

**PASTORAL ADAPTIVE CAPACITY IN THE CHANGING CLIMATE IN  
KILOSA DISTRICT**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE  
REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN RURAL  
DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE.  
MOROGORO, TANZANIA.**

**2015**

## ABSTRACT

Kilosa District is the district in Morogoro Region that has been affected by climate change for many years. This study assessed the pastoral adaptive capacity in the changing climate in Kilosa District. Both simple random and purposive sampling techniques were used to obtain sample. Qualitative data were collected using key informant interview, Focus group discussions and field observation, while quantitative data were collected using household questionnaire survey. Analysis of qualitative data was done using content analysis technique, while quantitative data were analyzed using Excel SPSS computer software. The result revealed that there is a significant shift of rainfall in the study area which started to manifest in 1972-1974 leading to change of rainfall pattern from bimodal to unimodal. The trend in current decades has been consistent with climate change scenarios, with lower rainfall and more frequent, and severe droughts most pastoralists were aware of climate change impacts and how to overcome the problems. The results show that climate change lead to water scarcity, disease to livestock and increased distance to the grazing land Pastoralists have started adapting to climate change by migrating, diversifying to other economic activities such as crop farming and business. Some were reducing the number of livestock as well as using improved breeds. Various institution played important roles in ensuring the sustainability of natural resources, such as setting a grazing land (*Olailili* as named in Maasai language) to be used during dry season. Some construct charco dams “lambo” for water harvesting. This study recommends that the community should diversify to other economic activities so that they can earn income rather than relying on livestock while climatic condition is not favorable and the government of Tanzania should put more effort on training and advocating pastoral to use high breed animal to avoid overgrazing also regular review of policies.

## DECLARATION

I, Zakayo Rachel, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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Date

The above declaration is confirmed

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## ACKNOWLEDGMENTS

My sincere thanks should go to the Almighty God for giving me life, good health, and the capability to accomplish this study successfully. My sincere thanks should go to my parents Mr. and Mrs. Zakayo Jacob for supporting me all this time at SUA. May God bless you and grant you a long life!

My sincere thanks are also extended to Dr J.M. Abdallah for his guidance, insight, positive criticisms, and many suggestions from the inception of this study to its completion. I also owe my sincere thanks to Dr E. Chingonikaya for his support and criticism. My gratitude also goes to the Kilosa District Executive Director for giving me permission to undertake this study in the district.

I, also, owe a lot of thanks to the ward executive officers in Kilosa district especially Mr. Bakari Ugwasu of Rudewa Ward who give me a support in the field. I highly appreciate their positive cooperation. Besides, I wish to thank Kilosa elders as well as households for their cooperation during the field work. Also, I wish to thank the support and cooperation I received from my fellow students pursuing Master of Arts in Rural Development batch 2012/13 particularly Mr. Simeon Maeda and Mr. Fidelis Kisusi. I real appreciated their genuine cooperation and contribution.

Also I owe a big thanks to my relatives especially those who had good intention towards me I thank them for their prayers, may God bless them!

Finally, I am indebted to Jackson Masakia, my Fiancé for his immense moral and material support throughout my studies and enduring my long absence for two consecutive years. Stay blessed! Equally appreciated, is the moral support I received from my lovely son Jadon for enduring my absences in his early childhood stage.

## **DEDICATION**

This work is dedicated to my parents Mr. and Mrs. Zakayo, and to my fiancé as well as my beloved son Jadon Jackson.

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## LIST OF ABBREVIATION AND ACRONYMS

CBOs	Community based organization
CDM	Clean Development Mechanism
DFID	Department for international Development
EMA	Environmental Management Act
ETFRN	European Tropical Forest Research Network
FAO	Food and Agriculture Organization of United Nations
FGD	Focus group discussion
GEF	Global Environment Facility
GHG	Green House Gases
KII	Key informant interview
LDCF	Least Developed Countries Fund
MDGS	Millennium Development Goals
NAMAs	Nationally Appropriate Mitigation Actions
NAPAs	National Adaptation Programs of Action
NCCSC	National Climate Change Steering Committee
NCCTC	National Climate Change Technical Committee
NGOs,	Non -governmental organization
NSGRP	National Strategy for Growth and the Reduction of Poverty
PMO	Prime Minister's Office
PPP	Public Private Partnership
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus
SCCF	Special Climate Change Fund
SPSS	Statistical Package for Social Science

TMA	Tanzania Metrological Agency
TNRF	Tanzania Natural Resource Forum
UNDP	United Nation Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nation Children Fund
URT	United Republic Of Tanzania
WMO	World Metrological Organisation

## CHAPTER ONE

### 1.0 BACKGROUND INFORMATION

Climate change refers to a systematic change in the key dimensions of climate including average temperature, wind and rainfall patterns over a longer period of time (IPCC, 2001). Climate change is rapidly emerging as one of the most serious global problems affecting many sectors that leads the world development with undesirable impacts on environment, human health, food security, economic activities, natural resources and physical infrastructure (Magombo *et al.*, 2012; IPCC, 2007).

Significant attention has been devoted to the so-called determinants of adaptive capacity, which are characteristics of communities, countries, and regions that influence their propensity or ability to adapt to the impact of the climate change. As Smit and Pilifosova (2001) state: “these determinants of adaptive capacity relate to the economic, social, institutional, and technological conditions that facilitate or constrain the development and deployment of adaptive measures. Smith and Pilifosova (2001), further argue that countries with limited economic resources, low levels of technology, poor information and skills, poor infrastructure, unstable or weak institutions, and inequitable empowerment and access to resources have little capacity to adapt and are highly vulnerable. Similarly, Adger (2003) argues that their capacity to adapt to climate change “is a function of access to resources”.

In Europe, for instance, agricultural sector is believed to benefit from gradual climate change due to improved technology and good financial status that result in to improved adaptive capacity (McCarthy, 2001). The negative consequences of climate change in Africa are already happening as prevalent from frequent floods, droughts and shift in marginal agricultural include pastoral systems (Collier *et al.*, 2008).



The considerable works on adaptive capacity has been done after the publication of IPCC third assessment report in 2001, which identified adaptive capacity as element of vulnerability. Several of the studies focused on the adaptive capacity at the national level (Haddad, 2005; Adger and Vincent, 2005; Brooks *et al.*, 2005; Adger *et al.*, 2004; Yohe and Tol, 2002) and few of the latter studies have been focused at the sub-national level (Jakobsen, 2011; Nelson, *et al.*, 2010b; Gbetibouo and Ringler, 2009).

There is limited information and institutions addressing climate change related issues due to lack of and problems associated with climate data (Thornton *et al.*, 2010). Whereas country-level assessments based on macro-economic modeling may have relatively modest climate information needs, micro-economic studies require data at better resolutions (Mendelsohn *et al.*, 2000).

Historically, pastoralists have been marginalized socially, politically and economically (Sørensen, 2006). Available documents show that colonial and post-colonial policies have marginalized pastoralists and hunter gatherers over time. Pastoralism in Tanzania suffers from the effects of settlement, encroachment on their traditional pastures, lack of infrastructure, unfavorable market mechanisms, and difficulties of marketing their products (DANIDA, 1995).

### **1.1 Problem Statement**

From early 1980's through 2010's Tanzania has experienced frequent droughts and floods which have affected millions of people and their livelihoods across the country with considerable negative economic impact (Imhoff, 1998; Mary and Majule, 2009 cited in Rwambali *et al.*, 2012). Pastoralists in Kilosa district have suffered a lot following climate change stressors due to massive livestock mortality, drought and occurrence of diseases

such as rift valley fever and other epizootics (Shemsanga *et al.*, 2010). Apart from that, evidence suggests that during high rainfall periods, *Ndigana* become a serious problem and rift valley disease is most prevalence following *El Nino* in central parts of Tanzania (Majule *et al.*, 2007b).

The traditional top-down approach (global study) has little local and regional specificity and has failed to address the regional and local impacts and abilities to adapt to climate change impacts. Klein (2004) clarifies that adaptation is undertaken by governments on behalf of society, sometimes in anticipation of change, but again in response to individual events. At any level, adaptation proceeds through two main steps: facilitation and implementation (*ibid.*). Whereas the former involves raising awareness, removing barriers and making funds available for adaptive strategies, the later involves making physical operational changes in practice and behavior. Klein (2000) argues that, the main reason why scientists and policymakers paid little attention to adaptation until recently is that the understanding of the process and mechanisms along which adaptation to climate change occurs is still limited, while uncertainties concerning the location and magnitude of impacts remain considerable.

The poor adapt in diverse ways that are usually unnoticed, uncoordinated, and unaided by national government, development agencies or international agencies. This autonomous adaptation is often overlooked in international and national efforts to manage the impact of climate change. Despite local communities having an important role to play in terms of future adaptation to climate change, unfortunately their contribution to those initiatives is not well documented. According to indigenous and traditional peoples and climate change IUCN (2008), there has been little recognition of the reservoir of knowledge underlying coping strategies and adaptive capacity of local communities. This argument can be

verified from the fourth report of the IPCC (2007) which does not recognize ongoing local community adaptation to climate change. Therefore this studies revealed knowledge of adaptive methods that has been undertaken by pastoral communities in Kilosa district.

## **1.2 Justification for the Study**

There is an increasing trend in the literature and by agencies in the donor community toward understanding how best to improve adaption and resilience to climate change vulnerability across multiple scales (Walsh *et al.*, 2008). Therefore this study generates information on determinants of adaptive capacity and it increases the understanding of the determinants of adaptive capacity between pastoral communities and among different socio-economic groups. Information in this case is useful for policy makers and implementers of strategies such as Tanzania National Adaptation Programme of Action (NAPA). Specifically, the Government of Tanzania is currently implementing the MDGs through phase two of the National Strategy for Growth and Reduction of Poverty (NSGRP) famously known as *MKUKUTA* whose goal No 4 under cluster two aims at, among other things, ensuring sustainability of the environment and climate change adaptation and mitigation. The proposed study therefore, stands to provide significant policy recommendations that will contribute to the attainment of the goal.

It is, thus, imperative to understand the actual dynamics of climate change impact and adaptive capacity at the lowest levels of the society, such as households, communities and districts (Deressa *et al.*, 2008), and in that way enhance the relevancy of the top-down policy approaches to foster adaptive capacity to climate change among pastoral society (Ford and Smith, 2004).

### **1.3 Objectives**

#### **1.3.1 General objectives**

To assess adaptive capacity among the pastoralist in the situation of climate change

#### **1.3.2 Specific objectives**

- i. To identify the impacts of climate change and variability to pastoral activities.
- ii. To examine adaptive elements of pastoral communities on climate change in Kilosa District.
- iii. To determine the contribution of state agencies in enhancing pastoral system's resilience to climate variability and change impacts.

### **1.4 Research Question**

- i. What are the impacts of climate change in Kilosa District?
- ii. What are the adaptive elements of pastoral communities on climate change in Kilosa District?
- iii. What are the roles of institutions in enhancing pastoral adaptive capacity to climate change impacts?

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Overview of Climate Change

The evidence from the Intergovernmental Panel on Climate Change (IPCC) is now overwhelmingly convincing that climate change is real, and that, it will become worse, the poorest and most vulnerable people will be affected first and most. One of the sectors most sensitive to global warming is agriculture, the implication of these scenarios for the attainment of the Millennium Development Goals (MDGs) is obvious, especially in developing countries where systems resilience is low (Sokona and Denton, 2001; IPCC, 2007 and UNDP, 2008, Ozor and Cynthia, 2010).

Ozor and Cynthia (2010), report that the livestock production systems would be vulnerable to climate change in respect of anticipated decrease in rainfall in sub-Saharan Africa and consequent reduction in the available pastureland, declining availability of surface water resources for animals, possible increase in salinity at water resources for animals and possible increase in salinity at watering points due to increase in temperature and evaporation in the face of reduced rainfall. Therefore, mitigation and adaptation remain the most popular options to manage the impacts of climate change on pastoral and agriculture in the world today.

#### 2.2 Adaptation

Actions and adjustments undertaken to maintain the capacity to deal with stresses induced as a result of current and future external changes (Alland, 1975; Nelson *et al.*, 2007). Adaptation can be both autonomous and planned, autonomous adaptation is the ongoing implementation of existing knowledge and technology in response to the changes in

climate experienced, and planned adaptation is the increase in adaptive capacity by mobilizing institutions and policies to establish or strengthen conditions that are favorable to effective adaptation and investment in new technologies and infrastructure (Easterling *et al.*, 2007).

### **2.3 Adaptive Capacity**

Preconditions that enable actions and adjustments in response to current and future external changes depend both on social, political, economical and biophysical elements (Nelson *et al.*, 2007). Adaptive capacity to climate change refers to both the ability inherent in the coping range and the ability to move or expand the coping range with new or modified adaptation (Smith and Pilifosova, 2001). Adaptation depends greatly on the adaptive capacity or adaptability of an affected system, region, or community to cope with the impact and risks of climate change. The adaptive capacity of communities is determined by their socio-economic characteristics. According to IFPRI (2007), access to credit and extension, awareness of climate change as well as access to market information (input and output markets) are some of the important determinants of farm-level adaptation. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainty in climate including variability and extremes. In this way enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development (Smith and Pilifosova, 2001).

### **2.4 Adaptation to Climate Change**

Having proven that the impact of climate change are serious and may be more severe in the coming decades, researches are now involving mitigation and adaptation in climate change studies. Adaptation to climate change refer to adjustment or intervention which take place in order to manage losses or take advantage of the opportunities presented by

changing climate (IPCC, 2001). It is the process of improving the society's abilities to cope with changes in the climatic condition across time scale from short term (e.g. seasonal to annual) to long term (decades to centuries) (Thiaw, 2007). If appropriate, adaptation can reduce negative impacts and even create benefits from new opportunities provided by changing climatic conditions.

According to Lange (2007) various types of adaptation can be distinguished including anticipatory and reactive adaptation, private and public adaptation as well as autonomous (i.e., intrinsic to the system under consideration) and planned adaptation often is interpreted as the result of deliberate policy decision on the party of public agency, based on awareness that condition are about to change or have changed and that action is required to minimize losses or benefit from opportunities (Pittock and Jones, 2000; Smith and Pilifosova, 2003). Autonomous adaptation are widely interpreted as initiatives by private actors rather than by governments, usually triggered by market or welfare changes induced by actual or anticipated climate change (Leary, 1999). Smith *et al.* (1996) describe autonomous adaptation as those that occur “naturally” without intervention by public agencies where as planned adaptation called “intervention strategies”.

## **2.5 State and Agency**

These are human created formal and informal mechanisms that shape social and individual expectations, interactions, and behavior (Ostrom, 1990; North, 1990; Bates, 1981). State structure and shape outcomes through the actions of individuals and decision makers associated with them (Agrawal, 2008). These state agencies include an administrative unit of government like village council, ward and district council and regional secretariat, Tanzania Meteorological Agency (TMA) and NGOS. Therefore how these agencies assist or hamper pastoral adaptive capacity deserve research attention.

## **2.6 Initiatives Taken toward Climate Change and Adaptation in Tanzania**

A range of initiatives and programs have been undertaken in Tanzania in the context of UNFCCC and its Kyoto Protocol focusing addressing climate change at national level. As the first step, Tanzania ratified UNFCCC and its Kyoto Protocol in 1996 and 2002, respectively to certify that climate change issues are addressed at the national level supported by national policies and legislation. Therefore, implementation of the UNFCCC and the Kyoto Protocol is further supported by the enabling environment including the National Environment Policy (1997).

Various adaptation and mitigation initiatives and programmes, strategies and plans demonstrates the national commitment in addressing climate change issues and its contribution to global efforts to adapt and mitigate climate change. Formulation of NAPA in 2007 formed a clear basis for identifying and implementing adaptation actions at both sectoral and local levels. Furthermore, several mitigation initiatives have been implemented in the context of CDM and other emerging mitigation opportunities such as REDD+. Ongoing national REDD+ initiatives are expected to enhance adaptation in Tanzania as the net sink through its forests in various forms. The National REDD+ Strategy is based on the National Framework for REDD+ developed in 2009 and is linked to current development strategies such as the National Growth and Poverty Reduction Strategy Programme (*MKUKUTA*) and the National Vision 2025. The goal of the Strategy is to facilitate effective and coordinated implementation of REDD+ related policies, processes and activities so as to contribute to climate change mitigation/adaptation and overall sustainable development.

The implementations of the REDD strategies at sectoral level were made the responsibility of the relevant Government Departments and Agencies. Prime-Minister's Office-Regional



Administration and Local Government (PMORALG) are working intimately with Local Government Authorities (LGAs) through their various departments in association with lined sectoral ministries to implement REDD and *MKUKUTA* strategic interventions at local level. The established cross sectoral committees, which are the NCCSC and the NCCTC, are expected to facilitate coordination of cross-sectoral climate change activities. (URT, 2003).

Civil Society Organizations' and Development partners are encouraged to cooperate with the Government in implementing the NAPA strategy through various projects and/or programmes (URT, 2007). They are encouraged to support the Government in implementing the Strategy by providing technical and financial support, as well as facilitate resource mobilization. They are also encouraged to provide capacity building and facilitate technology development and transfer to various stakeholders in implementing the Strategy, the private sectors either individually or in collaboration with the Government under public-private partnership (PPP).

Generally, all initiatives at both national and local levels are geared towards enhancing Tanzania's participation in addressing climate change in order to build resilience and achieve sustainable development. Tanzania will continue to explore all emerging opportunities under the Convention and its Kyoto Protocol in the subsequent commitment periods to be agreed upon by the Parties. It is envisaged that the National Appropriate Mitigation action (NAMAs) as well as NAPs, supported technologically, financially and with appropriate capacity building will enhance the contribution of Tanzania in addressing climate change. Unfortunately, understandings of adaptive capacity at local level are still very much in their infancy (Vincent, 2007).

## 2.7 Impacts of Climate Change to Pastoral Activities

About 85% of all economic activities in Tanzania depend on the climate-driven agricultural and livestock sectors, the sector is hampered by rainfall variability and a lack of long-range forecast indicators. Regardless of changes in rainfall, changes in temperature are likely to have significant implications for water resources, food security, natural resource management and human health. Tanzania Meteorological Agency (TMA, 2009) reported that some of the previous highly productive areas such as the southern and northern highlands would continue to be dry with significant decrease in rainfall. These results would have long-term implications in agriculture and livestock sector planning and resources allocation such as seeds, pesticides and the shifts in types of produce (URT, 2009). Climate change is likely to exacerbate social inequalities due to uneven distribution of the costs of damage, necessary adaptation and mitigation efforts (Paavola and Adger, 2002). The most dominant and widespread disaster due to climate change is drought, whose frequency is observed to be on the increase in Tanzania (Kangalawe *et al.*, 2009). Drought has severely affected the agricultural sector leading to impacts such as famine, malnutrition, low production and productivity of crops and animals (Mubiru, 2010).

Climate change adaptation varies among regions and socio- economic groups, in that those with the least capacity to adapt are normally the most vulnerable to climate change impacts (Magistro and Roncol, 2001). This is particularly true for pastoral communities who inhabit the arid and semi- arid regions with high climate variability. Most pastoral adaptation to climate change are socio-cultural (that is change in management), usually a series of reactive response to climate event such as drought (Galvin *et al.*, 2001). Northern Tanzania pastoralist such as Maasai, Nyaturu and Barbaig have changed over the last few decades as a response to unfavorable climatic condition, population pressure, cattle disease, unfavorable price ratios between livestock and crops, restriction of mobility

imposed by encroachment of sedentary agriculturalist and their relatively clearer adaptation property right and deepening poverty in the pastoral communities. New adaptations include cultivation of staple and cash crops, long distance relocation with cattle and migration to cities for wage employment (Ndagala, 1998). Certainly in many cases traditional local coping strategies by pastoral may no longer be sufficient during prolonged drought seasons (Oba, 2001).

## **2.8 Adaptive Elements of Pastoral Communities on Climate Change**

Empirical research by Cutter (1995); Denton (2002); Enarson (2002), shown that entitlements to elements of adaptive capacity are socially differentiated along the lines of age, ethnicity, class, gender and religion. It is evident that women have different positions and faces different challenges to men when comes to issues related to coping and adapting to climate change. According to Agarwal (1992) cited in Tipilda and Kristjanson (2008), women and men livestock keepers typically face different livelihood opportunities and constraints in managing livestock as well as in coping with poor access to markets, services and technical information, periodic drought and disease, competing resource uses, policies that favor larger scale producers or external markets, and weak institutions.

Various studies done by Little *et al.* (2001) and Finan and Nelson (2001), indicate that people with good social and economic status are highly capable to adapt with climate compared with low socio-economic status pastoralists who are likewise deprived of basic facilities in education, health and infrastructure which affect their overall adaptive capacity; age, level of education, and literacy rate of pastoralists were found to be the main factors influencing households' ability to adapt diversified strategies, particularly concerning change and new technologies. Migration has long been an important

adaptation strategy for mountain pastoralists. Other strategies include: use of drought resistant seeds, livelihood diversification, and use of energy- saving devices.

## **2.9 Roles of State in Enhancing Pastoral System's Resilience to Climate and Change**

The state has become important as climate change and its impacts move from being the pet obsession of a few atmospheric scientists to becoming the subject of both minor conversations and intense scholarly exchanges (Agrawal, 2008). It is critically important to understand better the role of state in shaping adaptation, especially the role of local state like district, wards and regional secretariats, if adaptation to climate change is to help the most vulnerable social groups (ibid). Institutional arrangements structure risks and sensitivity to climate hazards, facilitates or impedes individual and collective responses, and shapes the outcomes of such responses (Agrawal, 2008). Understanding how they function in relation to climate and its impacts is therefore a core component in designing interventions that can positively influence the adaptive capacity and adaptation practices of poor populations. Therefore this study used Kilosa as important climate stressors affected district to assess the role of state in climate change adaptation. Osbahr (2007) suggest that institutional capacity must be strengthened in order to learn the gaps between local and national processes, and between formal and informal patterns of adaptation, as well as identify priorities.

## **2.10 Determinants of Adaptive Capacity**

Various studies that offered suggestion to combat risk of climate change by looking determinants of adaptive capacity (see example Smith and Pilifosova, 2003; Wall and Marzall, 2006) noted that adaptation responses are almost infinite, and measures are very specific to a particular location and situation this indicate that what may work in one place

or with certain social economic group may not work or may not be feasible elsewhere, this emphasize the need to tailor adaptive capacity studies to fit circumstances from local level. Adaptive capacity determined by various studies (Adger, 2003) included economic, technology, information skills, infrastructure, institution, social capital and equality, these determinants are closely interconnected, effective use of skills as well as social network and infrastructure and how well this can deal with risk and distribute resource fairly. In addition, successful adaptation also requires recognition of necessity to adopt, knowledge about available options, the capacity to access them and ability to implement the most suitable one (Fankhauser and Tol, 1997). Also, ability to adapt on the situation of changing climate impacts is often dependent on the effectiveness of social network and infrastructure (Toman and Bierbaum, 1996). Similarly adaptation is related to the stability and capacity of the institution to manage risk associated with climate and other conditions (Smith and Lenhart, 1996; Huq *et al.*, 1999).

Also, Handmer *et al.* (1999) recognized that adaptive is greater if social, cultural and political and human capital (education and personal security) ensure that the allocation of power and access to resource are distributed equitably. According to Adger (2003), individuals, organizations and institutions focus their researches on determinants of systems or national adaptive capacity by referring on economic resources, level of technology, information and skills, infrastructure, institutions and empowerment. It is reported that countries with low resources have little adaptive capacity and are highly vulnerable to the effects of climate change.

Adaptation options are also limited by the range of possible responses by individuals, community or a nation and this is so if there is limited or lack of technology available (Scheraga and Grambsch, 1998). Adaptive capacity is therefore likely to vary depending

on availability and access to technology. Many of the adaptive strategies identified to be possible in the management of climate change and variability are directly or indirectly related to technology (Burton, 1996). These technologies include early warning systems, crop breeding (genetic engineering), water management practices and irrigation, and protective structures. The current level of technology and the ability to develop new ones are important determinants of adaptive capacity. Other requirements essential for strengthening adaptive capacity is exposure to the development and judicious use of new technologies for sustainably and development of natural resources (Goklany, 1995).

Successful adaptation requires credit of the necessity to adapt, knowledge about available options, the capability to access them and the ability to use the most appropriate ones (Fankhauser and Tol, 1997). Lack of trained and skilled staff to facilitate adaptation can limit the ability of a household, community or nation to employ adaptation options. In general, nations and regions with high levels of skilled and trained human knowledge are considered to have greater adaptive capacity to climatic variations than developing ones in which education and skills development is relatively low (Scheraga and Grambsch, 1998; Smith and Lenhart, 1996). Magalhães (1996) concluded that illiteracy and poverty are the major determinants of low adaptive capacity to climate change and variability. Again, adaptive capacity varies with social infrastructure and is regarded as a function of availability and accessibility of infrastructure to decision makers as well as vulnerable sub-sectors of a population (Kelly and Adger, 1999; Toman and Bierbaum, 1996).

Information and communication infrastructure enhances quick and effective diffusion of technology. This increases adaptive capacity as it may provide information to the pastoralists on the available options for adaptation. Institutions play the role of holding society together, giving it a wisdom and purpose and enabling it to adapt (O' Riordan and

Jordan, 1999). The role of inadequate institutional support is frequently cited as a hindrance to adaptation. For example, Smith and Lenhart (1996) indicated that in general, societies with advanced social institutions are more likely to have better adaptive capacity than those societies with less developed institutional arrangements.

Moreover, the institutions for research and development required for developing, improving and disseminating technology, the social institutions, financial and political institutions to support the process are fundamental. Arguments in support of adaptive capacity recommend that the probability that adaptive capacity will be greater is related to fair distribution of the resources of a community or nation based on proper social institutions and arrangements that administer the allocation and access to these resources. (Ribot *et al.*, 1996; Mustafa, 1998; Adger, 1999; Handmer *et al.*, 1999). The extent to which communities are permitted to draw on resources influences their adaptive capacity and their ability to cope (Kelly and Adger, 1999).

Similarly Nelson *et al.* (2010) conducted a research on the vulnerability of Australian rural communities to climate variability and change: Part II-Integrating Impacts with Adaptive Capacity. Their study analyzed adaptive capacity using the rural livelihoods framework developed by Ellis (2000) as the conceptual framework underpinning deductive construction of an adaptive capacity index. This framework conceptualizes adaptive capacity as an emergent property of the varied forms of human, social, natural, physical and financial capital from which rural livelihoods are derived, and the flexibility to substitute between them in response to external pressures (Ellis, 2000). Nelson *et al.* (2010) also argued that farm households with a greater diversity of assets and activities are likely to have greater adaptive capacity because of a greater capacity to substitute between option livelihood strategies in times of tension.

Ojwang' *et al.* (2010) on Analysis of Climate Change and Variability Risks in the Smallholder Sector Case studies of the Laikipia and Narok Districts representing major agro-ecological zones in Kenya. Also Kalinda (2011) conducted a research on Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. Mengistu (2011) conducted a research on farmers' perception and knowledge of climate change and their coping strategies to the related hazards, but this on Adiha, central Tigray, Ethiopia.

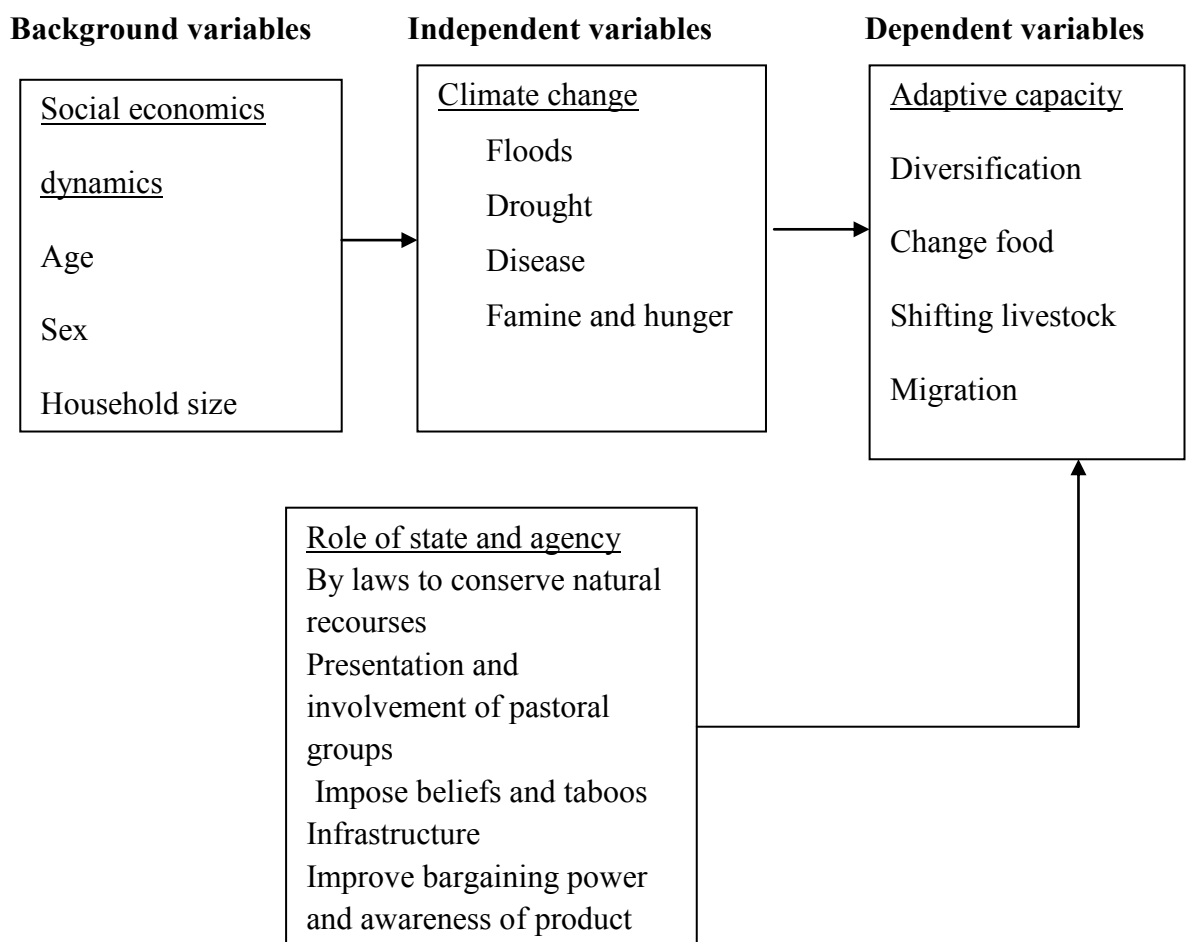
However, all above mentioned studies did not analyze determinants of adaptive capacity among pastoralists or smallholder farmers. Adapting to climate change effects requires resources and always resources. However, individual within the household have different vulnerability and adaptive capacity (Denton, 2002). For example, in male headed household women may face time constraints resulted from their heavier burdens of household tasks.

## **2.11 Conceptual Framework**

Climate change impact such as drought, flood, diseases and hunger put pastoral community in Kilosa in a great risk (Mung'ong'o and Mwamfupe, 2003). The impact might vary with socio-economic characteristics such as age, sex, income level and household size all these might dictates how pastoral communities change the way of living. There might be adaptation done by pastoral community in Kilosa district through various ways like livelihood diversification, migration, technology, rain water harvest etc, these can be done to ensure survival for pastoral community. To achieve adaption there should be effective state and agencies to coordinate the process of adaption, state agency roles as referred in page 8 of the 29 is in the Prime Minister's office (PMO) that has the role to coordinate disasters, Tanzania metrological agency (TMA) provide weather records



and early warning system, NGOs, CBOs provide training, regional secretariat, village government, and district council all these are required to have capacity in terms of resources, reach and incentives to plan for and deliver the services and adaption responses, including undertaking research and development, forecasting and communications and implementing policy and laws.



**Figure 1: Conceptual framework**

## 2.12 Theoretical Framework

The theoretical framework for this study is based on the conceptual approaches by Chambers (1989) and Yohe and Tol (2002) because they provide explanation for the farmer's adaptive capacity at a local scale. Adaptive capacity is determined by several major determinants such as technology, resources, institution, information and human

capital. These determinants are also suitable predictors of adaptation for Kilosa because they manipulate how capacity translates into adaptation (Burch and Robinso, 2007). Although Yohe and Tol's (2002) determinants of adaptive capacity are specific enough to explain local adaptation process, they are not targeted to a particular sector and do not give details the reality of small scale farmers or local communities. Unfortunately, understandings of adaptive capacity are still very much in their infancy (Vincent, 2007), and there is no agreement about its determinants at national, community or household level (Jones *et al.*, 2010). In additional communities with limited access to resources and entitlement, poor knowledge and skills and, unstable or weak institutions might have little capacity to adapt and are highly vulnerable (McCarthy *et al.*, 2001).

In contrast, Chambers (1989) built his theory of vulnerability and adaptation on several case studies of poor small-scale farmers. He concluded that poor people typically seek to reduce vulnerability not by maximizing income, except by developing and diversifying their portfolio of capital assets. Chambers initiate that “most poor people do not prefer to place all their eggs in one basket”, and hence, tradeoffs exist between security and income (Chambers, 1989). This is compared to pastoral communities in Kilosa District who did not concentrate on livestock themselves as the source of income but they have started looking for alternatives as the way to adapt to the climate change and variability.

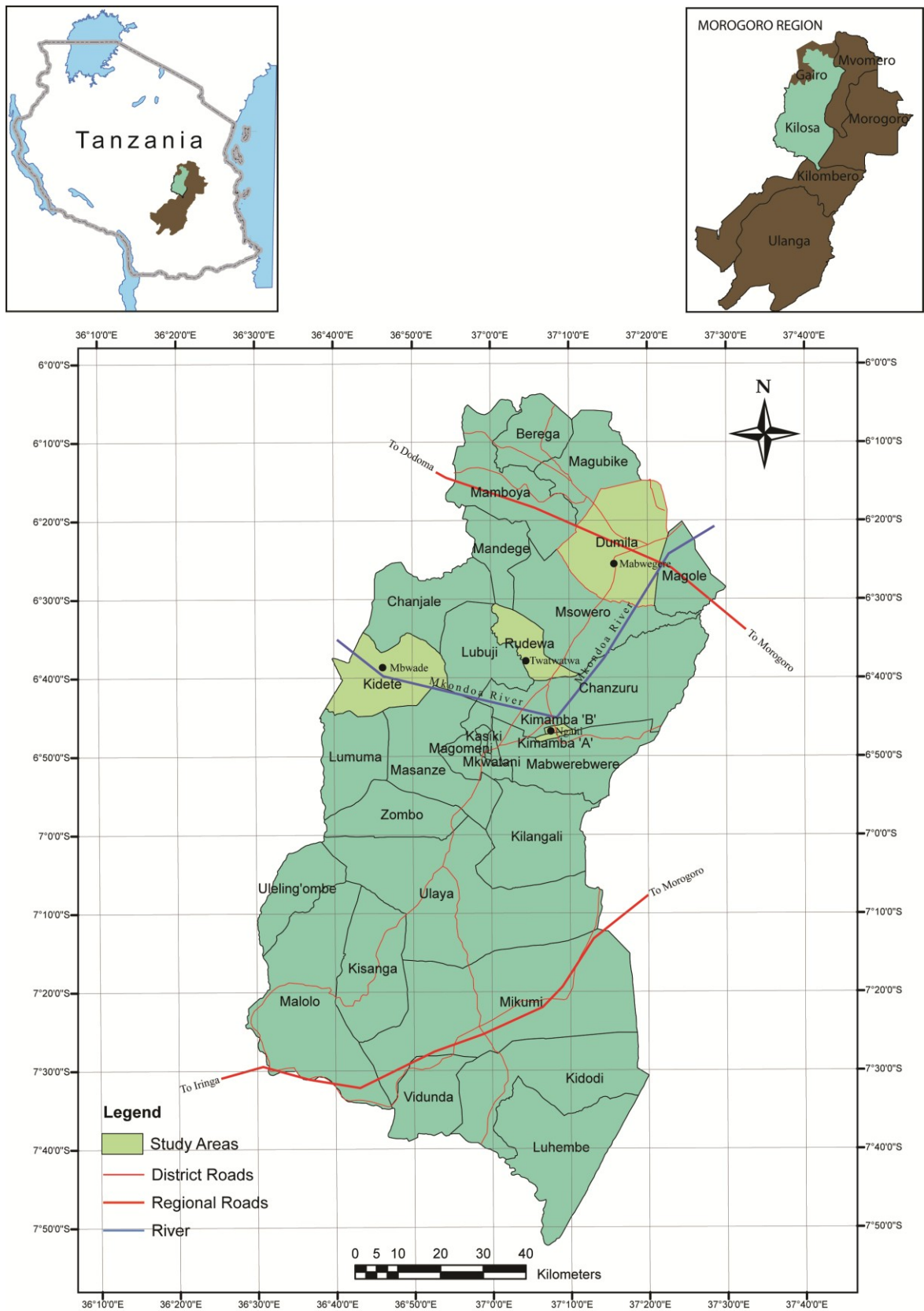
## CHAPTER THREE

### 3.0 METHODOLOGY

#### 3.1 Description of the Study Area

The study was conducted in Kilosa district, Kilosa is among five administrative districts of Morogoro Region Fig .2 show the district. According to URT (2009), Kilosa district represent a unique vulnerable area to climate change impacts, with the major land use systems found in the country co-existing, these include leased estate farms, national ranches, national parks, reserved catchment forests, small-hold subsistence farming, agro-pastoralism and pastoralism.

The district is characterized into three physiogeographic units namely mountains and upland, plateau and flood plain (Shashira *et al.*, 1997). The flood plains lie at about 400 to 550m, plateau at about 1100m and high land up to an attitude of 2200m. The flood plains which comprises both flat and undulating plains extending to the foothills in the west of kilosa district. This plain is subject to seasonal flooding and is mainly occupied by the pastoralist Maasai. Livestock keeping is an important economic activity in the district following the large influx of pastoralist from Northern Tanzania (Benjaminsen *et al.*, 2009). Kilosa district has a typical tropical semi-arid type regulated by seasonal movements of the intercovergence zone (Misana *et al.*, 1997).



**Figure 2: Map of Kilosa showing the study area**

### **3.2 Research Design**

The study used a cross sectional research design where data were collected at one point in time. Unlike longitudinal research design, cross sectional research design allowed data collection at one point in time from different individual or group of respondents see also (Barley, 1994).

### **3.3 Sampling Design**

Kilosa district is administratively divided into nine divisions and 37 wards (Morogoro Regional Commissioners Office, 2006). Simple random sampling technique was employed to select four wards among the 37 wards. Random sampling was used to select one village from each ward. Purposive sampling was employed to select officials at national council such as from Prime Minister's Office, district office and Tanzania Metrological Agency. The selection of the officials considered their familiarity with incidence of climate change and adaptive capacity.

### **3.4 Sample Size**

Table 1 indicate total number of households where 104 households were randomly selected from the four villages, the head of the household was supposed to respond to the questions, this means 26 households from each ward. Based on the available number of household (475), twenty two percent (22%) of the pastoral households were selected from sampled wards. This percent was used in order to enable the researcher to have a sample size that was between 80 and 120 respondents which was suitable for rigorous statistical analysis (Kish, 1965; Sudman, 1976). A total of 104 pastoral household were selected where by 26 respondent from four ward were interviewed.

**Table 1: Sampling frame**

<b>Village</b>	<b>Total number of household</b>	<b>Number of household selected</b>
Twatwatwa	230	26
Ngaiti	300	26
Mbwade	211	26
Mabwegere	234	26
<b>Total</b>		<b>104</b>

### **3.5 Data Collection Methods**

Data collection techniques varied according to objectives and their respective requirements as described below. Both primary and secondary data were collected in order to achieve the reliable information for the study.

#### **3.5.1 To asses Climate trend and variability in Kilosa District**

Primary data were collected through Household questionnaires (Appendix 1), focus group discussion (FGD) and Key Informant Interview (KII). FGD was done in each village making a total number of four groups of 7-10 respondents. The FGD aimed to find the adaptive capacity and climate variability among pastoralists. Primary data were intended to give information direct from primary sample and allow the collection of large volume of data.

Secondary data collected were 30 years climate data from TMA, past records on climate change about five years .The weather data were collected nearest metrological station in Illonga. Other secondary data were collected from administration office in Kilosa District example from prime minister's office (PMO), extension officers, agricultures and livestock officers, district level natural recourse officer, ward, village leaders as well as pastoral record themselves (Appendix 4).

The information gathered by this method includes local community perception on climate change and variability, and coping method developed by pastoralists. To obtain qualitative data, details on study area population, socio economic, natural vegetation and the effort made to combat the effect of climate change toward pastoral activities was collected.

Descriptive statistics method was used to present finding of the respondents on how they believe on the climate change impact and variability. Trend analysis was performed to determine shifts and trend climate change and variability. Descriptive statistics and inferential statistics were employed under this objective.

### **3.5.2 Determination of adaptive elements of pastoral communities on climate change in Kilosa District**

Primary data for this objective were collected using household questionnaire and focus group discussion methods. The household questionnaire survey was done using a structured questionnaire (Appendix1), while the focus group discussion was guided by a checklist (Appendix 2). The FGD was applied to capture non quantifiable information especially on climate variation and adaptation practice that pastoral used to cope with climate change and variability. The information gathered under this objective includes how pastoral communities adapt and cope to the climate change impact. The following indicators were used to asses' diversification, technology, water resource development and management and reduced number of livestock.

Data collected under this objective was analyzed using Statistical Package for Social Science (SPSS) and content analysis for quantitative and qualitative data respectively. Inferential analyses (t-test) were used to analyze this objective.

### **3.5.3 Assessment of contribution of the state and agency to enhance pastoral system's resilience to climate change impact**

In this study, state agencies were perceived at different levels starting from family (household) through local authorities to national governing bodies both public and private. Both primary and secondary data were obtained using structured questionnaire and focus group discussions. Also by visiting previous researches done by NGOs in Kilosa district. Furthermore, by collecting and reviewing local government documents on climate change in Kilosa (Appendix 4). Under this objective information on the roles played by the state agency in the particular area were obtained. Therefore, the respondents consisted of local and central government agencies as well as organizations ranging from community based (CBOs) to national ones dealing with pastoral societies.

Information gathered under this objective includes supports the pastoral communities receive from state agency during or before climatic disasters so that they can cope with the situation. Some information indicate that pastoral receive support like training and infrastructure.

Qualitative data from household survey were subjected to descriptive statistics where measures of central tendency particularly frequencies were determined. In order to compare the relations among variables cross tabulations and content analysis were used. The study used Statistical Package for Social Sciences (SPSS) software to analyse survey data

### **3.5.4 Adaptive capacity index by Pastoralists on the changing climate**

In computing adaptive capacity index among pastoral communities on the changing climate, the study picked the most important elements of adaptive capacity like household



size, extension services, and number of livestock. High adaptation and low adaptation was determined by asking the respondent the number of livestock they had as they revealed that someone owning livestock ranging from 500-1000 has high adaptive capacity while the one with 500-50 has low adaptive capacity. Binary Logistic regression analysis was employed to obtain relationship between dependent and independent variables. The model is used when the dependent variable is dichotomy and independent variables are of any type (Agresti, 2000; Power and Xie, 2000). The rationale for choice of a model was based on the fact that it is a powerful and popular one in a social science at predicting a dependent variable on the basis of continuous and or categorical independent variables. The model was concerned with influence of wealth from livestock on the adaptive capacity of pastoralists to climate change.

**Test statistic:** *Binary Logistic regression*

$$H_0 : \beta_1 = \beta_2 = \dots = \beta_n = 0$$

$$H_1 : \text{At least one of } \beta_s \neq 0$$

$$\text{Logit}(Y) = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon_i \dots \dots \dots (i)$$

Where:  $\pi$  = probability of the event,

$\alpha$  = Y intercept,

$\beta_i$  = regression coefficients,

$X_s$  = a set of predictors.

**Table 2: Variables used in the binary regression equation**

<b>Variable</b>	<b>Description</b>
Y	Adaptive capacity to climate change (0 = Low, 1 = High)
X <sub>1</sub>	Age (years)
X <sub>2</sub>	Education level (0=no formal education, 1=formal education)
X <sub>3</sub>	Household size
X <sub>4</sub>	Wealth from cows
X <sub>5</sub>	Wealth from goats
X <sub>6</sub>	Wealth from calves
X <sub>7</sub>	Wealth from sheep
X <sub>8</sub>	Climate change Information access
X <sub>9</sub>	Consultation of Extension services

## **CHAPTER FOUR**

### **4.0 RESULTS AND DISCUSSION**

#### **4.1 Social Demographic Characteristics Respondents**

##### **4.1.1 Sex of the respondents**

The sex of the respondents is presented considering the socio-cultural decision making aspects of the pastoralist communities. In this study, 75% of the households were male headed, while female headed were 25% .This was expected since Maasai culture does not allow women to speak on behalf of their husbands. In pastoral community, women have negligible role in decision making socially, politically and economically. However, inter-village assessment was highly statistically significant ( $p \leq 0.007$ ) implying the high differences in sex among surveyed villages. Also compared to other villages Mabwegere village had fewer male because some of them migrated to different places to seek employment while others had transferred their livestock to search water and pasture.

#### 4.1 Demographic Characteristics of Respondents

**Table 3: Demographic characteristics**

13Variables	Twatwatwa	Ngaiti	Mbwade	Mabwegere	Overall
	n=26				(n=104)
% of Respondents					
Sex of respondents					
Male	84.6	92.3	69.2	53.8	75.0
Female	15.4	7.7	30.8	46.2	25.0
X <sup>2</sup> = Significant at 0.007					
Marital status					
Single	7.7	11.5	0.0	15.4	8.7
Married	92.3	88.5	100.0	84.6	91.3
X <sup>2</sup> = Significant at 0.235					
Education level					
Informal	42.3	61.5	42.3	61.5	51.9
Primary	38.5	34.6	34.6	23.1	32.7
Secondary	15.4	3.8	23.1	11.5	13.5
College	3.8	0.0	0.0	3.8	1.9
X <sup>2</sup> = Significant at 0.473					
Age group					
20-30	8.0	26.9	7.7	11.5	13.6
31-40	24.0	30.8	26.9	23.1	26.2
41-50	52.0	23.1	53.8	50.0	44.7
>51	16.0	19.2	11.5	15.4	15.5
X <sup>2</sup> = Significant at 0.415					
Household size					
1-5	15.4	46.2	23.1	46.2	32.7
6-10	53.8	53.8	73.1	53.8	58.7
11-15	23.1	0.0	3.8	0.0	6.7
>16	7.7	0.0	0.0	0.0	1.9
X <sup>2</sup> = Significant at 0.001					

#### **4.1.2 Age**

The age determines the economic and marital status of the respondents. About 44% of the respondents were in age class of 31- 40 years as shown in Table 3. This class is perhaps more active and well informed about socio-economic issues including climate change. In Maasai community age plays a very important role. In this study, 4.8% of the respondents were 61 years and above. Old people are less active in the society activities and in some cases tend to lose their memories (Guralnik *et al.*, 1997). Despite this; the interviewed group in this study was very active with very clear memory perhaps due to the fact that they migrated from another area. However, age was contributing insignificantly ( $p= 0.41$ ) toward adaptive capacity of the respondent, implying that there is inverse relationship between age and adaptive capacity.

#### **4.1.3 Marital status**

In pastoral communities, especially among the Maasai, one who is married is respected (have a 'Boma'). The results show that 91.3% of the respondents interviewed were married. About 4 % were single and 2.9% were separated, while 1.9% were widow (Table 3) and 1.9% of the widow husbands. Reason for widow was: husband or wife passed away through accidents or conflicts and others abandoned their family and moved to other villages in search of pasture and water for their livestock and they come back home during rain season. Malaria typhoid and HIV/AIDS were the commonest diseases responsible for the most death. It was however not clear whether these diseases were associated with climate change or other factors. Climate change is known to influence the occurrence of malaria in some areas (McMichael, 2003). However, marital status contributed insignificantly to adaptive capacity ( $p=0.235$ ) indicating that there is no relationship between marital status and adaptive capacity. In contrast marital status induces someone to work hard due to family responsibilities (World Bank, 2009).

#### **4.1.4 Level of education**

Mobility due to search of pasture and water forces the pastoralists to migrate from well developed areas for social services to hostile environment where there are no social services like schools and hospitals. Only 52% of the respondent's attained informal education, while 32.7% attained primary education. In these circumstances, the pastoralists lack access to education and health services. Sarkjkinge (2011) concluded as follows: 'Lacking good access to healthcare and education, pastoralists are hugely reliant on their animals'. Despite governmental support, girls regularly drop out of school to help their mothers to gather fire wood and water in the changed harsh climatic conditions. Moreover, education level of the respondent contributed to adaptive capacity insignificantly ( $p=0.473$ ) indicating inverse relationship between education level and adaptive capacity.

#### **4.1.5 Household size**

The finding in Table 3 shows that about 67 % of households had a total number of five members and above, while 26.9% had 3-5 people per household and 5.8% had three and less than three members. Big numbers of educated/skilled people in a family or community are expected to have higher level of understanding of various issues and amenities societal changes. Most of the heads of the families in this community were elders who did not have formal education this could comprise the expected level of understanding and adapting to climate change in a modern way. DFID (1997) points out that at household level, human capital is a factor of the amount and quality of labour available which varies according to household size, skill level and health status among others. However, household size contributed highly significant to adaptive capacity ( $p=0.001$ ) this means that household size contribute much to the adaptive capacity of a

certain household because there is enough labour that can assist in adaption process, for example shifting/transfer of livestock need enough people to take livestock far away.

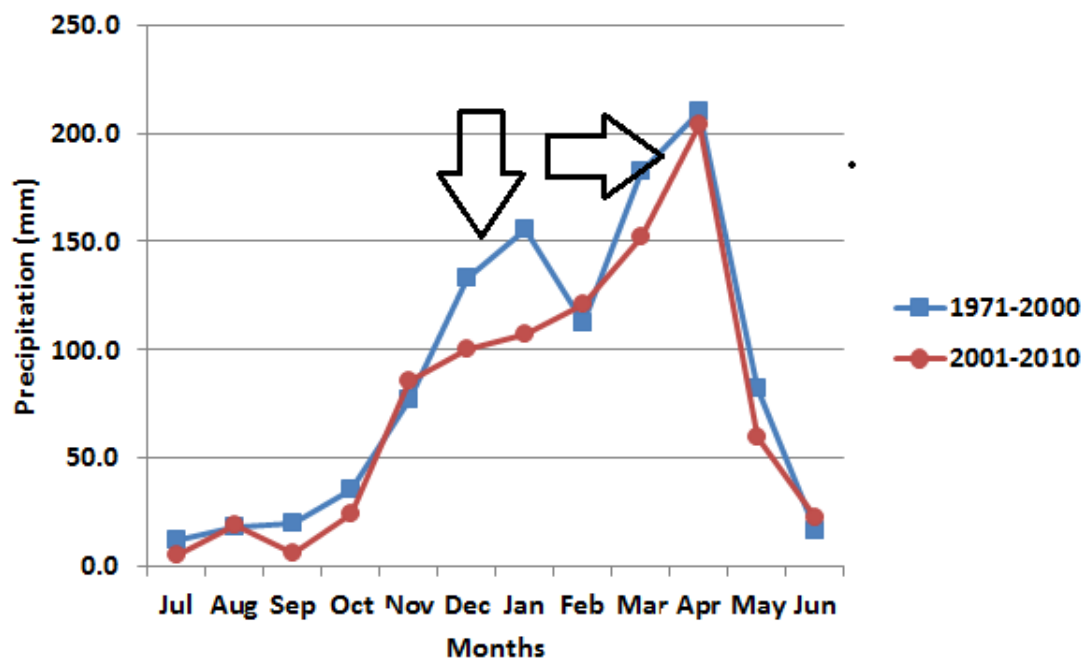
## **4.2 Trend and Variability of Climate Change Impact in Kilosa District**

### **4.2.1 Rainfall pattern**

Data from Illoga Tanzania Metrological Agency station was used to analyze climate change and variability for the study area. Rainfall has been inconsistent showing a significant shift in recent years, with clearly observed changes in the beginning of the rain season. Although Kilosa has a long history of rainfall variability, the trend in current decades has been inconsistent with lower rainfall and more frequent, more severe droughts. This trend has contributed to some part of Kilosa drying out severely (Solomon *et al.*, 1987). In Kilosa significant climate change started to manifest around 1972 and 1974. In the last two decades there have been four prevalence of drought in 1997, 1999, 2000 and 2001. The past climate of the area was at least better because if the short rainy (*vuli*) fail then the long rains (*masika*) would likely occur and vice versa (URT, 1997). Currently there has been a consecutive failure of *vuli* and *masika rains* and the situation is worsening.

Pastoralist society have severely been impacted by climate change because of variation in rainfall pattern, this is because in some years there was excessive rainfall which lead to excessive runoff water which carries away the upper layer of the soil and in most cases it leads into floods. For example floods of December 2009 to January 2010 that was caused by a very high rains in mpwapwa was very disguising leading to killing of people and livestock, destroying farms and infrastructure (roads, railway line, buildings, transmission poles). About 26103 people were displaced, 207 km of roads and 2 km of central railway line were destroyed, 100 poles of power line destroyed, three primary schools and 137 charco dams for livestock water, 12088ha of crops destroyed and several livestock were killed (TMAFS,2010).

Kilosa has bimodal rainfall pattern falling from March, April and May (long rains) and November, December (short rains) yet lately short rains have either disappeared or are very calm leading to extended droughts (Fig. 3). Present evidence of climate change supporting the shift paradigm is the observed shift in rainfall patterns from bimodal to unimodal rainfall regimes in some areas. For example, Manyara and some parts of Morogoro and Kigoma regions which have long been characterised by bimodal rainfall distribution are now experiencing a shift towards unimodal rainfall regime (URT, 2008). Irregularly pastoral areas are severely hit by famine and death of livestock due to lack of pasture and water this was revealed during focus group discussion. It was noted in the study areas that the environment is not only destroyed by flood and extended drought but also other factors like overgrazing and forest burning. All this together with drought and flood lead to land degradation (Charney *et al.*, 1977) according to the other overgrazing and inappropriate land use can lead to land degradation and desertification.



**Figure 3: Rainfall trend in the study area using Illonga data**



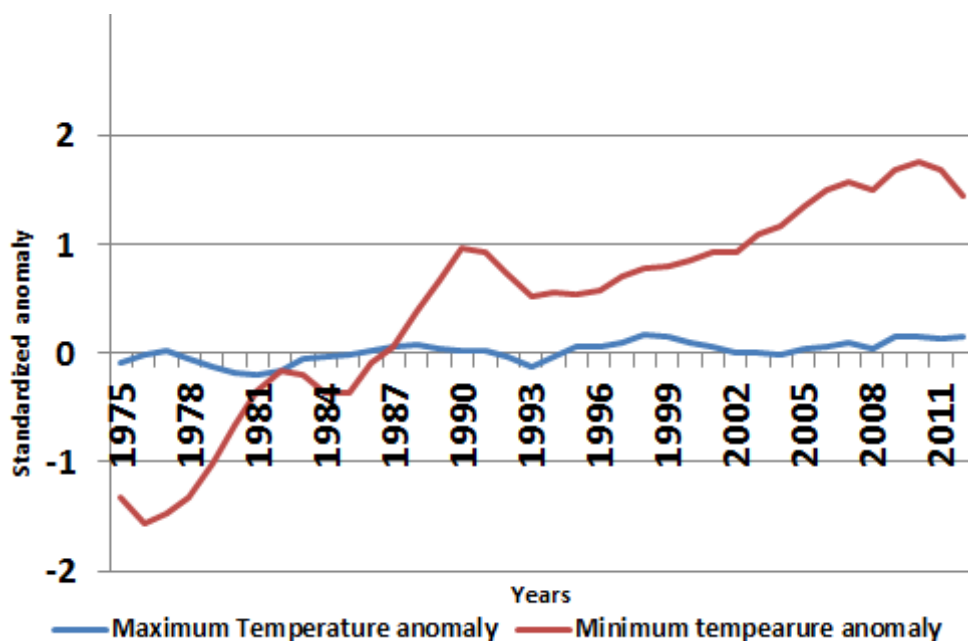
#### 4.2.2 Temperature

Minimum temperature is warming faster by up to +3.0 °C since 1971 while Maximum temperature is warming at a gentle slope (Fig. 4). Warming trend of minimum temperature may be interpreted as signals for changes in climate in Kilosa (URT, 2009a) area. Observing at the temperature parameter both maximum and minimum there is an increasing trends all over the year except for the short rain season of maximum temperature which is increasing at gentle slope while in the minimum temperatures there is increasing temperatures throughout the year except for the long rain season. While the rainfall is decreasing and becoming unpredictable, temperature levels have also been rising. Tanzania Meteorological Agency (TMA, 2009) indicated that some of the previous highly productive areas such as the southern and northern highlands will continue to be affected by declining rainfall, frequent droughts and significant increase in spatial and temporal variability of rainfall with long term implications in the agricultural sector planning and resources allocation, such as seeds, pesticides and even the shifts in types of agricultural produce (URT, 2009a).

Changing climate has resulted in a general decline in agricultural productivity, including changes in agro-diversity. The prevalence of crop pest and diseases is also reported to have increased posing more challenge to agriculture (Shemsanga *et al.*, 2010). There was an agreement among respondents during focus group discussion that the temperature has increased during the past ten to twenty years. Changes in temperature and rainfall as well had a negative effect on pastoralist as these had contributed to shifts in planting calendar and conditions. On the other hand, rise in temperature also causes high soil moisture loss, consequently affecting plant performance, resulting in stunted growth of crops and pasture. In Kilosa this will have a negative impact to the livelihood of pastoralists particularly in terms of pasture and water to feed their livestock. This could also lead to

land use conflicts with other land users particularly farmers. This could result into massive emigration in search for water and pasture and could lead into land use conflicts with other land users particularly farmers. There is also jeopardy of some livestock moving to water shed areas consequently leading to environmental destruction.

The implication of the changes in various climatic parameters such as rainfall and temperature have overall led to low agricultural yield, decrease in pasture and water sources for livestock leading to food insecurity. This has led to low productivity, poor meat quality and generally low slaughter weights that fail to fetch better prices in markets (Orindi *et al.*, 2005). Due to this pastoralists end up searching for alternative activities like crop cultivation or business (Ojwang' *et al.*, 2010).



**Figure 4: Temperature Trend in the study area**

#### 4.2.3 Impact on pasture

Climate variability has led to drying up of the water sources for both human and livestock.

Pastoralists have to travel long distances and use a lot of time (hours) in search for pasture

and water. Table 4 shows the views of the respondents on changes occurred over time due to climate change. About 39% of the respondents said that they had to walk between six and eight kilometres to reach the grazing areas, while 26% said they had to walk between three and five km. However, 99% of respondents said that there were differences that they could observe in the distance covered to walk to reach grazing areas. This happened in the past 10 years because during those times they could even walk one meter to find grazing area but as for now due to climate impact grazing areas are unpredictable.

Furthermore, during key informant interview with TANZANIA Metrological Agency (TMA) officials, it was revealed that there was increase in temperature which lead to climate change impacts and affect pastoral activities, but they have trayed to disseminate information to pastoralists and farmers in Kilosa. For example, they provided early warning on severe events of weather to community and kept on updating information on climate change and variability. They provide information on monthly forecast, 3month forecast and 10 months forecast. Doing that helped pastoral communities to prepare themselves with any bad event as well as to be in position in adapting to the impact of climate change.

#### **4.2.4 Impacts on water availability**

The decrease in rainfall amount across the rainy season significantly impacted the water points and rain fed agricultural production systems. About 39% of the respondent agreed that change in rainfall resulted to water scarcity. In many parts of the world water is a scarce recourse even in absence of climate change and this situation seems to worsen as demand increase and water quality deteriorates. It has become obvious from the interviews and the focus group discussions that continued rainfall deficits in the past ten to twenty years has created a terrible condition in water quantity and access as well as production of

rain fed crops. In Kilosa and mpwapwa floods of December 2009 to January 2010 lead to destruction of 137 water sources. Furthermore, the irregularity of rainfall has made overall pastoral production, the main source of income together with livestock, complicated and unreliable.

#### 4.2.5 Impacts on livestock production

Livestock comprises the main source of income for the pastoralists in the study area. About 89 % of the respondents reported delay in the start accompanied by short and insufficient and unpredictable rains that cause pasture deficit. This has increased livestock mortality, vulnerability to diseases and poor body condition due to long distance travel in search of water and pasture. (Shemsanga *et al.*, 2010). Species like *Brancharia*, *Cynodon* and *Eleusine jegeri* which were mostly preferred by livestock have disappeared (Hein, 2006). This resulted in reduced household incomes from livestock and livestock products. Also during focus group discussion the participants said that; *during severe droughts, we fed shoats, young animals, sick cattle and lactating cows, which provided milk for the family, with tree branches and leaves from Euclea divinorum* (Olkingei as known by the Maasai pastoralists), *Acacia nilotica* (Olkiroriti), *Acacia lahai* (Oltepesi), *Olea africana* (Lorien) and Olkerosha. Livestock were fed on twigs and leaves of all these tree species but fed on pods from *Acacia nilotica* (Olkiroriti tree). The pods from *Acacia nilotica* were usually used to feed livestock when it is as there is a risk for abortion when livestock fed on green pods. Pods were also fed to lactating animals to increase milk yields. Twigs from *Acacia tortilis* provides a staple browse especially for goats since forage is available throughout most of the dry season when other sources are scarce (Fagg, 1991).

*“In the past, diversity of available forage has allowed us raise different types of livestock. As pasture condition deteriorated over the years we have shifted from fewer cattle to more sheep and goats to sustain subsistent households’ income as well as activity diversification to some petty businesses and crop cultivation.”*

#### 4.2.6 Impact on livestock disease

About 87% of the respondents agreed that climate change contributed to presence of new crop and livestock pests and diseases. Reduced water and pasture for livestock could result into weakening of animal and with even more changes in climate scenarios it could lead to increased livestock problems. In the study villages, for last fifteen years new diseases such as anaplasmosis, babesiosis and east cost fever have been recorded while cases of worms and foot mouth disease have increased. Cattle mortality rate is quite high, it is assumed to range between 25 and 30 per cent respectively due to above mentioned diseases (URT, 2005). Increased death could decrease market prospect damage income generation and weakening the ability of household to access food recourses.

**Table 4: Changes over time due to climate change**

<b>Changes</b>	<b>Responses</b>	<b>n</b>	<b>%</b>
Walking distance to the grazing land in kilometres	3	9	8.7
	3-5	28	26.9
	6-8	41	39.4
	8-10	26	25.0
	<b>Total</b>	<b>104</b>	<b>100</b>
Differences to walk in past 10 years	Yes	103	99.0
	No	1	1.0
	<b>Total</b>	<b>104</b>	<b>100</b>
Distance to take animals for grazing increased?	Yes	93	89.4
	No	11	10.6
	<b>Total</b>	<b>104</b>	<b>100</b>

#### 4.2.7 Impact on quantity and quality of livestock

The result shows views of the respondents on the effects of climate change in their area. About 73% of the respondents indicated that climate change had effects on livestock by decreasing its quality that means livestock become very weak in that sense it cannot attract

the buyer to buy a certain livestock. That means it lowers down the business, while 24% of the respondents said that climate change had effects on livestock quantities for about past 20 years. It appears that the climate change product. The decrease in livestock can impact their income consequently increase the level of poverty.

Kilosa District takes the lead in the number of livestock, with an average of 69.0 per cent of total cattle in the region. The Table 5 reflects the number of marketed livestock in Kilosa District from the primary market of Parakuiyo, Mfuru, Ngaiti, Mbwade, and Mkongeni sales through authorized markets was comparatively low in number in relation to the number of livestock in the district this was due to the presence of middlemen and the distances the cattle owner is forced to cover to get to these market. Also the number of livestock traded now is somehow increasing since the pastoralist are selling so that they can diversify to other economic activities as a result of climate impact that lead to deterioration of water and pasture.

**Table 5: Shown the marketed livestock in twenty past years**

<b>Year</b>	<b>Cattle</b>	<b>Goats</b>	<b>Sheep</b>
1990/91	5 225	873	42
1991/92	8 322	2 113	178
1992/93	6 228	1 010	80
1993/94	6 528	1 850	51
1994/95	4 221	1 248	36
2005/6	18 240	7 560	200
2007/8	8 640	3 468	430
2009/10	9 720	1 012	300
2011/12	12 240	4 570	199
2013/14	15 354	3 400	703

Source: Regional Livestock Development Office, Morogoro

In the last ten (20) years, rich Maasai had up to 3000 herds of livestock while a moderate pastoralists could have 1200 herds of livestock and the poor ones had 50 herds, but currently the rich one could hardly have 2000 herds, while the moderate ones 800 herds and the poor less than 20. In Tanzania drought has affected different societies, particularly, the pastoralists and there are empirical evidence shows that such circumstances has lead to increased poverty (Mbilinyi *et al.*, 1999).

### **4.3 Adaptive Elements of Pastoral Community in the Changing Climate**

Adaptive capacity is important measures that enable people to take in the impact of a certain shock to greater or less extent, depending on how resilient the individual is. In the study area coping or adaptive capacity varied from individual and location of the area under study. The interviewed respondent had shown that climate change had several impacts to their livestock, therefore they have developed their adaptation methods which assist them with the situation. These methods are shown in Table 6.

#### **4.3.1 Change the way of livestock keeping**

Pastoralist society have started to reduce the number of livestock due to reduction of pasture, scarcity of water and low land holding capacity for large number of livestock. It is believed that most of these problems happened because of climate change impact, in order to cope with the worsening situation about, 87% of respondent said that livestock keeping changed in order to combat climate change this was done by selling their livestock to traders, needy household and government. On the other hand the government issued a directive encouraging farmers to expand their agriculture fields in order to make country self-sufficient in food production and pastoralist are encouraged to reduce numbers of livestock to prevent overgrazing and soil erosion (Ndagala, 1990).

Majority of pastoralist were however keeping large number of livestock regardless of reduced pasture and water. Resistance to change and the habit of keeping large number of livestock is a cultural issue which incidentally is environmentally and economically unacceptable by government. In year 2009 heads of cattle died due to drought and most of remaining heads were too weak to sell and the sold ones fetched very low price.

#### **4.3.2 Soil and water conservation practices**

About 55% of the respondent agreed that one way of coping to climate change impact was soil and water conservation practice through digging shallow wells/lambo /pugu for both human and livestock use. This was done through self-help (“harambee”) basis. Pastoralist in Rudewa had three lambo. This lambo was used by the community for domestic use as well as for animals; the livestock drink water from the lambo. Intensification of water wells had increased in the five last years. Formerly people used to get water from natural ponds which lately had dried up.

#### **4.3.3 Change food**

Results from this study show that 94% majority of pastoralist had changed their eating habit by switching from eating livestock products to eating cereal crops and leguminous crops. According to Nestel (1989), Maasai diet is dominantly consisted with meat, milk and, blood from cattle. Change in feeding habit is associated with reduced number of livestock and/their poor health as a result of climate change impact. Eating habit could also being influenced by modernization of the Maasai. Small farms of maize owned by Maasai were witnessed in some areas particularly in the valleys.



#### **4.3.4 Pastoralist migration from rural to urban**

Traditional pastoralists are rural dwellers migration from one area to another searching for water and pasture for their livestock. Because of ecological and economic hardship coming from the climate change impact some Maasai particularly women and young men are compelled to immigrate to urban and per-urban to look for alternative source of livelihood. About 92% of the pastoralists confirmed that urban emigrants had increased and become a serious problem in their communities. In the last decade's majority of young men migrate to urban areas to work as security guards, hair dresser selling of ornaments and traditional medicines, while women are involved in the later activities. Few Maasai sold most of their livestock and invest in town particularly in guest houses, transport business and veterinary inputs shops.

#### **4.3.5 Shifting of livestock**

The findings indicated that about 64% of pastoralist used to shifted cow from drought to lowland areas to benefit available pastures in the woodland and avoiding possible outbreak of human and livestock. Extended and severe drought has compels pastoralist to shift their livestock to ramset area in search for green pasture and water. Most of cattle left behind in the lowland during drought suffering from disease and death is a common phenomenon. Migration habit of this nature basically has been a traditional drought coping method and has positive impact to environment in that allowed the affected area to recover (Potkanski, 1994). These migrations however result in serious conflict with farmers since livestock destroy watershed areas and create compact along farms. Some of these conflicts have resulted into serious fight leading to death of people and livestock .However during long rain season most of Kilosa ward like rudewa, Kimamba, and Mbwa were flooded example in February 2010 and pastoralist had to move to highland causing social and ecological problems (Kilosa District Council, 2010). In last decades El Nino events

accompanied with floods have become more frequent and destructive in many parts of the world (Trenberth and Geophys, 1996).

#### **4.3.6 Diversification**

Some pastoralists had reduced movement in search for pastures and water and migrating to different parts or urban areas and instead they have engaged in different economic activities in their communities about 95% of the respondent agreed that they currently not depend on livestock but their also engaged in crop cultivation , business, and others in activities such as hunting in order to increase they are income and cope with the climate change impact this practice especially agriculture will help to reduce conflict between pastoral and farmers because the maasai farmers are likely to keep away their livestock from crops and perhaps of other people. Therefore these activities will reduce environmental degradation, also referring to focus group discussion with TMA the said that they have played a great role in advising pastoral to diversify this did that through workshops and training to farmers and pastoral communities in Kilosa District.

**Table 6: Adaptive elements on climate change**

<b>Adaptive measure</b>	<b>Frequency</b>	<b>Percentages</b>
Transfer of livestock	64	61.5
Soil and water conservation	39	37.5
Reducing number of cattle	45	43.3
Eating habit	43	41.3
Migration	44	42.3

#### **4.3.7 Accessibility of information on climate change issues**

Moreover Table 7 shows availability and accessibility of information on climate change by respondents in the study area. Out of the 104 respondents, 89% said that they had

access to climate change information because some of extension officers inform them, also they get information from newspapers or television this was said by one respondent during focus group discussion in Mabwegere village.

On the other hand during focus group discussion with TMA they responded that they used to disseminate information to pastoral and farmers in Kilosa district. For example they provided early warning of severe early event of weather to community as well they keep on updating because there is a climate change variability so they provide information then information is monitored and updated. For example they have Monthly focused, 3 month focused and 10 month focused this help to keep pastoral aware of any event that can emerge in their area.

Furthermore, 95% of respondent said that had access to information on start of rainfall. All of the respondents also said they accessed information on floods incidences and drought occurrences because they have local knowledge on detecting the seasons this was said by one elder during focus group discussion in Rudewa (Mr. Leyeni saigurani). our former elder taught us to detect this kind of things during our youth age at that time we were prepared to become “Morani” so we were taken far away from home so that women cannot understand what we were doing. In there they get various knowledge including family care, livestock disease, rainfall, first aid when someone is injured by animal and how to be strong during the fight. The following were how the pastoral communities used to detect events they revealed that during focus discussion as moderate drought, severe drought, temperature, vegetation change, lack of pasture and pest and diseases.

**Table 7: Accessibility of information on climate change issues**

<b>Variable</b>	<b>Responses</b>	<b>n</b>	<b>%</b>
Do you have access to climate change information?	Yes	91	89.2
	No	13	12.7
	<b>Total</b>	<b>104</b>	<b>100</b>
Accessed information on start of rain	Yes	87	95.6
	No	4	4.4
	<b>Total</b>	<b>91</b>	<b>100</b>
Accessed information on wind change	Yes	36	39.5
	No	55	60.5
	<b>Total</b>	<b>91</b>	<b>100</b>
Accessed information on end of rainfall	Yes	80	87.9
	No	11	22.1
	<b>Total</b>	<b>91</b>	<b>100</b>
Accessed information on flood incidences	Yes	91	100
	No	0	0.0
	<b>Total</b>	<b>91</b>	<b>100</b>
Accessed information on drought occurrence	Yes	91	100
	No	0	0.0
	<b>Total</b>	<b>91</b>	<b>100</b>

#### **4.3.8 Factor influencing adaptive capacity index**

In determining adaptive capacity among pastoralist the following indices were employed house hold size, number of livestock, gender, consultation of extension services and education. Table 8 shows that Wald statistics are non-zero values, which implies that there is interaction between the dependent and independent variables. According to Norusis (1990) and Powers and Xie (2000), the non-zero Wald statistic values indicate the presence of relationships between the dependent and explanatory variables. Thus, on the basis of the results of this study the null hypothesis was rejected in favor of the alternative hypothesis that socio-economic factors significantly influence the adaptive capacity of pastoralists to climate change at 5% level of significance.

#### **4.3.8.1 Age**

Age has a negative regression coefficient (B) of -0.029 and the odds ratio (Exp b) of 0.971 (Table 8). This implies that a decrease in age, which was statistically insignificant at probability of 5% ( $p=0.302$ ), decreases adaptive capacity to climate change by a factor of 0.971. Age has influence on knowledge of climate change from the fact that old people can notice the trend of changes of events in a place than are young people and hence aged pastoralists are able to adapt to climate change than are young people. In other words, old people have great experience on climate change than young people. Age affects adaptation to climate change because as the age of the household head increases, the person is expected to acquire more experience in weather forecasting and that helps increase in likelihood of practicing different adaptation strategies to climate change (Tizale, 2007).

#### **4.3.8.2 Education level**

Education has a negative regression coefficient (b) of -0.487 and the odds ratio (Exp b) of 0.615 (Table 8). This implies that a unit decrease in this variable, which was statistically insignificant at probability of 5% ( $p=0.399$ ), decreases adaptive capacity to climate change by a factor of 0.615. People who are educated are able to access information on climate change from various media and sources than people who are illiterate and vice versa. This result is in line with augment that education improves awareness of potential benefits and willingness to participate in local natural resource management and conservation activities (Dolisca *et al.*, 2006).

#### **4.3.8.3 Household size**

Household size has a positive regression coefficient (b) of 0.138 and the odds ratio (Exp b) of 1.148 (Table 8). This implies that a unit increase in this variable, which was statistically insignificant at probability of 5% ( $p=0.186$ ), increases adaptive capacity to climate change

by a factor of 1.148. Family size determines labor endowment, which would enable a household in accomplishing various other income generating activities. Some of the family labour could engage in other non pastoral activities that would help in generating income for increasing adaptive capacity compared to pastoralists with small family sizes.

#### **4.3.8.4 Information access**

Information access has a positive regression coefficient (b) of 1.213 and the odds ratio (Exp b) of 3.365 (Table 8). This implies that a unit increase in this variable, which was statistically insignificant at probability of 5% ( $p=0.151$ ), increases adaptive capacity to climate change by a factor of 3.365. People with information on climate change and the adaptation mechanisms at their disposal are able to make use the information to change their management practices in response to changing climatic and other conditions (Tizale, 2007).

#### **4.3.8.5 Extension services**

Extension services have a positive regression coefficient (b) of 2.512 and the odds ratio (Exp b) of 12.330 (Table 8). This implies that a unit increase in this variable, which was statistically significant at probability of 5% ( $p=0.024$ ), increases adaptive capacity to climate change by a factor of 12.330. Extension services were seen to uniquely contribute to adaptive capacity and determine the information that pastoralists obtain on grazing activities and the application of innovations through counseling and demonstrations by extension agents. The effect of exposure to extension programmes is enormous. For instance, Onu (2006) found that farmers who had access to extension contact adopted alley farming technologies 72% more often than farmers who had no access to extension contact. Nhemachena (2007) also noted that exposure to extension services influences the capacity of farmers to adapt to climate change. This result is also in line with augment that

extension improves awareness of potential benefits and willingness to participate in local natural resource management and conservation activities (Dolisca *et al.*, 2006).

#### **4.3.8.6 The number of cows**

Number of cows has a positive regression coefficient (b) of 0.002 and the odds ratio (Exp b) of 1.002 (Table 8). This implies that an increase in total wealth, which was statistically insignificant at probability of 5% ( $p=0.453$ ), increases adaptive capacity of pastoralists to climate change by a factor of 1.002. Income in this study is defined by referring to assets owned and controlled by individuals within the household. URT (2006) argue that the ownership of household items may be taken as an appropriate measures of household wealth. In this study asset ownership defines the wealth of pastoralists communities as they refer someone who has a large number of livestock to be rich since the main asset they possess is livestock therefore the one having this asset has the large possibility in adapting to climate change impacts.

#### **4.3.8.7 The number of goats**

The number of goats has a negative regression coefficient (b) of -0.005 and the odds ratio of 0.995 (Table 8). This implies that a unit decrease in this variable, which was statistically insignificant at probability of 5% ( $p=0.272$ ), decreases adaptive capacity by a factor of 0.998. Failure to have little or no asset decrease adaptive capacity at great extent this is because having more than one asset is a sign of diversification which will play an important roles in increasing adaptive capacity among pastoralists. Vogel (2000), for example, argues that access to resources such as credit is the decisive determinant for the ability to implement appropriate adaptation practices.

#### **4.3.8.8 The number of calves**

The number of calves has a negative regression coefficient (b) of -0.016 and the odds The number of calves ratio (Exp b) of 0.984 (Table 8). This implies that a unit decrease in this variable, which was statistically insignificant at probability of 5% ( $p=2.320$ ), decreases adaptive capacity by a factor of 0.998. likewise having small number of livestock decreases adaptive capacity among pastorals, since adaptation require a significant level of fund as well community with poor economic status are unable to adapt to climate change impact.

#### **4.3.8.9 The number of sheep**

The number of sheep has a negative regression coefficient (b) of -0.008 and the odds ratio (Exp b) of 0.992 (Table 8). This implies that a unit decrease in this variable, which was statistically insignificant at probability of 5% ( $p=1.111$ ), decreases adaptive capacity by a factor of 0.994. Here adaptive capacity among pastoralists will be low since their total wealth is not good unless otherwise they posses number of asset they would have been in better position to adapt. Smith and Pilifosova (2001) further argue that countries with limited economic resources have little capacity to adapt and are highly vulnerable.

Generally in measuring adaptive capacity this study revealed that wealth of pastoralist community influence adaptive capacity but there is no any asset that has a unique contribution to adaptive capacity. The results indicate a community's adaptive capacity and preparedness for climate-induced change varies across the region. Furthermore, mapping adaptive indicators helps to highlight community's strengths in coping with changes as well as areas for improvement.



**Table 8: Factors influencing adaptive capacity of pastoralists to climate change**

Variables	95.0% C.I.for EXP(B)							
	B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
	-0.029	0.028	1.064	1	0.302	0.971	0.919	1.026
Education level	-0.487	0.577	0.712	1	0.399	0.615	0.198	1.904
Household size	0.138	0.104	1.752	1	0.186	1.148	0.936	1.409
Number of cows	0.002	0.003	0.453	1	0.501	1.002	0.997	1.007
Number of goats	-0.005	0.010	0.272	1	0.602	0.995	0.976	1.014
Number of calves	-0.016	0.011	2.320	1	0.128	0.984	0.964	1.005
Number f sheep	-0.008	0.008	1.111	1	0.292	0.992	0.976	1.007
Information								
access	1.213	0.846	2.057	1	0.151	3.365	0.641	17.666
Extension								
services	2.512	1.113	5.094	1	0.024	12.330	1.392	109.234
Constant	-0.557	2.001	0.078	1	0.781	0.573		

#### 4.3.9 Comparative mean wealth of livestock by villages

As results indicate from the Table 8 above, there is a significant difference in wealth from livestock across villages at  $P \leq 0.01$  computed from Anova. Therefore having significant different in total wealth among different villages also their adaptive capacity will also vary, meaning that the village with a large wealth will be able to adapt to climate change easily and highly rather than the village with little wealth their adaptive capacity will be low. Adger (2003) argues that their capacity to adapt to climate change “is a function of access to resources”

**Table 9: Comparative mean wealth of livestock by villages**

<b>Village name</b>	<b>Cow wealth</b>	<b>Anova P-Value</b>	<b>Goat wealth</b>	<b>Anova p- Value</b>	<b>Calf wealth</b>	<b>Anova P- Value</b>	<b>Sheep wealth</b>	<b>Anova P- Value</b>	<b>Total wealth from all livestock assets</b>	<b>Anova P- Value</b>
Twatwatwata	112.4669	0.005	39.8619	0.430	43.0993	0.0001	37.2742	0.0001	228.4446	0.001
Ngaiti	75.0781		52.7014		14.4867		44.4652		176.5019	
Mbwade	186.9439		49.5911		11.7216		75.3694		346.0269	
Mabwegere	123.5874		50.7854		11.7817		39.7127		213.0138	
<b>Total</b>	<b>124.5191</b>		<b>48.2349</b>		<b>20.2723</b>		<b>49.2054</b>		<b>240.9968</b>	

#### **4.3.10 Constraints faced by respondents on measures taken to cope with climate change effects**

Adaptation to climate change need human and capital recourses, human need skills and knowledge and equipment to deal with changing climate. These recourses are however, expensive and in most cases poor families can hardly afford them. This will therefore mean that the poor families are likely to be more affected with the impact of climate change than the rich families. Inability of poor household to apply coping methods may increase vulnerability and widen the gap between the rich and the poor (Kates, 2000). About 95% of the respondent said that poor people lack effective means and method to cope with the changing climate. However poor people will have limited access to modern equipment and technology to cope with the impact of climate change.

##### **4.3.10.1 Lack of capital**

In Table 10 the findings indicate the constraints that respondents faced when they took different measures to cope with climate change effects. Out of the 104 respondents, 88% indicated that they lack capital to acquire modern technology and technique in combating the impact of climate change, hence the society failed to buy equipment such as generators, water pipes and tanks to store water for human and livestock use. Well-off pastoralist use to buy farms remains to feed their livestock in the newly harvested maize, beans, and paddy from farmers. However some pastoralists cannot afford to buy farms remains this has resulted to death of livestock as well as unhealthy condition to livestock. Weak animal were vulnerable to disease such as babesiosis, east cost fever, tick bone disease as well as people are not able to treat their livestock this situation lead to animal death as well new breed of livestock need intensive care something that most of pastoral communities cannot afford

#### **4.3.10.2 Conflict**

Furthermore, majority 87% of the respondents indicated that conflict with neighbours also emerged as a constraint this is because during the coping process as pastoralist migrate to different places this may result to conflict between farmers and pastoralist especially when livestock enters the farm land to eat example land conflict occurred in 2/2/211. This has happened several times in Kilosa district as a result of climate change impact people are struggling to find area to cultivate and feed animals but this incidence has lead mass killing and death in Kilosa district. For example, surveys (Shem *et al.*, 2005) show that existing number of cattle in Tanzania has already surpassed the normal carrying capacity in most of the areas. Increasing land scarcity and conflicts of interest between different land users in these and other areas have implied that huge numbers of people have migrated in search of arable land and pastures elsewhere.

#### **4.3.10.3 Lack of information on weather incidence**

However 66% of the respondent unveiled that weather strongly influenced the performance of human and livestock in Kilosa. Lack of information on weather incidence for example the pastoral failed to capture the trend of rainfall, humidity and temperature. Also they did not understand the TMA language because they said it was too scientific. For that matter people can scarcely plan for feeding schedule and this is done unscientifically which can result to low production of livestock. Indigenous knowledge is widely used to forecast weather but this does not seem to be very effective in the modern digital world. Moreover lack of scientist to train them on how to cope with climate change has merely affected the productivity and increase poverty level. This scenario is due to lack of experts or lack funds to implement the service. Giles (2005) and Hellmuth *et al.*, (2007) indicated that there Are very few climate scientist in Africa, also Africa lack sufficient and functioning metrological station n to give reliable weather data .For stance

entire Kilosa has only one metrological station which is estimated to be eight times lower than the minimum recommended by the world metrological organisation (WMO).

In the study area traditional coping method to climate change are becoming very low, forcing people to look for alternatives. In Kilosa communities suggested that in order to cope with the changing climate they need diverse adaptation method which could be implemented and help them face current problems, they believe that their own action /method and future plans can have big impact on their ability to cope with climate changes. However adaptive capacity in both areas is limited by their low access to education and training, health services, financial recourse and services and information. In addition vulnerability to climate change is enhanced in the study area by land degradation, population pressure, conflict, social and gender inequalities, inadequate government policies, capacities and coordination, and the deteriorating role of traditional social institutions.

#### **4.3.10.4 Lack of knowledge in adapting method**

Nearly everyone 89.2% agreed that lack of knowledge on how to cope with climate change impact. Globally many community lack recourses, knowledge, veterenarian and extension services and research technology in their development (FAO, 2008). Some of the pastoral community believe that climate change is punishment from god to human for going against gods will and directive knowledge on effect of climate change and since the changes are associated with beliefs/morals adaptation measure could be overlooked because of the notion of “god’s will” (Smith, 2008). Lack of formal education amongst the pastoral communities could impact knowledge to adaption to climate change. The government does not seem to put more effort in conveying knowledge and skills to these

people. On the contrary there is scarcely any NGO working in this community for the purpose of creating more awareness on climate change and coping methods.

**Table 10: Constraints faced during the application of these measures**

<b>Constraints faced</b>	<b>Responses</b>	<b>n</b>	<b>%</b>
Lack of capital	Yes	90	88.3
	No	14	13.7
	<b>Total</b>	<b>104</b>	<b>100</b>
Conflict	Yes	89	87.3
	No	15	14.6
	<b>Total</b>	<b>104</b>	<b>100</b>
Lack of information on weather incidence	Yes	68	66.6,
	No	36	35.3
	<b>Total</b>	<b>104</b>	<b>100</b>
Lack of knowledge in adapting method	Yes	91	89.2
	No	13	17.2
	<b>Total</b>	<b>104</b>	<b>100</b>

#### **4.3.11 Views of respondents on what to be done in case of prolonged rainfall**

Table 12 indicates views of the respondents on what they would do in case of prolonged rainfall, 85% of the respondent said that they would made shallow wells to reserve water for both human and livestock. About 87%of the respondents indicated that they would divide their plots into portions to be planted at different periods due to continued rainfall. The portion would be used to plant grass for future time especially during dry seasons this is a local method used by pastoralist. It's called (*Olalili*) in Maasai language. It's something like enclosure system because no one is allowed to enter olalili until the arranged time when grasses are matured.

About 85%of the respondents said that they had planted trees to improve vegetation cover for future environmental improvement of their area. Respondents agreed that planting tree

would be very important in conserving their environment, for example in Rudewa and Kimamba ward they said that they had seen from other villages that are already implementing REDD projects that every household was supposed plant at least five trees after cutting one tree.

**Table 11: Views of respondents on what to do in case of prolonged rainfall**

	Responses	n	%
Prepare shallow wells	Yes	87	85.3
	No	17	21.4
	<b>Total</b>	<b>104</b>	<b>100</b>
Prepare potions	Yes	89	87.3
	No	15	14.6
	<b>Total</b>	<b>104</b>	<b>100</b>
Plant trees	Yes	87	85.3
	No	17	16.6
	<b>Total</b>	<b>104</b>	<b>100</b>
Accessed information type three (end of rainfall)	Yes	80	78.4
	No	24	23.5
	<b>Total</b>	<b>104</b>	<b>100</b>
Accessed information type four (flood)	Yes	100	98.0
	No	4	3.9
	<b>Total</b>	<b>104</b>	<b>100</b>
Drought occurrence	Yes	100	98.0
	No	4	3.9
	<b>Total</b>	<b>104</b>	<b>100</b>

#### **4.3.12 Support received by pastoralists**

Likewise, Table 12 indicates that 45% of the respondents said that they get support in transfer of technologies from the NGOS officials who visited their villages for different projects. On the other hand 56% of the respondents indicated that they obtained support in

training, for instance in Rudewa ward they had get training from TNRF (Tanzania Natural Recourse Forum) on how to conserve natural resources. However, majority 54% said that they did not get support in transfer of technologies, while only (45%) indicated that they did not get support in training.

**Table 12: Types of support extended to pastoralist**

	<b>Responses</b>	<b>n</b>	<b>%</b>
Support in transfer of technology	Yes	46	45.1
	No	56	54.9
	<b>Total</b>	<b>104</b>	<b>100</b>
Support in training	Yes	58	56.9
	No	46	45.0
	<b>Total</b>	<b>104</b>	<b>100</b>

#### **4.3.13 Local initiatives to conserve natural resource**

Table 13 shows the local initiatives that were introduced in the study area. About 95% of the respondents indicated that there was local initiative in planting trees to conserve natural resources. Again, 97% of the respondents indicated that bylaws were formulated to conserve natural resources. These by laws had to be obeyed by everybody in the village. Anyone who disobeyed the laws had to be penalized. In Maasai community whenever, there is repetition in disobeying the laws, the offender has to be brought before Laiboni who is a Maasai leader who gives harsh punishment or curses to the offender. The Maasai communities are normally respecting the Laiboni because they regard him as their god.



**Table 13: Local initiatives to conserve natural resource**

	<b>Responses</b>	<b>n</b>	<b>%</b>
Planting trees	Yes	97	95.1
	No	7	6.8
	<b>Total</b>	<b>104</b>	<b>100</b>
Formulating bylaws to conserve natural resources	Yes	99	97.1
	No	5	4.8
	<b>Total</b>	<b>104</b>	<b>100</b>
Initiate conserving natural resource and environment	Yes	99	97.1
	No	5	4.8
	<b>Total</b>	<b>104</b>	<b>100</b>

#### **4.4 The Roles of State Agency in Enhancing Adaptation**

Table 14 shows views of the respondents on the roles of state agency role in enhancing adaptation process. About respondents 77% of the respondents, agreed that the state agency played an important role in adapting process. This is because most of NGOs and government officials and researchers when visited their villages were advising them about better way of livestock keeping and farming. Due to frequent visits made by researchers, one pastoralist said that *“climate change has now become like a gospel song in their district because many researchers are visiting them regularly”*. They also said that during disaster various institution and agencies came to assist the villages. The agencies and organisation as USAID, united nation children fund (UNICEF), RED CROSS, Sokoine University of agriculture (SUA), Tanzania natural resources forum (TNRF) and integrated water sanitation and hygiene (IWASH) for stance, IWASH. Some of the role includes construction of charco dam in Twatwatwa and Mabwegere facilitated by SUA through a project entitled Pastoral Farmers conflicts and water well which they can use to pump water.

It will become even more important for policymakers and public officials, farmers, businesses, service providers, vulnerable households, and other stakeholders to be able to access and forecasts and information about how they can prepare for and cope with extreme events (USAID, 2012).

However 13% of the respondent disagreed that state and other agency doesn't play any role in adapting to climate change. On the other hand, 74% of the respondents agreed that state agency takes into for account local knowledge whenever promoting technologies to be adapted by community members. Stern (2006) relates adaptation to building resilience, and recognizes that it will be a key response to reduce vulnerability to climate change. Adaptation is not limited to discrete projects (Leary, 1999), such as dams and sea walls. It includes a wide range of adjustments by entities such as households, firms and other institutions in response to the effects of climate change and variability. These include activities such as managing natural resources, input mixes in production, and changes in laws, programmes, policies and investments. Indigenous people can respond to climate change rate and magnitude of change by reducing the greenhouse gases (GHG) emissions, and by adapting to its impacts (UNFCCC, 2011).

Despite local communities having an important role to play in terms of future adaptation to climate change, unfortunately their contribution to those initiatives is not well documented. According to (IUCN, 2008) there has been little recognition of the reservoir of knowledge latent in the coping strategies and adaptive capacity of local communities. This argument can be verified from the fourth report of the IPCC (2007) which does not recognize ongoing local community adaptation to climate change.

Although 86.4% of the respondents agreed that adaptation to climate change can reduce impacts and requires significant level of funding, the negative effects of climate change

are likely to have the worst impacts on the poor, as they have limited access to capital, skills and labour (Eriksen *et al.*, 2005). Most of the poor people live in developing countries, and in Sub-Saharan Africa most of them are women and children (UNFCCC, 2011). According to ETFRN (2009), women who are likely to be hit hard by climate change already shoulder the burden of providing household livelihoods, and are among those most vulnerable to climate change, particularly as they are highly dependent on natural resources. Household livelihoods and food security are also likely to be vulnerable under the changing climate since both production systems and forests, which are a vitally important part of food security in the region, are intricately dependent on the climate system. This makes it imperative for climate change and climate variability measures to be taken seriously and for adaptation to be integrated into project development planning in both the private and public sectors in Sub-Saharan Africa.

About 87% of the respondents agreed that state agency would have to develop effective policy institution and have a good mechanism for executing its plans to facilitate adaptation to climate change and be able to access adaptation funds. During focus group discussion one participant said that climate change adaptation policies needed to be integrated into short-term and long-term goals however they said to promote indigenous knowledge so as to understand local livelihood vulnerabilities and climate interaction was important. Consequently, the notion of measure taken against climate change is rarely regarded as high priority by government and individuals and thus loses out in terms of funding and institutional support (Baker *et al.*, 2000).

**Table 14: View on the role state agency in adoption and adaptation process**

	<b>Responses</b>	<b>n</b>	<b>%</b>
State agency plays an important role in adopting process	Disagree	14	13.6
	undecided	10	9.7
	agreed	80	77.7
	<b>Total</b>	<b>104</b>	<b>100</b>
State agency takes into account local knowledge in adapting	Disagree	5	4.9
	undecided	22	21.4
	agreed	77	74.8
	<b>Total</b>	<b>104</b>	<b>100</b>
Adaptation to climate change can reduce impact but require significant level of fund	Disagree	4	3.9
	undecided	11	10.7
	agreed	89	86.4
	<b>Total</b>	<b>104</b>	<b>100</b>
State agency consider well off communities in adaptation plans	Disagree	65	62.5
	undecided	21	20.2
	agreed	18	17.3
	<b>Total</b>	<b>104</b>	<b>100</b>
Accessing adaptation fund will require the development of effective policy institution and good mechanism	Disagree	5	4.8
	undecided	9	8.7
	agreed	90	86.5
	<b>Total</b>	<b>104</b>	<b>100</b>

#### **4.4.1 Views of the respondents on government institution strength to enhance adaptation process**

However, Table 15 indicates the government strength in enhancing adaptation to climate change in kilosa district. Out of the 104 respondents, slightly above two thirds (62.4%) said that the government had developed metrological forecast capacity and provided information on climate change. Recent years, have witnessed rapidly increasing international attention to adaptation to the ‘unavoidable’ impacts of climate change

(NCCARF, 2010; Preston *et al.*, 2011). The rapid development of adaptation as a mainstream strategy for addressing climate vulnerability is evidenced by a broad range of emergent adaptation policy developments.

At international level, a variety of adaptation finance mechanisms have been established through the UNFCCC and/or the Kyoto Protocol more specifically including the Global Environment Facility (GEF) Trust Fund, the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF) and the Adaptation Fund. These mechanisms are complimented by a range of other multi-lateral arrangements for adaptation finance. Developed nations have also commenced a range of national adaptation initiatives including efforts to deliver climate information and projections, the development of adaptation guidance, institutional adaptation strategies and plans CEC, 2007; COAG, 2007; Swart *et al.* (2009), DCCEE, 2010; NRC (2010).

In addition 73.1% of the respondents said that the government provided education on climate change and environmental issues, but this was done by researchers and NGOs that visit the community for different projects. They used to educate pastoral and farmers about the impact of climate change. However during focus group discussion one participant said that

*“every new comer visiting Kilosa is talking about climate change it has become common to us, therefore at least we know how to cope this by reading news paper and listening to radios now days we have developed you see we even own telephone now which we can communicate with our relative from town and get different news through telephone”.*

About 87% of the respondents viewed that the government had improved infrastructures, especially in Rudewa and Kimamba were badly hit by flood from river Mkondoa which

destroyed infrastructure and loss of animals and people displacement. Some were remained homeless but government and other agencies facilitated social services including food, shelter and clothes as well they constructed a bridge that borders Kimamba and Rudewa ward. Moreover, 95.2% said that government offered flood protection measures. The villagers were advised to move to high land areas during the disaster also they were advised to do crop cultivation by using terracing (Makinga maji) and resistant crops. During key information with TMA officials it was noted that they had advised farmers and pastoralists to use better farming and animal keeping methods respectively.

**Table 15: Views on the government strength to address climate change issues**

	<b>Responses</b>	<b>n</b>	<b>%</b>
Develop metrological forecast capacity	Yes	38	37.6
	No	63	62.4
	<b>Total</b>	<b>101</b>	<b>100</b>
Information provision	Yes	97	93.3
	No	7	6.7
	<b>Total</b>	<b>104</b>	<b>100</b>
Education	Yes	76	73.1
	No	28	26.9
	<b>Total</b>	<b>104</b>	<b>100</b>
Infrastructure development	Yes	90	86.5
	No	14	13.5
	<b>Total</b>	<b>104</b>	<b>100</b>
Flood protection measures	Yes	99	95.2
	No	5	4.8
	<b>Total</b>	<b>104</b>	<b>100</b>

#### **4.4.2 Government and climate change issues**

Table 16 shows some interventions by the government to address climate change issues in the studied area. Out of the 104 respondents, 94.2% indicated that government should describe land tenure and ensured land access rights to her people. Recognising the need for pastoralist mobility and communal land tenure, and the contributions of customary institutions, is important for improving climate change adaptive capacities.

About 55% of the respondents said that government must increase presentation and involvement of pastoralist groups. Strengthening pastoralist institutions' level of engagement, and their capacity and ability to speak on their own behalf, is critical. A skewed focus towards more 'visible' land users, such as farmers, results in biases against other groups who have less capacity to advocate for themselves. Climate change makes remedying this state of affairs more urgent.

However, 87% of respondent said that the government must improve infrastructures to support efforts to mitigate climate change issues. Improved road networks, and more locally accessible livestock sales-points are needed. The need for infrastructure is made more imperative by current and anticipated changes in climate, as pastoralists have to be able to make rapid decisions concerning the sale of their livestock.

Similarly, majority (55.8%) of the respondents said that the government should improve bargaining power and awareness of product value. The better pastoralists are compensated for their products to reflect their true value, the more incentive there is to participate effectively in markets. Improvements in product processing facilities, and increased knowledge of other market opportunities such as those in wild harvested products, are also needed. About 58% of the respondents said that the government should enhance insurance.

Livestock insurance is important for pastoral development. According to Mortimore *et al.*, (2008), 'If assets are protected from droughts, investments can be cumulative, if not, then investment in food emergencies frustrates growth.

Furthermore, 63.5% of the respondents said that the government must improve education and skills to address climate change issues in the study area. Skills and education increase adaptive capacity to climate change and options for diversification (Sarkjkinge, 2011). They can also open up opportunities to sustain livelihoods which do not depend on the natural resource base. As climatic conditions become more severe, education allows pastoralists the freedom to supplement livestock keeping with other livelihood options which may not be affected by extreme drought or flooding. Most of pastoralists were complaining about education. During focus group discussion they said that there is no need to attend school because they have informal education that means they value informal education than formal education (Holt-Jensen, 2005).



**Table 16: Interventions by the government to address climate change issues**

<b>Interventions</b>	<b>Responses</b>	<b>n</b>	<b>%</b>
Land tenure and access right	Yes	98	94.2
	No	6	5.8
	<b>Total</b>	<b>104</b>	<b>100</b>
Increase presentation and involvement of pastoral groups	Yes	57	54.8
	No	47	45.2
	<b>Total</b>	<b>104</b>	<b>100</b>
Infrastructure	Yes	90	86.5
	No	14	13.5
	<b>Total</b>	<b>104</b>	<b>100</b>
Improve bargaining power and awareness of product value	Yes	58	55.8
	No	46	44.2
	<b>Total</b>	<b>104</b>	<b>100</b>
Insurance	Yes	44	42.3
	No	60	57.7
	<b>Total</b>	<b>104</b>	<b>100</b>
Education/skills	Yes	66	63.5
	No	38	36.5
	<b>Total</b>	<b>104</b>	<b>100</b>

## **CHAPTER FIVE**

### **5.0 CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Conclusions**

Fascinated findings were captured during the study. However the most important issue relevant to the research objective was picked for conclusion.

People in Kilosa District are aware of climate change, however they believed that climate change is change in rainfall patterns and change in temperature, Respondents interviewed during the study period, however, believed that there has been significant change in the rainfall and temperature patterns for the last twenty years. Similarly, the general perception of the people is that both rainfall and temperature have highly been fluctuating for decades now became unpredictable with less rainfall in shorter duration and warmer temperature over year now than usual.

Climate variability and change is now a reality and this has also been exposed from trend analysis of 30 years climatic data. It is likely that the revealed trends will continue and that there will be no reversal order to the present trends. In the study area there is a significant shift of rainfall pattern, whereby in the past decade rainfall were bimodal unlike currently it have shifted to unimodal. In view of the prevailing situation, appropriate interventions that aim at increasing water access and reducing travel distances and time to water sources such as rainwater harvesting and improvement in pasture availability are imperative.

Extreme weather conditions such as frequent periodic droughts, attributed to the climate change, are recent experiences of pastoralists. The effects of climate variability among pastoralists are now apparent and the pastoralists have developed methods of reducing the risks associated with these variations.

Moreover it's concluded that climate change has several negative impacts to human, livestock and environment at large. Generally climate change has led to reduced water, food, number of livestock and pastures. It has also lead to change in pastoral feeding habit. All this circumstances has lead pastoralists to develop several coping strategies to climate change in Kilosa District and the most outstanding are: reducing number of livestock, shifting livestock and changing feeding habit.

Pastoralist in Kilosa District had declared that there are important role played by state and agencies in enhancing their adaptive capacities. The most important role played is initiating pastoralist to diversify their economies, planting trees, infrastructure development as well as ensuring accessibility to climate change information. For stance TMA has the role to ensure that pastoralist and farmers in Kilosa District had access to information, example they provide three types of information one month focused, three month focused and ten month focused all this are updated regularly.

## **5.2 Recommendations**

The following recommendations are made in relation to the current study, own observation and related studies elsewhere.

- i. Policies and programs should be put in place to support local resilience and adaptive capacity to climate change. Climate change should result in pastoral communities being seen as custodians of degraded and un-degraded rangelands as policy adapts and politicians recognise the huge contribution these mobile systems can make economically, socially and, environmentally. Removing policy obstacles will allow pastoralism to function unimpeded and help ensure the resilience of the semi-arid dry lands and their communities in the face of climate change respectively.

- ii. It is recommended that house hold education and awareness creation on basic nutrition, water hygiene and adaption strategies to climate change should be given priorities in the district.
- iii. Climate adaptation should be mainstreamed into dry land plans and strategies at national and local/district level and at sectoral levels, such as disaster risk reduction, livestock development and agriculture.
- iv. Better awareness of how to access and use climate forecast is required at different levels of planning and implementation this because pastoral claimed during focus group discussion that they don't understand the information disseminated by TMA because it's too scientific.
- v. Full socio-economic costs and benefits estimates should be calculated for different adaptation strategies involving pastoralists. The costs and benefits should consider livelihoods, ecosystems and wider economic contributions.
- vi. Strengthening the capacity of pastoral groups to engage with debates on policy issues directly affecting their lives and livelihoods.
- vii. Ensure effective public information campaigns to help people understand and respond to the climate change challenges faced in different regions and district

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## APPENDICES

### Appendix 1: Pastoral adaptive capacity in the changing climate in Kilosa District

#### Household questioners

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#### General Particulars

Date of interview..... Questioner No: .....

Name of respondents (optional).....

District..... Ward.....

#### A1: Background Information

1. Age: ..... years
2. Sex (Tick ☒)
  1. Male [ ☐ ] 2. Female [ ☐ ]
3. Education level (Tick ☒)
  01. Informal [ ☐ ], 02. Primary [ ☐ ], 03. Secondary [ ☐ ]
  04. Colleges [ ☐ ], 05. Degree holder [ ☐ ]
  05. Postgraduate [ ☐ ] 06. Others (specify).....
4. What is your main occupation? (Tick ☒)
  01. Peasant [ ☐ ] 02. Business [ ☐ ] 03. Civil servant [ ☐ ] 04. Private sectors [ ☐ ]
  06. Student [ ☐ ], 07. Others (specify) .....
5. Area of residence
  01. Rural [ ☐ ], 02. Urban [ ☐ ]
6. Where did you attain primary education? .....
7. What is your marital status? (Tick ☒)
  01. Single [ ☐ ] 02. Married [ ☐ ] 03. Divorced/Separated [ ☐ ] 04. Widowed [ ☐ ]
  05. Others (specify) .....
8. What is the size of the household member ..... (number)

9. Main sources of income.....

10. What else do you involve in to get income out of livestock.....?

### **Livestock Ownership**

Animal	Number	If sold last year 1.Yes, 2.No	Quantity	Price/unit	Total value
Cow					
Calf					
Sheep					
Goat					

### **Impact of climate change towards pastoralists' society in Kilosa district**

23. Do you think climate change effects affect the Livestock keeping? 01.Yes 02.No

24. If yes how? 01. Decreases in quantity [ ], 02. Decrease in quality [ ] 03.Increase in quality [ ] 04. All of the above mentioned? [ ]

25. What do you think is the cause of climate change in this area? (allow multiple response).

01. Keeping of livestock [ ], 02. Cutting of trees [ ], 03. Burning of forest [ ],  
05. Increase in population [ ], 06. Need for areas for animal and crop  
cultivation [ ], 07. Construction activities like roads [ ], 08.Charcoal  
burning [ ]

26. How long do you walk to reach the grazing areas? 01.2km-3km [ ] 02. 3-5km [ ] 03.  
6-8km [ ] 04. 8-10km. [ ] 05. Others specify.....

27. Is there any different in the distance to walk in past 10yrs to today? 01. Yes 02.No

28. If yes give reasons how? 01. There is more hrs spent to reach grazing areas 02.  
Distance increased 03. All of the above

30. Put a tick in the respective box against each statement in the table below indicating 1.

Disagree 2. Undecided 3. Agreed.

No.	Statements	Disagreed	Undecided	Agreed
1	Reduced rainfall has no effects to Livestock keeping?			
2	Climate change has the relationship with the variability of rainfall, temperature and relative humidity			
6	There are approaches formulated by various institutions to overcome climate change effects to rescue livestock			
7	Unavailability of grass is not related to climate change			
9	Changes in rainfall can result to water			
10	Do you consider climate change to contribute to presence of pests and diseases			
12	Recently there is no decrease of livestock products because of climate change and weather variability			

31. From where have you heard about climate change? (Allow multiple responses):

01. Own observation 02. NGO ☐ 03. ☐ Newspapers ☐ 04. Researchers ☐  
 05. Village meetings ☐ 06. Listening to radio ☐ 07. Told by neighbours, friends or family ☐ 08. Department of meteorology 09. Input suppliers ☐ 10. Television, Radio and Newspapers ☐ 11. Others, (specify).....

32. When did you start to note the severe changes of the following?

Items	2008	2009	2010	2011	2012
Rainfall					
Temperature					
Flooding					
Drought					

33. In your opinion which sector has been most affected?

Sector	Most affected	Affected	Not affected
a. Crops			
b. Livestock			
c. Health			
d. Infrastructure			

### Adaptive elements

34. Have you ever at any time consulted an extension officer regarding your livestock problems? 01. Yes ☐ 02. No ☐

35. If yes, how did you interact with him/her? 01. Good ☐, 02. Bad ☐, 03. Fair ☐

36. Have you ever changed way of livestock keeping? 01. Yes ☐ 02. No ☐

37. If yes what facilitated you to change your way of keeping livestock?

.....

38. And how have you changed?

.....

39. Did have access to climate change information? 01. Yes ☐ 02. No ☐

40. What type of weather/climate information do you have access to? 01. Onset/Start of rain ☐ 02. Wind ☐ 03. Cessation/End of rain ☐ 04. Floods ☐ 05. Amount of rainfalls ☐ 06. Drought occurrence ☐ 07. Duration of rainy season ☐ 08. Others (specify.....)

41. How has the situation been in the last five years?

.....

42. What kind of food do you eat during dry season or shortage of food.....?

43. What measures do you take during flood and drought to cope with the situation?

01. Migration ☐ 02. Change food ☐ 03. Diversification ☐ 04. Change breeds ☐ 05.

Others ☐ (Specify) .....

44. What constrain do you face during these measures.....?

45. What would you do if the climate predict showed that there would be no rain next season.....?

46. What would you do if the climate forecast showed that there would be continuous rainfall? .....

47. Do you have any local knowledge to solve the problem.....

### **Role of state agency**

(1).Do you get any support from state agency?

(1) Yes (2) no

2. Which support do you get?

(Allow multiple answers)(1) Transfer of technology (2) financial support (3) training

(4) information.

3 .Is there any local initiative made by state agency to conserve natural resource?

(1 ) yes (2) no

4. Do you think there are continuous climate destruction challenges regardless of initiatives made?

(1) Yes (2) no

5. Why?.....(allow multiple answers)

(1) limited access to finance (2) insufficient technology transfer and development

(3) low adaptive capacity (4) inadequate institution arrangement (5) poor information management ( 6) low level of climate change awareness

Put a tick in the respective box against each statement in the table bellow indicating 1. Disagree 2. Undecided 3. Agreed

No.	Statements	Disagreed	Undecided	Agreed
6	State agency plays an important role in adopting process			
7	State agency take into consideration local knowledge			
8	Adoption to climate change can reduce climate impact but require significant level of fund			
9	Only well-off families can afford adaptation to climate change impact			
10	Accessing adaptation fund will require the development of effective policy institution and good mechanism			
11	There is no need to involve all members in the action of adoption in a certain community			
12	There is a need to build capacity to local institution in to support adaption			

13. Did the government build adaptive capacity and institutional strengthening?

(1) yes (2) no



14. Which one?..... 1. develop metrological forecast capability (2) information provision (3)education (4) infrastructure (5)flood protection measures.

14. Is there any intervention made to enable adaption?(1)yes (2) no

15. What are those...?

(1) Land tenure and access right

(2) Increase presentation and involvement of pastoral groups

(3) Infrastructure

(4) Improve bargaining power and awareness of product value

(5) Insurance

(6) education/skills.

**Appendix 2: Focus group discussion guides**

1. What do you understand about climate change?
2. What are the causes of the climate change in your village?
3. How does climate change affect your livestock?
4. How do you adapt climate change?
5. What challenges do you encounter in adapting climate change?
6. How have the quality and quantity livestock of been affected by climate change?
7. How have the quality and quantity livestock's products have been affected by climate change
8. In your opinions what are the main Livestock which are more affected by climate change.

**Appendix 3: A. Checklist of Items for Discussion with TMA.**

1. How ready are you to overcome the disaster in the particular Kilosa district?
2. What capacity TMA have on CC early warning to pastoral community?
3. What challenges the TMA have in relation to CC information?
4. How prepared are you to provide assistance during disasters associated with climate change such as drought, Floods and hunger?
5. Is there any cohort involved in the provision of information on climate in the district apart from TMA?
6. What major adaptive strategies do the TMA have to assist pastoral communities to adjust with CC?

**Appendix 4: Checklist for key informants****General information**

Village.....

Ward.....

District.....

1. What do you understand by the term climate change?
2. What are the causes of the climate change in your village?
3. How does climate change affect your livestock?
4. How do you adapt climate change?
5. Do you think pattern of weather is generally changing?
6. If yes, why do you think this might be?