobbying and advocacy on environmental related issues

7. **Government departments (Bahi and Kongwa District Councils)**
    - Maintain and facilitate the maintenance of peace and good government
    - Promote the social welfare and economic well being of all persons
    - Subject to the national policy and plans for rural and urban development, to further the social and economic development

8. **Tanzania Organic Agriculture Movement (TOAM)**
    - Awareness Creation: working to increase the public's knowledge of organic farming thereby enabling consumers to appreciate organic products and for farmers and experts to respond appropriately to environmental potentials and opportunities in both the foreign and domestic markets.
    - Capacity Building: increasing the competence of trainers, extension staff and facilitators by organizing training courses on organic agriculture and value chain development, encouraging and collaborating in establishing and functioning of organic training centers and colleges, and sharing information with members and stakeholders.
    - Information: as a focal point in the generation, compilation, and dissemination of information on the organic sector, working in collaboration with research institutions to investigate, understand, and document organic farming.
    - Lobbying and Advocacy: influencing the partnerships, networks, government departments, and other relevant institutions working in Tanzania in favour of the organic farming agenda.
    - Linkages and Networking: facilitating new linkages and networks and expanding existing ones. Strategic networking will allow the organization to learn from others, gain greater shared knowledge, and develop a stronger voice nationally to support organic farming.

9. INADES Formation Tanzania (IFTz)

- Provide extension education and training support services on agriculture (crop and livestock) production
- Provide extension education and training support services on environmental and soil conservation, local innovations in land and rainwater management
- Provide extension education and training support services on adaptation to climate change and management of dry land resources
- Provide extension education and training support services on mainstreaming gender and development
- Provide extension education and training support services on marketing, microfinance and savings and credit services
- Provide extension education and training support services on establishment and strengthening of community farmers organizations in form of groups associations and networks
- Provide extension education and training support services on food and seed security and nutrition

10. Research Institutions (TALIRI, ARI Hombolo and PRC)

- Conduct agricultural research
- Develop appropriate technologies for increasing agricultural production such as drought tolerant breeds of pasture, livestock and crops
- Empowerment of agricultural stakeholders

11. Lutheran World Relief (LWR)

- Strengthening the development of grape and rice value chain to ensure year round security and increased income of smallholder farmers in Dodoma region

12. St. Phillip Theological College

- Teach theology and community development
- Train men and women for pastoral ministry in church
- Equip men and women with skills for improvement of praxis
- Uphold and preserve the teaching and witness of God through the church and life of stewardship

QUESTIONAIRRES AND CHECKLISTS

QUESTIONNAIRE FOR HOUSEHOLDS

A. Profile of respondent

1. Place of residence: District..... Division..... Ward..... Village.....
2. Household number: .....
3. Sex of respondent ……
4. Age of respondent ……
5. Marital status ……
6. Education level ……..
7. Occupation ……
8. Number of years living in the area ……
9. Number of family Members: .....
10. Income level (per month): .....
11. What was the main source of your household's income during the past 5 years
12. Membership in any organization.……
13. If yes (in 12 above), name of the organization(s): .....
14. Name the Activities of the organization (in 12 above): ……
15. Assets owned by your household ……
16. Size of farm owned (ha): .....
17. Size of the farm cultivated (ha): ....
18. Type of food crops do you usually cultivate in your farmland ……
19. Type of cash crops do you usually cultivate in your farmland?
20. Type and number of livestock kept
21. What is the main source of water for your household during the dry season?
22. What is the main source of water for your household during the wet season?
23. What is your main source of energy for cooking or water boiling?
24. The type of house used by the household. **(Enumerator to Observe- Do not ask)**

B. Changes associated with climate change

25. What changes have been witnessed with respect to climate in the past 10 years in your area?
26. What do you think are the causes for these (**in 25** above) changes?

27. How such changes as **in 25** above affect your livelihood activities or sources?

S/n	changes	Effects of CC on livelihood activities or sources*
1.	unpredictable rainfall	
2.	Decrease in rainfall	
3.	Temperature increase	
4.	Temperature decrease	
5.	Floods	
6.	More intense storms	
7.	Droughts	
	Others (as specified in Qn 25)	

C. Climatic change driven impacts

28. For the past 5 years, did you produce enough food for your household? (Tick yes, no or don't remember in the table below)

2011			2010			2009			2008			2007		
Yes	No	Don't remember	Yes	No	Don't remember	Yes	No	Don't remember	Yes	No	Don't remember	Yes	No	Don't remember

29. In case the answer is no in some of the agricultural seasons above (**question 28**), what are the reasons for not producing enough food crops?
30. For the past 5 years, did you produce enough cash crops for your household? (Tick yes, no or don't remember in the table below)

2011			2010			2009			2008			2007		
Yes	No	Don't remember	Yes	No	Don't remember	Yes	No	Don't remember	Yes	No	Don't remember	Yes	No	Don't remember

31. In case the answer is no in some of the agricultural seasons above (**question 30**), what are the reasons for not producing enough food crops?

32. To what extent climate changes affect your livelihood activities? (Depending on the extent, **write 1: more severely, 2: severely; 3: less severely; and 4: not applicable (NA)** in the box provided against each climate change effects.

a) Reduces agricultural productivity [ ]
b) Affects planting season [ ]
c) Reduces livestock pasture [ ]
d) Reduces water availability [ ]
e) Affects the amount of land cultivated []
f) Affects the number of livestock [ ]
g) Reduces income [ ]
h) Destruction of crops [ ]
i) Destruction of settlements [ ]
j) Reduce water availability for livestock[ ]
k) Natural resources degradation [ ]
l) Affects socioeconomic activities [ ]

33. Which of the following climate related hazards affects you mostly? **(Rank the hazards based on level of importance whereby 1: most important, 2: Important, 3: less important).**

S/n	**Climate related hazards**	**(Rank 1 – 3)**
1.	drought	
2.	floods	
3.	More intense storms	
4.	Increase in temperature than normal	
5.	Decrease in temperature than normal	
6.	Damage due to heavy showers	
7.	Prolonged drought during what would be rainy season	
8.	Early end of rain season	
9.	Drought due to less rainfall during what would be rainy season	
10.	Unusual rainfall trend	
11.	Crop diseases (specify :.....)	
12.	Animal diseases (specify :.....)	

Note: 1- most important, 2 – important, and 3 – less important

34. Are there any periods in the past five years when the household experienced difficulties to feed household members?

S/n	Years	Please tick the appropriate response		Month(s) in the year (e.g. Jan, Feb, March etc)
		Yes	No	
1.	2011			
2.	2010			
3.	2009			
4.	2008			
5.	2007			

35. Who are the most affected, how and why? (**following difficulties in feeding household members as per question 34 above**)
    a) Most affected: All [ ] Men [ ] Women[ ] Children [ ] Elders [ ]
    b) How?: ……
    c) Why?: .....
36. How did you manage to control the situation (**difficulties in feeding household members**) as per **question 34 above**?
37. Have you lost livelihood sources (e.g. water, land) as a result of climate change hazards?
    a) Yes [ ] b) No [ ]

38. If yes (**as per question 37 above**), tick in the table below the appropriate resource lost as a result of climate change hazards in the area
    a) Agricultural land [ ] Reasons.....
    b) Forest [ ] Reasons.....
    c) Water sources [ ] Reasons.....
    d) Pastureland [ ] Reasons.....
    e) Crops [ ] Reasons.....
    f) Livestock [ ] Reasons.....
    g) Others (specify): .....
39. During the dry season, how long does it take you to fetch water from your main sources **(time for going to the water source and coming back)**?

40. During the dry season, how long the main source of water is located from your household?
41. How many hours per day do you spend in fetching water for domestic uses during the dry season?
42. Who is responsible for fetching water for household use?
43. During the wet season, how long does it take you to fetch water from your main sources **(time for going to the water source and coming back)**?
44. Below is the list of various effects associated with water availability and accessibility as a result of climate change, to what extent these effects affect your household members? **write 1: more severely, 2: severely; 3: less severely; and 4: not applicable (NA)**
    a) Affects education of children [ ]
    b) Increase women workload [ ]
    c) Source of waterborne diseases[ ]
    d) Leads to poor sanitation[ ]
    e) Source of food insecurity [ ]
    f) Limits water availability for livestock[ ]
    g) Limits pasture availability [ ]
    h) Others (specify).....
45. Where do you feed your cattle, goats and sheep during the dry season?
46. What effects do you experience on livestock as a result of climate change hazards (e.g. prolonged drought) in your area?
47. To what extent climate changes hazards (e.g. prolonged drought) affect your livestock keeping activities? (Depending on the extent, **write 1: more severely, 2: severely; 3: less severely; and 4: not applicable (NA)** in the box provided against each climate change effects
    a) Dwindling of pasture areas [ ]
    b) Drying of water sources [ ]
    c) Death of animals [ ]
    d) Trekking long distance on search for pasture [ ]
    e) Trekking long distance on search for water [ ]
    f) Temporary migration of animals [ ]

D. Local community adaptation and mitigation practices, usefulness and challenges

48. What kinds of activities are undertaken by household members?
49. What are the **agricultural techniques/strategies** used by the local community as adaptation practices to the problems associated with climate change hazards (e.g. drought/floods/bush fire etc)? Please tick the adopted strategy, indicate its usefulness, its implementation challenges, and measures to address the identified challenges).

50. What are the **income diversification strategies** used by the local community as adaptation practices to the problems associated with climate change hazards (e.g. drought/floods/bush fire etc)? Please tick the adopted strategy, indicate its usefulness, its implementation challenges, and measures to address the identified implementation challenges).
51. What are the **water management techniques/ strategies** used by the local community as adaptation practices to the problems associated with climate change hazards (e.g. drought/floods/bush fire etc)? Please tick the adopted strategy, indicate its usefulness, its implementation challenges, and measures to address the identified implementation challenges).
52. What are the **communal pooling techniques/ strategies** used by the local community as adaptation practices to the problems associated with climate change hazards (e.g. drought/floods/bush fire etc)? Please tick the adopted strategy, indicate its usefulness, its implementation challenges, and measures to address the identified implementation challenges).
53. What are the **adopted local community mitigation practices** in addressing the problem of climate change in the area (e.g. drought/floods/bush fire etc)? Please tick the adopted mitigation practice, indicate its usefulness, its implementation challenges, and measures to address the identified implementation challenges).
54. Are there household members who have migrated (permanently or temporary)?
55. If yes, what were the reasons for migration?
56. After migrating, how do they assist the household in adapting to the effects of climate change hazards (if any)?
57. How do you protect or manage water sources at your village?
58. During the rain season, do you harvest rain water at your household?
59. If yes, what facilities do you use in the storage of the harvested rainwater?
60. What are major uses of the harvested rain water?
61. For how long, your household can use the harvested rain water for various purposes from the last day of rain?
62. What type of cooking stove do you usually use?
63. Does your household use improved stoves in the view of conserving energy (e.g. firewood, charcoal, low cost biogas plant etc)?
64. Are there tree planting programs in your village?
65. If yes, how often the exercise of tree planting is undertaken?

66. How your household involved in environmental management particularly in tree planting?
67. Who facilitates the program of tree planting in your village?
68. When planting trees, where do you get tree seedling?

E. Role and contribution of actors in facilitating local community adaptation and mitigation practices

69. What appropriate resource management measures / practices did your household employed in the past five years in adapting to or mitigating climate change driven impacts?
70. Are there any actors/institutions assisting you in adapting to or mitigating climate change driven impacts?
71. If yes in 70 above, who are those actors/institutions [tick the most appropriate actor(s) or stakeholder(s)]
72. Do you have direct contact with actors/ institutions as identified in question 71?

73. If yes (as per question 72),
    a) Name the actor(s)/institution(s).....
    b) Since when you have been in contact? .....
74. If no (as per question 72),
    a) Why? .....
    b) Who assists you in getting the resources or assistance from actor(s)/institution(s) as identified in question 72? .....
75. What role do they play? ……
76. During the past five (5) agricultural seasons, did you receive any support from an agricultural (crops) extension worker?
77. If you received extension assistance/support, where did it come from?
78. What areas/area did you receive support from the extension workers?

F. Main challenges faced by local community as a result of climate changes

79. What challenges do you face as a result of climate changes and how do you deal with such challenges?

G. Role of land use planning in mitigating against climate change

80. What are the major land uses in your area
81. How do you manage land use activities in your area?

82. Does your household own woodlot (tract of woodland where trees are grown for fuel, posts, or timber?
83. If no, where do you obtain trees for fuel, post, or timber? ……
84. In your opinion, what are the major benefits of land use planning in addressing the problem of climate change? ……
85. In your opinion, what challenges do you face in the process of land management? ……

H. Administrative issues

i. Name of interviewer: .....
ii. Date of interview: .....
iii. Checked by: .....

QUESTIONNAIRE FOR LOCAL INSTITUTIONS

1. Name of the Institution: .....
2. Title of interviewee and roles.....
3. Category: NGO [ ] CBO [ ] Government Agency [ ] Others [ ] (specify).....
4. Operational Period (years): From ..... to.....
5. Institutional goals/objectives: ……
6. Are there other institutions/organisations within or outside Dodoma region working with your organisation/institution in facilitating local community to deal with climate change hazards in Dodoma region? Yes[ ] No [ ]
7. If yes (as per question 6 above),
    a) What are these institutions? ……
    b) What are the areas of collaboration? ……
    c) What are their roles? ……
8. How does your institution/organization respond to climate-related stresses affecting household or community livelihood activities or sources?.....
9. How the responses identified in question 8 above assist households or the local community in reducing their vulnerability to climate change?.....
10. How you institution/organization assist households or the local community to deal with climate hazards in a long run (sustainability)? ……
11. Do you organisation or institution have direct contact with households or the local communities? Yes[ ] No [ ]
12. If yes (as per question 11, how?.....
13. If No (as per question 11),
    a) Why? …….
    b) Who mediates? ……
14. In your organizational operations/activities, do you think you are adequately addressing the problem of climate change impacts? Yes [ ] No [ ]
15. What do you think should/needs to be improved? ……
16. What are the major challenges/obstacles to your organisation for addressing impacts of climate change hazards (drought and floods) in a successful and sustainable manner?.....
17. What should be done in order to address challenges/obstacles as identified in question 19 above? …….

Questionnaire No: .....

QUESTIONNAIRE FOR GOVERNMENT OFFICIALS

A. Basic information

1. Name of the government department.....
2. Title of interviewee and roles.....
3. Level: Central government [ ] Local government [ ]
4. Departmental goals/objectives:……

B. Nature, manifestation and magnitude of climate change driven impacts

5. What do you understand by climate change in local context?
6. How climate change impacts are manifested in the area?
7. Which sectors do you think are mostly affected by climate change hazards such as droughts and floods?

C. Mainstreaming climate change adaptation and mitigation practices

8. To what extent adaptation to climate change are integrated in your departmental plans, projects and programmes?
9. To what extent mitigation practices are integrated in your departmental plans, projects and programmes?
10. What challenges do you encounter in the integration of climate change adaptation and mitigation practices into your departmental plans, projects and programmes?

D. Local community adaptation and mitigation practices

11. What are the major local community adaptation and mitigation practices to climate change in Dodoma region?
12. How do you support the local community to adapt and mitigate climate change hazards?
13. What challenges do you encounter in the course of supporting the local community to better adapt or mitigate climate change hazards?
14. Do you think the local community adaptation and mitigation practices are useful in addressing the impacts of climate change? How?
15. What should be improved so that the local community can better adapt or mitigate climate change hazards?

E. Role and contribution of various actors and institutions in facilitating local community adaptation and mitigation practices

16. Do you know other actors other than the government involved in facilitating local community adaptation and mitigation practices? Please mention them?

17. What are the major roles played various actors/institutions in facilitating local community adaptation and mitigation practices?
18. What are the major contributions of various actors and institutions in facilitating local community adaptation and mitigation practices?
19. What challenges do you face in facilitating local community adaptation and mitigation practices?
20. What do you think are the challenges faced by local community as a result of climate change?

F. Administrative issues

i. Name of interviewer: .....
ii. Date of interview: .....
iii. Checked by: .....

Questionnaire No: .....

Questionnaire for local level key informants

A. Basic information

1. Name of key informant.....
2. Title and roles .....

B. Nature, manifestation and magnitude of climate change driven impacts

3. What do you understand by climate change in local context?
4. What are the major climate change hazards in your area?
5. How climate change impacts are manifested in your area?
6. How climate change hazards affects community livelihood activities and sources?
7. Which activities or livelihood sources do you think are mostly affected by climate change hazards such as droughts and floods? How?

C. Local community adaptation and mitigation practices

8. How does the local community deal with the effects/impacts of climate change hazards (e.g. drought and floods)?
9. How effective are the local community adaptation and mitigation practices useful in addressing the impacts of climate change?
10. Are there any challenges encountered by the local community in the course of dealing with the effects/impacts of climate change hazards? Yes [ ] No [ ].
11. If yes, what are the challenges? ……
12. What should be done so that the local community can better adapt or mitigate climate change hazards?

D. Actors and institutions involved in facilitating local community adaptation and mitigation practices

13. Is the local community capable of dealing with climate change hazards without assistance from other actors/institutions? Yes [ ] No [ ]
14. If No (as per question 12 above), why? ……
15. In the course of dealing with the effects of climate change hazards, are there any partners/stakeholders involved in facilitating local community adaptation and mitigation practices? Yes [ ] No [ ]

16. If yes,
    a) Please mention them?.....
    b) How do they (actors/partners) facilitate local community adaptation and mitigation practices? .....
    c) What are the major contributions of the named actors/partners in facilitating local community adaptation and mitigation practices?.....
    d) What do you think should be improved so that the named actors/partners can betters facilitate community adaptation and mitigation practices?.....
17. What challenges do you face in facilitating local community adaptation and mitigation practices? ……..
18. What do you think are the challenges faced by local community as a result of climate change? …….

E. Administrative issues

i. Name of interviewer: .....
ii. Date of interview: .....
iii. Checked by: .....

Checklist for Reviewing Mainstreaming Climate Change Adaptation and Mitigation Issues

The following a the key issues aiming at guiding the review of policies, programmes and plans for the purpose of understanding the mainstreaming of climate change adaptation and mitigation issues into policies (enabling policies), programmes and plans. Specifically, the review will focus on issues such as regulations, provision of information, training, funding, partnership and other necessary resources. Furthermore, the review will focus on the role of policies at regional, national and international level to influence/provide an enabling environment for adaptation and mitigation practices to work properly and finding out which policy and institutional issues that help or hinder communities to adapt/mitigate climate change

- Among important document to be reviewed at regional and international level includes:-
    - EAC climate change policy, programmes and plans
    - UNFCCC and Kyoto protocol
    - MGDS
- Among important document to be reviewed at national level includes:-
    - PRSP/MKUKUTA I&II
    - Vision 2025
    - Five year development plan (2011/2012 – 2015/2016
    - Sectoral policies (forest, agriculture, livestock, environment, land and water)
    - Government plans (national development plans, LGA plans and budgets, LGA implementation reports i.e. MTEF)
    - Government programmes such as Kilimo kwanza etc.
    - Country reports to UNFCCC
    - MDGS country reports

FGD CHECKLIST

This FGD CHECKLIST contains a number of questions in line with various key issues of focus as per research objectives. This questions aim at guiding the discussion between the focused groups on matters related to community adaptation and mitigation strategies. The use of FGD as a method of data collection is paramount for indepth understanding of local community adaptation and mitigation practices to climate change in Dodoma region.

Guiding topics and questions

A. Understanding of the climate context

- What are the anticipated impacts of climate change in the area?
- What climate change hazards are currently affecting the area?
- What are the actual impacts of these hazards?
- Which social groups are mostly affected by climate change hazards? What makes these groups more vulnerable?
- What are the coping strategies used to deal with these impacts? Or which adaptation and mitigation practices increase local community resilience to climate change hazards?
- Which adaptation and mitigation practices reduce the impacts of climate change hazards particularly on household and individuals?

B. Understanding of the livelihood context

- What resources are important to local livelihoods in the area?
- How are these resources affected by climate hazards?
- How important are these resources to the coping strategies?

C. Understanding the impacts of institutional and community interventions/activities

- Are the current livelihood resources vulnerable to current climate hazards?
- Are the current livelihood resources important to local coping strategies?
- How government and civil society institutions are capacitated so as to provide better support to communities?

D. Adjustment of institutional and community interventions

- What challenges are encountered during the implementation of adaptation and mitigation strategies?
- How can the intervention activities be adjusted to reduce vulnerability and enhance local community adaptive capacity?

- How feasible is to implement these changes in terms of local priorities, finances, institutional capacity, a supportive policy framework, and risks associated with future climate change?

CHECKLIST FOR DOCUMENTARY REVIEW

Crop production

1. Type of crops cultivated
2. Expected yield (for the past five years)
3. Actual yield (for the past five years)
4. Was it sufficient
5. Reason for reduced/increased productivity
6. Amount of land cultivated (for the past five years)
7. The general agricultural production trend (data on productivity be collected from the district agricultural office).
8. Challenges affecting crop production in the area.
9. Support given to farmers to deal with challenges identified in question 8 above.
10. How useful is that support in terms of dealing with challenges identified in question 8 above

Livestock

11. Types of livestock kept
12. Livestock productivity (also trend of livestock productivity)
13. How affected by climate change (availability of pasture and water)
14. Measures to deal with climate change challenges
15. Support given to livestock keepers
16. How useful are the measures for dealing with climate change challenges