

**EFFECTS OF CLIMATE VARIABILITY ON LIVESTOCK
PRODUCTION AND COPING STRATEGIES IN MAIKONA
LOCATION, MARSABIT COUNTY, KENYA**

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or for any other study.

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DEDICATION

This thesis is dedicated to my late mother Mrs. Illo Wato.

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ABBREVIATIONS AND ACRONYMS

ACTS	African Centre for Technology Studies
ALRMP	Arid Land Resources Management Project
ASALs	Arid and Semi-Arid Lands
CCCD	Commission on Climate Change and Development
DFID	Department for International Development, UK
ENSO	El-Nino Southern Oscillation
FGD	Focused Group Discussions
GDP	Gross Domestic Product
GECHS	Global Environment Change and Human Security
GoK	Government of Kenya
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
KARI	Kenya Agricultural Research Institute
KMD	Kenya Metrological Department
LUMES	Lund University Masters in Environmental Studies
NDMA	National Drought Management Authority
NFI	Non-Food Items
NGOs	Non-Governmental Organizations
ODI	Overseas Development Institute
OECD	Organization for Economic Cooperation and Development
PACIDA	Pastoralist Community Initiative Development and Assistance
SSA	Sub Saharan Africa
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNDP	United Nations Development Program
UoP	University of Peace
WWF	World Wide Fund

ABSTRACT

Climate change is viewed as one of the greatest challenges facing humanity manifested in form of variation in amount and distribution of precipitation, ocean salinity, wind patterns and aspects of extreme weather leading to droughts and flooding, among others. These changes threaten community livelihoods, economy, ecosystems and social cohesion. Africa is particularly viewed to bear the brunt of the climate change threats mainly due to its poor economic development and low institutional capacity. Vulnerable communities within the continent are facing the highest pressure. Among the conspicuous threats are decline in crop production, livestock deaths due to droughts, malnutrition, resource based conflicts and migration. Pastoral community in Maikona location (Marsabit County) is one such community. The existence of effective coping mechanisms is vital for the survival of these communities. This exploratory study sought to investigate the coping mechanisms that pastoral communities have employed in Maikona Location and their sustainability. The study employed both quantitative and qualitative methods, targeting 145 respondents including 127 Households respondents, 14 Youth and Women group members in FGDs and 4 technical/NGO representatives. Questionnaires, FGDs and key informant checklists were used as the main tools. Data were analyzed both descriptively and inferentially. It is envisioned that the study would give vital information to pastoral development stakeholders and policy makers on the actual impacts facing the pastoralists, the existing and appropriate coping mechanisms while guiding on the interventions and policy options. The study found out that there had been real and perceived changes both in the rainfall and temperature patterns. Field inquiries indicated a great change in rainfall patterns (94%) between 1980 and 2010 as well as a significant trend of decline from the data of the metrological department. These changes were established to be negatively impacting livestock production and the livelihood of the community in the study area. The local community was found seeking for relief food, buying food on credit and selling livestock asset as the common coping strategies. However, the sustainability of those strategies is in huge doubt since most of the respondents were not even sure of their longevity while others admitted they may not use them for long. Moreover, majority (84%) of the respondents could not tell the consequence of their strategies on the environment. The external supports provided to the communities were largely in response to emergencies and were not seen as sustainable in the long term. The study recommended that the metrological department should share rainfall data constantly with the pastoralists for them to understand the dynamics of rainfall and temperature variations on livestock production and possible coping strategies customized for their situation as well as advise them on sustainability. The study further recommended the need for a long-term support like establishment of livestock market, support to education through sponsorship and adopting policies that support mobility as opposed to sedentarization of the communities.

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

Climate change has been defined as a significant variation of the mean state of climate relevant variables such as temperature, precipitation and wind over a period of time, mostly to be taken as over 30 years (IPCC, 2007). Global climate change is a major threat facing humanity. According to Intergovernmental Panel on Climate Change (IPCC, 2007), climate change has led to an increase in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea level. At continental and regional levels, numerous long term changes in climate have been observed and include the widespread changes in precipitation amounts and distribution, ocean salinity, wind patterns and aspects of extreme weather resulting to droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. These changes threaten community livelihoods, ecosystems and social groups (Watson *et al.*, 1998; O'Brien and Leichenko, 2000). Agriculture/Livestock production sector as a livelihood option is one key sector which will bore the brunt of these changes in climatic conditions.

One region of the world where the effects of climate change are being felt particularly hard is Africa. Because of the lack of economic, development, and institutional capacity, African countries are likely to be among the most vulnerable to the impacts of climate change (IPCC, 2001). Thus, climate change impacts have the potential to undermine and even, undo progress made in improving the socio-economic well-being of Africans including East Africans (WWF, 2006). The negative impacts associated with climate change are also compounded by many factors, including widespread poverty, human diseases, and high population density. The increasing population pressure is estimated to double the demand for food, water, and livestock forage within the next 30 years (Davidson *et al.*, 2003).

Arid and Semi-Arid Lands (ASALs) and the poor in society are the most vulnerable and likely to be hardest hit by climate change due to their low adaptive capacity (IPCC, 2000). The risks threaten approximately 70% of rural people living in extreme poverty

around the world (OECD, 2001). Developing countries are experiencing the adverse impacts of climate change despite their low contribution to the greenhouse gases.

Therefore, climate change poses a serious threat to livelihoods and food security of millions of people living in the arid and semi-arid lands in Africa (WWF, 2006). This is because the agricultural systems and food production in the entire Sub-Saharan Africa (SSA) primarily rely on rainfall that is climate sensitive (Kietemi *et al.*, 2009). Analysis of climatic data in the region shows that the coefficient of variation of rainfall in semi-arid tropics can be as high as 50% while most of the annual rainfall often falls in few rainfall events within three to five months of the year. Predictions indicate a more severe crop production decline is expected in many parts of Africa leading to hunger, malnutrition, insecurity and migrations (Kietemi *et al.*, 2009).

In Kenya, over 80% of the country's landmass is classified as ASALs. The ASAL areas are prone to drought and unpredictable rainfall as well as other natural disasters. The region is home to about 10 million people and supports about 60% of Kenya's livestock population estimated at 60 million. Indeed, the livestock sub-sector in the ASAL accounts for 90% of the employment and more than 95% of the family incomes (GoK 2010) hence the sub-sector is the major enterprise in these ASALs. The subsector contributes 40% of the agricultural Gross Domestic Product (GDP) and 12% of Kenya's total GDP (GoK 2010).

However, the ASAL areas face a number of challenges, including impacts of climate change. According to KARI (2004), one of the main challenges facing the ASALs ecosystem is how to enhance communities' resilience whose livelihoods depend entirely on climate-sensitive resource. The vulnerability of pastoralists is escalating due to recurrent natural disasters joined with the increasing population growth and declining carrying capacity of the land. There is an agreement that pastoral areas face an increased risk of drought events due to increased rainfall variability and high temperatures (IPCC, 2007). Climate change impact has pushed many of the households in the ASALs resort to a number of coping strategies. It is evident that many pastoral households have resorted to settling near trading centres and water points to access relief food, water

without burdening their beast of burdens and to seek for casual employment and also to allow easy movement of their herds. However, failure of such coping strategies might endanger the very own survival of the pastoralists and there is already some fear that pastoral livelihoods, especially in East Africa, are fast becoming unsustainable more rapidly than other forms of rural livelihood (Morton, 2010). The pastoralist might therefore be in danger of being the first environmental refugees. The pastoral system, therefore, needs more research on the impact of climate change (DFID, 2009). This study is thus an effort aimed at reducing this gap by looking at the specific impact climate change has on the livelihoods of the pastoralists and what they do to cope as well as analyzing the effect of those coping mechanisms.

1.2. Statement of the Problem

Many researchers assert that pastoralism is the most resilient form of land use for Arid and Semi-Arid areas and has evolved over time with adaptation strategies for survival (UoP, 2009). This resilience is now challenged by climate change impacts mainly through recurrent droughts. As pastoralists fight to survive, they are employing coping strategies which might see them exist or abandon the pastoral form of livelihood all together. Failure of such coping strategies might endanger the very own survival of the pastoralists and pastoralism as a form of livelihood. There is already some fear that pastoral livelihoods, especially in East Africa, are fast becoming unsustainable. This is because as they struggle to survive, pastoralists might resort to coping mechanisms that might injure the environment further. As DFID (2009) asserts, there is therefore need for more research into the impact of climate change on the pastoral system and possibly the nature of the coping strategies the pastoralists are employing to survive. This study therefore aims at filling part of this gap by assessing the climate change impacts and specific coping strategies the pastoral communities employ in Maikona location of Marsabit County.

1.3. Objectives of the study

1.3.1 Main Objective

The main objective of the study was to investigate the effects of climate change on livestock production and the strategies employed by the pastoralists in Maikona location of Marsabit County to cope with those effects.

1.3.1. Specific Objectives

The specific objectives of this study were to:

- i. Trace the trends of rainfall and temperature in Marsabit between 1980 and 2010
- ii. Examine the effect of change in climate parameters on livestock production in the study area
- iii. Assess the strategies employed by the pastoral households to cope with the change in climate parameters
- iv. Evaluate the sustainability of the coping strategies employed by the households.

1.4. Research Questions

The study was carried out to answer the questions below:

- i. What is the trend of rainfall and temperature patterns in Marsabit between 1980 and 2010?
- ii. How has the change in climate parameters affected livestock production in Maikona location of Marsabit County?
- iii. What coping strategies have the pastoralists employed to cope with the changes brought about by changing climate parameters of rainfall and temperature?
- iv. How sustainable are the coping strategies employed by the pastoral households?

1.5. Research Hypotheses

The study was conducted to test the following null hypotheses:

- i. There is no significant change in rainfall amount and temperature in Marsabit between the year 1980 and 2010
- ii. There is no significant change in livestock production in Maikona Location of Marsabit County

- iii. There are no coping strategies employed by pastoralists in Maikona Location to cope with changes in climatic parameters of rainfall and temperature
- iv. The coping strategies employed by pastoral communities of Maikona Location to cope with changes in climatic parameters of rainfall and temperature are not sustainable

1.6. Significance of the study

The study will inform the pastoral development stakeholders and policy makers on the current status of climate change impacts on livestock production in the study area. The study results will thus guide the policy options, interventions and essential support necessary for sustainability of the nomadic pastoralists. Development actors like the Ministry of Agriculture, Livestock and Fisheries, National Drought Management Authority (NDMA) and Non-Governmental Organizations (NGOs) will utilize the findings and recommendation of the study to improve their interventions. Government agencies and other development actors can utilize the findings of the study to formulate and target awareness and sensitization programmes aimed at influencing the appropriate coping strategies for the pastoral communities. Interventions can be developed to discourage and curtail unsustainable coping strategies adopted by the communities.

1.7. Conceptual Framework

Climate change has impacts on livestock production mainly as a result of extreme weather events. These extreme weather events undermine the delicate ecosystem balance on which the pastoral system depends. In the study area, the significant variable is rainfall which is expected to decrease in many dry lands of Africa (Hesse and Cotula, 2006). The quality, quantity and spatial distribution of natural pastures and water, shaped by rainfall patterns, will be affected if the rainfall pattern changes significantly. This will in turn directly affect livestock production of pastoral areas. If sustainable coping strategies were employed by the pastoral households, with well-targeted external support (by Government and NGOs), the impact of the change on the livestock production will be reduced to sustain and even enhance the pastoral livelihoods. The

nature and magnitude of those coping strategies will influence the impact and pressure on the livestock production system for it to be sustained, and enhanced.

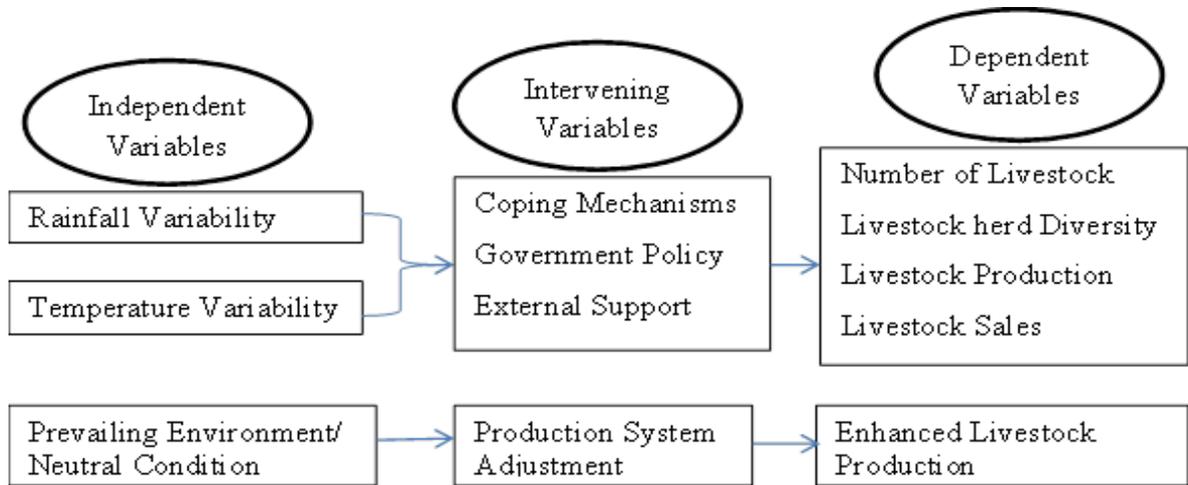


Figure 1.1: Conceptual Framework, Source: Author (2015)

In the conceptual framework (Fig. 1.1), variability in rainfall and temperature influence livestock production. These two factors of climate were the independent variables upon which livestock production factors depend. The nature of rainfall and temperature changes dictates the prevalent condition under which the pastoral communities live with their major livelihood option of livestock rearing. The prevalent changes in climatic variables of temperature and rainfall is thought to negatively affect livestock production which is believed to erode the livelihoods quality of the pastoral communities, especially for purely pastoral communities like the Gabbra community in Maikona location. To avert this and to sustain their livelihoods, the community will strive to employ some internal coping mechanisms among them increased rate of migration, relying on relief food and borrowing food from relatives/shops, among others, while development actors do also come into play to support the community under the influence of government policies and regulatory environment. These actions are thought to help cushion and reduce the impact of reduced livestock production and deteriorating livelihoods. Indeed, the internal coping mechanisms and external support are all geared towards sustaining the livestock production and preserve the livelihoods. However, if the coping mechanisms and the external interventions are well selected and properly

delivered, the targeted livestock production may even be enhanced thus improving the livelihoods of the community.

1.8. Scope of the study

The study was conducted in Maikona Location of Marsabit County. The study targeted the purely pastoral households largely inhabited by Gabbra community.

1.9. Limitation of the study

The study was limited to Maikona location of Marsabit North District in Marsabit County. For a more conclusive result, all the pastoral regions may need to be studied which was not possible due to constraints such as distance, terrain and accessibility. Moreover, 1980-2010 is a short time to make an authoritative conclusion for climate parameters. In addition, there is general dearth of published literature on issues of climate change among pastoralists in the study area. The review of literature was thus largely drawn from materials from NGOs assessments and literature from other regions of Africa.

1.10. Operational Definition of Terms

Climate Change: Refers to a long term (over a decade) change in climate patterns that can be identified by changes in the mean and/or the variability of its properties whether due to natural variability or as a result of human activity

Climate variability: This is the fluctuation of the climatic parameters of a region from its long term mean.

Livelihoods: Refers to means of securing the necessities of life or supporting one's existence

Pastoralism: Pastoralism is the livelihood activity of rearing livestock often moving with the herds in search of fresh pasture and water (nomadism).

Coping strategies: Refers to the ways that people employ to tolerate, reduce, or minimize adverse impacts, in this case, climate induced adverse impacts on their livelihoods.

Sustainability of coping strategies: The capacity of coping mechanisms to endure and be used for long without injuring the environment and the livelihoods of the people using

Climate Change Impact: These are positive or adverse consequences of long term changes of climatic patterns on people and environment. These impacts may be manifested in adverse weather events like flooding and drought, melting of snow and glaciers, rising of sea levels

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

There has been linear rising trend in temperature over the last 50 years from 1956-2005, an increase of about 0.13°C per decade (IPCC, 2007) globally. Records on precipitation indicate that there are changes in precipitation pattern. Precipitation significantly increased in Eastern parts of North and South America, Northern Europe and Northern and Central Asia. However, it declined in the Sahel, the Mediterranean region, South Africa and parts of South Asia. Generally on global level, drought is likely to extend further (IPCC, 2007).

These variabilities are expected to impact livelihood globally either positively or negatively but more the latter. Much of these negative impacts will be felt in Africa mainly due to decreased precipitation and increased temperatures predicted and being felt in the continent. As indicated in the report of Working Group II of the IPCC, the developing countries will be hardest hit (IPCC, 2001). IPCC (2007) also depicted Africa as one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of multiple stresses occurring at various levels and low adaptive capacity. Africa and mainly Sub-Saharan Africa is thought to be more vulnerable to climate change because of its dependence on agriculture and natural resource, warmer baseline climates, low precipitation, and limited ability to adapt (Kurukulasuriya and Mendelsohn, 2008; Nhemachena and Hassan 2008). The vulnerability is further aggravated by the fact that current climate is already severe, present information in poorest and technology change has been slowest in Sub Saharan Africa (Kotir, 2010).

2.2 Impacts of Climate Change

Climate change is affecting rains, increase in frequency of drought and rise in temperatures, threatening the availability of fresh water for agricultural production and other uses (Kotir, 2010). IPCC (2007) concluded that climate change may severely compromise food production and food security in many African countries. This is

mainly because farming in Africa is highly dependent on rainfed agriculture (GECHS, 2008) either through crop production or livestock rearing.

2.2.1 Temperature

The continent of Africa is generally noted to be hot and dry with current trends showing warmer spells than it was 100 years ago (Hulme, 2005; Kurukulasuriya and Mendelsohn, 2008; Kotir, 2010). Warming trend has been noted likewise since 1960s. The 21st century has been warming at about 0.5°C/century (Kotir, 2010). Hulme *et al.*, 2005 in Kotir 2010, recorded 1987 and 1998 as the warmest years. Sub-Saharan Africa (SSA) is anticipated to warm as it lies in tropical and subtropical latitudes, where temperatures are high throughout the year (Kotir, 2010).

In future, the whole of Africa is expected to warm across all seasons throughout the century (Kotir, 2010). In SSA, by 2100, the temperature rise will be about 2-4.5°C which is expected to be stronger than global average (Muller, 2009).

High ambient temperature, relative humidity and radiant energy compromise the ability of animals to dissipate heat. As a result, there is an increase in body temperature, which in turn initiates compensatory and adaptive mechanisms to re-establish homeothermy and homeostasis. These re-adjustments, generally referred to as adaptation, may be favourable or unfavourable to economic interests of humans, but are essential for survival of the animal. For an already hot area though, the adjustment are largely unfavourable. Thus, an increase in air temperature would affect directly animal performance by affecting animal heat balance. Therefore, when temperature rises above normal, for already hot areas like Maikona, animal heat exchange is affected. They fail to dissipate the extra heat load accumulated during the day hence affecting the animal's thermoregulation and feeding behaviour. The result is a significant decline in milk production and reproduction. Extreme events, may also affect beef animals.

2.2.2 Changing Precipitation Pattern

In Sub-Saharan Africa, rainfall pattern is mainly influenced by El-Niño Southern Oscillation (ENSO) events. These often result into frequent extreme weather events such as droughts and floods which lead to reduced food production causing severe food shortages (Dore, 2005; Haile, 2005). According to observations, ENSO influences contrasting rainfall variability in Sahel, East Africa and South East Africa with Sahel becoming drier, East Africa being wetter and South East Africa being stable (Kotir, 2010). Though the IPCC AR4 suggested potential increases in mean precipitation across East Africa, especially in summer, some recent work has contradicted this, suggesting the potential for decreased rainfall over Kenya in the future. Recent analysis has shown increasing drought and the country is exposed to a high water security threat. However, large uncertainties remain, and as such, knowledge is little improved beyond that reported in the Intergovernmental Panel on Climate Change Assessment Report 4(IPCC AR4).

2.2.3 Extreme Weather Events

In many parts of SSA, natural disasters revolve around either too much rain (flooding) or too little rain (drought). Unpredictable rainfall and increased temperatures are projected to increase frequency and intensity of the extreme weather events. Droughts and floods have been commonly experienced in many parts of SSA especially around the Horn of Africa and the Sahel (Kotir, 2010). A third of population in Africa resides in drought prone areas and therefore is vulnerable to the impact of droughts (UNDP, 2008). It is indeed recorded that in the Sahel, the Horn of Africa and Southern Africa since 1960 drought is strongly persistent (UNDP, 2008). Closer home, in 1990s and 2000s, a number of East African countries, including Ethiopia, Kenya and Somaliland, have suffered severe droughts. Food was scarce and rendered many people food insecure. According to UNDP's Human Development Report 2007/8, the 2000/2001 and 2006 droughts were the worst in the last 60 years in Kenya affecting more than 3.5 million people.

Climate in East Africa is said to be more variable and less predictable. Global climate model predicts increased temperatures, shifts in rainy seasons and intense rains (Nassef *et al.*, 2009), but why the frequent droughts? Could this be uniform over the whole of East Africa? What will be the case of ASAL areas? One thing is certain, that the past droughts have hit hard the ASAL areas whose main habitats are pastoralists.

One main impact of climate change on pastoralists is in the protracted drought. According to a UNDP Human Development report of 2007/2008 in UN OCHA (2009), the area affected by drought will double by the end of this century from 25% to 50% though the number of droughts might not increase significantly, they are likely to last for longer. This will make recovery difficult. The mean annual number of people killed and affected by drought in East Africa, for instance, has increased over ten folds within the last 30years from 584 per 100,000 people in 1974-78 to 6067 per 100,000 people in 1999-2003 (UN OCHA, 2009).

Drought often leaves tracts of other impacts on pastoralists. According to UN OCHA (2009), key among them are poverty, conflict, food aid dependency and migration (some of which are cross border). Pastoral poverty is intrinsically linked to climate vulnerability. What characterizes both poor and rich pastoralist is vulnerability: a major drought or animal disease outbreak can reduce a rich pastoralist to destitution in a few days. Drought creates scarcity of resources like water and pasture whose pressure often trigger conflicts among pastoralists. Such conflicts often create insecurity even in neighbouring non-pastoral areas leading to displacement of people. A 2007 UNEP post-conflict Environmental Assessment report on Sudan cited in UN OCHA (2009), for example, notes that competition over scarce resources such as water and pasture, brought about by climate change, is one of the triggering factors of conflict in Northern Sudan. Another impact of drought among pastoralists is dependency on food aid. Absence of mitigation of impact of climate unpredictability among pastoralist is increasing humanitarian emergency and this has led to persistent dependence on food aid (UN OCHA, 2009). This is true for pastoralists of Northern Kenya who have been on food aid since the year 2000.

During severe droughts, pastoralists often migrate to far zones to look for pasture residue and access water sources. As rainfall becomes more unpredictable, and the environment becoming more unstable, mobility will be even more important (Le Hou'rou, 1996). Sometimes, migration may mean even across international borders as faced by the Maasais who often cross to Tanzania, Pokots to Uganda, Turkana to Sudan and Gabra and Borana to Ethiopia. According to the IOM report cited in UN OCHA (2009) cross-border migration has already been a livelihood strategy for generations. This is particularly true for pastoralist in the Horn of Africa with significant implications for cross-border conflicts (UN OCHA, 2009).

2.3 Climate Change Coping Strategies among Pastoralists

Of all the natural resource based land uses in the dry land, pastoralist functions better within the context of wide rainfall variability and unpredictability. This is because it presents a more logical adaptation route than other livelihood activities and land uses which do not have the advantage of mobility (Nori and Davides, 2006; Anderson *et al.*, 2009). Pastoralists therefore employ various coping strategies to deal with climate and non-climate stress. Some of the common coping strategies are migration to market centres, seeking casual employment, seeking refuge in education (GECHS, 2008). Le Hou'rou (1996) noted that many East African Pastoralists (Somali, Redille, Gabbra and Samburu) have shifted from cattle husbandry to camel rearing in response to the deterioration of their environment. Another group like Turkana has increased the proportion of goats to sheep. From the trend, one question that begs an answer is “what next?” Which is their next option?

One seemingly effective and probable strategy for the pastoralists in the long term is further diversification of their livelihood both within the pastoral system (i.e. increasing reliance on more drought-resistant species such as camel) and out of livestock production (UNCCD/UNDP/UNEP, 2009). However efforts to diversify out of livestock production are likely to be constrained by the difficult environment characterizing the pastoral areas especially in the harsh conditions similar to the study area.

Moreover, in the face of unprecedented rainfall variability and shifts, the rich indigenous coping strategies might not be sufficient any more to reduce the negative impacts of climate change nor are such strategies adequately supported (GECHS, 2008). In absence of adaptation or any coping strategy, most of the pastoralists lack the skills, skilled labour or capital necessary to specialize in another activity as a reliable source of income. Instead, most have to resort to a range of opportunistic activities, including wild foods, producing charcoal and seeking casual employment. As drought situation intensifies, the options often dwindle and more people are pushed into these few activities of marginal and decreasing returns. When faced with severe and prolonged climatic events, some of the most vulnerable people have to sell key productive assets such as land, livestock, farm tools, roofs from their homes or even resort to prostitution, thereby endangering their lives and livelihood in the long term, which for many leads to destitution (GECHS, 2008).

2.4 Sustainability of Climate Change Coping Strategies among pastoralists

Among the coping strategies observed to be commonly used by the pastoralists to cope with the main hazard of drought include; buying food (on credit), getting assistance from relatives, seeking for relief food, selling livestock and other household assets to buy food, borrow food, seek for casual work, reducing number of meals, skipping meals, engage in petty businesses, and moving to market centres (Gwambene and Majule, 2009). It is worth noting that a successful coping strategy usually develops to an adaptation mechanism. An example is the mobility of pastoralism. This was a coping strategy that developed and became a characteristic adaptation of pastoralists. In face of increased rainfall variability and scarcer resources of pasture and water, the pastoralists have intensified their mobility. Other strategies include separation of livestock herds and charcoal burning.

Because of the changing climatic conditions and socio-political factors, experts argue that the adaptive capacities of pastoralists have eroded, so that they have become more susceptible to climate change than ever before and that their coping mechanisms may no longer be considered as effective options for mitigating the adverse future climatic

impacts (University for Peace, 2009). According to UNDP (2008), many of the coping strategies that have served drought affected communities well may become inadequate in light of the frequent occurrences of droughts, rapid socio-economic and long-term climatic changes. It is obvious that the increased frequency of drought events have challenged the effectiveness/sustainability of these coping strategies. With dwindling natural resources (water and forage), there is little the pastoralists can do to create access to such resources. According to Land O'Lakes International (2007), for pastoralists, adapting and coping with shocks is the norm but in today's environment pastoralists find they are unable to cope effectively if at all. The question that begs answer from these observations is what other coping options have the pastoralists turned to?

2.5 Summary of Research Gaps

The following is the research gap that this study tries to address.

- i. Indigenous coping mechanisms are not sufficient any more
- ii. Options for the pastoralists are rapidly dwindling

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Geographical Features of the Study Site

Maikona location is within Chalbi desert in Kenya. Consequently the rainfall in the study area is usually erratic, unreliable and highly variable in space and time. However, rainfall is the most important climatic factor affecting biological productivity and the overall economy of the residents. The area receives a bi-modal rainfall pattern averaging about 200-300mm per annum (Climate Data-org, 2015) though quite unpredictable. Maikona location generally experiences high temperatures of about 35°C during the day and accordingly, high evaporation rates. The average temperature in the area is about 30°C.

Maikona location lies at the edge of the desert basin below 600 m A.S.L. The vegetation mainly comprises annual species of poor quality grass, which are irregular in distribution. The zone receives an average annual rainfall of about 200-300 mm

The main economic activity in the area is pastoralism. However, the area can hardly support cattle rearing but can be used by camels and small stock because dwarf shrubs are abundant. The grazing seasons are extremely short, lasting for a few months after the rains. The soils are for most parts shallow and gravelly sandy loam. This condition made the inhabitant to adopt nomadic form of lifestyle to survive unpredictable precipitation. However, recently, due to frequency of droughts, they have tended to settle around the trading centres and water points to allow the livestock to move as quickly and as frequent as possible to take advantage of the lightest showers even when it is far away. Therefore, settlements are scattered around water points and trading centres of late. When livestock move around, often the children and the elderly are left behind at these centres like Maikona.

3.2. Design and Locale of the Study

The study was an exploratory one that employed both quantitative and qualitative methods. It used the cross-sectional survey approach. The major focus was to assess how climate change has impacted on the livestock production system and the nature of

coping strategies that the pastoralists have employed towards the impact of climate change. The study, further examined the sustainability of the coping strategies. The study site was Maikona location of Marsabit County. The study area was chosen because it is largely a pastoral district and is thought to give a good insight about the impact of climate change on pastoral livestock production system.

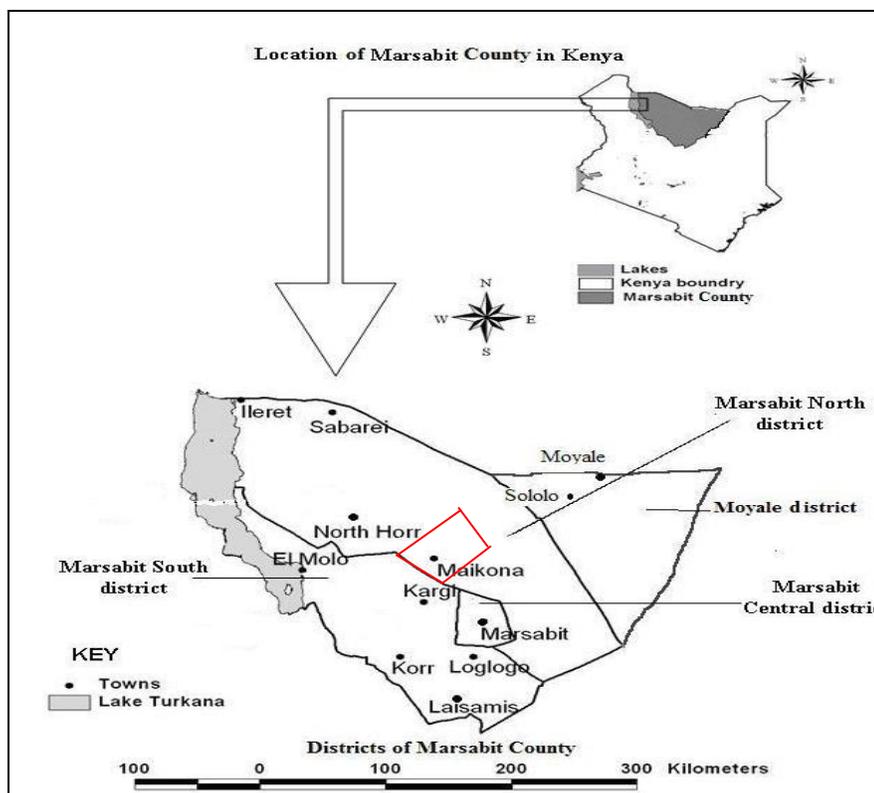


Fig 3.1: Map showing the study area in Marsabit County in relations to Kenya
Source: Waweru, 2010.

The specific site was Maikona sub-location. The study was conducted in villages around the Maikona trading centre whose geographical coordinates range from $2^{\circ} 54' 02.30''\text{N}$ to $2^{\circ} 57' 16.70''\text{N}$ and $37^{\circ} 37' 55.40''\text{E}$ to $37^{\circ} 40' 03.60''\text{E}$

3.3 Study Population and Sampling Procedure

The study was conducted in Maikona location of Marsabit North District. A total of 145 respondents participated in the study including 127 household respondents, 14 Youth and Women group members in FGDs and 4 technical/NGO representatives. As per the

2009 census data, Maikona had a total of about 1265 households. The households acted as the sampling frame. The researcher sampled 10% of the total households for the study in accordance with Mugenda and Mugenda (2003) sample determination. The 10% taken translates to a sample of about 127 households in three village clusters as shown in Table 3.1. The sample households were selected using systematic random sampling.

Pre-determined household interview schedule was used to collect quantitative data while qualitative data were captured using focus group discussions (FGD) and key informant interviews. The heads of households were the main respondents. In case the head was not available, the senior most adult present was interviewed. The researcher also interviewed purposively selected key informants namely the Livestock production officer, Metrological Department officer, Arid Land Resource Management Officer and a Pastoralist Community Initiative Development and Assistance (PACIDA) officer as an NGO representative. Moreover, apart from the key informants' interviews, the researcher also carried out Focus Group Discussions (FGDs) with members of the pastoralist households. Youths (both females and males) and adult females were mainly targeted in the focus group discussion so as to incorporate their views. This was because household heads who were thought to be respondents for the household questionnaires were expected to be mainly male adults. The groups had at least six members with consideration of homogeneity in each group to enhance openness. In addition, secondary documents were reviewed to triangulate and compare the emerging issues. The secondary documents reviewed included previous studies, documentary and programme reports by non-governmental and governmental bodies.

Table 3.1: Village clusters and the number of households sampled.

S/No.	Village Clusters	Number of respondents
1	Oromo Gala/Katello Demo	46
2	Guyo Roba	41
3	Diba Okotu	40
Total		127

3.4 Research Instruments

In order to gather information, questionnaire was the main tool used to get views of the pastoralist households, while Focus group discussion checklist helped gather information from the groups, mainly through resource trend analysis, problem analysis and historical resource trends. Key Informant checklist was also used to gather information from officials of Ministry of Livestock, Meteorological Department and NGOs while a documentary review for climate change parameters was done.

3.5 Data Collection

The data collected included; the traditional weather patterns of the area, historical climatic variables (temperature and rainfall) trends, the awareness level of the pastoralists about the changing climate, the trend of the priority livestock numbers as an indicator of production within the last ten years, the types and nature of the impacts the changing climate variability has had on the livestock production for the priority species and the coping strategies the pastoralists have employed in reaction as well as the existence of external support to help the pastoralists adapt to the climate change impacts.

3.6 Data Analysis

The questionnaire data were coded, tabulated and analyzed using Ms excel. The data collected from the officials and key informants were largely analyzed descriptively in line with the research questions. The analyses were used to draw statistical and descriptive inferences. Descriptive statistics were computed to establish the percentage of responses and coefficient of correlation was computed to assess whether there was any relationship between climatic variables of temperature and rainfall and livestock production. The results of the analyses were presented using graphs (mainly line and bar) and cross-tabulation tables.

CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION OF RESULTS

4.1 Introduction

This chapter presents an analysis and interpretation of data collected during fieldwork. The analysis and interpretation are done within the framework of the core objectives that the study sought to address. The respondents included members of selected households, local NGOs (PACIDA and Care Kenya), Meteorological Department and Livestock production officers. Data presented here are organized into four themes based on the key research questions that guided fieldwork for the study, which were trends and patterns of temperature and rainfall, effect of variability in climate parameters and on livestock production, coping strategies employed by the pastoral households, and the sustainability of those coping strategies. This study proceeded in different phases. The data collection phase first sought to establish the demographic and social characteristics of the respondents

4.2 Demographic Characteristics of the Respondents

This section presents some of the demographic aspects of the respondents. Accordingly, the main demographic features of the respondents featured in this section include: gender of the respondents, occupation of the respondents and level of education of the respondents.

4.2.1 Distribution of Respondents by Gender

The researcher found it important to establish the gender proportions of the respondents. The pattern of this distribution is as presented in Figure 4.1.

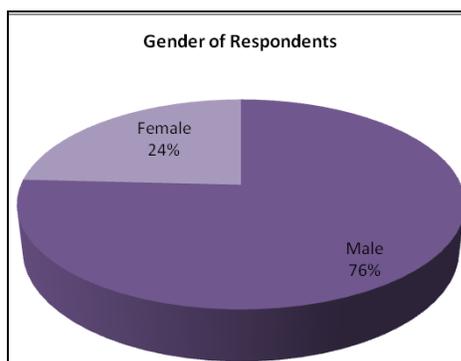


Figure 4.1: Distribution of the respondents by gender

As depicted in Figure 4.1, 76% of the respondents were men while 24% of the respondents were women. This gender distribution has a lot of implications in understanding the perception of men and women and the nature of strategies used to cope with adverse weather changes between male and female members of the pastoralist households.

4.2.2 Distribution of Respondents by Level of Education

As one of the basic indicators of one's socioeconomic status, the researcher sought to establish the level of education of the individual respondents. The pattern of this distribution is as presented in Figure 4.2.

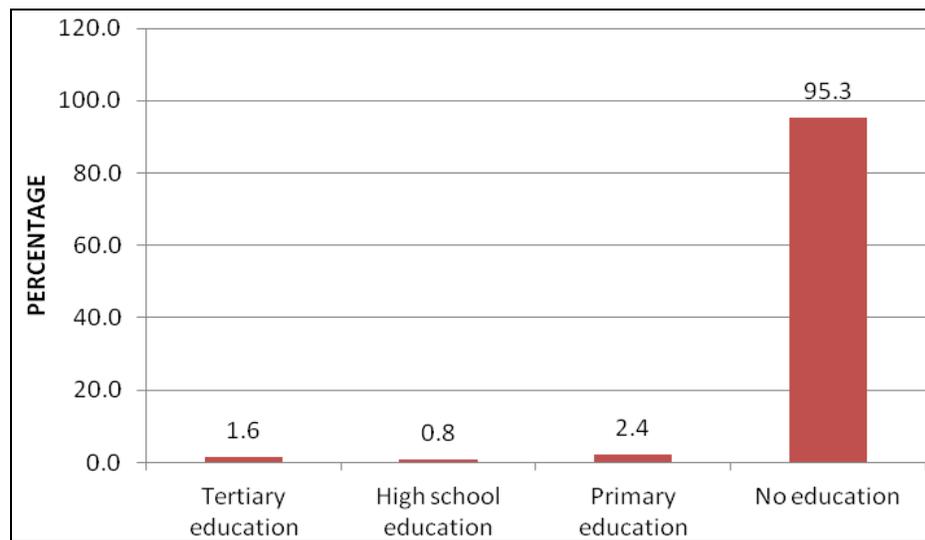


Figure 4.2: Distributions of respondents by level of education

It was clear that illiteracy was overwhelmingly high at 95% in the research community especially among adults.

4.2.3 Distribution of respondents by Occupation

Another basic indicator of socioeconomic status sought using the questionnaire by the researcher was the occupation of the individual respondents. The pattern of this distribution is as presented in Figure 4.3 below. Livestock rearing was reported to be the main occupation with 93% (n=127) of the respondents relying on it. Business, Casual

employment and those destitute relying only relief all at 2% of the respondents while those in formal employment were only one percent.

Distribution of Respondents by Occupation

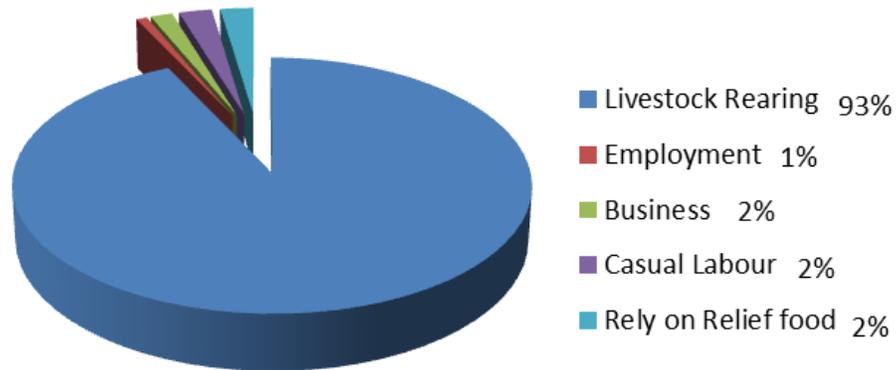


Figure 4.3: Distribution of respondents by occupation

With livestock rearing being the predominant occupation, the researcher decided to get the gender dynamics of this occupation. As shown in Figure 4.4, more males are the ones involved in the livestock rearing than their female counterparts though the difference was not significant possibly due to the fact that all family members normally took joint responsibility in rearing the family stock.

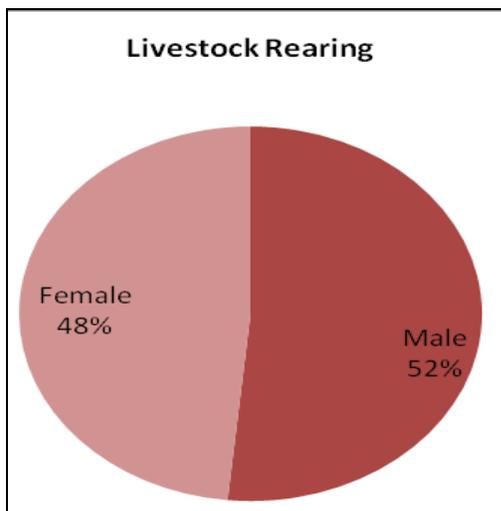


Figure 4.4: Distribution of respondents involved in rearing livestock by gender

4.3 Climate parameter variability and their effect since 1980 in Marsabit

The researcher sought, among other things, to establish the trends and patterns of climate parameters (rainfall and temperature) and its consequences since 1980 in Marsabit County in Northern Kenya. This section therefore provides the findings on this objective.

4.3.1 Trends and patterns of rainfall in Marsabit County

Respondents were asked a number of questions concerning rainfall patterns in the study site. One of the questions was whether in their opinion, there had been changes in rainfall in recent years. Their responses were as indicated below.

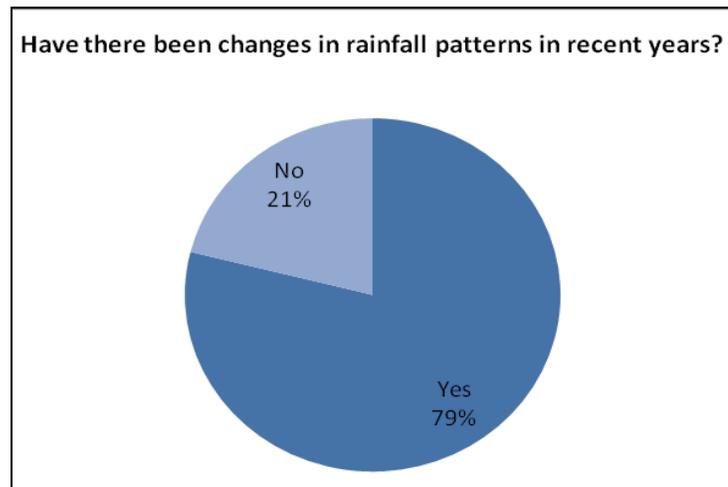


Figure 4.5: Changes in rainfall pattern in the recent years

A clear majority of the respondents confirmed that there had been some changes in the rainfall patterns (Fig. 4.5) while a minority, 21%, could not confirm whether there has been changes. It is possible that the barrier in interpretation of time and use of different calendar may have made some respondents not to comprehend the changes.

Nonetheless, the researcher sought to find out the real nature of the changes in rainfall where the respondents were asked to indicate the nature of the changes in the patterns of rainfall and the results were illustrated in Figure 4.6 below.

Nearly all the the respondents (95%), indicated that there was a decrease in the pattern of rainfall as opposed to only 5% who indicated that the changes were manifested in terms of increase in the amount of rainfall citing the rains in late 2011 as an example, which was actually outside the study period. The respondents cited the evidence of persistent drought with a good number putting the cycle of the drought at every two years.

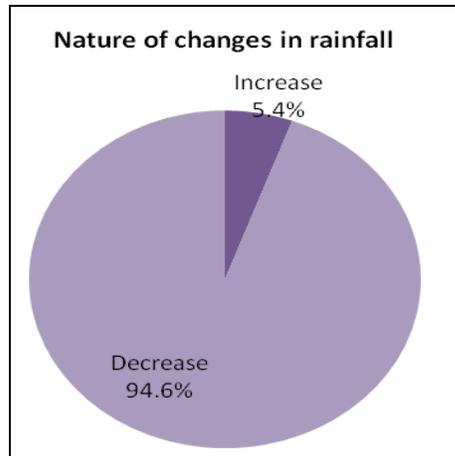


Figure 4.6: Nature of changes in rainfall

The respondents, however, seem oblivious on what causes the changes they experienced as presented in Table 4.1. The majority (38%) of the respondents negated knowledge of causes of the changes they experienced, while similarly a substantial percentage (20%) answered in a desperate manner, that it was God's plan and 12% thought that it was God's punishment for people's social ills and persistent conflict. 10% thought that it is because the area is a desert and naturally rainfall was scarce and that further desertification was worsening the rainfall patterns. Only 2% thought the changes may be due to climatic change, which was quite insignificant. This was an indicator of community's poor awareness of the climate change facts that the whole worlds is grappling with.

To corroborate the information from the pastoralists, the researcher sought rainfall data from the meteorological department and plotted in Figure 4.7. The data revealed a slight change in the pattern of rainfall which was inclined towards a decrease. There is indeed a consistent pattern of decrease save for 1997/1998 El-Niño rains. However, it is worth

noting that rainfall data are obtained from Marsabit metrological station about 100Kms away from Maikona (since no such data are available at Maikona) but can be an indication of rainfall pattern for the entire area.

Table 4.1: Reasons for the cause of changes in the rainfall pattern in Maikona

Reasons	Frequency	Percentage
For decrease		
Don't Know	48	38
Weakening cultural practices	16	13
Existing desert and desertification	13	10
Social ills and Conflicts	10	8
God's plan and nature	28	20
Climate and weather changes	2	2
Strong wind and dust	2	2
Population increase& over-exploitation of resources	2	2
For Increase		
To save livestock and humans	6	5
Total	127	100

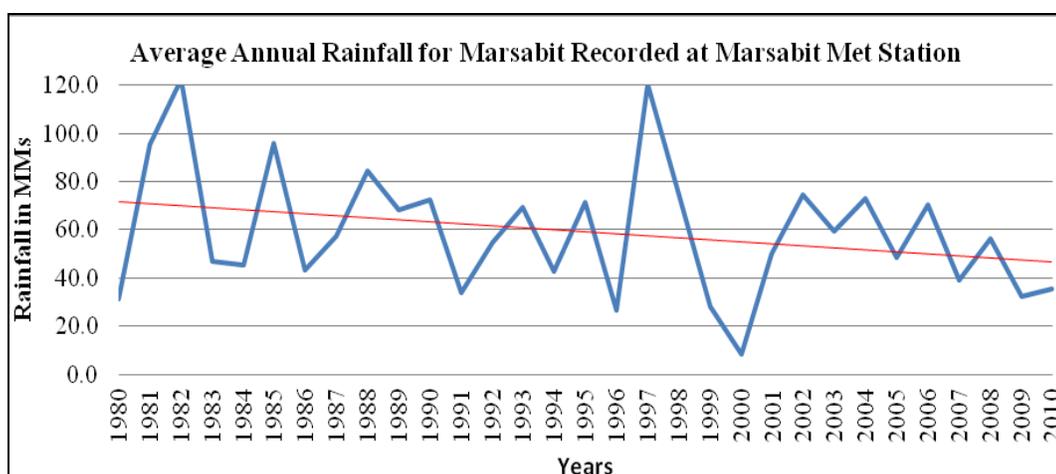


Figure 4.7: Trend in rainfall pattern in Marsabit between 1980 and 2010, Source: KMD

4.3.2 Impact of the changes in the rainfall pattern

As to the effect of change in rainfall pattern on their livelihoods, an overwhelming majority of the respondents (95%), answer were negative. These results were indicated in Figure 4.8.

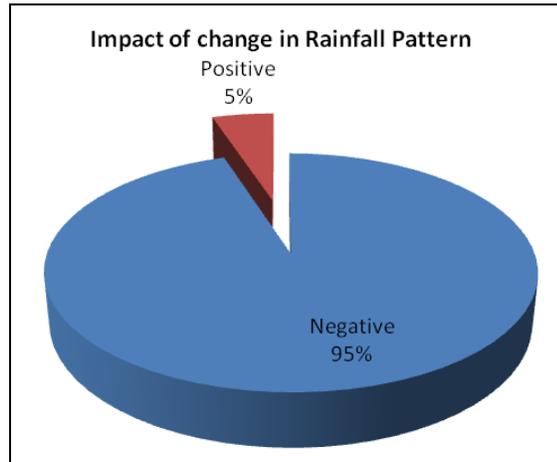


Figure 4.8: Response of impact of change in rainfall pattern

Majority of the respondents said that the change in rainfall pattern has had a negative impact on them. They mentioned reduction in pasture production which affected livestock health affecting their livelihoods. Distance to water points was also reported to increase with each drought, increasing trekking distance for the humans and livestock. Livestock die during droughts reducing their numbers and productivity. During droughts, livestock breeding is disrupted and the numbers therefore dwindle. The respondents reported relying heavily on relief food during persistent droughts.

4.3.3 Trends and patterns of temperature in Marsabit County

Besides the issues of rainfall, respondents were asked a number of questions on temperature patterns in the study site. One fundamental question asked was whether there had been changes in temperature patterns in recent years. Their responses were as presented in Figure 4.9

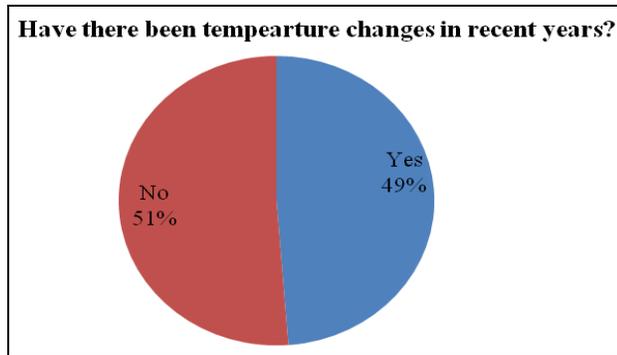


Figure 4.9 Changes in temperature patterns in the recent years

It was established that half of the respondents(51%) said they had not noticed any changes in the temperature patterns while 49 % confirmed that there had been some changes in the temperature patterns. This disparity was not anticipated but it is possible that the respondents may not comprehend or detect changes in temperature pattern though they were complaining that it was very hot those days even during the interview. Nonetheless, the researcher further sought to find out the real nature of the changes in temperature. When those respondents who claimed they had experienced some changes were asked to indicate the nature of the changes in the patterns of temperature, a whopping majority(97%) claimed to have experienced increased temperature as indicated in the Figure 4.10 below.

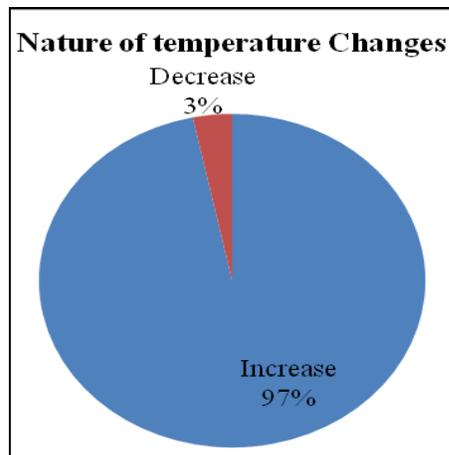


Figure 4.10: Nature of temperature changes

Probed further to give explanations as to why they thought temperature in the area was increasing, they gave the following justifications shown in Table 4.2.

Table 4.2: Justifications for the nature of changes in temperature

Justifications	Frequency	Percentage
Heat all through	23	38
Extreme hot days and cold nights	18	29
Very hot during the day	8	13
Hot days with strong dry winds	9	15
Others	3	5
Total	61	100

As illustrated in Table 4.2, it was possible that those factors could actually lead to increase in temperatures as correctly perceived. Indeed, though the respondents answered them differently, many of their answers were fundamentally related. It was therefore like they all agreed that there was extreme heat during the day. Some qualified with cold nights, with strong wind and so on. However, when probed further the possible cause of these signs and the increase in temperature, majority of the respondents had no knowledge as evidenced in the answers tabulated in Table 4.3.

Table 4.3: Reasons for temperature changes

Reasons for temperature changes	Frequency	Percentage
Unknown	42	70
Extreme sunshine	4	6
Drought	10	16
People abandoning culture	1	2
Land degradation	4	6
Total	61	100

The majority of the respondents (70%) could not tell what caused the changes in temperature directly while others allude to reasons like drought, increase in sunshine, degradation, and people abandoning their culture hence being punished.

4.3.4 Conventional temperature records

The researcher sought data from the meteorological department so as to understand the trend in temperature in the study area. Though these data were obtained from Marsabit, the researcher believed that the data can give a fairly accurate trend in the region. The trend in the temperature is shown in Figure 4.11. A close look at this trend shows that the mean annual temperature in Marsabit is increasing though marginally. However, the average minimum temperature has increased by 0.6°C as indicated in the trend line in Figure 4.12. This means the temperature is rising which collaborates the response by 38% of the respondents. On the other hand, the trend in the average maximum temperature as indicated in Figure 4.13 is nearly constant thus bringing the trend in average annual temperature at a marginal increase of 0.6°C .

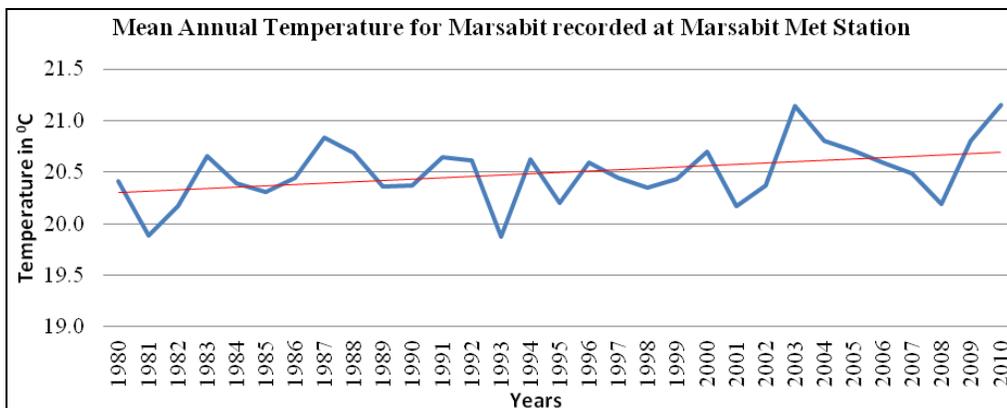


Fig 4.11: Trend in temperature pattern in Marsabit between 1980 and 2010(Source: KMD)

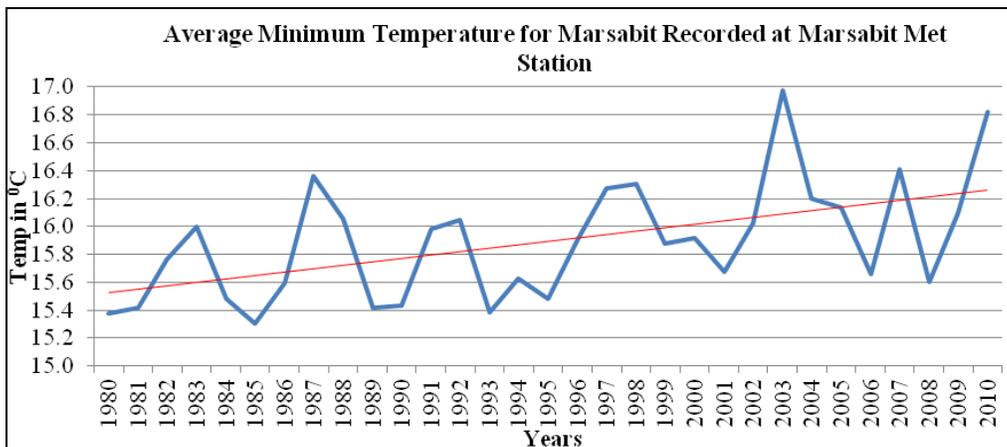


Figure 4.12: Trend in minimum temp pattern in Marsabit between 1980 and 2010(Source: KMD)

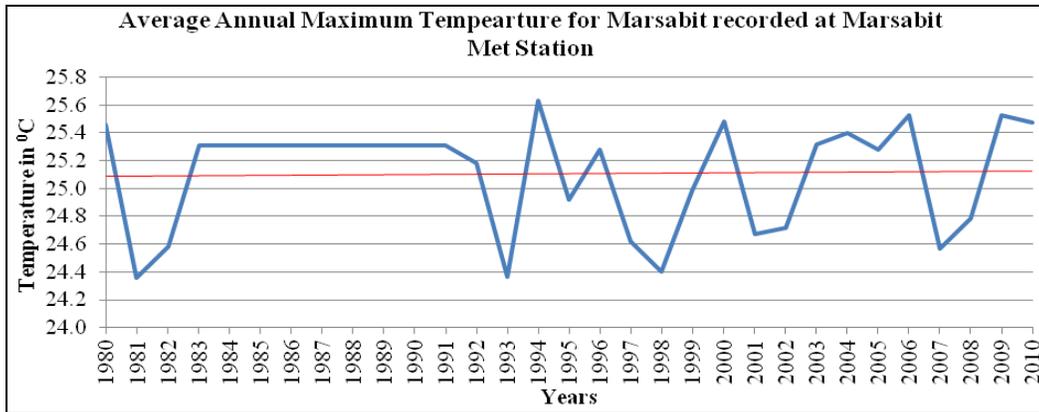


Figure 4.13: Trend in maximum temperature pattern in Marsabit between 1980 and 2010(source: KMD)

4.3.5 Impact of the changes in temperature levels

Having established the perceived and real changes in temperature and possible reasons behind the changes, the researcher sought to investigate the impact of the changes in the levels of temperature on the respondents' livelihoods. Majority of the respondents (68%) indicated that the impact was negative and a significant minority (32%) remained non-committal whom researcher concluded as lack of clear understanding to the impact or question. Figure 4.14 below shows this response.

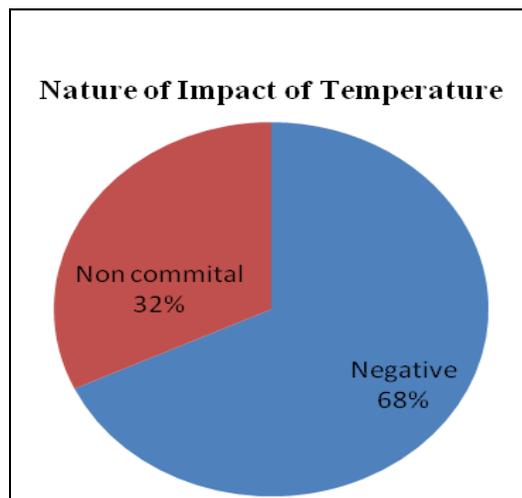


Figure 4.14 Impact of Temperature Change

Interviews held with livestock production officer revealed that the impact was negative, though he could not provide a formal data. This being a community of pastoralists who entirely depend on livestock, the harsh or rather high temperature levels made grazing

difficult or disrupt the feeding pattern of the livestock particularly during the day which reinforced the responses of negative impacts. High temperature was also noted to be unfavourable to pregnant goats which many respondents claim cause miscarriage and premature births.

4.3.6 Climate parameter variability and livestock population

The research also sought to examine the effect of variability in climate parameters and pasture availability on livestock production in study area. To achieve this, the researcher sought the respondents' opinion on whether there was any relationship between changes in the production of their livestock and the climatic variable of rainfall. Their responses were indicated in Figure 4.15.

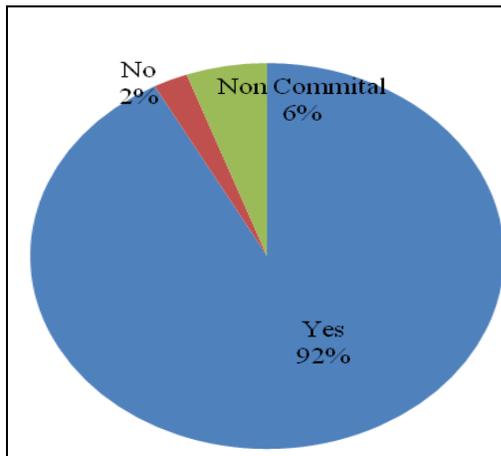


Figure 4.15: Relationship between changes in the production of your livestock and rainfall variation.

The majority of the respondents(92%) confirmed that there is a relationship between changes in the production of their livestock and rainfall. The researcher sought to find out from the respondents how the changes in rainfall affected the livestock production. Among key issues raised were; increase in rainfall increases livestock production such as milk and meat, animals multiply during the rainy season. On the contrary during the dry season, livestock production reduces since livestock population decreases because of less fodder, extreme drought and heavy torrents kill livestock. The rainfall data obtained from Marsabit metrological station in Figure 4.7 show the pattern of rainfall. From the trend line, the pattern is a downward trend. The figure shows that rainfall was highest in the year 1997/1998 during the El-Niño and lowest the year 2000 during a

severe drought which community reportedly lost many goats and sheep. The trend in population for the three top most priority livestock species in the area was plotted to establish the trend and for comparison with that of climatic parameters as plotted in the Figures 4.16, 4.17 and 4.18.

Figures 4.16, 4.17, 4.18: Distribution of the population of goat, sheep and camel in the former Marsabit District between 1981 and 2007.

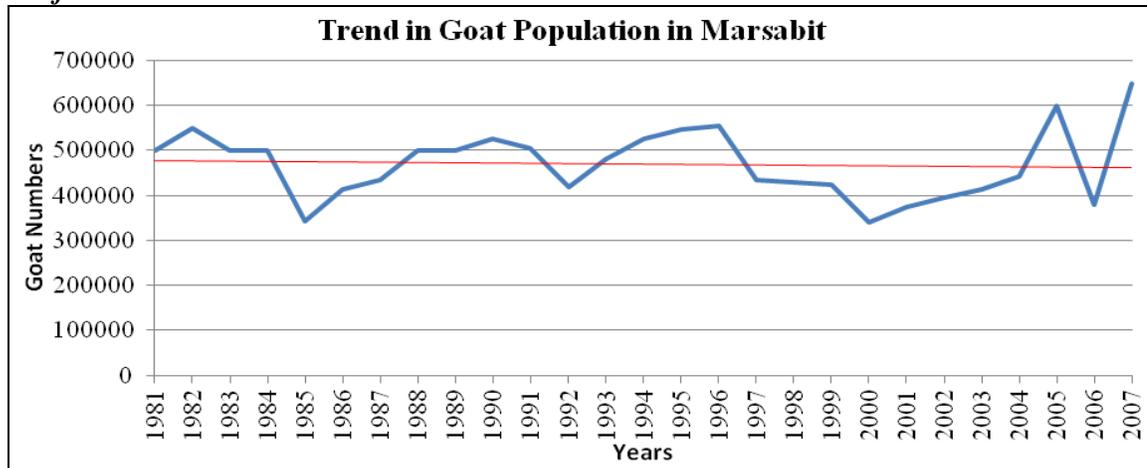
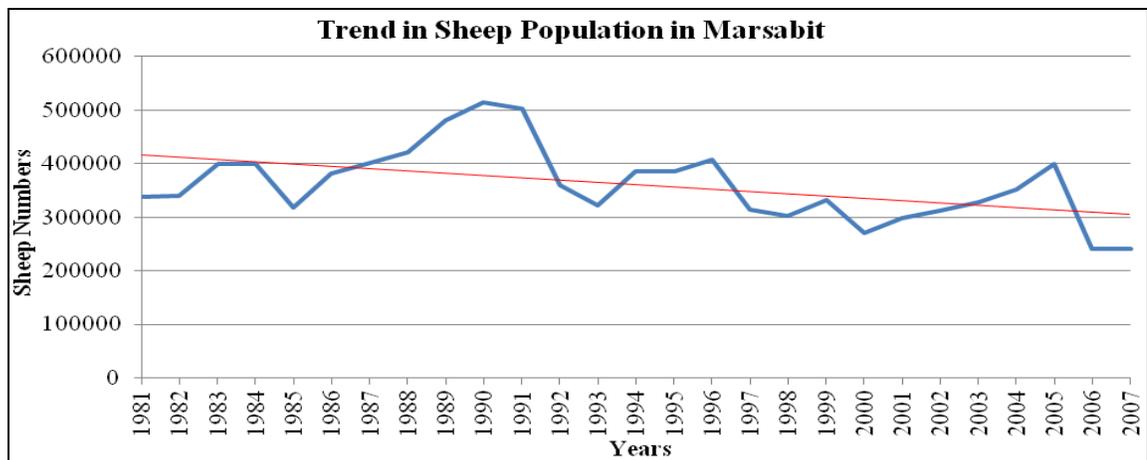
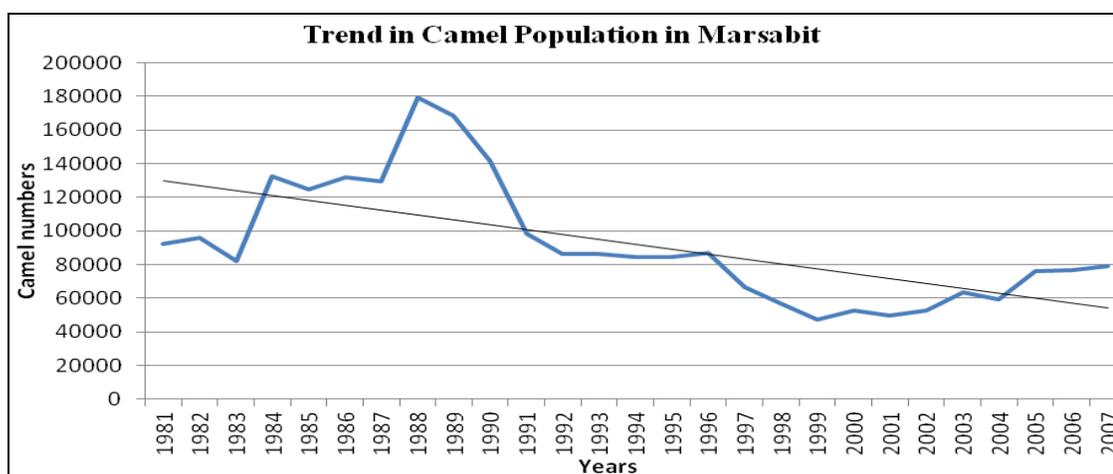


Fig 4.16: Population of goats in former Marsabit District(source: MLD)



4.17: Population of sheep in former Marsabit District(source: MLD)



4.18: Population of camel in former Marsabit District (Source: MLD)

Figure 4.16, 4.17 & 4.18 show that whereas the population of the goats remained nearly constant with only very marginal decrease over the period between 1981 and 2007. However, the decrease in the populations of sheep and camel are relatively rapid as the trend lines show. Even though the population data obtained from the Ministry of Livestock Development is not specific to Maikona Location but for the former Marsabit district, it can be a good indicator of the trend of the livestock population in the area including Maikona Location. Therefore, the researcher envisioned making some conservative conclusions based on the data. The population of goats, sheep and camel are used due to the fact that the three livestock types are the priority in terms of livelihoods support for the community in the study area as shown in Tables 4.4, 4.5 and 4.6.

Table 4.4: Priority 1 Livestock Response.

Livestock type	Frequency	Percentage
Goat	10	8
Sheep	102	80
Cattle	0	0
Camel	10	8
Donkey	0	0
Others	5	4
Total	127	100

Table 4.5: Priority 2 Livestock Type Response

Livestock type	Frequency	Percentage
Goat	101	80
Sheep	17	13
Cattle	0	0
Camel	2	2
Donkey	0	0
Others	7	6
Total	127	100

Table 4.6: Livestock Priority 3 Response.

Livestock type	Frequency	Percentage
Goat	8	6
Sheep	3	2
Cattle	6	5
Camel	100	79
Donkey	0	0
Others	10	8
Total	127	100

From the Tables 4.4, 4.5 and 4.6, it is clear that the priority livestock types in livelihoods support for the respondents are sheep, first priority at 80%, and goat second priority at 80% while camel is the third most important livestock in supporting livelihoods of the community at 79%. Therefore impact of climatic variables on these three most important livestock species is critical to the survival of the community in the study area.

4.3.7 Relationship between climatic variables and livestock population

The researcher felt there was need to find out the relationship between the climatic variables of rainfall and temperature and the three important livestock species. This

would help establish whether indeed the variations in livestock numbers were as a result of variation in climatic parameters.

Table 4.7 Pearson Coefficient of correlation values between climatic variables and livestock numbers

a) Livestock Population and Average annual Rainfall Pearson(r) coefficient of correlations values

Livestock type	Pearson(r) values
Sheep	-0.0818261
Goats	-0.0232771
Camel	0.1588662

b) Livestock Population and temperatures Pearson(r) coefficient of correlations values

Livestock type	Annual Min. Temp, Pearson(r) values	Annual Max. Temp Pearson (r) values	Ave. Annual Temp, Pearson (r) values
Sheep	-0.2232953	0.0994897	0.1175409
Goats	0.0049123	-0.0477104	-0.0962073
Camel	-0.4009187	0.0791865	-0.0695692

A closer look at the figures in Table 4.7 reveals mixed relationships which is not very obvious though in actual sense, one would expect a straight obvious relationship between livestock population and those climatic variables. This may be attributed to the quality of the data especially livestock data due to the gaps and the fact that they were mainly estimates. However, some weak relationship can be observed. The relationship between rainfall and sheep and goat population is weak and tends towards negative. One would expect this relationship to be strong and positive but this is not obvious due to the fact that the population of those livestock do increase even by a reducing margin as human population owning the livestock increases. Again the rainfall measurement is confined at Marsabit meteorological station while the livestock population is widespread and due the nomadic nature of the population, it may be difficult to correlate the two.

Nevertheless, the relationship between rainfall and camel population is positive, meaning that the camel numbers increase and decrease with the rainfall. This trend is as expected and may be accurate as opposed to those of sheep and goat due to the fact that camel population is not as high as sheep and goat naturally and even small change could be felt. Likewise, the relationship with temperature is not as straight as anticipated. The researcher decided to analyze the relationship for the annual minimum, annual maximum and average annual temperatures just to enhance the actual position. Goats and camel numbers seemed to have negative relationship with average annual temperature. This may be so because extreme temperatures do negatively affect livestock population. On the other hand, sheep population seemed to be more sensitive to minimum temperatures more than the maximum.

4.4 Coping Strategies to Climatic parameter variations

This study was also interested in establishing the strategies employed by the pastoral households to cope with climate variability and pasture availability. On this, the respondents were asked to indicate whether there were strategies they devised to survive or reduce the impact of climate variability. Their responses were captured in Table 4.8.

Table 4.8 Climatic variability coping strategies

Response	Frequency	Percent
Yes	125	98
No/Non-committal	2	2
Total	127	100

Asked which strategies they employed, the respondents outlined a number of strategies among them diversification of livestock herd, separation of livestock herd, increasing mobility of livestock herd, migration to market centres/water points, buying/borrowing food on credit, reducing frequency/quality/quantity of meals, seeking relief food and remittance from relatives, seeking refuge in education, looking for casual employment, engage in small businesses, charcoal burning, chang'aa brewing, selling of household assets and livestock. The researcher went further to establish the three top most

important priorities. According to the respondents, seeking relief food is the most important strategy at 45 % (F=57) while buying food on credit to be paid when the drought ends is apparently the second priority strategy at 32% while sale of livestock including lactating ones is the third priority strategy at 28%. Other significant strategies worth mentioning are separation of livestock herds, diversification of livestock species, increased mobility of livestock herd and seeking casual employment around the trading centres. The result were as tabulated in Table 4.9

Table 4.9: Figures of the top three most important priority strategies

Coping strategies	1st Priority		2nd Priority		3rd Priority	
	F	%	F	%	F	%
None Committal	2	2	2	2	2	2
Diversification of livestock herd	15	12	8	6	2	2
Separation of livestock herd	20	16	6	5	5	5
Increased mobility of livestock herd	10	8	9	7	7	7
Migration to market centres/water points	7	6	0	0	0	0
Buying food on credit	2	2	41	32	16	16
Borrow food	0	0	2	2	0	0
Reduce frequency of meals	1	1	0	0	3	3
Reduce the quality /quantity of meals	0	0	3	2	0	0
Rely on relief food	57	45	16	13	26	27
Rely on remittance from relatives	0	0	2	2	2	2
Seek refuge in education	1	1	6	5	3	3
Seek for casual employment	9	7	11	9	4	4
Engage in small businesses	3	2	2	2	1	1
Burning of Charcoal	0	0	4	3	0	0
Sale of Livestock	0	0	15	12	27	28
Total	127	100	127	100	98	100

4.5 Sustainability of the coping strategies

Among the many ways that sustainability has been defined, the simplest and most fundamental is "the capacity to endure." Sustainability is based on a simple principle that everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations.

4.5.1 Duration the coping strategies could be used

The researcher was therefore interested in establishing whether the coping strategies used by the respondents have the capacity to endure in serving them. In this regard, the respondents were asked to indicate the duration they thought they would continue using these strategies whose responses were as shown in Figure 4.17 below. From the distribution, it was clear that the respondents were uncertain for how long they may continue using the strategies they indicated usage. A significant number, 61%, thought that they may not use the strategy for long while 25% thought that the strategy were short-term.

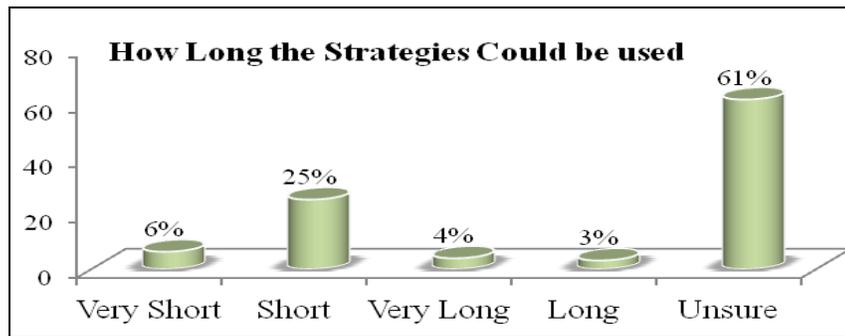


Figure 4.19 Duration for using the strategy

Probed deeper as to why they would want to use the strategies they had indicated, the respondents gave reasons like lack of capital, lack of education, decreasing number of livestock, persistent drought, unreliable relief and the general uncertainty of the weather conditions.

4.5.2 Respondents awareness of environmental impact of the coping strategies

After a significant establishment of coping strategies that the respondents employ, the researcher sought to find out if the respondents knew of any impact that their coping strategy may have on the environment. Table 4.10 shows the distribution of their responses.

Table 4.10: Knowledge of environmental impact of coping strategies

Response	Frequency	Percentage
Yes	20	16
No	107	84
Total	127	100

From the distribution of these findings, it was clear that majority (84%) of the respondents were not aware of any environmental impact of the copying strategies they employ in navigating climatic changes. This is in a way closely related to the profile of the respondents especially the educational profile. This may be an indicator of low environmental awareness and the level of consciousness.

4.5.3 Impact of the coping strategy to future survival

To cement the investigation on sustainability, the respondents were asked whether they knew if their coping strategy (ies) affected their livelihood/survival in future in any way. Majority of about 64% indicated that they knew while remaining 36% maintained that they were unaware. This again becomes an issue worthy of concern since most of the strategies employed do have some impact on the future lives of the residents yet a substantial number were unaware. Nevertheless, a question was posed to those who responded they are aware of the impact of their present strategy on their future livelihood whether they knew the nature of the impact. Of these, 86% indicated that they thought it was negative while only 14% indicated that they knew it to be positive.

Some of the explanations given for negative impacts of those scoping strategies include increase in poverty as sources of livelihoods diminish during sales of livestock, separation of family when livestock move far away as well as inaccessibility of the

livestock products such as milk during such times due to distance. As nomadic pastoralists settle near market centres or water points to access relief and water, nomadism dies out leading to high concentration of people around those centres thereby causing land degradation. Borrowing food on credit plunges family in to debts cycle and decreases family wealth while also risking bad debts for the small kiosk owners. Moreover, since majority employ reliance on relief food as a strategy, it creates dependency hence breaking down livelihoods system of the community.

On the other hand, respondents have noted that settling around the market centres for relief food and water has offered them a chance to take their children to school which secures the future of those children and the extended family. Also diversification of livestock herd has helped some respondents sustain their livelihoods since they relied on the remaining type of livestock when one is affected by the droughts. On the other hand, increased mobility of the herd is reported to have saved some herds during extended droughts.

4.5.4 Constraints inhibiting the development of coping strategies

The researcher sought to establish the constraints that inhibit respondents from developing coping strategies to cope with trends in climate variability. In their responses, 85% cited some form of inhibition to cope effectively. They mentioned two main constraints, that is, low level of education at 51% and lack of capital at 59% to set up more effective strategies. Other constraints they blamed include: The nature of land and the environment, inability to move long distance due to disability, old age, general body weaknesses and having young children that inhibit long distance movements. Others blamed poverty or having fewer numbers of livestock to support them cope effectively while some widows felt they lack adequate support to cope effectively on their own. Conflict between pastoral communities in far flung reserve grazing areas was also blamed to an extent undermining coping. It should however, be noted that they did not make any suggestions of the kinds of strategies they would have wanted to set up if they had this capital, or rather, the strategies that they had and which were hard for them to adopt because of the rather high expenses involved.

4.6 Existence of external support

The researcher sought to know whether there are any Government departments or Non-Governmental Organizations that support/ever supported them to overcome the impacts of climate variability. A majority of them, 98% confirmed that they got such support while 1.6% denied there being such support in overcoming the impact of climate variability. Since many of the respondents had indicated that there is such support, they were asked to indicate the sources of this support. Their responses are as indicated in Table 4.11.

Table 4.11: Sources of support

Supporting Institution	Frequency	Percentage
NGOs	74	58
Government Department	51	40
No support	2	2
Total	127	100

In this regards, respondents recognize the support given by government departments in helping them cope with extreme climatic conditions at 40%. The NGOs have also been mentioned as giving support in helping the people in the study area to cope the impact of climate change. The most active NGOs were Food for Hungry (FH), PACIDA, Christian Children Fund (CCF), Community Initiative Facilitation and Assistance (CIFA) and the Red Cross. The government departments that were mentioned as giving the most assistance include the Livestock department, Government department of ALMP (now NDMA) and the Department of Veterinary Services. The Department of livestock production and veterinary services combined were mentioned by many respondents having supported them followed by Office of the President (Provincial Administration) and the ALRMP/NDMA at 15% and 12% respondents respectively.

The researcher sought to find out the nature of support given by the NGOs and the government departments. Respondents gave multiple responses where they indicated having received more than one form of support. The responses were presented in Table 4.12 below.

Table 4.12: Nature of support given by government departments

Nature of Support	Frequency	Percentage
Relief-Food Voucher, Cash relief, Nutritional Supplements	124	98
Destocking and Vaccination	49	39
Animal feed relief	42	33
Non Food Items-utensils	12	9
Sponsorship of students in education	18	14

From Table 4.12, the main form of support given by government and NGOs were relief either in form of food relief, food voucher or cash relief followed by destocking and vaccination

4.7 Future strategies towards reducing the impact of climate change

The respondents were asked to give their opinion of the strategies that would be used in future and which would reduce the climate change impact. Their responses were as represented in Table 4.13.

Table 4.13: Possible future strategies towards reducing the impact of climate change

Strategy	Frequency	Percentage
Migrate out of the area	8	6
Abandon pastoralism	5	4
Diversify within pastoralism	20	16
Diversify economic activities	47	37
I don't know	47	37
Total	127	100

The responses depict a community which has probably been pushed beyond limit or with very few options owing to the number of respondents unsure of what to do, about 37%. A similar number envisions diversifying their economic activities but their options seem slim due to poverty and unfavourable environment. A small number even thought of abandoning pastoralism, an indicator of despair. However, diversification within

pastoralism was an option seen by those yet to despair at 16% of the respondents. Some of the ways suggested for diversification are adding more species of livestock, separating the herd and further increasing mobility of the herd. The researcher also took keen interest in those who would wish to diversify the economic activities to survive the vagaries of the weather. Some of the options given included seeking casual employment, engaging in petty trade and some unfavourable means like brewing chang'aa and burning charcoal. They thought these activities may help them survive but the health issues and the acceptability of chang'aa option was unresolved while the environmental sustainability of charcoal burning in an already degraded desert environment may not be feasible.

4.8 Suggestions on external intervention

The respondents were asked to indicate what they thought could be done to help them cope with climate changes. In their response, they mentioned a number of suggestions which include establishment of stable livestock markets, restocking, support education for their children, creation of awareness especially on environmental conservation, enhancement of development activities for casual labourers, creation for more opportunities for casual employment, continuous and adequate relief for both animals and people, awareness creation and capacity building on ways of coping with weather changes and the provision of water for animals in the areas with pasture and lack of water. Now that mobility is part of the lifestyle of the respondents, there were suggestions of support for mobility and continuous peace building and conflict resolution among the communities.

4.9 Discussion

This section presents interpretation of some of the conspicuous findings of this study and its comparison with the limited data available on the area. The section is organized into four thematic areas based on the key research questions of the trends and patterns of temperature and rainfall, effect of variability in climate parameters on livestock population, coping strategies employed by the pastoral households and an examination of their sustainability.

The gender composition of the respondents may have some implications in understanding the nature of strategies used to cope with adverse climate changes. The study established that there were more male respondents than female respondents. This may be influenced by the culture of the community where male, the head of the family, is the official spokesperson of the family on every matter whenever he was present especially if the information seeker is an outsider. However, since the pastoralists tend to their livestock as a family unit, the respondents gender may not have much influence on the responses given in other sections. However, it is significant that illiteracy is overwhelmingly high among adults in the research community. This is consistent with the statistics from the Kenya Bureau of Statistics (Thornton *et al.*, 2009). It is worth recognizing that the level of education influences individual's access to information, understanding of issues including climate information and options available for adaptation to adverse climatic changes.

As expected, the predominant occupation of the respondents was livestock rearing. This could be influenced by several factors chiefly the nature of the environment of the study site. Maikona sub Location is in the heart of Chalbi desert. This makes farming and other livelihood activities difficult owing to the low precipitation, the rocky nature of the soil, high temperature and soil salinity levels.

The respondents confirm that there were indeed changes in the pattern of rainfall in the study area and almost all of those respondents are in agreement that the pattern of change is that of reduction. The minority who responded the changes manifested in increase in the amount of rainfall cited the rains in late 2011 as an example, a time which was actually outside the study period, may be unable to comprehend the instruction on study time frame and due to the barrier in interpretation of time since the community uses a different calendar. Persistent drought occurring every two years was cited as an indicator of changing rainfall pattern. This finding is consistent with the prediction of IPCC(2007). However, the respondents were oblivious of what caused the changes they experienced. This ignorance was an indicator of community's poor awareness of the climate change issues that the whole world is grappling with. This

could be attributed to the high illiteracy levels, lack of exposure beyond their community boundary and little understanding of the dynamics of climatic patterns coupled with strong cultural ties and heavy reliance on nature. Indeed, the metrological records of rainfall obtained from the Marsabit Metrological station corroborated the community's perception. The data showed a pattern of declining rainfall in the area though marginally. However, due to lack of such services in Maikona, the data relied upon were collected about 100KMs away and it was believed that it can give an indication of the trend in the entire County.

According to a study by Witsenburg and Roba(2004) covering the period of 1920-2001, Marsabit and Moyale stations registered an annual rainfall deviating at least 75 per cent from the long-term mean of 81 years. The study illustrates that Marsabit station registered a sharp fall in the annual rainfall during the last 40 years or so of the study period. In terms of the decadal differences, the rainfall between 1960 and 2001 revealed a more proportionate decrease (relative decrease of 8.7% per year) compared to a marginal increase between 1919 and 1960 (at a relative rise of 2.5% per year). This would suggest an increased possibility of reduced annual rainfall during the last 20 year period relative to the similar earlier periods. The mean annual rainfall for Marsabit is 11 per cent below the overall average during the last decade and this decade had also the lowest average rainfall in comparison to all the other decades. Witsenburg and Roba(2004) concluded that Marsabit experienced lower rainfall, on average, over the last three decades compared to the previous thirty years during their study period of 1920-2001. Their study also concluded that the risk of adverse precipitation over the last three decades was twice as high as over the previous 50 years. This result confirms respondents' popular view that: "these days it rains less' and/or 'nowadays droughts occur more frequently."

The respondents clearly indicated that the pattern of change in rainfall has had a negative influence on their livelihoods. Most outstanding effects were its reduction of pasture production, which affected livestock health, crashing the livelihoods of the community. Distance to water points was reported to increase with each drought, hence

increasing trekking distance for the humans and livestock thereby affecting their health. Livestock die during droughts thus reducing their numbers and productivity. During droughts, livestock breeding is disrupted and the numbers therefore dwindle. This plunges the community in poverty and resort to relief dependency as the last recourse in the cycle. Witsenburg and Roba(2004) concluded that while the human population grew continuously over the years between 1920 and 2001, the livestock numbers and rainfall data depict similar downward trends overtime, especially during the last decade of that period and this collaborates the finding of this study.

On the other hand, the respondents were not able to tell change in temperature, may be due to the fact that they were unable to physically detect changes in temperature pattern. It is possible that without an instrument, one may not tell slight changes in temperature. However, a whopping majority of those who thought to have noticed some changes claimed the temperatures were increasing. This collaborated with the notion of global warming where the temperature was thought to be on the rise. The data from Marsabit Metrological Station did also support the fact about increasing temperature though slightly on average. However, the average minimum temperature has increased tremendously which means the area was becoming hot throughout as indicated by the respondents.

However, the respondents could not tell what caused the changes in temperature but alluding to reasons like drought, increase in sunshine, degradation and people abandoning their culture hence being punished by God. This is an indication of low level of awareness about climate change phenomenon. Generally though, the respondents report experiencing negative impacts of increased temperature some of which were disruption of grazing or disruption of livestock feeding pattern particularly during hot days, miscarriage especially in small stocks, premature births and even death of young kids and lamb during migrations. Scientifically, warming is thought to alter heat exchange between animal and environment, and feed intake, mortality, growth, reproduction, maintenance, and production are all affected, potentially (Thornton *et al.*, 2009). Moreover, there are scientific records where increased temperature has been

linked to livestock mortality (Thornton *et al.*, 2009) hence reduction in productivity. It has also been shown that during unusually high temperatures, livestock physical activities decline including feed intake (Thornton *et al.*, 2009). In addition, high temperatures as well as reduced feed intake put a ceiling on milk yield irrespective of feed intake, and in the tropics, this may be between half and one-third of the potential of modern cow breeds. Increased energy deficits may decrease fertility, fitness and longevity (King *et al.*, 2006)

As thought, the effect of rainfall on livestock population in the study area was direct. Residents reported milk and meat production as one such direct relationship. It was also reported that livestock multiply during favourable seasons and die during prolonged dry spells. The reduced rainfall pattern as established in the study area has caused net decline in livestock numbers due to decreased forage. Livestock also did fetch poor prices during the frequent drought cycles reported. Consequently, it was revealed that the population of the three priority livestock has declined over the study period with sheep and camel being the most affected. When livestock numbers declined, their production which is directly related reduced, hence directly affecting the livelihoods of the pure pastoralists. This directly impacted on food availability and other needs. It therefore corroborated the responses of the respondents in the study area that changes in climatic variables have had negative impact on their livelihoods and that the quality of their lives was decreasing. When looked from the perspective that the population of people in the area was increasing and that of their livestock was decreasing, it therefore means that the residents were becoming poorer. This finding is in conformity with existing known facts that precipitation reduces and temperature increases crop and pasture yield reduces. Rising temperatures and changes in rainfall patterns have direct effects on pasture yields (IFPRI, 2009). The availability and quality of pasture directly affects livestock production in the pastoral areas where the livestock purely depend on range resources.

To survive, it was established that residents devised a number of coping mechanisms with three top most important priorities being seeking relief food, buying food on credit to be paid when the drought ends and sale of livestock productive herd including lactating ones. Unfortunately, the respondents were uncertain for how long they may continue using the strategies and some of their strategies; especially the top priority option seemed unsustainable. It is not possible to tell because provision of relief food may not be in their control or they can't tell for how long they may continue getting food on credit. Even environmentally speaking, the residents could not tell the impact of what they were doing; theirs was just to survive by all means. This is an indicator of community with poor environmental awareness levels and /or lack of viable means of survival. Indeed the main impediments to adoption of strategies were identified as lack of opportunities; financial capital, lack of education, decreasing number of livestock, persistent drought, unreliable relief and the general uncertainty of the weather conditions.

This study has revealed that the present coping strategies affected the target community's own ability to adapt in future in terms of increase in poverty as sources of livelihoods diminish due to sale of productive livestock, separation of family when livestock move far away as well as inaccessibility of the livestock products due to distance. As nomadic pastoralists were settling near market centres/water points to access relief and water, nomadism was at risk leading to high concentration of sedentary people around those centres, thereby causing environmental degradation. Borrowing food on credit plunges households in to the cycle debts and erodes family wealth as families incur bad debts for the small kiosk owners. Moreover, since majority employ reliance on relief food as a strategy, it was clear that the relief food was creating dependency, hence breaking down livelihoods system of the community.

On the flipside, settling around the market centres to access relief and water offered the residents a chance to take their children to school which secures the future of those children and the extended family. Also diversification of livestock herd was helpful as way to sustain their livelihoods because different species were affected differently since

they relied on the remaining type of livestock when one is affected by the droughts increased mobility of the and herd was able to save some herds during extended droughts.

With the overwhelming effect of drought cycles, it was clearly established that there were external support both from the government and NGOs. The main support identified included relief supplies and nutritional supplements, veterinary services, NFIs and student scholarships. It was not clear how sustainable those supports were especially with the feeling of dependency syndrome setting-in. On their own, the community appeared pushed beyond limit or with very few options as a sizeable number was unsure of what to do and requires animation and propositions of well researched options. A similar number envisions diversifying their economic activities but their options seem slim due to poverty and unfavourable environment. A small number even thought of abandoning pastoralism, an indicator of despair. Some of the ways suggested for diversification within pastoralism included; adding more species of livestock, separating the herd and further increasing mobility of the herd. The researcher also took keen interest in those who would wish to diversify their economic activities to survive the vagaries of the weather. Some of the options given included seeking casual employment, engaging in petty trade and some unfavourable means like brewing chang'aa and burning charcoal. They thought these activities may help them survive but the health issues and the acceptability of chang'aa option is unresolved while the environmental sustainability of charcoal in an already degraded desert environment may not be feasible.

The community had suggested some options like establishment of stable livestock markets, restocking, support education for their children, creation of awareness especially on environmental conservation, development of infrastructure, continuous and adequate relief for both animals and people, awareness creation and capacity building as some of the ways of coping with climate vagaries and the provision for water for animals in the areas with pasture and lack water. And now that mobility is part of the lifestyle of the respondents, there were suggestions of support for mobility. On a

similar note, IPCC in its AR4 report had suggested livestock insurance schemes, credit schemes, and income diversification opportunities as some of the possible viable adaptation options (IPCC, 2007).

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

The chapter provides the conclusions, implications of the findings and recommendations for further study and management actions.

5.2 Conclusion of the findings

The main objective of the study was to investigate the impacts of climate change on livestock production system and the strategies employed by the pastoralists in Maikona location of Marsabit County to cope with the impacts. Thus, the first specific objective was to trace the trends and patterns of climate parameters (rainfall and temperature) and pasture availability in Marsabit County since 1980. Using the data obtained from KMD and field queries, it was established that there was rainfall variation within the period of 1980-2010 in Marsabit which had consequently affected livestock production negatively. Livestock production is construed to have reduced by even higher margin than the decrease in rainfall owing to other factors like overstocking due to population pressure leading to overgrazing and degradation. On the other hand, the temperature data indicates a slight increase in average annual temperature for Marsabit which is largely attributable to increase in minimum temperature. The increase in minimum temperature was quite significant, a typical character of climate change as predicted by IPCC (IPCC, 2007). This change in temperature pattern affected livestock production negatively due to its impact on grazing and foliage quality.

The changes in these parameters (reducing rainfall and increasing temperature) have conspired to have negatively impacted on pasture quality and availability thus reducing livestock production in the area. Indeed the data from the ministry of livestock do support this conclusion as livestock numbers declined. It was inferred that as the livestock population decline so is the production. It can then be deduced that the quality of life of people in the study area has substantially decreased owing to the fact that the population is purely nomadic pastoralists depending on livestock.

The households were found to have devised some coping strategies, the main ones being seeking relief food, buying food on credit payable after droughts and selling livestock including the lactating ones. Other significant strategies are separation of livestock herds, diversification of livestock species, increased mobility of livestock herd, seeking casual employment around the trading centres and engaging in petty trade. However, the sustainability of those strategies especially the three top ones mostly used is in huge doubt. Similarly, the community is oblivious of impact their actions had on the environment. It was concluded that some strategies were seen to be harmful to the environment indeed like charcoal burning and settlement around market and water points that caused degradation.

It was also noted that there were external supports that the communities in the study area receive during extreme droughts from government and NGOs mainly responding to emergencies largely as relief but the support were not sustainable and long term. Dependency syndrome was setting in. Some positive aspects of some of the strategies were however noted amid this seemingly unsustainable cling to the straw. For instance, settlement near market centres in search of relief food and for ease access to water gave the community in the study area an opportunity to take their children to school which would otherwise have been difficult because of distance and their mobile way of life.

It was also established that there were some constraints that inhibit the respondents from developing coping strategies to cope with the climate variability. The main ones being the nature of the environment, lack of awareness of the whole issues due to low level of education and awareness on climate change issues as well as and poverty and lack of capital to set up more effective strategies or diversify their livelihoods.

5.3. Recommendations

5.3.1. Recommendation for further study

This study was not exhaustive on its own. It was not possible to conduct a more extensive study that can be extrapolated due to time and financial constraints. Therefore, the researcher suggests the following areas for further studies:

- i. Conduct a more extensive research that covers more pastoral areas for comparison and generalization.
- ii. Deeper investigation into the nature and sustainability of strategies including reliance on external support to ascertain their impact and to devise better ways of delivery.

5.3.2. Recommendation for management actions

As concluded, rainfall and temperature variations has affected livestock production in the study area. Livestock survival and production then directly affected the livelihoods of the community, hence their quality of life was reducing. Awareness of this fact can help the affected people to choose appropriate strategies to adapt. This study therefore recommends that the metrological department shared rainfall data constantly with the pastoralists so that they could understand the dynamics of rainfall and temperature variations on livestock production as well as an elaborate awareness programme on the whole issue of climate change, its impact and possible coping strategies customized for their situation.

The study further recommends that the strategies that the pastoralists adopt need to be modified to make them more sustainable. It is considered that the main strategies that the communities use like seeking relief coupled with the tendency of government and NGOs intervening during emergencies cultivate the culture of dependency. Likewise, the other most used strategy of borrowing food on credit has been viewed as plunging those households in debts worsening their poverty situation. This study recommends that there is need to empower the communities and devise long-term strategies instead of damaging short term but easy interventions. Some of the ways suggested and especially prominent in the FGDs thought to be helpful towards this end include:

- i. Establishment of livestock market in the area. It came out clearly that there is no good livestock market apart from Nairobi. It is quite expensive transporting the livestock and since most of the pastoralists are illiterate they are exploited by middlemen. Consequently these middlemen benefit more than the original owners themselves. It should not be forgotten that most of these illiterate livestock owners have never gone beyond Marsabit and could not even dare transporting their livestock.

- ii. Supporting education through sponsorship was also suggested as one of the sustainable ways to help them instead of short-term emergency measures. Education would help transform the next generation which would easily grasp the issues of climate change. It was also suggested in the FGD that it was time pastoralism is approached from commercial perspective and it is thought that it would be the educated people who would drive this agenda easily.
- iii. Putting in place policies that support mobility. Nomadic people lament that so far all government policies are in support of sedentarization. This is so because all schools, health facilities and other important amenities are static. So for them to access these services, they are forced to settle near those facilities. Such settlements cause overgrazing and degradation further leading to desertification. This study suggests that there is need to support mobility so as to save the environment. Mobile schools and mobile clinics/doctors may be some possible ways to avail these services to the nomads without injuring the environment.

Other ways could be restocking particularly focusing on drought resistant animals like camel as opposed to goats and sheep as many agencies do. Provision of water in far flung grazing areas during extreme droughts may save livestock. A tailored economic support for the pastoral drop outs to start petty trade was also suggested. Very few people have ever seen bank services in the area. They suggest that small flexible loans can be designed for this group.

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APPENDICES

Appendix 1: Questionnaire for Pastoral House Hold

Dear Respondent,

My name is Molu Wato. I am a student at Kenyatta University pursuing a master's programme in Environmental Studies (Climate Change and Sustainability). I am currently conducting a study on climate change impacts and their coping strategies among pastoral communities of Northern Kenya for my thesis. It is my humble request that you assist me by responding to the following questions so that I conclude this study successfully.

1. Name of respondent:
2. Gender: Male Female
3. Village..... HH No.....
4. Please state your highest level of education

University	<input type="checkbox"/>
High School	<input type="checkbox"/>
Primary School	<input type="checkbox"/>
None	<input type="checkbox"/>
5. What do you do for a living?

Livestock rearing	<input type="checkbox"/>
Employment	<input type="checkbox"/>
Business	<input type="checkbox"/>
Others,	<input type="checkbox"/> Specify.....
6. If you rear livestock, which type? Please tick against all the relevant category

Goat	<input type="checkbox"/>
Sheep	<input type="checkbox"/>
Cattle	<input type="checkbox"/>
Camel	<input type="checkbox"/>
Donkey	<input type="checkbox"/>
Other, specify	<input type="checkbox"/>

7. Of the livestock you rear, Please assign them numbers 1-4 as per its priority of importance/contribution to your survival.

Goat	<input type="checkbox"/>
Sheep	<input type="checkbox"/>
Cattle	<input type="checkbox"/>
Camel	<input type="checkbox"/>
Donkey	<input type="checkbox"/>
Others	<input type="checkbox"/> (Specify).....

8. In recent years (within the last thirty years), were there any changes in the production of your livestock? Yes No

9. If yes, what was the trend?

Increase	<input type="checkbox"/>
Decrease	<input type="checkbox"/>

10. What do you thought could be behind the trend in 9 above?.....

11. In your opinion, have there been changes in rainfall rates in recent years?

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>

12. If yes, what changes did you observe?

Increase	<input type="checkbox"/>
Decrease	<input type="checkbox"/>

Please give an account of the nature of these changes.....

13. What do you think could be the reason for the changes in 12 above?.....

14. In your opinion, were there are changes in temperature pattern in recent years?

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>

15. If yes, what changes did you observe?

Increase	<input type="checkbox"/>
Decrease	<input type="checkbox"/>

Please give an account of the nature of these changes.....

16. In your opinion, what caused the changes in 15 above?

17. How do the changes in rainfall rates affect your life?

Positive

Negative

Explain your choice in 17 above.....

18. How do the changes in temperature pattern affect your life?

Positive

Negative

Explain your choice in 18 above.....

19. Do you think there is any relationship between changes in the production of your livestock and the climatic variable of rainfall? Yes No

Explain your answer (in terms of the relationship)

20. Do you think there is any relationship between changes in the production of your livestock and the climatic variable of temperature? Yes No

Explain your answer.....

21. Are there strategies you devised to survive or reduce the impact imposed on you by the changes in climatic variables? Yes No

22. If Yes, Which one?

a. Diversification of livestock herd-1

b. Separation of livestock herd-2

c. Increased mobility of livestock herd-3

d. Migration to market centres-4

e. Buying food on credit-5

f. borrow food-6

g. Reduce frequency of meals-7

h. Reduce the quality /quantity of meals-8

i. Rely on relief food-9

j. Rely on remittance from relatives-10

k. Seek refuge in education-11

l. Seek for casual employment-12

- m. Engage in small businesses-13
- n. Charcoal burning-14
- o. Chang'aa brewing-15
- p. Sell of household assets-16
- q. Sale of livestock-17
- r. Others specify.....

23. If you are engaged in multiple strategies (above), please list them in order of your priority.....

24. For how long do you thought you will continue using these strategies?

- Very short-1
- Short-2
- Long-3
- Very long-4
- Unsure-5

Please explain your answer.....

25. Do you know of any impact that your coping strategy may have on the environment?

- Yes No

26. Do you know if your coping strategy (ies) affect(s) your livelihood/survival in future in any way? Yes No

27. If Yes, Are they positive or Negative? Positive Negative

Explain your answer.....

28. In your opinion, is/are there other coping strategy (ies) that will help you cope with the current trend in future? Yes No

29. Are there any constraints that inhibit you to develop coping strategies to cope with trends in climate variability? Yes No

30. If yes, which are the constraints?

- Level of education
- Lack of capital
- Lack of land

Nature of land/environment

Others, specify.....

31. Is there any Government department or Non-Governmental Organization that supports/ever supported you to overcome the impacts of climate variability?

Yes No

32. If yes which institutions and what is the nature of the support?

Government department(s)

a. Livestock Department

b. ALMP

c. Veterinary Department

d. Others, specify.....

Nature of support.....

NGO(s)

a. PISP

b. PACIDA

c. FH

d. REDCROSS

e. WFP

f. Save Our Souls

g. CARE, Kenya

h. CIFA

i. CCF

j. Others, specify.....

Nature of support.....

33. In future, what strategies do you expect to employ to reduce the impact of climate variability on your livelihood?

a) Migrate out of the area

b) Abandon pastoralism

c) Diversify within pastoralism

- d) Diversify economic activities
- e) Don't know
- i. If your answer is (a) in 33 above, kindly specify where you could migrate to and why you thought it is better.....
- ii. If your response is (b) in 33 above, what livelihood option would you turn to?
- a) Formal Employment
- b) Trade
- c) Crop cultivation
- d) Rely on relief food
- iii. If your choice in 33 above is (c), how would you diversify within pastoralism
- a) Diversify of livestock herd
- b) Separate livestock herd
- c) Increase mobility of livestock
- Kindly explain the nature of livestock diversification, separation or increased mobility.....
- iv. If your response in 33 above is (d), kindly specify the type of diversification.
- a) Seek refuge in education
- b) Seek for casual employment
- c) Engage in small businesses
- d) Charcoal burning
- e) Chang'aa brewing
- f) Others, specify.....

34. What do you thought can be done to help you cope with climate change?

Thanks for your time!

- d) Are there factors that reduce community's capacity to cope? Yes.....
No.....Which ones?
9. What does the future looks like for the livestock sector, being the livelihood of the community within the district? BrightUncertain.....Why?
10. a) Is there any external support that your department or community received/receiving for the livestock sector in the community to reduce the negative impacts of the climate change? Yes..... No.....
- b) If yes, which institutions? Government.....Which Department?.....
- NGO.....Name..... What form of support?
Explain
11. What do you thought can be done to alleviate the situation/help the community cope with the situation sustainably?

Appendix 3: Interview Schedule for NGOs, Other Departments/ Institutions

My name is Molu Wato. I am a student at Kenyatta University pursuing a master's programme in Environmental Studies (Climate Change and Sustainability). I am currently conducting a study on climate change impacts and their coping strategies among pastoral communities for my thesis. It is my humble request that you assist me by responding to the following questions so that I conclude this study successfully.

Name.....Position.....

NGO.....

District of Operation

1. a) Have you been operating in Marsabit North District within the last 10 years?
Yes.... No...
b) If yes, what are your main activities in the district?
2. What do you thought is the main challenge to the livelihood of the people in the district?
3. Do you think climate change has any impact on the community in the district?
Yes..... No..... If Yes, why? What do you think is the extent of the impact?
4. What can you say about the trend of temperature and rainfall in the district in recent years? Yes.....No..... Temperature; Increase..... Decrease..... Rainfall; Increase..... Decrease..... Please give the account of your experience.
5. What can you say about the trend in livestock production in recent years?
Shoat; Increase..... Decrease..... Camel; Increase..... Decrease..... Cattle; Increase..... Decrease..... Donkey; Increase..... Decrease.....
What do you think is the cause of this trend?
6. In your opinion, is there any relationship between the trend in climatic variables and livestock production? Yes..... No.... If yes, what is the relationship? Please explain.

7. Do you know of any coping strategy the community has adopted to cope with climate change? Yes.... No..... If yes, which strategy? In your opinion, are the strategies sustainable and why?
8. Do you know of any institution that is helping the pastoralists cope with climate change impacts? Yes... No... If yes, which institutions? Government (Name Department)..... NGOs (Name).....
What is the nature of this support?
9. What are the major challenges that the community face to cope with climate change?
10. What challenges do other institutions/stakeholders face in order support the pastoralists to cope with the changes in the climate?
11. What does the future look like and why? Bright.... Uncertain..... Why?
12. What do you thought can be done to enable communities cope with the climate change impacts?

Thank you

Appendix 4: Interview Schedule for Metrological Department

My name is Molu Wato. I am a student at Kenyatta University pursuing a master's programme in Environmental Studies (Climate Change and Sustainability). I am currently conducting a study on climate change impacts and their coping strategies among pastoral communities of Northern Kenya for my thesis. It is my humble request that you assist me by responding to the following questions so that I conclude this study successfully.

Name.....Position.....
 District.....Station.....

What is the trend in rainfall and temperature in Marsabit County?

Rainfall; Increase Decrease No change

Temperature; Increase Decrease No change

1. If there are changes, what is the extent?
2. What is the implication of this trend on the main livelihood activity (livestock production) in the area? Positive Negative
 Why?.....
3. What will the future scenario be?.....
4. What do you thought can be done to cushion pastoralists?.....