UNIVERSITY OF NAIROBI

DEPARTMENT OF EARTH AND CLIMATE SCIENCES

IMPACTS OF CLIMATE CHANGE ON SUSTAINABLE PASTORALIST LIVELIHOODSOF POKOT COMMUNITY IN WEST POKOT COUNTY, KENYA

LOLEMTUM JOSEPH TIMU

Thesis submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy Climate Change and Adaptation, department of Earth and Climate Sciences of the University of Nairobi.

NOVEMBER, 2023

DECLARATION

I, LOLEMTUM JOSEPH TIMU, hereby declare that this Thesis is my original work and has not been presented in any other university.

Signature -  29th, November, 2023

LOLEMTUM JOSEPH TIMU

I85/53778/2018

CERTIFICATION BY SUPERVISORS

The undersigned supervisors approve that they have read and hereby recommend for the acceptance by University of Nairobi the Thesis entitled ***''IMPACTS OF CLIMATE CHANGE ON SUSTAINABLE PASTORALIST LIVELIHOODS OF POKOT COMMUNITY IN WEST POKOT COUNTY, KENYA''***

PROF. CHARLES K.K GACHENE

Department of Land Resource Management and Agricultural Technology

University of Nairobi and Associate Member,

Department of Earth and Climate Sciences

P.O Box 30197-00100

Nairobi Kenya

Signature  29th, November, 2023

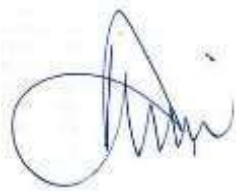
Dr. ALI ADAN ALI

Department of Geosciences and Environment

Technical University of Kenya and Associate Member,

Department of Earth and Climate Sciences

P.O. Box 52428 - 00200,

Signature  29th, November, 2023

DEDICATION

I dedicate this Thesis to my wife Salome, Children, Chebet, Chepangat and Cherop, my nice Chansang, Chelatan, my brother in-law Denis and my brothers for the moral and material support they gave me during the research and writing of this Thesis. They suffered absence while remaining and praying patiently for my success. They all have my wholehearted thanks. I also dedicate this work to my parents, Rabecah Timu and Timu Siwa who denied themselves a decent living to lay a firm foundation for my academic achievements.

ACKNOWLEDGEMENTS

First and foremost, I like to acknowledge with deepest sense of gratitude my supervisors; Prof. Charles K.K. Gachene and Dr Ali Adan Ali, for giving me technical support, valuable advice and insightful critique of the whole thesis. They have been of the utmost significance in this researcher. Similarly, without their encouragement, I would have found it very difficult to move forward. I am also incredibly appreciative to my friend Atupamoi Moses from whom I learnt a lot since initial development of this research, during the proposal writing, data analysis and importantly editorial and technical support. I acknowledge the University of Nairobi forgiving me an opportunity and a good environment to learn this course. More importantly, I would like to thank KCSAP for their financial support in this research. Finally I would like to thank the communities in West Pokot, despite the fact that they make a living under extreme circumstances, where climate change impacts are adverse, poverty and illiteracy levels are high and rampant.

TABLE OF CONTENTS

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ACRONYMS AND ABBREVIATIONS

ADB-Asian Development Bank

ASAL- Arid and Semi-Arid land

CBPP-Contagious Bovine Pleuropneumonia

CCAFS-climate change agriculture and food security system

CCAF-climate change agriculture and food security

CCPP -Contagious caprine pleuropneumonia

CRA- Commission of revue allocation

DFID-department for international development

ECF-East Coast Fever

EDE-Ending Drought Emergency

FAO-Food and Agriculture Organization

FEWSNET: Famine Early Warning System Network

FMD-Food and Mouth Disease

GDP- Gross Domestic Product

GHG-Greenhouse Gas

GIS - Geographic Information System

GIZ- Gesellschaftfür Internationale Zusammenarbeit

GOK-Government of Kenya

GDP- Gross domestic product

HPG-Humanitarian Policy Group

ICCA- Institute of Climate Change Adaptation

ICEM -International Centre for Environmental Management

IDB-inter American development Bank

IFAD-International Fund for Agricultural Development

IGAD-Intergovernmental Authority on Development

ILRA- International Law Review Association

ILRI-International Livestock Research Institute

IPCC-Intergovernmental Panel on Climate Change

IUCN-the World Conservation Union

KCSAP-Kenya Climate Smart Agricultural Project

KNBS- National Bureau of Statistics

KNCCAP -Kenya, National Climate Change Action Plan

LSD-Lumpy Skin Disease

NDMA-National Drought Management Authority

NOAA- National Oceanic and Atmospheric Administration

OIE - World organization for animal health

PPR - Peste des Petits Ruminants

RVF-Rift Valley Fever

SDG-sustainable development goal

SPI-Standard Precipitation Index

USAID- United States Agency for International Development

VCI-Vegetation Condition Index

WWF- World Wide Fund for Nature

DEFINITIONS OF KEY CONCEPTS

Adaptive Capacity: It is the strength of element at risk to adapt and cope with existing impacts of climate variability.

Adaptive Strategies: These are longer-term initiatives that enable an individual to mitigate and build resilience to any effects of climate change.

Anthropogenic Activity: It is pollution emissions that are produced from human activity, or it is generally major human actions that have negative impacts on the environment.

Exposure: It is the presence of element at risk of being adversely affected by impacts of climate change

Extreme Events: It comprises of action that has devastating effects to livelihood, environment, people and properties, mainly influenced by climatic variability.

Climate Change Adaptation: It is the practical actions taken to manage or reduce risks of climate impacts and enhance community resilience to climate extreme events.

Climate Change Coping: These are the responses to an experienced impact with short-term vision and adaptation to climate variability.

Disasters: Serious disruption of functioning of community, that lead to loss of life and property that goes beyond coping capacity of affected population

Hazards: It is potential happening of phenomenal that pose risk to community, properties, or environment

Mitigation: It is minimization of potential threats or impacts associated with exposure to risks.

Resilience: It is the ability of an element to recover from shocks of climate extreme event

Sensitivity: It is the average change in the Earth's surface temperature in response to changes in radioactive forcing, the difference between incoming and outgoing energy on Earth.

Risk-Risk: It is combination of likelihood and consequence; the latter measured as vulnerability to a climate change.

Vulnerability: Relative lacks capacity to bounce back after hazard or inabilities cope with disasters

ABSTRACT

West Pokot is among the adversely affected counties by climate extremes. The Pokot community is mainly pastoralist, whose mainstay is on livestock keeping, a very fragile livelihood to climate change shocks. The vulnerability of pastoralist to climate extremes has been exacerbated by frequent strike of climate change hazards. This has contributed to high poverty index among the residences, increased food insecurity, diminished livelihood, and reduced livestock production. In order to address this gap, the study examined the impacts of climate change on sustainable livelihood of pastoralist community in West Pokot County. The study was further guided by the following specific objectives: (1) to evaluate vulnerability of pastoralist Community to effects of climate change in West Pokot County, (2) to examine impact of climate change on livelihoods and livestock production in West Pokot County, (3) to evaluate community-based adaptation and coping strategies that pastoralists adopt to mitigate the impacts of climate change to pastoral livelihoods in West Pokot County, Kenya, (4) to evaluate the existing framework, policies and practices that enhance sustainability of the pastoral livelihood in West Pokot County, Kenya. The study used mixed method designs which included qualitative and quantitative data. The primary data sets consisted of 384 questionnaires for Household survey installed in ODK, 12 Key Informant Interviews and 8 Focus Group Discussions. Respondents at household level were selected through random sampling, while FGD and KII were selected through purposive sampling method .These data were complemented with secondary data from Standardized Precipitation Index and Vegetation Index cover for NDMA**.** Data at various points were analyzed using vulnerability and capacity tool, normalized difference Vegetation Index, frequencies, score and SPSS version 25. The results obtained from the analysis of the collected data were presented in forms of tables, charts, graphs and narratives. The study revealed that drought is the most threatening climate extreme in West Pokot, with pastoral livelihood zone being more susceptible. It was further noted that majority of residence in West Pokot County are pastoralist with 48%, agro-pastoralist at 32% and mixed farming at 20%. Additionally, pastoralists are highly exposed to effects of climate change, with 59.5% indicating high effects and 13.3% low effects. However, livestock body condition during climate extreme event shows that 71.4% was in deteriorating condition, 26.8% was in fair category and 1.8% was in good condition. Furthermore, the invasive and poisonous plant species had spread into grassland, and it was suppressing indigenous pastures germination and killing animals. The study also indicated that livestock was threatened

by livestock break diseases, pasture, and water shortage during drought period. Consequently, forest cover had rapidly reduced in the entire county with increased invasive plant species. Pastoralist were the most affected by climate extremes with 71.4% of the respondents indicating very high, while the mixed farming was found to be less affected with 12.2% of the respondents indicating very low. Furthermore, different livelihood zones were affected differently with pastoral zone reported to be adversely affected and it was found to be the most vulnerable zone. The study indicated that pastoralists adapt to climate change by practicing pasture management, conservation of crop residues as livestock feeds and designating seasonal grazing area, it was again found that pastoralist coping mechanism during drought period showed that 63.5% migrate and 35.2% stay at home, and 0.3% distribute to friends/relatives, for livestock diseases control. It further found that 45% of the respondents preferred livestock vaccination, 25% of the respondents appreciated regular dipping and spraying as effective in disease control. In terms of livestock breeds that are resilience to impacts of climate changes, respondents indicated 53.9% goats and 23.7% camels. The level of significance is between 90%-99% confidence level, with p-value of < 0.01. Sustainability of pastoralist can be achieved through pasture management, livestock breed diversification and livelihood diversification, enhanced disease surveillance and frequent livestock mass vaccination. These results would be useful in developing climate change action plan that can enhance the communities' resilience to impacts of climate change. This study recommends for strengthening community capacity on livelihoods and livestock breed diversification and enhance pastoralist capacity on pasture establishment and rangeland management systems.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Climate change is one of the greatest challenges that the world is facing today (Food and Agriculture Organization FAO, 2017). Droughts, floods, landslide, lightning, and storms can lead to resource scarcity and undermine livelihoods, National Oceanic and Atmospheric Administration (NOAA) annual climate report (2020). The combined land and ocean temperature has increased at an average rate of 0.13 degrees Fahrenheit (0.08 degrees Celsius) per decade since 1880. However, the average rate of increase since 1981 (0.18°C/0.32°F) has been more than twice that rate. Because of these, concerns are increasing that climate change may act as a "threat multiplier" which poses a risk to human survival. With erratic rainfall experiences climate change has the potential to increase food insecurity.

The existing threats to food security and livelihoods was exacerbated by climate change due to a combination of factors that include the increasing frequency and intensity of climate hazards, diminishing agricultural yields and reduced production, rising sanitation and health risks, increasing water scarcity, and intensifying conflicts over scarce resources (NOAA, 2020). The risk is higher in Africa and other regions where the dependence on natural resources is strong and the adaptive capacity to climatic changes is low, (Schilling, 2012). Africa is one of the continents mostly severely affected by impacts of climate change. This is because the geographical characteristics of the African continent make it highly vulnerable to the effects of climate change especially from the projected changes in the rainy seasons and insensitivity of droughts, which in turn may affect livelihoods and food security (FAO, 2017).

An estimated 25–60 percent of the East Africa Community population is undernourished, with almost10 percent of its population living under chronic food insecure conditions in the past decade, due to both worsening climatic shocks and non-climatic stressors, such as escalating food prices, conflicts over natural resources, high poverty rates, rapidly increasing population rates, and high post-harvest losses (United States Agency for International Development (USAID, 2017). It is noted that the impacts of climate change

especially in the Horne of Africa is adverse. As a consequence of increase desertification, increases in diversity, climate change impacts depend on the environmental and socio-economic set-up of particular sub-regions.

East Africa in specific is home to many pastoralists, agro pastoralists, and private ranches, national parks and various investments and development projects, (Intergovernmental Panel on Climate Change IPCC, 2014). Climate forecast data show that the East Africa is getting warmer and drier, by between 0.9°C and 1.2°C, with rainfall declining at an average rate of 20–100 millimeters every 10 years, (Capra, *et al*, 2013). This is accompanied by high inter- seasonal rainfall variability, especially in marginal pastoralist areas. These trends result in the reduction of arable land suitable for staple food production, shifts in agro- ecological zones and declines in agricultural productivity, as well as increases in natural resource base conflicts. It is, in many ways, negatively affecting local community livelihoods (USAID, 2017).

In the arid and semi-arid lands (ASALs) climate change poses a serious threat to livelihoods of millions of people, (WWF, 2006). This is because the livelihoods systems and food production in the entire Sub-Saharan Africa primarily rely on rainfall that is climate sensitive. 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 was expected in many parts of Africa leading to hunger, malnutrition, insecurity and migrations, (Kietemi. 2009). Climate change brings greater risk of pests and diseases to ASAL agricultural systems, affecting crop and livestock productivity and widespread climate change impacts on agricultural productivity which requires adaptation through complex systemic and transformational changes in livelihoods and food security systems accompanied by combination of improved trade policies (Climate Change, Agriculture and Food Security CCAFS, 2015).

It has been observed that in ASAL regions the productivity of livestock and livestock products is below global averages, and is constrained by climate variability due to seasonal water and pasture scarcity. For instance, the regional livestock resource base is

estimated at 50.2 million head of cattle, 59.6million goats, 25.3 million sheep, 6.3 million pigs, 109.8 million poultry, and 0.9 million camels (Herrero ., *et al.* 2010). Average milk productivity in the region was 340 kilograms per animal during the period 1965–2010 and increased to 410 kilograms per animal during the period 2005–2010 (USAID, 2017). 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.

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 sub-sector is the mainstay of ASAL communities, which contributes 40% of the agricultural Gross Domestic Product (GDP) and 12% of Kenya's total GDP, (GOK 2010).

Vulnerable people in Kenya generally have over the years developed a variety of alternatives to decrease their risk in times of droughts. However, new and persistent environmental, political and social pressures often limit choices that have traditionally been available, exacerbating their vulnerability (Victor, 2015). Kenya is the most highly food insecure country among the five East Africa Community. With the worst-affected population living within the arid and semi-arid regions of the member's states, an area that has high rainfall variability, declining rainfall trends and increasing surface temperatures. The main drivers of recurrent food insecurity in the region are as follows: recurrent extreme climatic shocks (droughts and floods) leading to poor livestock and agricultural production, increased resource-based conflict and civil insecurity, environmental degradation, human, crop, and livestock diseases and weak institutional capacities (USAID, 2017).

Kenya's economy is very dependent on climate-sensitive sectors such as agriculture, livestock, water, energy, tourism, wildlife, and health. The increasing intensity and magnitude of weather-related disasters in West Pokot County aggravates conflicts, mostly over natural resources, and contributes to security threats (GOK, 2018).The climate change has caused extreme weather events in Kenya that have led to loss of lives,

diminished livelihoods, reduced crop and livestock production, and damaged infrastructure. An example is the torrential rains and severe flooding from heavy rain of 2018 that devastated communities that were already struggling to recover from a prolonged drought of 2017. Climate change is likely to negatively impact Kenya's future development and achievement of the Kenya Vision 2030 goals and the Government's Big Four agenda for 2018-2022 with priority areas being ensuring food security, affordable housing, increased manufacturing and affordable healthcare (GOK, 2018).

The consequence is that in the face of a climatic anomaly such as drought, or a fast-spreading health risk such as the current outbreak of Rift Valley Fever in the region, pastoralists are often the hardest hit. These factors in combination make the pastoralists in Kenya very vulnerable to current and projected droughts (FAO, 2018).The dominant livelihood in the West Pokot County is pastoralism, a system of production that is characterized by livestock mobility and the communal management of natural resources. Pastoralist communities have been largely marginalized from social, economic and political resources in recent decades (SAFERWORLD 2009).

While climate variability and climate change extremes, particularly droughts in West Pokot County, strongly affect both pastoralists and crop farmers, the impacts are higher on the pastoralists, because it constitutes the majority in the fragile ASALs area, where there is a greater probability of drought occurrences. For instance, drought contingency planning is often non-existent, particularly with regards to the provision of veterinary services, initiating drought risk reduction measures (NDMA, 2017).

1.2 Statement of the Problem

Climate change has increased the frequency and magnitude of extreme weather events in Kenya that have led to loss of lives, diminished livelihoods, reduced crop and livestock production, damaged infrastructure, among other adverse impacts (GOK, 2018). West Pokot County is among the arid and semi-arid area in Kenya and adverse effects of climate change impact negatively on the livelihood, food security and environment, which are key contributor of social-economic development. The general problem is that climate variability has exposed pastoralists in West Pokot to risks such as loss of livestock due to drought and livestock diseases, destruction of livelihood and food insecurity among others. Majority of the pastoralists in West Pokot have not yet recovered from the impacts of the previous droughts episodes (NDMA, 2022).

High poverty and illiteracy level are what increases pastoralist vulnerable and be hardest hit by climate change extreme events due to their low adaptive capacity, with poverty level at 57.4% and illiteracy level at 37% that greatly undermines their adaptive uptake of adaptation strategies, (KBNS, 2019).

The specific problem is that vulnerability of pastoralists to climate change, and conflict is further worsened by the fact that people in West Pokot County are greatly marginalized, coupled with chronic drought (CRA, 2017). The predicted changes in rainfall patterns result to increased water scarcity and unpredictable pastures availability. Violent conflicts involving pastoralists are mostly triggered by competition over scarce resources, mainly water and pasture increases exposure of pastoralist to great loss of livelihood (IPCC, 2000). Livestock sectors are the most vulnerable to climate change, which directly impact the economic strength of ASAL counties such as West Pokot County and increases the risk of hunger, malnutrition, and food security, as the poorest community suffers the worst consequences of the adverse weather caused by climate change (María, 2012). As climate change exacerbates stresses on the production system, the rate of destitution among pastoralists is likely to increase unless policies that enable adaptation and a choice of livelihoods are implemented to allow people to maintain or improve their conditions independently of livestock-keeping (HPG, 2009). The climate change poses serious threat to fragile pastoral livelihood, the increased climate change shocks increases vulnerability of pastoralist to adverse effects of climate related hazards. The sustainability of pastoralist is at stake with climate extremes.

1.3 Objectives

To examine impacts of climate change on sustainable pastoral livelihood and livestock production in West Pokot County for enhanced community resilience'

To examine impacts of climate change on sustainable pastoral livelihood and livestock production in West Pokot County for enhanced community resilience.

1.3.1 Specific Objective

The study specific objectives are to:

i. Evaluate vulnerability of pastoralist Community to effects of climate change

ii. Asses impact of climate change on livelihoods and livestock production

iii. Evaluate community-based adaptation and coping strategies to mitigate the impacts of climate change in West Pokot County, Kenya'

iv. Evaluate the existing framework, policies and practices that enhance sustainability ofthe pastoral livelihood in West Pokot County, Kenya

1.3.2 Research Question

The study research questions were:

i. What contribute to the vulnerability of pastoralist community in West Pokot County?

ii. What are the impacts of climate change on the livelihood's zones in West Pokot County?

iii. What are community-based adaptations and coping strategies to mitigate impacts Climate Change?

iv. What are some of the existing policies what support sustainability of pastoralist?

1.4 Justification

Climate variability is a reality in the 21st century that poses threats to pastoral communities living in Arid and semi-arid areas. Despite the devolved system of government establishment and the presence of the non- state actors notwithstanding, West Pokot County still experiences adverse effects of climate extreme events. This study aimed to examine the impacts of climate change on livelihoods of pastoralist community and explore community-based adaption approaches to effectively respond to climate change threats in relation to pastoral livelihoods and proposed intervention measures that can cushion pastoral livelihood from threats of climate change.

The study aimed at establishing strategies such as seasonal grazing pattern management, pasture establishment, migration with livestock to Uganda and diversification of livestock breed that can be employed in mitigating the adverse effect of climate change in West Pokot County, in order to build pastoralist resilience to effects of climate variability. The findings provide relevant data to the stakeholders in planning and mainstreaming climate change risk reduction measures in their development programs. The findings further contribute to the body of knowledge in the academia and provide insights on climate change. Climate extremes have significant environmental, economic and social impacts. A lot of the economic impacts occur in agriculture and related sectors

in the County; including livestock, water, environment, health and forest. Many times, the impact of drought is widespread and often difficult to determine accurate financial estimates of damage therefore an action is needed mitigate this climate change risk, (NDMA, 2014).

The study focuses on enhancing sustainability of pastoralist livelihood through proposing interventions that can protect or reduce risk resulting from climate extreme events on their livelihood. The study also aimed at identifying existing pastoralist coping strategies to deal with climate variability and other shocks or stresses, which include building social networks as forms of insurance, traditional weather forecasting in order to be prepared for climatic changes and ingenious means of protecting assets use in ASAL counties (FAO, 2000). This study provides insights, evidence and information on the effects of climate variability on pastoral livelihood, adaptation strategies and development of sustainable pastoral livelihood framework. The findings will guide policy makers, Government, donors and researchers in coming up with appropriate, innovations anddevelopment interventions in order to improve the livelihoods of the pastoral communities (IPCC, 2014).This study filed the gap, through exploring sustainability of pastoral livelihood and recommended sustainable measure that reduce pastoralist vulnerability to effects of climate extremes shocK.

1.5 Scope of the Study

The study focused on impacts of climate change on sustainable pastoralist livelihood of Pokot community of Kenya. The study analyzed vulnerability of pastoral community to effects of climate change in West Pokot County, in order to determine the impacts of climate change on livelihoods zones and livestock production in West Pokot County. The study also explored community-based adaption approaches to effectively respond to climate change threats in relation to pastoral livelihoods and to develop reliable and sustainable pastoral livelihood framework in West Pokot County. The study focused on specific parts of the West Pokot County that are more affected by climate change like Pokot North, West Pokot and Central Pokot Sub- counties. The study focused on three livelihoods zones namely Pastoral, Agro- Pastoral and Mixed Farming.

1.6 Assumption of the Study

The researcher proceeded with several assumptions mainly: the respondents were to give correct information; the information given was to be correct at the time. Other assumption was that the area being predominantly pastoral area. Adverse impacts of climate change on natural resources like water, pasture and forage has direct influence on livestock production and food security. Due chronic exposure to climate-related disasters, pastoralist have developed adaption and coping mechanism to enhance their resilience to effects of natural disasters.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter focused on reviewing the existing literature on implication of climate change on food production and pastoral livelihoods in West Pokot County, pastoralist vulnerability to impacts of climate change, implication of climate change on different livelihood zones, and various communities.

2.2 Global Effects of Climate Change

Increased global warming has devastating effects on social-economic development of low- and medium-income Countries due to lack of the technical and financial resources to cope up and withstand the effects of climate change (Hulme, 2001). In addition, globally poor economic development and low institutional capacity to adapt to the shocks hence compromising their resilience to climate change since Africa is without access to the required technological and financial resources that are urgently needed to implement substantial adaptation programmes (Walter, 2016). Impacts of climate change affect ecosystems in a variety of ways, for instance, warming could force species to migrate to higher latitudes or higher elevations where temperatures are more conducive to their survival (Lagarde, 2014).

Climate change impact agriculture in many ways; including biophysical, ecological, and some are economic: A shift in climate and agricultural zones towards the poles; Changes in production patterns due to higher temperatures; A boost in agricultural productivity due to increased carbon dioxide in the atmosphere; Changing precipitation patterns; Increased vulnerability of the landless and the poor (Dietz.S & Stern.N, 2014).

2.3 Climate Change Impacts in Kenya

Kenya experienced the worst drought in 2008, 2009, 2011 and 2017 that affected many people, but the worst affected was those who live in arid areas. Thousands of livestock were lost, several people died and many had to migrate from their home areas to new areas (Njiru, 2012). In 2012, income from the main crops totaled KES 3.2 billion, with maize and beans alone accounting for 96% of this value. In comparison, the livestock sector contributed KES 29.6 billion of Kenya GDP, 93% of which was to be from trade

in cattle, goats, sheep and camels (Kenya County Climate Risks Profiles Series, 2018).

The relative importance of these different agricultural enterprises varies depending on their spatial and temporal distribution (GOK, 2016). The Pastoralism practiced by Pokot community is mainly nomadic or transhumance, which is characterized by risk-spreading and flexible mechanisms, such as mobility, communal land ownership, large and diverse herd sizes, and herd separation and splitting (Opiyo *et al*. 2011).

2.4 Pastoralist Vulnerability to Effects of Climate Change

Pastoralists and agro-pastoralists are one of the most climate change vulnerable groups in West Pokot. To counter this fact, it is necessary to increase their resilience to protect their livelihoods in the short term. Increased climate variability could decrease herd sizes as a result of increased mortality and poorer reproductive performance of these animals. This decrease in animal numbers affect food security and compromise the sole dependence of pastoralists on livestock and their products, as well as the additional benefits they confer (Herrero, *et al*, 2016).

The inhabitants of ASAL of Kenya are among the poorest and most vulnerable populations to effects of climate change. They suffer from an increasing array of both natural and human- made shocks that serve as effective barriers to productive and sustainable livelihoods and relegate a majority of the population to a state of chronic poverty. The increasing frequency of droughts, floods and climate-related disease epidemics coupled with unfavorable socio- economic trends and underdeveloped infrastructure highlights the predicament facing Kenya's ASAL populations and institutions concerned with their welfare and development (ILRA, 2007). Changes in both climate system and socio-economic processes are viewed as drivers of hazards and vulnerability that are inherently dynamic **(**IPCC, 2017). There are three components that determine a system's vulnerability to climate change and provide useful information for assessing and reducing climatic threats such as exposure to hazards: Climate exposure indicators include temperature rise, heavy rain, and drought (Parry, 2005).

The degree of a system's sensitivity to climatic hazards depends not only on geographic conditions but also socio-economic factors such as population and infrastructure,

financial ability. Indicators of sensitivity can encompass geographical conditions, land use, demographic characteristics, and industrial structure such as dependency on agriculture and extent of industrial diversification. Adaptive capacity describes the ability of a system to cope up with climatic extremes. Adaptive capacity to climate change depends on physical resources, access to technology and information, varieties of infrastructure, institutional capability and the distribution of resources. Economic capability represents the economic resources available to reduce climate change vulnerability (Yohe & Tol, 2002).

2.5 Exposure of the Pastoralists to Climate Change

Pastoralists are particularly vulnerable to the frequent droughts that characterize the ASALs. The most direct impact of drought on the livelihoods of these pastoralists is the drying up of water sources and declining forage resources for livestock resulting from the increasing aridity. Among the pastoralist, this is exacerbated by the fact that many landowners are increasingly selling off their productive lands for other commercial purposes thus pushing the local pastoralists to the drier parts of the district (Victor A. 2015).

Pastoralists are amongst the most at risk to climate change, yet they are amongst those with the greatest potential to adapt to climate change, and they may also offer one of the greatest hopes for mitigating climate change (Jonathan & Michele, 2008). These pastoralists are among the most vulnerable groups largely due to their limited adaptive capacity. The only notable exception to this exposure may be pastoralists living in mid-latitudes where higher temperatures could lead to richer pastures and increased livestock production (FAO, 2016).

The impacts of climate change on livestock focus on animal productivity, animal health and biodiversity, the quality and amount of feed supply, and the carrying capacity of pastures, (van de Steeg & Tibbo, 2012). The animal production may decrease. Indeed, a reduction of25 percent in animal production is estimated to result solely from reduced feeds and increased heat stress. Higher temperatures could also reduce dairy milk yield in relation to feed (Verner, 2012). The vulnerability associated with climate change in some

pastoral environments has its roots in the restriction of tried and tested pastoral coping strategies (Jonathan & Michele (2008). The impacts are threatening the already-fragile livelihoods of pastoral farmers who are already experiencing lesser livestock productivity. These trends are already pushing small-scale farmers to diversify into off-farm activities to supplement their livelihoods (FAO, 2018). Pastoralists are experiencing rapid changes in their environment and welfare despite these positive attributes as a result of increase in a series of subsequent droughts resulting to high mortality of livestock numbers as pasture and water sources disappear. In addition to increased human population and settlement impacting traditional grazing grounds and resulting competition for dwindling water sources, pastoralists often suffer from climate change extreme events (FAO, 2017).

Climate change is affecting the ASAL and pastoral livelihoods particularly those living in climate sensitive area like West Pokot County. The delicate balance that is the mainstay of pastoral is being undermined by climate change (Bent, 2006). The quality, quantity and spatial distribution of natural pastures are mainly shaped by rainfall (Boneya, 2013). The predicted changes in rainfall patterns results in increasingly scarce, scattered and unpredictable pastures. The distribution and productivity of permanent pastures and water points, which are so critical for livestock survival during the dry season, are bound to decline. Scarcer resources, coupled with current levels of demographic growth, are likely to lead to stronger competition between pastoral communities and other groups possibly resulting in conflict and even violent clashes. As a result, access to pastures becomes more difficult, leading to loss of livestock and of livelihoods in the longer term; pastoralists are likely to further diversify their livelihoods, both within the pastoral system and out of livestock production. However, efforts to diversify out of livestock production are likely to be constrained by the difficult environment characterizing pastoral areas in Africa (CCD, 2008).

It is therefore necessary to increase their resilience and protect their livelihoods. Increased climate variability has resulted to decrease in herd of cattle due to increased mortality and poorer reproductive performance of the animals (Ingrid H. *et al.*, 2010). These decreases in animal numbers affect food security and compromise the sole dependence of pastoralists on livestock. Under increased climate variability, the need for diversification

of income, strategy often employed in pastoral areas, becomes ever more important (Ingrid. *et al.,* 2010). Climate change and, increasingly, climate variability have substantial impacts on environmental security as well, as the conflicts over livestock assets often observed in these regions are likely to escalate in the future as a result of changes in environmental conditions (Mario, 2016).

Pastoralism is a complex livelihood system that seeks to maintain an optimal balance between pastures, livestock and people in uncertain and variable environments. Despite the important role that Pastoralism plays in supporting local livelihoods, contributing to County economy in some of the poorest counties, and in providing diverse ecological services, its capacity to adapt to climate change remains a challenge because of its exposure and sensitivity to climate change (Nori, 2008). Domestic livestock play a central role in West Pokot County. Their value goes beyond the production of meat. Livestock value is based on the full set of services. They supply milk, meat, blood, hides and income. Livestock is not only a form of saving but also a cultural symbol, function and rituals, it is difficult to abandon Pastoralism in the event that it becomes climatically, environmentally, or economically unviable (ILRI, 2006).

High levels of vulnerability and low adaptive capacity have been linked to factors such as a high reliance on natural resources, limited ability to adapt financially and institutionally, high poverty rates and a lack of safety nets (Thomas & Twyman, 2005).The very nature of the pastoralist lifestyle in West Pokot County is highly dependent on natural resources, such as availability and accessibility of water and pasture for their animals. According to Ebei, (2007) the severity of droughts and their impact on livestock production translates into reduced purchasing power of pastoral households' food security.

Climate change therefore threatens to exacerbate existing vulnerabilities and creates new ones for the poor. These new vulnerabilities may include loss of livelihoods through increased extreme events; food insecurity due to changes in temperature, rainfall patterns and falling crop yields; increased morbidity and mortality associated with a rise in water- and vector-borne diseases for livestock; and a deepening poverty cycle associated with diversion of livelihood assets towards recovery and coping mechanism. The impacts of

climate change may further entrench development disparities, as those with the least stand to suffer the most (IUCN, 2004). Livelihoods and economic activities in West Pokot are highly vulnerable to climatic fluctuations, with the County of the Arid and Semi-Arid Lands (ASALs) being among the most vulnerable to recurrent climate change extreme event (UNDP, 2013). Vulnerability of pastoralist to climate change is about how structural socio-economic conditions render Climate change as the biggest long-term threat against the possibilities to end poverty especially in aspects of hunger and malnutrition. This makes adaptation to climate change a fundamental driver of development in agriculture, livestock, food security and other efforts to achieve the SDGS (Tarhule, 2007).

Climate change affects pastoralists, differently, the livelihoods of pastoralist communities are highly dependent on natural resources, hence are affected by the impacts of climate change. However, the degree of vulnerability to climate change between and within pastoral communities varies according to factors such as age, sex, wealth rank,economic engagement, ownership of different livestock species and geographical location. This implies heterogeneity in adaptation and difficulty of replication or scaling up of successful adaptations across the community. On the other hand, it is encouraging that pastoralists have accumulated and continue to accumulate deep-rooted knowledge and experience in adapting to the ever-changing environment caused by climate change, and they are flexible (Michael & Kifle 2009). Climate change, along with other social and environmental factors, has altered pastoral livelihoods in various directions, their coping strategies and their social position. Increasing poverty is among the effects of climate change in pastoral societies like the Maasai (Crompton 2008).

The increased frequency of climate extremes is of particular concern since it reduces the time for poor households to recover from one climatic shock to another. There is also the risk of unprecedented shocks, such as the flooding experienced in Kenya more so ASAL counties like West Pokot, following extended drought. Traditional coping strategies may not be sufficient in this context as they force the poor to rely on ad-hoc and unsustainable responses (Gallopín, 2006).Their ability to adapt are constrained by factors such as increasing land degradation; conflicts over scarce resources which limit movement and destroy assets that are key to adaptation; limited access to information; limited education, skills and access to financial services and markets required to diversify their livelihoods

(Lenyayon G., 2013).

Climate change adversely affect the core economic sectors such as agriculture, energy, water, and health by presenting a formidable challenge to efforts to reduce poverty and achieve the SDGs, big four agenda and EDE in Kenya. Therefore, a thorough understanding of the inter-linkages between climate change and livelihood systems is crucial. The most vulnerable groups of people in Kenya are those who heavily rely on their own, livestock and agricultural production for the largest proportion of their food requirements (Daniel, 2015). In Kenya, Pokot are predominantly pastoralists who keep livestock under a nomadic free-range system and depend on livestock for subsistence and cultural reverence. They have been marginalized for decades from mainstream development with limited access to water and basic social amenities such as healthcare and schools (Hughes, 2006), such marginalization is deeply entrenched in Kenya since independence, and pastoralist areas are neglected in the policy development processes and allocation of resources. This has negatively impacted on the socio- economic advancement of the pastoralist and subsequently reduced their adaptation abilities (Moiko, 2004).

Climate change in combination with other drivers of declining biodiversity has reduced the effectiveness of pastoral societies to maintain both social harmony and resilience. At the same time, the reduction in pastoralist's capacity leads to decreased reliance on pastoralism and agro-pastoralism for food security. Pastoralism is a weather sensitive livelihood system that purely depends on availability and distribution of precipitation and appropriate temperature ranges among other climatic elements. While climate change may present some opportunities in some cases, it is also likely to impact negatively on the livelihoods of the pastoralist community (Daniel S. 2015). In pastoral and agro-pastoral systems, livestock are key assets for pastoralist community that provide multiple economic, social, and risk management functions. The impacts that climate change brings about is expected to catalyze the vulnerability of livestock systems and reinforce existing factors that are simultaneously affecting livestock production systems and the loss of livestock assets can lead to community becoming poor and long-term effects on their livelihoods (Solomon Tiruneh,2018).

2.6 Pastoral Livelihoods of Pokot Community

The livestock sector is the most important segment of West Pokot's economy. The livestock types kept by Pokot to manage and spread risk include cattle (zebu), camels, goats, sheep and donkeys. Livestock possession plays multiple social, economic and religious roles in pastoral livelihoods, such as providing a regular source of food in the form of milk, meat and blood for household members, cash income to pay for cereals, education, healthcare and other services. In pastoral communities, livestock is also essential for payment of dowry, compensation of injured parties during raids, symbol of prosperity and prestige, store of wealth and security against drought, disease and other calamities. Livestock is therefore a fundamental form of pastoral capital, besides functioning as a means of production, storage, transport and transfer of food and wealth (Behnke, 2008).

West Pokot County is one of the food deficient and food insecure County in Kenya (GOK, 2007). The increasingly arid conditions in the county are generally viewed as impact of climate variability. The county is situated where extremes of climate variation such as drought and unpredictable rainfall patterns, coupled with famine and related hydrological disasters, are being experienced, (Obwocha & Everlyne, 2015). Moreover, West Pokot County has a diversity of ecological zones, all affected differently

by climate variability impacts (Jones *et al*., 2009).

Livestock keeping, and particularly through Pastoralism by nomadic communities, faces significant challenges from the impacts of climate change. The 2010 national climate change response strategy, noted that nearly half of all livestock in Kenya is found in fragile ecosystems, such as Arid and Semi-Arid Lands (ASALs) that are most vulnerable to climate change, and livestock production is therefore not exempted from the vagaries of climate change, (KNCCAP, 2013).West Pokot County is among those counties thought to have some of the highest number of livestock population in Kenya: 1,534,612 cattle; 3,519,148 sheep; 5,994,881 goats; 832,462 camels; 558,189 donkeys; 165,349; Poultry (indigenous); 15,449 Poultry (commercial); and 32,581 Bee hives (KNBS, 2019). The nomadic transhumance practiced by this ethnic community is characterized by risk-spreading and flexible mechanisms, such as mobility, communal land ownership (GOK, 2010). The livestock species have different forage and water requirements with variable

levels of resilience during drought period (Anthony, 2016).

Livestock in the pastoral areas are the major source of food (milk and meat). Animal-source foods are nutritionally dense sources of energy, protein, and various essential micronutrients. They match particularly well with the nutrients needed by people to support normal development, physiological functioning, and overall good health. Consumption of even small amounts of animal-source foods has been shown to contribute substantially to ensuring dietary adequacy, preventing under nutrition and nutritional deficiencies (Neumann *et al.,* 2002), and having positive impacts on growth, cognitive function, and physical activity of children; better pregnancy outcomes and reduced morbidity from illness (Sadler *et al.,* 2012).

Addressing the role sedentary livestock production systems in the future, including issues such as efficiency of production as well as the complexities of market engagement, is crucial to address whatever trajectory of change, these systems contribute to food security in a way that is equitable, environmentally sustainable, economically viable (Capper, 2011), For example comparing nutritional status of children from nomadic and sedentary population groups (Pedersenand B., 2008), concluded that farming appears to be a poorer adaptation than nomadic pastoralism in harsh environments such as arid and semi-arid. Mobile pastoral systems in East Africa seem to perform better than sedentary systems under the same conditions (Krätli, *et al.,* 2013).

2.7 Influence of Climate Change on Livestock Production

The high estimates assumed that all livestock production is affected in the same percentage as the households in the study area. The large range between low and high estimates is a result of the uncertainty about the number of households impacted when only a relatively small number of livestock holding households were captured in the survey (GOU, 2015).Climate change is expected to result in fall in productivity. Livestock productivity may be lowered by 50% in 2050s compared to without climate change scenario. Agricultural GDP with climate change may be lowered by 3% to 30% than without climate change agricultural GDP in 2050.Climate change may increase the number of people looking for food aid by 30% (World Bank, 2010). There is an increased drought expense by 72% in 2050s (FDRE, 2015).Increasing temperatures and decreasing

rainfall reduce yields of rangelands and contribute to their degradation. Higher temperatures tend to reduced animal feed intake and lowers feed conversion rates (Rowlinson, 2008).

Livestock and climate change have a close relationship; the spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall (Iqubal, 2013). Changes in the patterns of rainfall and ranges of temperature affect feed availability, grazing ranges, feed quality, weed, pests and disease incidences. High production animals are subjected to greater influence by climatic factors, particularly those under tropical conditions, due to high air temperatures and relative humidity (Aklilu *et al*., 2013). Reproductive functions of livestock are vulnerable to climate changes and both female and males are affected adversely. Heat stress also negatively affects reproductive function (Amundson *et al.,* 2006 & Sprott *et al.,* 2001). The climate change scenario due to rise in temperature and higher intensity of radiant heat load will affect reproductive function (Madan & Prakash, 2007).

The impacts of climate change on livestock and pastoral system include changes in herbage growth, drying up of animal's water points and changes in the composition of pastures and in herbage quality (Herrer J., *et al,* 2016).The negative effects of increased temperature on feed intake, reproduction and performance across the range of livestock species are reasonably well understood (Porter *et al*., 2014). There is much less certainty concerning the aggregated impacts of climate change on livestock systems with and without adaptation. Livestock are a critically important risk management resource. For about 170 million poor people in sub-Saharan Africa, livestock may be one of their very few assets (Robinson *et al.,* 2010).

According to Digambar (2011) there is direct impact of climate change on the growth of palatable grass species and that regeneration of fodder species in pasture and forest fodder is decreasing because of less rainfall leading to a shortage in diversity and quality of livestock fodder. This has led to a decrease in livestock population which has further affected the production of milk, milk products and meat. The drought also affected livestock by drying wetlands, pasture land, water resources, streams and decreasing availability of drinking water for livestock. Changes in temperature, rainfall regime and CO2 levels will affect grassland productivity and species composition and dynamics,

resulting in changes in animal diets and possibly reduced nutrient availability for animals (Izaurralde *et al.,* 2011). In pastoral and agro-pastoral systems, livestock are key assets for people, providing multiple economic, social, and risk management functions. The impacts of climate change exacerbated the vulnerability of livestock systems and reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food/livestock feeds and products and increased conflict over scarce resources (IFAD, 2011).

2.8 Climate Change as Catalyst of Livestock Diseases and Vectors

Climate variability and extremes adversely affect the livestock sector directly and indirectly by aggravating the prevalence of livestock diseases, distorting livestock production system and the sector profitability. The climate variability and its impact on livestock system and livestock disease is common among pastoralists communities, For instance, increasing temperature and changes in the behavior of rainfall lead to changes in the spatial and or temporal distribution of climate-change sensitive livestock diseases (Desalegn Y,*et al.,* 2018).The prevalence of CCPP has increased particularly during the past decade and other livestock disease that are reported are FMD, trypanosomiasis, coenurosis, black leg, anthrax and tick infection are the most prevalent livestock diseases (Ayal & Muluneh, 2014).

The high mobility of livestock caused by shortage of pasture and water aggravates the spread of contagious diseases, such as bovine pleuropneumonia, Pasteurellosis and camel respiratory complex disease, due to contact between animals from different regions, including wild animals (Ayal *et al.*, 2015). The impacts of climate changes in ecosystems on infectious diseases depend on change in ecosystems, the type of land-use, disease specific transmission dynamics, risky and susceptibility of the populations (Patz *et al.*, 2005). According to the FAO (2007) among the direct effects of climate change are high temperatures and changes in rainfall patterns, translating into an increased spread of existing vector-borne diseases and macro parasites of animals as well as the emergence and spread of new diseases. In some areas, climate change can also cause new transmission models and these effects will be felt by both developed and developing countries, but ASAL Counties will be most affected because of their lack of resources, knowledge, veterinarian, extension services and technology. Some of the indirect effects will be brought about by changes in feed resources linked to the carrying capacity of

rangelands, the buffering abilities of ecosystems, increased desertification processes, increased scarcity of water resources and lower production of grain(Digambar, 2011). Severe drought result to direct impact on the growth of palatable grass species and that regeneration of fodder species in pasture and forest fodder is decreasing because of less rainfall leading to a shortage in diversity and quality of livestock fodder (Aklilu *et al.*, 2013).

Decrease in livestock population further affects production of milk, milk products and meat. The drought also affected livestock by drying wetlands, pasture land, water resources, streams and decreasing availability of drinking water for livestock. Increase in temperature leads to outbreak of new borne diseases and scarcity of fodder led to change in livestock pattern (Zelalem *et al*., 2009). Many pastoral communities experience a severe reduction in their assets, with an average reduction of 80% in livestock holdings from their peak holdings over the past ten years mainly by climate change (Stark, *et al.*, 2011). Additional study indicated that the decline in the number of livestock species namely cattle, goats, sheep and donkey kept by pastoralists is associated with most of the animals dying as results of severe droughts (Zelalem *et al.,* 2009). Livestock health problems are exacerbated by climate change such as the high prevalence of Trypanosomiasis, emerging of new types of foot and mouth disease and other respiratory diseases in the lowlands are among other challenges that affect livestock fertility (Stark, *et al.*, 2011).

2.9 Climate Change and Food Security

The vulnerability of food security to climate change focuses on local consumers whose food security depends primarily on national and county produced food (Wang, 2010; Füssel, 2010). Food production is likely to decrease due to adverse impacts of climate change, given the increase in temperature and drought occurrences. It results to water scarcity; rise in animals feeds prices and increase in demand for quality feed.

Furthermore, this also leads to increase in food prices and hence reduces access to food. Global commitment in mitigating climate change may alter the costs of energy and the way farmers farm their livestock (Hellen, 2010). According to Füssel (2010), the socio-economic exposure can be represented by the agricultural share of total labor force, and GDP respectively (FAO, 2008). Strategies that help reduce the potential negative impacts

of climate change on food production systems with a focus on rural livelihoods in poor developing countries serve to maintain global and regional food security must be a priority of climate change policy responses. A commitment to feeding the hungry and lifting increasing numbers of rural farmers in developing countries out of poverty for current and future generations must be a strong focus of adaptation and mitigation planning. Augmenting resilience in vulnerable systems and increasing capacity to adapt with a focus on food security is achievable through specific cultural, technical, system and policy options that are embedded within, but also informing, socio-economic development strategies (FAO, 2012). Climate changes affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability. It will have an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. Its impacts will be both short terms, resulting from more frequent and more intense extreme weather events, and long term, caused by changing temperatures and precipitation patterns (FAO, 2008).

Impacts of climate change on pastoral systems, more so on livestock systems have had devastating effects on livelihood of pastoral community. The impacts on grazing systems include changes in herbage growth and changes in the composition of pastures and in herbage quality. In higher latitudes, future increases in precipitation may not compensate for the declines in forage quality that is attributed to temperature increases, and cattle will experience greater nutritional stress in the future. The proportion of browse in rangelands may increase in combination with more competition if dry spells are more frequent (Yusman Syaukat, 2015).

The semi-arid and arid rangelands are likely to see increase in rainfall variability associated with impacts on rangelands productivity. This may have significant negative effects on herd dynamics, stocking density and the productivity of pastoral production systems. In arid and semi-arid Kenya, for example, the loss of animals and subsequent losses in milk and meat production by 2030 as a result of increased drought frequency that could amount to more than US $630 million (Mario H. *et al*., 2016). Eighty percent (80%) of the country is arid or semi–arid and the economy dependent on climate sensitive sectors, such as rain–fed agriculture. More than five million smallholders are engaged in

different types of agricultural activities and are particularly vulnerable to seasonal climate variability, droughts and food Security (FAO, 2017).

2.10 Pastoralist Community Resilience to Climate Change

Pastoralist resilience depends heavily on indigenous knowledge of the environment and of the production system, and the customary institutions that enable pastoralists to capitalize on this knowledge. Strong social organization and customary institutions are common features of many successful pastoral societies and have been critical for the effective management of unpredictable environment (Ramoeketsi, 2010**).** Local communities seek to adapt to new challenges attributed to climate change. They do not seek solutions aimed at responding to climate change alone; rather for holistic solutions to enhance their resilience to a wide range of risks and shocks from different sources, some of which may have equal, or greater, negative impacts to their communities (Berardi, 2016).

Adaptation practices to climate change by the local communities are grounded on their indigenous knowledge. This knowledge is embedded in the socio-cultural context of the community. Local communities use this knowledge to inform their decisions when responding to climate change impacts. Therefore, the Integration of indigenous knowledge with new technologies to deal with climate change may assist communities in effectively responding to impending climate changes (Ajani *et al.,* 2013, p.24).

2.11 Pastoralist Adaptation Strategies in the context of Climate Change

Adaptation is the ability to respond and adjust to actual or potential impacts of changing climate conditions in ways that moderates harm or takes advantage of positive opportunities. It reflects positive actions to change the frequency and intensity of impacts, as opposed to coping strategies that are responses to impacts once they occur. The adaptation can be anticipatory, where systems adjust before the initial impacts take place,it can be reactive, where change is introduced in response to the onset of impacts that will re-occur and reflect a structural change of state of the system: in climate terms, where new temperature and rainfall patterns emerge (Balgis O.*et al*., 2005).

The increased impacts of climate change and variability make the rural pastoralist to practice various adaptation and coping strategies, which include mainly indigenous knowledge and wide variety of skills developed outside the formal education over a long period of time among the rural communities (Mongi *et al.,* 2010). Improving local genetics through cross breeding of livestock with heat and disease tolerant breeds, if climate change is faster than natural selection the risk of survival and adaptation of the new breed becomes greater (Hoffmann, 2008). Adaptation strategies address not only the tolerance of livestock to heat, but also their ability to survive, grow and reproduce in conditions of poor nutrition, parasites and diseases. Such measures could include identifying and strengthening local breeds that have adapted to local climatic stress and feed sources and improving local genetics through cross-breeding with heat and disease tolerant breeds (Getachcew, 2010).

Climate variability more strongly stimulates adaptation than changes in climate. The high levels of climatic variability that characterize the rangelands suggest that pastoralists should be well able to adapt to a changing climate (HerrerJ.,*et al*., 2016). In order to map adaptive capacity, we looked for those characteristics of livestock production systems that influence the capacity of the livestock keepers to prepare for, respond to, and recover from climate related impacts, each indicator need to be mapped and combined them into one single index of adaptive capacity (Thornton *et al*., 2006). The adaptive capacity of pastoralists is what has made them to be resilient throughout history and has enabled them to sustainably exploit their natural environment. Their adaptive management skills have enabled pastoralists to create and maintain biodiversity in many environments of extraordinary natural beauty, which are enjoyed by consumers worldwide (Jonathan D, 2008).

Climate changes exacerbate existing pressures on biodiversity and bring new challenges of its own. Adaptation to climate change is therefore a priority for conservation and environmental management. It is, however, an issue where specialist knowledge and theoretical principles need to be made accessible to a much wider group of people, if progress is to be made on the ground (Sarah, *et al.,* 2014).

The vulnerability that is associated with climate change in some pastoral environments has its roots in the restriction of tried and tested pastoral coping strategies. Pastoral adaptation faces a myriad of challenges, of which climatic change is but one, and indeed, the challenge of climate change seems insignificant to many pastoralists who are faced with extreme political, social and economic marginalization (Jun Wang, *et al.,* 2016).

Livestock off-take at different stages of a drought's development is an important adaptation strategy used by pastoralists. In times of drought and food shortage, increased off-take is obligatory to meet the household's demand for food for two reasons (long and short rain) (Francis Opiyo, *et al*., 2015). Diversification of herd composition and species are other key strategies that have enabled pastoralism to thrive in a harsh environment for centuries (Speranza, 2010). The capacity to adapt is something intrinsically pastoral, and sustainable pastoral development must be founded on the understanding that adaptive capacity is what makes pastoralism work: restoring and enhancing adaptive capacities must therefore be central to development plans. The flexibility, mobility and low-intensity in the use of natural resources afforded by pastoralism may increasingly provide livelihood security in environments where sedentary production fails (Jonathan & Michele 2008).

2.12 Pastoralist Community-Based Adaptation

Community-based adaptation describes an approach to increase the resilience of some of the world's poorest communities to the impacts of climate change. This approach should be a community-led process, based on local priorities, needs, knowledge and capacities, which can then empower people to cope with and plan for the impacts of climate change (Hannah *et al.,* 2010). Pastoralists perceive climate change as increased temperature, expanded desertification, droughts and reduction of grazing lands. Moreover, they experience climate change as reduced livestock productivity (milk, ghee and meat), change in livestock feed availability, reduced quality of natural pasture, and increased human and livestock disease (NurAbd Mohammed, 2010).

The outcome of climate extreme events demonstrate evidence of climate variability as seen through drought, extreme temperature, increased human and animal diseases, and rangeland degradation. Climate variability and change have led to pasture and water shortages, increased loss of livestock, and heightened vulnerabilities to climate change

hazards amongst pastoralists, due to adverse impacts of climate change, communities are making effort to cope with climate change hazards through spatial mobility, digging of water wells in the riverbeds and embracing new breads of livestock that are more drought tolerant as an approach of dealing with climate change. These traditional adaptation strategies are currently less effective due to prolonged droughts (Macharia *et al.*, 2010).

2.13 Pastoralist Coping Strategies to Effects of Climate Change

Climate change Coping strategies in ASAL Counties help communities survive the effects of climate change. The poor and marginalized are struggling to cope with current climate variability. The climate becomes more variable and creating additional risks so that the poor becomes more vulnerable (DFID, 2004). The key areas of investment in climate change coping mechanism include natural resource management and environmental protection; livestock-based enterprises; promotion of alternative livelihoods and institutional capacity- building targeting the creation of resilience, among others (IGAD, 2013).

Pokot community's principal livelihood is Pastoralism and nomadic system that is believed to have evolved under variable climatic conditions which have triggered livelihood strategies that are currently being deployed by the community to meet changing environmental conditions (FAO, 2017). The Pokot Community as Pastoralists have traditionally used risk- spreading strategies over the years such as diversifying economic strategies to include livestock, bee keeping, agriculture and poultry farming. The livestock species kept include camels, cattle, sheep, goats, and donkeys, all of which have different forage and water requirements and variable levels of resilience to drought. The camels, cattle, and goats provide milk, which is consumed by the households (Notenbaert *et al.*, 2007).

Indigenous goats are well-adapted to the local climate and can utilize low quality forages (Katiku *et al*., 2013). Thus, one adaptation measure is cross-breeding of goats and sheep with more climate-resilient breeds, such as Galla goats (Recha & Radeny, 2017). Cross-breeding higher yielding animals with indigenous breeds enable the farmer to have more climate- resilient livestock whilst also producing more milk and meat than pure indigenous breeds. cross breed with improved small ruminant management practices for

example sheep and goat husbandry, housing, fodder development and conservation, animal health management), cross-breeds are better able to cope with low quality feedstuffs, can better withstand heat stress, recover more quickly from drought due to faster growth and thus reach a market weight more quickly. Furthermore, they are more resilient to disease burden (Recha &Radeny, 2017).

Other on-farm adaptation measures include grassland improvement/rehabilitation, integration of legumes to improve the nutrient content of grasslands, planting of fodder trees, conservation of feed (e.g. hay) for dry periods, provision of shade for livestock, adjustment of livestock numbers to the available grassland, rainwater harvesting and water management (Omondi *et al*., 2013). Experiences within the CCAFS Climate-Smart Villages project (Recha & Radeny 2017) show that these measures, implemented through community-based organizations, can help farmers increase their income (e.g. by the sales of livestock at higher prices) and contribute to food security (Gilbert, 2015).

2.14 Livelihood Framework in West Pokot County.

The livelihoods framework provides comprehensive and complex approaches in understanding how people make a living. It is used as a loose guide to a range of issues that are important for livelihoods, and it can be rigorously investigated in all its aspects. Livelihood approaches emphasize the understanding of the context within which people live, the assets available for them, livelihood strategies they follow in the face of existing policies and institutions, and livelihood outcomes they intend to achieve (Berehanu, 2007).

The sustainable livelihood framework is a tool for understanding the livelihood strength and strategies of a particular population. This framework also assists government and non- government agencies to implement their development goal for a given community (Bruno *et al,* 2008). It signifies a system of interrelated factors that determine whether a livelihood is sustainable or not, and which forms part of the sustainable livelihoods approach. Therefore, sustainable livelihood relies on sustainable management of our ecosystem (Peter, 2015).

Sustainable livelihoods have the ability to cope up with and recover from shocks and stresses while maintaining the livelihoods both now and in the future without undermining the naturalresource base. According to DfID (2000) livelihood framework, the communities ways of earning a living are supported by five types of capitals including natural, human, financial, physical and social capitals which communities use to cushion their livelihoods from stressors **(**Mahendra, 2011). The livelihoods in Arid and semi-arid areas frequently faced with multiple stressors or shocks including variability in climate, environmental, socio- economic and even political instability, over-exploitation, development and also poor prioritization of actions to combat climate change impacts which have high potential to impact on livelihoods while reinforcing on each other negatively (IPCC, 2007). Climate change is however, often acknowledged as the primary threat to livelihoods in the 21st Century especially, where it can undo years of development (Boutin & Smit, 2015). Livestock is the fastest growing sector, and in ASAL counties like West Pokot it accounts to 80% of the GDP, particularly in dry lands (World Bank, 2007). Community based sustainable livelihood and environmental management measures ought to be implemented to build resilience to the stresses of drought and other climate variations and extremes (Balgis*et al*., 2005).

2.15 Conceptual Framework

The framework was based on livelihoods analysis model, which define different assets that are known to be key instruments of sustainable livelihood. This approach recognizes the importance of access to elements of livelihood such as food security, and the systematic inequalities that keep some people from obtaining this access (HPG, 2009). The study analyzed vulnerability at households, ecosystems, environment and the general threats of climate change extreme events on pastoral livelihoods. For the purpose of this study, this framework guided the process of determining vulnerability basing on its three parameters namely, exposure sensitivity to climate change and the capacity to cope with impacts of climate change. Basing on vulnerability model, the greater the exposure or sensitivity, the greater the vulnerability and adaptive capacity is inversely related to vulnerability.

So, the greater the adaptive capacity, the more resilient the community is. The framework is however modified to fit into and guide this study (table. 2.1). Therefore, reducing

vulnerability would involve reducing exposure through specific measures (Smith *et al.*, 2001). These extreme weather events undermine the delicate ecosystem balance on which the pastoral system depends on it (Wato, 2016). The IPCC's (2007) assessment technique that vulnerability depends on exposure, sensitivity and adaptive capacity was adopted. This vulnerability assessment sought to geographically portray each of the factors by looking at the sub-factors that drive exposure, sensitivity and adaptive capacity, (Kenneth & Felix, 2015).

2.16 Study Variables

(i) Independent Variables: These are factors that influenced adherence to climate change adaptation and mitigation measures. The other independent variables are the anthropogenic activity that contributes to greenhouse gases production, which increases the global warming through raising surface temperature.

(ii) Dependent Variables: The dependent variables are adherence to sustainable pastoral livelihoods, which threaten livelihoods of pastoral community crippled by adverse effects of climate extreme events.

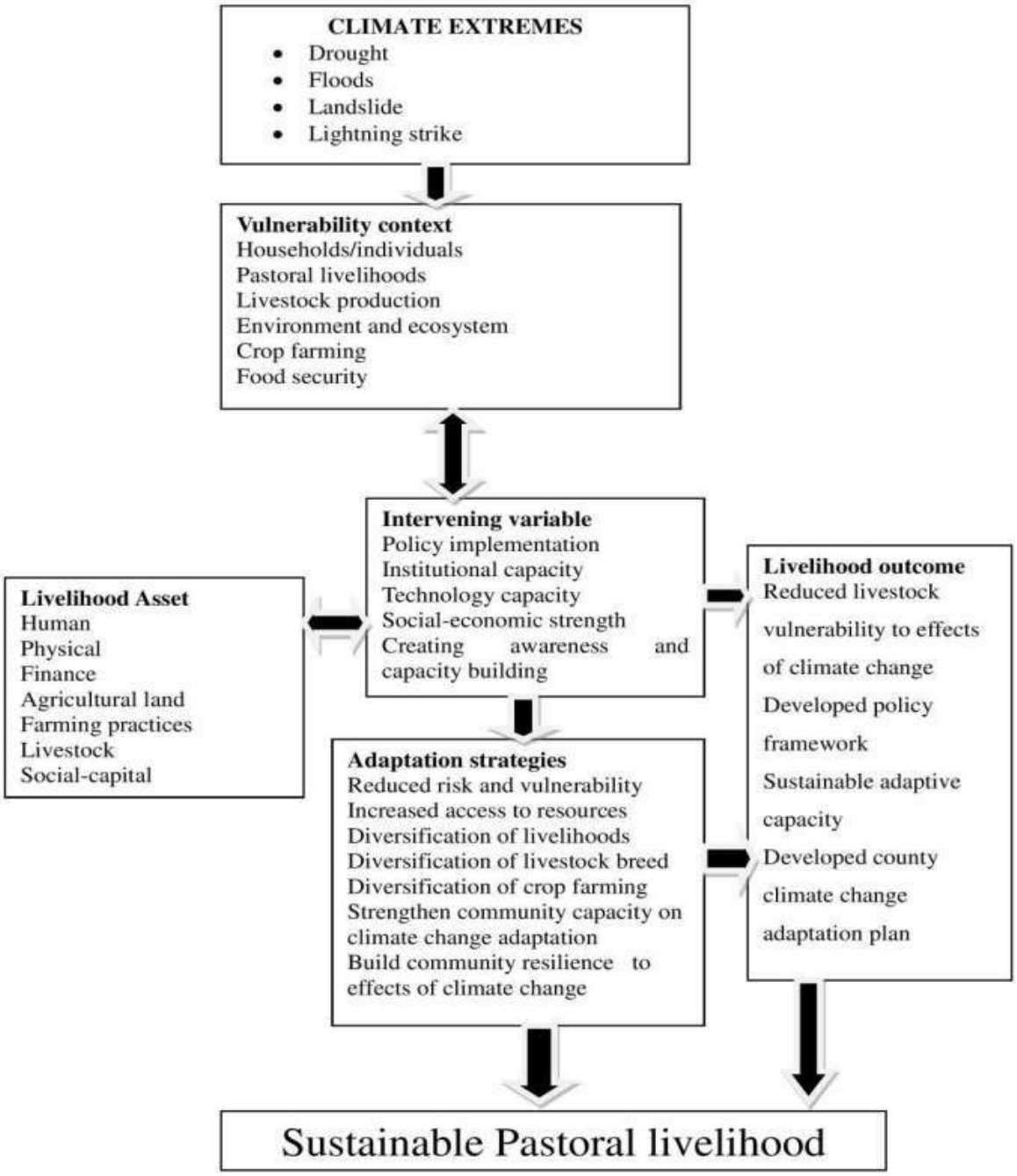


Figure 2.1: Conceptual Model
Source: Researcher, 2020

2.17 Study Gaps

Despite the various studies carried out in the area of climate change, adaption and coping mechanism, linking impacts of climate change to pastorals livelihood have not been clearly revealed, other researchers focus mainly on drought, which is one of the many climate extreme events thus ignoring serious implication of this other climates extreme events that have severe impact on pastoralism.

For example Riché, *et al., (*2009), studied adaptations to drought that is embedded in traditional social structures and resource management systems of community and failed to study on threats of climate change on natural resource and how these resources support pastoralism. The study by Thomas (2014) focused on livelihood systems of the poorest pastoral communities and how climate change undermining their capacity to build sustain- able livelihoods and reduce their vulnerability, but did not explore sustainable approach of mitigating climate change impacts.

On coping strategies Guyo, (2013) studied the effect climate variability in relation to impact of drought on the management strategies of the Borana community but his work had limited information on the effects of climate variability on the Borana pastoralist livelihoods. Study by Jillo (2006) focused on herd and livelihood diversification as a response to poverty, his study indicates that the herd diversification as coping strategy has become ineffective and they attribute this to human population growth and encroachment of cultivation into key grazing areas. Despite the fact that these factors have been caused by droughts and shortage of rainfall, the study never linked the collapse of the coping strategy to climate variability. The other limitation is that the study only concentrated on one coping strategy instead of exploring community-based adaptation strategies that can be enhanced to counter adverse effects of climate change by pastoralist communities. Although several studies have been conducted in the study area about the Pokot pastoralists, but there are still gaps as indicated by the foregoing literature review. First, there is no study which has been conducted on the effects of climate variability on Pastoralist among the Pokot Community livelihoods, coping strategies and how to enhance sustainability of identified Climate change risk reduction approaches. It is clear that little has been done on exploring the link between climate change adaptations and sustainability of pastoralist livelihood, this study therefore intent to intervene on this gap,

through exploring sustainable strategies for pastoralist embrace in climate change adaptation. .

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter on the research methodology describes the geographical area where the study was conducted. The sub-sections described include, the study design, population and the sampling strategy. The data collection instruments including methods of maintaining validity and reliability of the instruments are explored in detail.

3.2 Area of Study

The study was carried out in West Pokot County that is one of the 14 Counties in the Rift Valley region. It is situated in the North Rift along Kenya's Western boundary with Uganda. It borders Turkana County to the North and Northeast, Trans Nzoia County to the South; Elgeyo Marakwet County and Baringo County to the Southeast and East respectively. The County lies within Longitudes 34^0 47'and 35^0 49' East and Latitude 10^0 and 20^0 North. The County covers an area of approximately 9,169.4 km^2 stretching a distance of 132 km from North to South (Figure 3.1). The county has four constituencies namely: Kapenguria, Kacheliba, Sigor and Pokot South and a total of twenty county wards. Kapenguria and Kacheliba constituencies have six wards, while Sigor and Pokot South have four wards each. The population of the county is estimated at 621,240 persons, this population consists of 307,013 (49.7%) males and 314,213 (50.3%) females (KNBS, 2019). The County is among those with the highest number of livestock population in Kenya: 1,534,612 cattle; 3,519,148 sheep; 5,994,881 goats; 832,462 camels; 558,189 donkeys; 165,349 Poultry (indigenous); 15,449 Poultry (commercial); and 32,581 Bee hives (KNBS, 2019). West Pokot County is characterized by a variety of topographic features. On the northern and north eastern parts arethe dry plains, with an altitude of less than 900 m above sea level. On the southeastern part are Cherangani Hills with an altitude of 3,370m above sea level. The county has a bimodal type of rainfall.

The county depends more on the long rains than the short rains for crop production, regeneration of pasture, browse and recharge of water sources. The county experiences a bimodal type of rainfall with the long rains falling between March and June while the short rains fall between September and November. The low lands receive 600 mm

per annum while the highlands receive 1,600 mm per annum. The county also experiences great variations in temperature with the lowlands recording temperatures of up to 30^0 C and the highlands experiencing moderate temperatures of 15^0 C. These high temperatures in the lowlands cause high evapo-transpiration which is unfavorable for crop production. The high- altitude areas with moderate temperatures experience high rainfall and low evapo- transpiration hence suitable for crop production.

The county also experiences great variations in temperature with the lowlands experiencing temperatures of up to 30^0 C and the highlands experiencing moderate temperatures of 15^0 C**.** Pokot community is the predominant in the study area, Sangwer is the second largest community, and the Turkana, Luo, Kikuyu and Luhya are the minority in the county. The main social-economic activities in the West Pokot County are pastoralist and agriculture, with three ecological zones, namely, Pastoral. Agro- pastoral and Mixed farming, according to the (IEBC 2012), the County has four Sub- Counties namely Pokot North, Pokot Central, West Pokot and Pokot South (CIPD 2018- 2022).

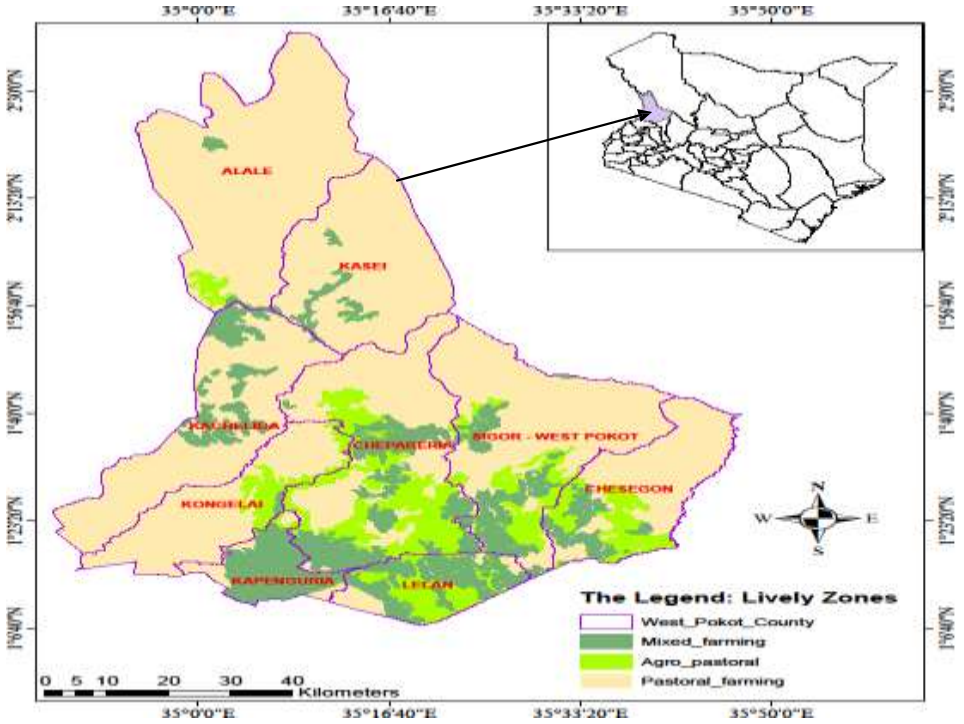


Figure 3.1: Map of West Pokot in the map of Kenya

Source: Researcher, 2020

3.3 Research Design

In this study, the qualitative method focused on in-depth data collection on trends of temperature and rainfall and its effect on livestock production system and diseases. The quantitative method dealt mainly with the temporal trends of temperature and rainfall and pastoralists' perceptions on climate situation and its effect on the livestock system water and pasture availability for objective one and two. Triangulation data collection method and analysis was applied to increase the validity and reliability of the results (Creswell, 2008).

A descriptive, survey and evaluation design was relevant in this study, because it employs both qualitative and quantitative approaches (Table 3.1). A survey was used to collect original data for describing a population through direct observation (Mouton, 1996). A survey obtains information from a sample of people by means of self-report, that is, the people respond to a series of questions posed by the researcher (Polit &Hungler, 1993). In this study the information was collected through self-administered questionnaires distributed personally to the subjects by the researcher. Characteristics, for example behaviour, opinions, beliefs, and knowledge of a particular individual, or group, this design were chosen because it meets the objectives of the study (Burns & Grove, 1993).

Cross sectional survey design was employed in examining respondent's attitude, and knowledge. The main season for adopting cross sectional design in this study was that the design was suitable in assessing respondents' opinion and attitude and knowledge. Evaluation research design concern with assessing the effects and impacts of climate variability on pastoralist livelihood and understanding perception of their exposure to climate extremes. Table 3.1, below summaries the research design for each objective and the variables for measurement.

Participatory research encompasses use of systematic inquiry in direct collaboration with those affected by an issue being investigated or studied for the purpose of action.
It involved collective, reflective and systematic inquiry in which researchers and community stakeholders engage as equal partners in all steps of the research process. Random sampling was used during household data collection, while purposive sampling

was used when sampling sub-counties, Wards, KII and specific groups of people to be included in FGD.

Table 3.1: Research Designs of the Study

Specific Objectives	Variables/Indicators	design
To evaluate vulnerability of pastoralist Community to effects of climate change in West Pokot County, Kenya	Food security Livestock's migration Conflicts, deaths of livestock Lack of pasture and water	Descriptive survey
To examine impact of climate change on livelihoods and livestock production in West Pokot County, Kenya,	Food insecurity Loss of livestock Environmental degradation	Evaluation
To evaluate community-based adaptation and coping strategies to mitigate the impacts of climate change in West Pokot County, Kenya'	Livelihood diversification Trained farmers on climate smart livestock Improved livestock breeds	Evaluation
To evaluate the existing framework, policies and practices that enhance the sustainability of the pastoral livelihood in West Pokot County, Kenya	Developed Policy Trained famer on pasture establishment Rangeland management system Livestock's diversification	Participatory

Source: Researcher, 2021

3.4 The Study Population

Population is elements (individuals, objects and events) that meet the sample criteria for inclusion in a study. The study population consists of the local community in the area, key informants from department of meteorological, national drought management authority branch office in West Pokot County, ministry of agriculture and livestock at the county level, non-governmental organizations that operate within West Pokot County, UN agencies that work in West Pokot County and some selected key informants in West Pokot County.

3.5 Research Strategy

Research strategy is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in the procedure. The research design adopted was descriptive in nature Mugenda, (2003), defined descriptive study as studies conducted within communities to establish the extent of the problems or gaps that have not been previously explored in-depth. Its explanation was to determine and report the way things are, these types of research attempt to describe such things as possible behaviour, attitude and devalues.

3.6 Sample Size

The sample size determined using the formula of Fisher *et al (1991).*

$$n = \frac{z^2pq}{d^2}$$

Where-:

n - The desired sample size (assuming the population is greater than 10,000)**z** - The standard normal deviation, set at 1.96, which corresponds to 95% confidence level

p - The proportion in the target population estimated to have a particular characteristic. If there is no reasonable estimate, then use 50 percent (the study used 0.50).

q=1.0–p

d = the degree of accuracy desired, here set at 0.05 corresponding to the 1.96.

In substitution, $n=\frac{1.96^2 x\ 0.5(1-0.5)}{0.5^2}=384$

Table 3.2: Sample Frame

Sub-County	Target Ward	Wards	Target Households	Sampled Household
North Pokot	3	Suam	30100	39
		Kodich	12363	16
		Kapchok	13631	18
West Pokot	2	Riwo	50239	65
		Siyoi	20904	27
Pokot South	2	Chepareria	57787	74
		Batei	44846	58
Pokot Central	2	Sekerr	27544	35
		Weiwei	40446	52
Total	9		297,860	384

Source: KNBS, 2019

3.6.1 Data Collection Methods

This study used various methods of data collection, which include Questionnaires, Surveys. Observations, Focus Groups discussion, transect walk and Key informant interview,

3.6.1 Data Collection Techniques

The researcher collected both primary and secondary data for the purpose of data collection and analysis.

3.6.1.1 Primary data

Primary data were collected through sample size of 384, with questionnaires installed in ODK software, interview schedules from inhabitants of Pokot North, Pokot Central, Pokot South and West Pokot Sub-counties. Questionnaires were administered by the researcher and research assistants to the target population through ODK. In this study it reached inhabitants of all the different sampled villages in the four sub-counties of West Pokot. to gain a better insight in the differences, patterns and similarities of the human response situation of inhabitants of the studied areas.

3.6.1.2 Secondary Data

The study reviewed secondary data from existing, thesis reports, baseline surveys and previously compiled data that were used to investigate impacts of climate change

pastoralist livelihood. The secondary data was collected from climate change and adaptation and drought management stakeholders and line ministries/ departments.

3.6.1.3 Household Survey

The questionnaire was pre-tested among households in West Pokot County but those households selected in pre-test were not included in the actual survey (Barribeau, *et al.*, 2015). This allowed final adjustments on the data collection tool. The semi-structured questionnaires were administered to households. The information generated from the semi- structured questionnaire and data gathered from both FDGs and Key Informant interviews was compiled and analyzed. The respondents were systematically selected from a list of households targeted in the respective village to ensure equitable representation**.** To ensure equal representation of both male and female, a list was designed to indicate gender segregation of head of household and it was used in picking respondents systematically according to the proportionate villages' sample.

3.6.1.4 Focus Group Discussion

The household survey was triangulated with participatory assessments and field observations. Participatory assessments included 8 FGDs for men, women and youths; it was a round table discussion with local community from the four sub-counties. The FGDs compromised people of different category in term of age, experiences and knowledge. The participants were selected randomly at the level of women, youths and men, while purposive sample was used at the category level such women, youths and men, purposive simple was also used in sampling area where FGD was to be conducted and this was guided by livelihood zone of area, example pastoral, agro-pastoral and mixed farming. The FGDs was undertaken to develop deep insights on the communities' pastoral livelihood activities, vulnerability to climate change and climate change mitigation, adaptation and coping mechanism. A checklist guide was prepared and updated based on questionnaire survey used in the FGDs. FGDs also discussed major sources of income and livelihood options and how these changed over time.

3.6.1.5 Key Informant Interviews

Interviews were held with twelve (12) key informants who were selected purposely because of their knowledge, skills and experience to inform the study objectives. The

interviews were conducted at the informants' offices. These includes NDMA, meteorological department, Water resource management authority (WRMA), Department of Environment, Water and Naturals resources, agriculture, livestock and pastoral economy. This guide was designed to ascertain information on the informant's observation of communities' pastoral livelihood impacts to climate change and how communities could contribute to climate change mitigation and adaptation for sustainable pastoral livelihoods. Field observation was also made to capture and crosscheck issues raised in the FGDs and key informant interviews such as livelihood activities, adaptation, and coping mechanism practices to climate change.

3.6.1.6 Observation

Through observation, the study was to verify information from questionnaires and discussions with the study sample. It was through observation that it can be possible to check indigenous risk assessment and mitigation practices as coping strategies in the area. The study was to verify some investments, social services, infrastructures and availability, as well as, effectiveness of the forest linked and other options for adaptation in the area (Peter, 2015).

3.6.1.7 GIS-Based Information

Researchers examined the GIS-based images, natural resources and livestock concentration. The researcher assessed topography and land use in the County and its surrounding using GIS and Remote Sensing tools. The GIS-based assessment was complemented by field trips, ground surveys and discussions with respondents in the concerned areas. This helped in validating information in order to enhance accuracy of information.

3.7 Data Analysis Methods

This study employed the livelihood vulnerability index (LVI) and standard precipitation index (SPI), which makes use of major components like water, agriculture, food, asset, livelihood strategies, socio-demographic, social network, and frequency of natural disasters and variability, while KII and FGD data was analyzed using Microsoft Excel.

3.7.1 Descriptive Data Analysis

This analysis mainly focused on analyzing the descriptive statistic of the spectrum. The data mainly compose of information on pastoralist vulnerability, community-based adaptation measure, impacts of climate change on livestock production system and evaluation of the existing policies framework and best practices for enhanced sustainability of pastoral livelihood. The study used statistical package for social science (SPSS) version 25 and Microsoft excel software to analyze quantitative data collected. The data was further summarized and presented in tables, charts, graphs and figures. The perception of the respondent and their back ground factors were analyzed through categorization of 40 variables into binaries of yes or no. It was then summed up to score, multiplied by 100% and divided by 40 variables to get index score of sustainable pastoral livelihood system. Seven variables were used to compute index score of vulnerability of the respondents. The Cronbach Alpha was computed to test the coherence of the score.

3.7.2 Inferential Statistic Data Analysis

Cross tabulation was used to compare relationship among the variables, to give inferences, the data were analyzed using bi-variances analysis to a certain the association and level of significance between the dependent variables. Quantitative data were analyzed using SPSS software version 25.Chi-square was used to examine statistical significance of the relationship between variables. Regression analysis to determine influences of climate changeon sustainable pastoralist livelihood and if it is the function of the demographic factors such age, sex, household size and residences of the respondents. Regression was further analysis and was used in determining the relationship between rainfall and temperature trends. Table3.2 shows summary of data analysis.

Table 3.3: Research Designs for the Study

Objective	Data Collation	Methods of Data analysis
To evaluate vulnerability of pastoralist Community to effects of climate change in West Pokot County, Kenya	Examining GIS, Satellite and VCI images and information, FGD, Household Survey, KII and transect walk	Vulnerability and capacity analysis tool And participatory disaster risk assessment
To examine impact of climate change on livelihoods and livestock production in West Pokot County, Kenya,	30 years of daily meteorological data of Temperature, FGDS, KII, Household survey, probing techniques transect walk	Normalized difference vegetation index (NDVI) to analyze impact of climate change impacts on environment, ecosystem, vegetation cover and forage conditions and use of correlation
To evaluate community-based adaptation and coping strategies to mitigate the impacts of climate change in West Pokot County, Kenya'	FGD, KII, GIS, Satellite, remote sensing and VCI	Local based knowledge and structural analysis model to analyze information on the physical and biological environments and often have a wealth of field experience on adaptation measures, descriptive and use of chi-square
To evaluate the existing framework, policies and practices those enhance sustainability of the pastoral livelihood in West Pokot County, Kenya	FGD, KII and Workshop, CSG,	Sustainable livelihood Framework and Participatory Which is based on understanding people's access to assets that typically include natural, human, social, physical and financial capital that inform approach to be used in climate change vulnerability

Source: Researcher, 2021

3.7.3 Data Management and Quality Standard

Quantitative data from the field was cleaned to provide accurate information that can be used for data analysis, there was high-level quality control of quantitative data, and the data was collected using online-system open data kit (ODK) by well-trained team of data collectors using smart phones. The principal researcher who was administrator of the system invited the research team, trained and hosted them in server for the results relay. During the data collection process, the principal researcher supervised the research team and always had access to the server for data quality assurance. The principal researcher accesses to research assistants' phones every evening a day for verification purpose before questionnaires were sent to the server. After completion of the data collection, the principal researcher downloaded and exported the raw data to SPSS version 25for analysis. However, validity and reliability of the data were adhered to throughout the data collection period.

3.8 Ethical Considerations

Prior to start of field work, I sought an introduction letter from institute of climate change and adaption of the University of Nairobi, which introduced me to NACOSTI, which issues research license, which permitted this study to be undertaken. Authorization was granted by the national council of science and technology (NACOSTI) to conduct research in West Pokot County, Kenya. The ethical guidelines outlined in the APA Ethics code (2002) was considered and included in this study. Each participant was given participant information sheet before they participated in an interview. The information sheets and consent forms were available in an appropriate language version in order to cater for Pastoralist/Community whose first language is not English. In the information sheets, the nature of the research was explained and it was clearly stated that participation in the research is completely voluntary, and there will be no penalties should they refuse to participate. The information sheet also provided participants with the expected time it takes to complete the interviews. Participants were informed that they may withdraw from the study at any time, and that there are no adverse consequences of withdrawing from the study. Participants were also ensured that the information they gave was confidential and their identities was not revealed by the researcher or the translator; and remain anonymous (example names of the participants was not attached to the transcribed data).The study was carried out in full compliance with the local customs, standards, laws

and regulations, from National and County Government authorization permit.

The researcher was familiar with and respected the culture of the local community under study. Full confidentiality of all information and the anonymity of the participant were maintained. Participants were offered access to research results, presented in a manner and language they could understand.

3.9 Data Validity and Reliability

Mugenda *et al.*, (1999) explains that reliability is a measure of degree to which a research instrument yields consistent results or data after accepted trials. Reliability of measurements concern the degree to which a particular procedure gives similar results over a number of repeated trials. This can be achieved after administering the same instrument more than once to the same group, a method referred to as test-retest. Validity and reliability of data from this study was to ensure effectiveness of the data collection tools. The tools and approaches used for data collection for both primary and secondary data generated valid and reliable information. Triangulation and crosschecking (validation and or verification) during data analysis strengthened data validity and reliability. Information from this study can therefore be sufficiently valid and reliable.

CHAPTER FOUR
RESULTS AND DISCUSION

4.1 Introduction

This chapter presents and discusses the quantitative and qualitative study findings based on households collected data, focus group discussion and key informant interviews, the respondent's knowledge, attitude and believe. It further presents the study objectives results and findings starting with socio-demographic characteristics of the household heads and analysis of community exposure to effects of climate change, sensitivity and adaptive capacity of pastoralist to effects of climate change, and general vulnerability of pastoralist to climate extremes and temporal trends.

4.2 Demographic Characteristics of the Respondents

This section presents some of the demographic aspects of the respondents from the study area. The main demographic features of the respondents in this section include gender, occupation, marital status, level of education and economic level of the respondents. The demographic data of the respondents was affected by climate change differently; therefore, vulnerability to climate change was directly link with demographic characteristic of an individual, this implies that adaptation measure necessitate community resilience to climate extremes.

4.2.1 Gender of the Respondents

The respondents were asked to indicate their gender and the results are shown in Fig. 4.1, where the majority of respondents were female 52% (200), and male 48% (184). This data was collected in February when part of West Pokot normally experiences dry season, whereby majority of men had started migrating with their livestock to Uganda. The findings reveal that gender was a key factor in climate change adaptation and decision-making processes on climate change risk reduction measures. The findings meant that when animals migrate, women in the study area are left at home with children, while men move with animals to Uganda leaving women and their children suffering from impacts of the drought. The results also implied that women in the study area also lack key information because their social role restricts most women to be at home and limit their responsibility to bearing and raising children in the pastoralist context, therefore, they cannot access early warning information from media, newspaper or public gatherings, so this study agree with NDMA, (2017), who found that drought affect people differently, with women, elderly and youths being the most affected population.

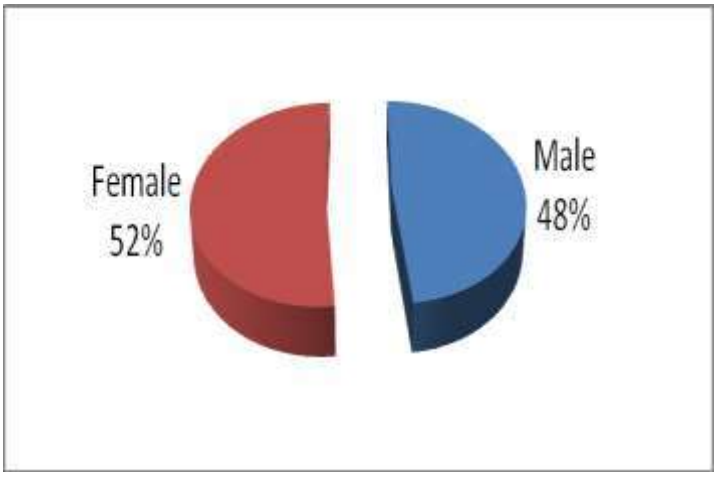


Figure 4.1: Distribution of Respondents by Gender

Source: Researcher, 2020

4.2.2 Respondent's Distribution per Sub-County

The findings evaluated respondents' distribution per sub-county among the four sub-counties in West Pokot County. It was noted that majority of the respondents were from West Pokot Sub-county with 31.8 % (122). This was attributed to the fact that West Pokot Sub-county was densely populated compared to the other three sub-counties. Pokot South Sub-county was second with27.7% (106), Pokot North had 22.8 % (88) and Pokot Central had 18.8% (72). Therefore, figure 4.2 show respondents' distribution per Sub-County. These findings are supported by KNBS (2019), which shows that West Pokot Sub-County has a total population of 184,446, Pokot North has 134,485, Pokot Central has 119,016, Pokot south has 80,661 while Kipkomo has 102,633. Respondents' distribution helped the researcher to understand the various existing vulnerability and adaptation measures, climate extreme events and differ with region and location. Choice of adaptation measures differ per area and it was informed by the hazard or most threatening climate extremes in the locality.

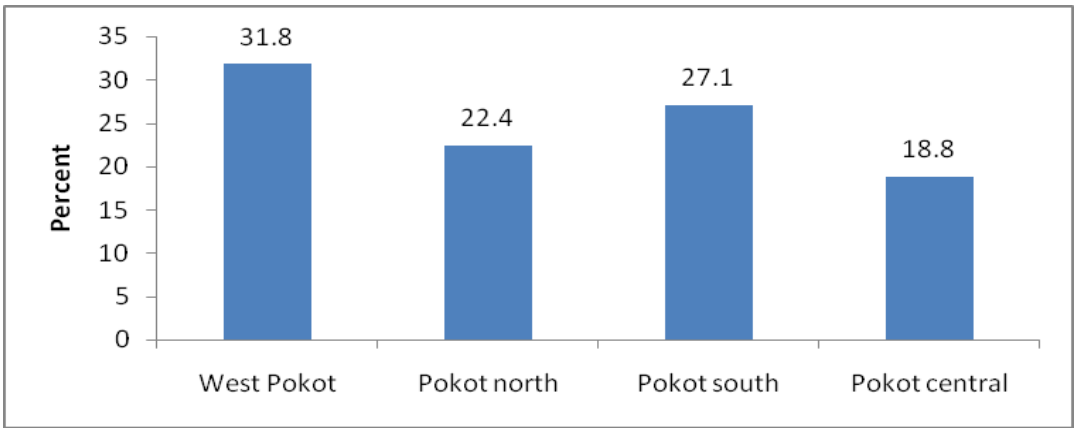


Figure 4.2: Respondents distribution per Sub-County

Source: Researcher, 2020

4.2.3 Respondents Distribution per Ward

This study sampled 9 out of 20 Wards in the County, the result was Batei (15.9%), Riwo15.4%(59),Siyoi16.4%(63),Chepareria,12.5%(48),Sekerr9.9%(38),Weiwei,8.9%(34),Kodich 7.8%(30), Kapachok 7.8%(30) and Suam 6.5%(25). The findings show that mixed and agro- pastoralist livelihood zone had densely populated than pastoral area, this was evidence from respondents' distribution per Ward and event per sub-county. This means that mixed farming Wards like Batei, Riwo and Siyo attract many populations compared to agro-pastoralist (Chepaeria, Weiwei and Sekerr), while pure pastoralist Wards (Kodich, Kapchok and Suam) are sparsely populated. During focus group discussion, it was revealed that West Pokot was divided into three livelihood zones, namely; pastoral agro-pastoral and mixed farming and climate change affect them differently, with different magnitude and intensity. Therefore, any proposal adaptation and mitigation strategies vary depending on livelihood zones zone.

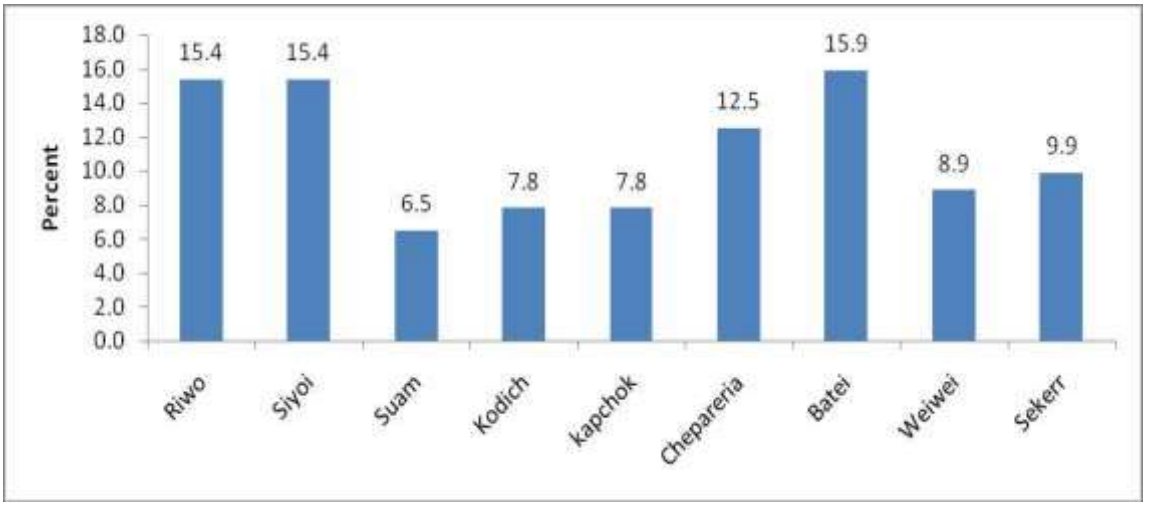


Figure 4.3: Respondents distribution per Ward

Source: Field data, 2020

4.2.4 Distribution of Respondents per Ecological Zones

These findings indicate that large part of West Pokot County was pastoral livelihood zone, with 48% (184) Pastoral, 32% (123) Agro-pastoral and 20% (77) Mixed farming. The study shows that, West Pokot was predominantly pastoralist area with majority of residents keeping livestock as the main source of livelihood, as indicated by Figure 4.4. The findings are attributed to fact that over 80% of West Pokot County was arid and semi-arid, where main livelihood practiced there was livestock keeping. This means that due to climate change and the need to adapt with climate variability's, the communities in West Pokot are embracing other livelihoods depending on ecological zone where they live, example agro-pastoral and mixed farming are transformed from pure pastoralist, due to impacts of climate change. Ecological zones are categories based on climatic condition, temperature, rainfall it receives, and the kind of livelihood practiced. Finding indicated that most part of West Pokot County was predominantly pastoral and agro-pastoral region, this therefore informs the kind of livelihood being practiced in West Pokot County and how the livelihood was sensitive or exposed to effects of climate change. Majority of the residents in the study area practice pastoralism, a livelihood that was very sensitive or vulnerable to climate extremes, with no alternative livelihood that can supplement or substitute the livestock rearing. The study agrees with NDMA (2016), that ASAL counties depend on livestock as main source of their livelihood and food security. The study during FGD further found that livestock in West Pokot were of traditional and cultural value among the Pokot community, this shows how people value or are attached to animals.

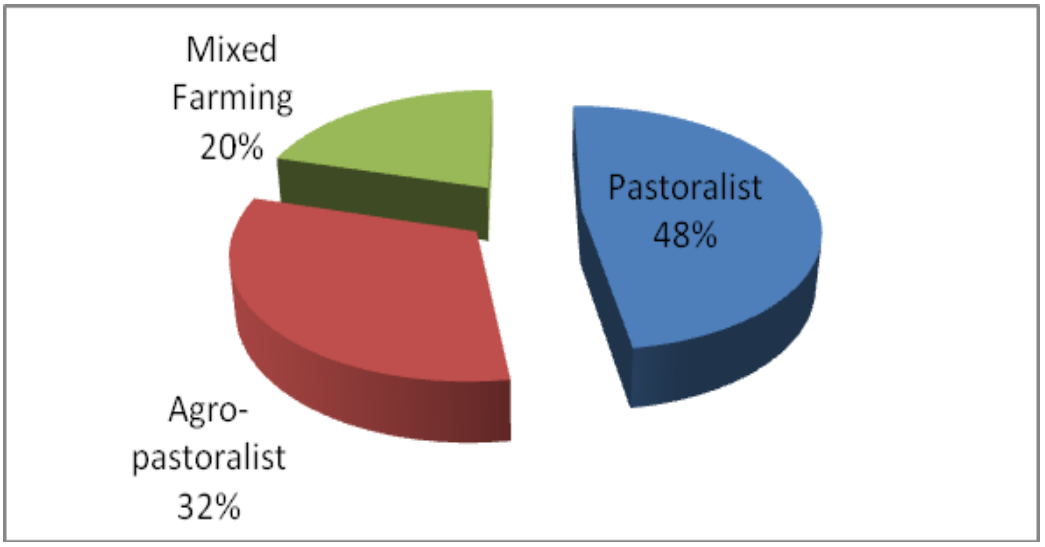


Figure 4.4: Distribution of respondents basing on the ecological zones

Source: Field Data, 2020

4.2.5 Occupation of the Respondents

The findings show that majority of the respondents are livestock keepers with 46.6% (179)crop farming 17.4% (67) business 17.2% (66) casual labour 11.7% (45) employed 4.7% (18) mixed farming 0.3% (1) others 1.3% (5) and those without occupation are 0.8% (3). The findings revealed that livestock keeping was the main source of livelihood in the study area, and this therefore justifies that West Pokot county was mainly a pastoralist county, with majority of the residents practicing livestock keeping. This implies that the livelihood of residence in West Pokot was threatened by climate change, because during drought, the area experiences water crisis and shortage of pasture that directly impacts the livestock sector and the few that practice agricultural farming relies on rain-fed agriculture that was threatened by unpredicted rainfall and chronic drought in arid and semi-arid Counties such as West Pokot.

Table 4.1 shows occupation of the respondents

Occupation of respondents	Frequency	Percentage
Livestock keeping	179	46.6
Business	66	17.2
Employed	18	4.7
Casual labour	45	11.7
Crop Farming	67	17.4
Mixed farming	1	0.3
Others specify	5	1.3
None	3	0.8
Total	**384**	**100%**

Source: Field Data, 2020

The other sources of livelihoods as mentioned by the respondents under the option of others was sand harvesting, sale of aloe vera liquid, alluvial gold mining, sale of firewood, sale of wild fruits, charcoal burning and wild vegetables. The findings show that every respondent was linked to an occupation that supports their daily living. This finding indicated that West Pokot was predominantly pastoralist, with majority of the respondents being livestock keepers. West Pokot County being ASAL, it justifies how this County was prone to climate extreme events and how susceptible their livelihood is to effects of climate change.

The findings show that natural capital was the term used to describe the stocks of natural resources from which further resources and services can be developed which prove useful to livelihoods. A broad variety of resources fall within this category, within the framework for sustainable livelihoods, the relationship between natural capital and the context of vulnerability was especially close. A large number of shocks which devastate the livelihood strategies of the most disadvantaged in a society are naturally occurring processes which destroy natural resources, such as forest fires, droughts, floods and landslide (UNDP 2017), indicated that for sustained livelihood the natural capitals need to be increased so that the community can be cushion from effects of climate change.

4.2.6 Marital Status of the Respondents

The study sought to find out marital status of the respondents. Majority of the respondents 82.6% (317) were married, 13.3% (51) were single, 1.8% (7) were divorced, 1.3% (5) separated and 1.0% (4) widow. Marital statuses inform the choice a household takes in climate change adaptation. Households headed by window and divorced was more susceptible to effects of climate variability hence more susceptible to impact of the climate extreme events. This finding means that marital status of the respondents was linked to adaptation choice and also vulnerability of household to the effects of climate change. The results indicated that married couples are more resilient because they can make informed decision in climate change adaptation strategies compared to divorced and single. This study agrees with Gebre Michael & Kifle, (2009), who noted that Climate change impacts vary on marital status of an individual. Example during drought couples can share responsibility in searching for food for the household; this gives mores adaptive strategy to married household compared to single and divorced who struggle for themselves. Figure 4.6 show marital statuses of the respondents.

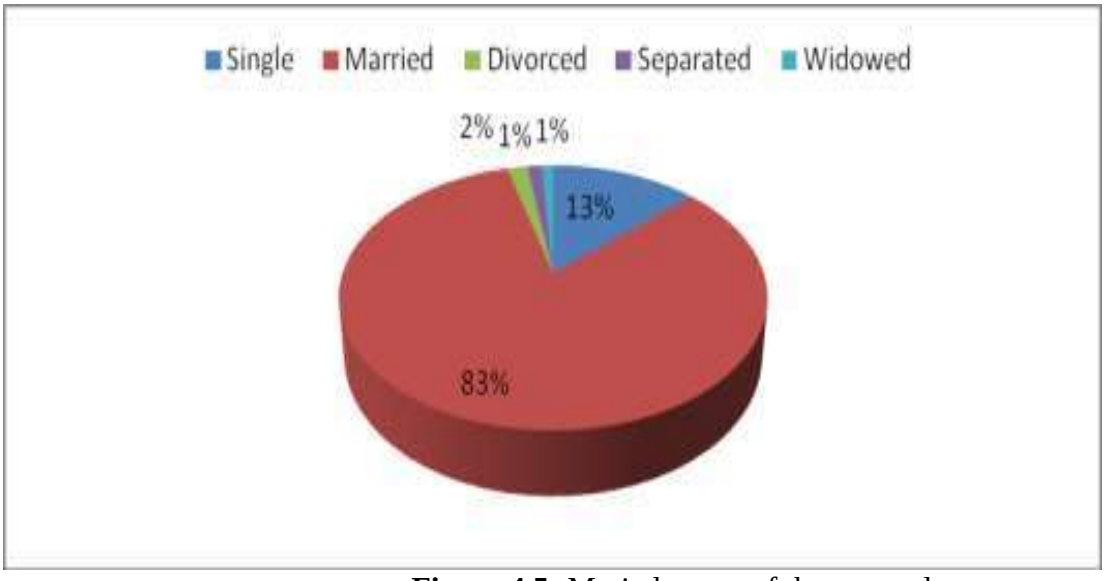


Figure 4.5: Marital status of the respondents

Source: Field Data, 2020

4.2.7 Education Level of the Respondents

This study found that education level of the respondents was as follows; 20.6% (79) had primary education, 50.5% (194) no education, while secondary education at 19.5% (75) and university/College at 9.4% (36). Education being basic measure of one's adaptive capacity status of an individual, the researcher sought to establish the level of education of the individual respondents. The pattern of this distribution was as presented in Figure 4.6. It was clear that illiteracy was overwhelmingly with 50.5% of the respondents indicated not gone to school. It was evidence that West Pokot County has high illiteracy level with majority of the respondents being people who attended primary and those other never went to school. The results mean that education and knowledge influences climate change adaptation, coping and mitigation measures. The finding reveled that education level of the respondents informs the adaptation measure and climate change risk reduction measure that help community reduce their vulnerability to effects of climate change, because majority of the respondents have no education, which influences actions to be taken in relation to climate change adaptation measure, this findings was supported during FGD, where respondents stated that majority of those who initiated pasture establishment, livestock breed improvement and land enclosure are those who are learned or those who had been trained on climate smart farming. This was attributed to the fact that illiteracy levels influence adoption to climate change risk reduction. An illiterate person cannot be employed, therefore in terms of financial resource, uneducated person experiences financial challenge. This means that during crisis he/she cannot have financial muscle to counter threats of climate related risk. Educational levels of the respondents are presented in Figure 4.7.

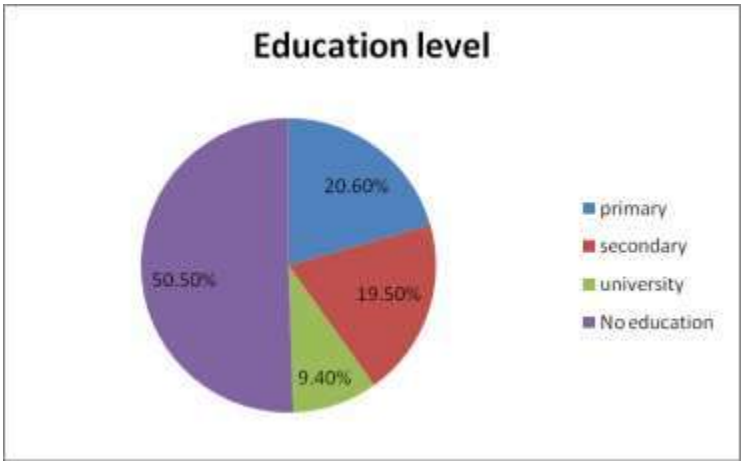


Figure 4.6: Education level of the respondents

Source: Field Data, 2020

4.2.8 Employment status of the Respondents

The study found that 58.3% (224) of respondents are unemployed, 34.1% (131) are self-employed and 7.6% (29) are employed. The study assessed employment status of the respondents by use of questionnaires. Employment status of an individual informs the adaptive capacity and coping strategies when climate extreme events strike. Findings shows that majority of the respondents are unemployed, with only a small fraction being employed. This therefore revealed that majority of the respondents in the study area are vulnerable to impacts of climate change because resilience to climate change was influenced by the economic level of an individual. The household income provides an indication of potential vulnerability and coping options that the household have when climate related stresses occur. These results meant that the income of the pastoralist in the study area was closely linked to livestock keeping, which was sensitive sector to effects of climate change. Figure 4.8 show economic level of the respondents.

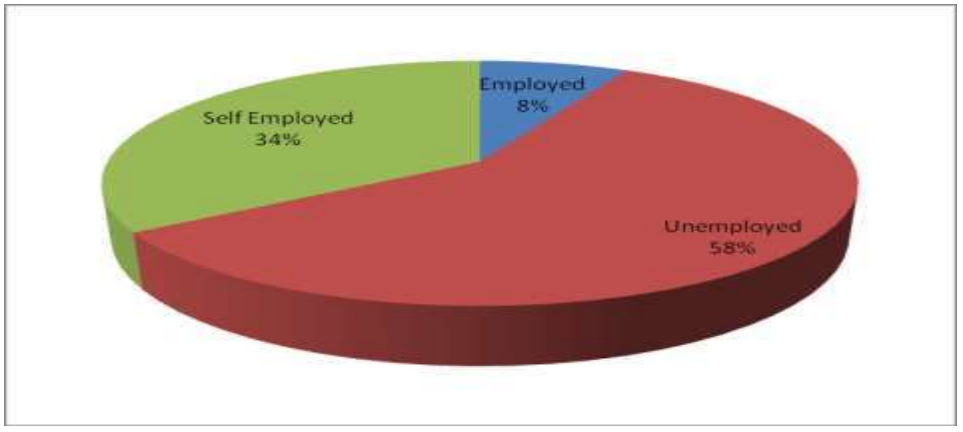


Figure 4.7: Economic levels of the respondents

Source: Field Data, 2020

4.2.9 Age Bracket of the Respondents

The findings indicate that most household representatives interviewed were within the age group of 35-49 years 33.3 % (128), followed by 31.5% (121) (25-34 years), 13.5% (52) were (18-24 year), 16.4% (62) were (50-64 year) and 5.2% (20) were (65-80 year). This finding show that majority of the respondents were aged between 35-49 years, while few respondents were within the age of 65-80 year, which was attributed to the fact that the age of65 year and above respondents are old, and many do not have time to listen during interview. The results indicated that majority of household heads were of age between 35-49 year, which show the duration of the respondents in the area, hence have important information on climate change impacts on their livelihoods and

how best they respond to those effects. These results indicated that most of the respondents are youthful (18-35 years), who are now facing the brunt of climate change and whose livelihoods are at risk of climate variability. The alluded that the crisis of climate change was seriously experienced by youth, and therefore any positive change to climate change extreme was to be spearheaded by youth, whose development was at jeopardy to effects of climate change; figure 4.7 shows the age bracket of the respondents. This study was supported by FAO (2018), which revealed that the most vulnerable groups to climate change shocks are women and youths, who have limited control of resource and decision making in society. The study further found that majority of respondents are above the youth age bracket, which has wealth on information, and experiences in climate change effects. Those of age of 50 year and above have enough information due to long experience and interaction with weather and climate variability.

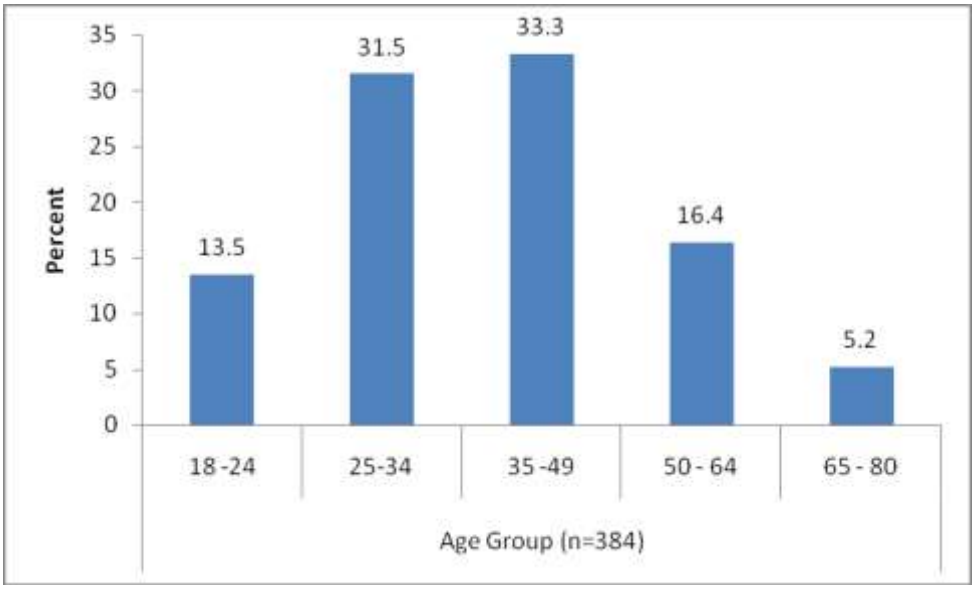


Figure 4.8: Age bracket of the respondents

Source: Field Data, 2020

4.3 Effect of Climate Change on livestock support sectors

The study investigated respondents' perception on how climate change has led to reduction in livestock production and the finding was also confirmed by the respondents, when they were asked whether there were any changes in the production of their livestock in the recent years (within the last 30 years). Figure 4.10 shows the changes observed by the respondents. The finding reveals that, 82% (315) of the respondents noted that

their livestock and crop production has been decreasing due to adverse impact of climate change, while 18% (69) indicated no change.

It was also noted that livestock production has declined in recent years, farmers have been experiencing poor yield with low production. West Pokot County was drought prone county where drought cycle has increased thus causing serious damages to pastoralist. These findings justify vulnerability of pastoralists to effects of climate, where production system of the livestock indicated to be adversely affected by impacts of climate change (NDMA, 2017).

The finding noted that few of the respondents indicated that no change has been experienced, majority of the respondents who indicated no change are from highland areas, where impacts of climate change are not adversely experienced. The study further indicated that climate change has led to loss of lives, diminished livelihoods, reduced crop and livestock production and damaged infrastructure and this was supported by (Daniel, 2015), who indicated that, climate change adversely affects the core economic sectors such as agriculture and water and presents a formidable challenge to efforts to reduce poverty and achieve the SDGs in Kenya. It was further indicated that nearly half of all livestock in Kenya was found in fragile ecosystems, such as Arid and Semi-Arid Lands (ASALs) that are most vulnerable to climate change and livestock production was therefore not exempted from the vagaries of climate change.

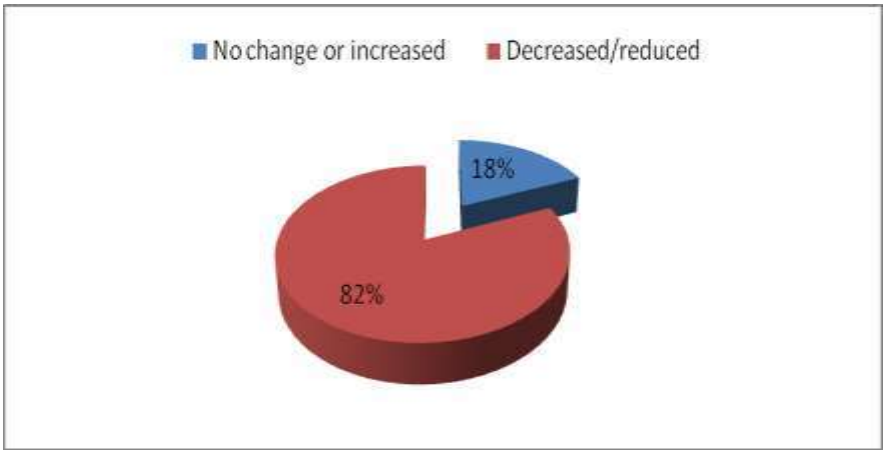


Figure 4.9: Effect of climate change on the sectors related to climate.

Source: Field Data, 2020

4.4 Vulnerability of livelihood zones to Climate Change Related Shocks

The findings assessed pastoralist vulnerability to climate shocks and study reveal that, respondents from mixed farming reported that harsh climatic condition was the main cause of livestock death (63.3%), while pastoral zone report that livestock disease as main cause of livestock death (46.3%) and for agro-pastoral zone also report livestock disease as the main cause of livestock death (45%), as shown on figure 4.11. The finding indicates that the livelihoods are threatened by specific climate extreme events. For example, pastoral was exposed to livestock disease, agro-pastoral was threatened by harsh climatic condition and mixed farming was at risk of pest and crop disease.

During FGD and Key informant interview it was reported that due to variation in weather pattern many livestock disease has emerge and they strike frequently leading to huge death of livestock in West Pokot County. According to the FAO (2017), among the direct effects of climate change are high temperatures and changes in rainfall patterns, translating into an increased spread of existing vector-borne diseases and macro parasites of animals as well as the emergence and spread of new diseases. It was further found that climate extreme triggers new transmission models that affects pastoralist adversely, due to lack knowledge on veterinary services, few animals' health worker compared to animals ratio.

During the focus group discussion, it was noted that mains source of water for livestock are water pans, water from these sources was stagnant and during dry season large herds of livestock concentrate on theses water points, which increased livestock vulnerability to highly infectious livestock diseases. It was further indicated that during drought episode majority of livestock from West Pokot normally migrate to Uganda in search for pasture and because animals interact from different area, it enhances spread of most threatening livestock diseases. There was no strong enforcement of livestock market closure in West Pokot during diseases outbreak with porous border of Kenya-Uganda where livestock get in and out without controlling the movement in a relation to diseases control.

It was also found that stolen livestock from the neighboring communities transmit diseases from one area to another; this was because stolen animals could have been infected already and when it interacts with other animals they get infected. This study

was supported by Nejash & Kula (2016), who found that distribution of infectious diseases (human, animal and plant), the timing and intensity of disease outbreaks are often closely linked to climate change. Harvell *et al.,(* 2002), also indicated that climate change bring about substantial shifts in disease distribution, higher temperatures increase the rate of development of pathogens or parasites that spend some of their life cycle outside their animal host, which may lead to larger populations.

The study was further supported by Thornton *et al.*, (2008), who found that expansion of vector populations into cooler and more temperate zones, the changes in rainfall pattern may also influence expansion of vectors during wetter years, leading to large outbreaks of disease such as Rift Valley Fever virus in East Africa. The study also illustrated that there are livestock disease associated with seasons, example CBPP, PPR and FMD was associated with rain season, while east coast fever was associated with dry season. Although the study indicated that during dry season infection and outbreak of livestock diseases are rampant, because during this season animals' main source of water are water pans, dams and designated watering point, where animals from different area share one water point, thus increase chances of disease spreading due to interaction and sharing of one water point.

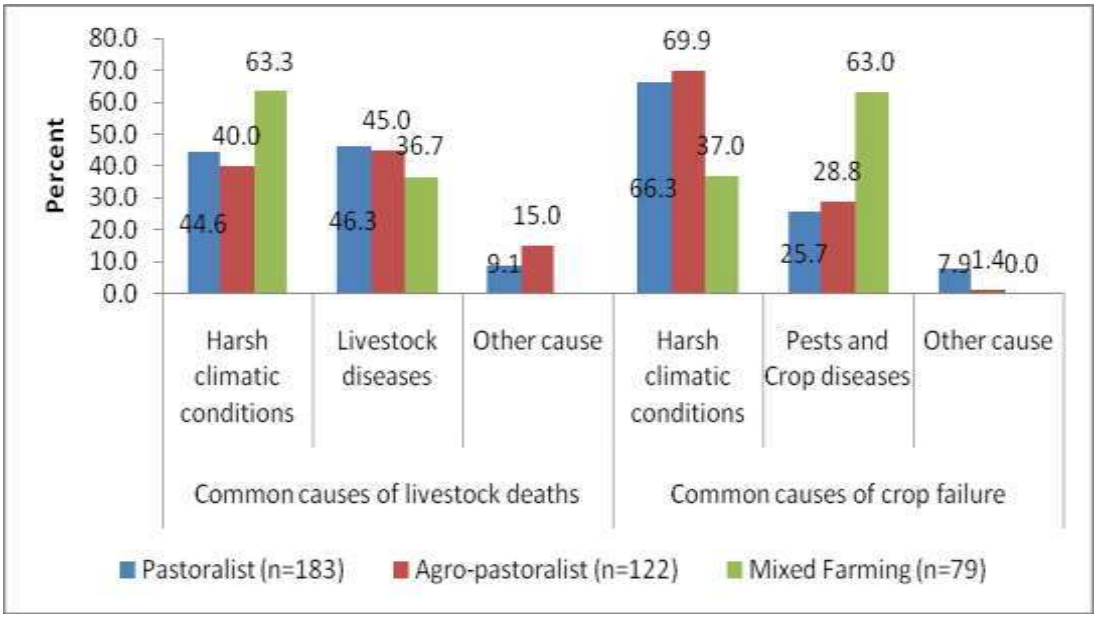


Figure 4.10: Common causes of livestock deaths in West Pokot County

Source: Field Data, 2020

West Pokot County being among those prone to various hazards that threaten pastoralists, the study evaluated various hazards that pose risk, the results indicates that livestock disease was the main cause of livestock deaths with 48.3% (185) of respondents indicating that their livestock die due to disease outbreak, 31.3% (120) of livestock death were associated with droughts. The study further assessed the most common climate extreme events, and the findings show that 56.8% (218) of the respondents' indicated drought is the most common hazard in West Pokot, 20.1% (77) of the respondents indicated pest and livestock disease, 17.2% (66) indicated floods, 3.9% (15) indicated landslides and 2.1% (8) indicated lightning strikes.

These results therefore confirm that drought and livestock diseases are the most devastating hazards to livelihoods of pastoralist. The finding therefore means that West Pokot was drought prone county with increasing frequency of drought occurrences. This study was consistent with (ILRA, 2007) which states that inhabitants of the arid and semi-arid lands (ASAL) of Kenya are among the poorest and most vulnerable populations to the effects of climate change. They suffer from an increasing array of both natural and human-made shocks that serve as effective barriers to productive and sustainable livelihoods and relegate a majority of the population to a state of chronic poverty (Molu, 2016), further noted that Climate change was viewed as one of the greatest challenges facing humanity and was manifested in form of climate variability that results to extreme weather conditions leading to droughts and flooding, among others hazards. This study was also agreed with (USAID, 2017), that state droughts, floods, lightning strikes, and landslides are becoming more frequent (1–2 year cycles), limiting the ability of vulnerable households to recover from the prolonged drought cycles. The livelihoods of pastoralists and marginal agricultural communities rely heavily on rain-fed and are highly sensitive to climatic and non-climatic shocks. Abdela & Jilo (2016), stated that climate change, in particular global warming, affects animal health by influencing the host-pathogen- environment system both directly and indirectly. The direct effects are more likely to influence diseases that are associated with vector transmission, water or flood, soil, rodents, or air temperature and humidity.

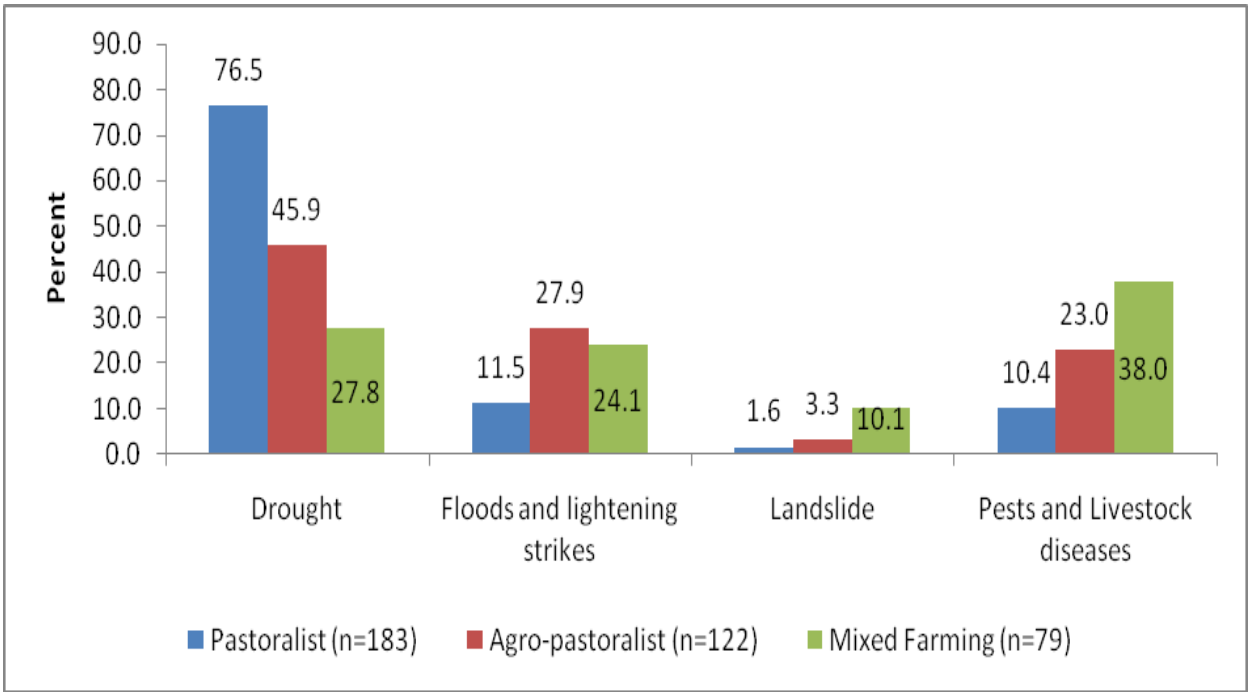


Figure 4.11: Common climate extreme events per livelihood zones in West Pokot County

Source: Field Data, 2020

4.5 Livestock Deaths Due Climate Change Extreme Events

The findings analyzed livestock death for the last five year from the sampled households. The findings show that, pastoralist community reported to be adversely affected by climate change due to many reported cases of livestock deaths. It was also indicated that cows and sheep are more vulnerable to climate change compared to other animals; that was because cows and sheep recorded highest number of deaths with 2989 cows and 3117-sheep death reported by respondents in pure pastoral ecological zone. Cows and sheep feeds on pasture that is sensitive to climate shocks, thus compromising ability of cows and sheep to withstand impacts of climate variability. The finding further show that camels, goats and donkey are among the most resilient animals during drought season, because these animals feed on forage and dry leaves. For example, camel access forage from tall trees, while goats climb tree to access forage and donkeys feeds on dry human waste and sisals that are not affected by drought. During focus group discussion one of the respondents stated that,

"Cows *diseases have increased recently, because of migration in and out of Kenya to Uganda in search of pasture, along the migratory routs these animals are infected with*

diseases and again because of interacting with other cows from different area, different communities, emerging of livestock diseases has been witnessed, example lumpy skin disease is new here, we have never experienced before but animals brought it from Uganda".

The study was consistent with Goldman & Riosmena (2013), who stated that seriousness of climate risk and the potential consequences of climate change that is triggered by the recurrent drought episodes cause massive cattle deaths, severe feed shortages and water scarcity which leads to serious socio-economic impacts to pastoralist community. This therefore implies that pastoralist community who depend completely on livestock suffer huge economic setback during drought. During focused group discussion, it was found that frequent droughts in ASAL area result to severe economic impacts due to poor livestock markets couple with poor livestock body condition that cannot attract good market price.

Table 4.3: Descriptive statistics for the livestock deaths for the last five years by type of animals and livelihood zone

	Pastoralist				**Agro-pastoralist**				**Mixed Farming**			
	Mean	**Median**	**SD**	**SUM**	**Mean**	**Median**	**SD**	**Sum**	**Mean**	**Median**	**SD**	**SUM**
Numberof animals	75.9	17	159.7	9188	35.9	8	120.1	2156	9.6	4.5	15.2	289
Numberof cows	24.7	9	47.0	2989	12.9	5	36.6	773	4.8	3	4.6	145
Numberof goats	17.9	5	33.4	2167	11.0	1	40.5	662	2.6	0	6.2	77
Numberof sheep	25.8	3	69.4	3117	11.2	1	42.1	669	2.2	0	4.6	67
Number of camels	2.7	0	14.0	330	0.0	0	0.1	1	0.0	0	0.0	0
Numberof donkeys	2.7	0	13.6	323	0.1	0	0.5	6	0.0	0	0.0	0

Table 4.4: Differences between deaths of animals (livestock) and level of sustainability of pastoral livelihood system (%)

	Level of sustainability of pastoral livelihood system	**Mean**	**Std. Deviation**	**Std. Error**	**Mean Difference**	**F**	**P-value**
Animals have died for the last 5 years	Unsustainable	64.13	149.79	12.89	-24.97	1.574	0.211
	Sustainable	39.16	116.53	13.37			
Cow	Unsustainable	21.88	44.38	3.82	-9.34	2.513	0.114
	Sustainable	12.54	34.46	3.95			
Goat	Unsustainable	14.39	30.80	2.65	-1.72	0.126	0.722
	Sustainable	12.67	38.48	4.41			
Sheep	Unsustainable	22.63	65.91	5.67	-12.13	2.159	0.143
	Sustainable	10.50	38.38	4.40			
Camel	Unsustainable	2.32	13.26	1.14	-2.08	1.862	0.174
	Sustainable	0.24	1.14	0.13			
Donkey	Unsustainable	2.37	12.92	1.11	-2.25	2.301	0.131
	Sustainable	0.12	0.63	0.07			

X^2 - Pearson Chi-Square score; F – ANOVA F-test score; and SD – Standard Deviation, std. Error – standard error

No colour means no significant difference between the households with unsustainable and Sustainable pastoral livelihood system. There is no significance difference however there exists mean differences between the households with unsustainable and sustainable pastoral livelihood system

Source: *Field Data, 2020*

The study found that pasture and water scarcity were the main causes of livestock death, occasioned by recurrent drought in West Pokot County, livestock especially cows and sheep are the vulnerable to climate-related shocks that include massive deaths of livestock, emaciated body condition and poor productivity thus reducing livestock population. The study was supported by (MLDF, 2015), who found that the livestock sector is ranked as one of the vital economic sectors in Tanzania that was severely impacted by climate change if no serious actions are taken to respond to its adverse consequences, then the livelihood of the pastoralist is at risk.

The study found that an estimate of 9188 animals died in single climate extreme from the sampled household respondents as shown on table 4.3, translating to huge economic loss to pastoralist, example an average of Ksh 10,000 per animals x9188 resulting to Ksh

91,880,00 in a single strike of drought. In a year West Pokot experiences at least three catastrophic phenomena associated with climate change, this translates to loss of Ksh 275,640,000. This justify that high poverty index in West Pokot county was as result of climate extremes, this implies that climate extremes retired development and it was the main source of poverty to Pokot Community, this finding justify why was West Pokot County being among the top ten most poor Counties in Kenya. The increased frequency of natural hazards associated with climatic variability result to high magnitude and high intensity, where pastoralist loss huge herd of livestock.

4.6 Animals Feeding on Poisons Plant

The study found that due to frequent drought episode, animals are exposed to feeding on poisonous plants that are invasive and poses a serious threat to animal's health. This study was confirmed by key informant, who noted that,

"Every year we loss many animals due to feeding on poisonous plants , especially during dry spell and onset of the long rain when all pasture and dry matter are swept away by first rain runoff".

During FGD it was revealed that Cocklebur plants was the most common dangerous poisonous plant that have killed many animals, this was well reported in Pokot North and Riwo Ward of West Pokot Sub-County, as shown in Plate 3.1 . It was further noted that these plants grow along the river-banks, or crops land. The study found that among the factors that expose the livestock to the poisonous plants was shortage of feeds. These plants poisoning cause health problems in livestock with huge economic loss to the pastoralists due to production loss, morbidity and mortality of their animals. Taffese & Samson (2009), found that during times of pasture abundance, animals avoid eating poisonous grass species, however, during drought, due to scarcity of pasture, animals are forced to consume poisonous plants, exposing themselves to Phyto-poison, Plate 3.2.

Moreover, due to the increasingly deteriorating conditions of the rangeland, grazing on degraded pasture can expose the animals to the risk of soil-borne bacterial diseases. The key informants narrated that during drought, due to scarcity of pasture, animals are forced to consume poisonous plants, exposing themselves to phyto-poison. After the April incidence of high number animal died of poisonous plant, the community reveled that they are now taking measures of restricting their animals along the river bank and plantation farms where those plants grow, the key informant indicated that use chemical

of can greatly reduce the growth of such plants, because it suppress the plant or kill the plant at early stage of germination, thus seeds cannot development, it was further revealed that the plant is very poisonous at first weeks of germination, therefore community restrict their animals from grazing along the river bank and crops farm where these plants growth as risk reduction measures.

Plate 4.1a & b: Dead cows at Nakwapuo, Pokot North after feeding on poisonous plant (Cocklebur), April, 2020

Source: Field data, 2020

Plate 4.2a & b: Cocklebur plant that killed 90 cows in Pokot North, April, 2020

Source: Field Data, 2020

4.7 Vulnerability of pastoralist to Impacts of Climate Change

The study assessed Pastoralist community vulnerability to impacts of climate change and sustainability of pastoral livelihood system, the findings revealed that household determines the vulnerable of community in the context of climate extremes. For instance this study show that there was significance level in determining the household size and vulnerability with d=4.5 and p-value <0.01, which show 99% level of significant KNBS, (2019) affirm this by indicating that West Pokot County had high birth rate, with large household size.

During FGD and KII the study further indicate that climate extreme events such as floods and lightning strikes, pests and livestock diseases were found to be factors that contribute to pastoralist vulnerability to climate change, chi-square test show that d=11.5 and 10.2 and p-value was <0.01 respectively which was an indication of high level of significance, this therefore inform that theses nature hazards are the most threatening and great problem in realization of sustainable pastoral livelihood in West Pokot County.

The study further found that crop failure and crop pest/diseases are some of the key factors that compromise realization of sustainability of livelihood, with d=8.2 and p-value<0.01 which indicate high level of significance. During focus group discussion it was reported that emerging of crop farming was an indication of adaptation measure for Pokot community who were traditional pure pastoralist with livestock being the main source of food security, but because of the unpredicted weather pattern influenced by climatic variability the community had to initiate coping and adaptive mechanism to climate change by exploring other source of livelihood and food security, such as crop farming and business.

It was noted that many key indicators that contribute to sustainability to pastoral livelihood are all affected negatively by climate change, for example water, pasture and forest cover, although the association may not have considered under correlation analysis, but those biophysical indicators which are exposed to effects of climate change, as shown on Table 4.5. Sustainability of pastoral livelihood system was noted to be compromised by exposure of community livelihood support system being sensitive to effects of climate change. This mean that the severe drought experienced in West Pokot, hinders community realization of resilience to climate change extreme.

The key informant from NDMA stated that,

"*During drought episode biophysical and production are the key indicators that informant the level of drought phases. This was noted when those indicator area either within the range or out of range, we normally monitor those indicators to determine drought phase that we are in as County".*

This statement was supported by drought classification by VCI-3month values.
The study further shows that pastoralists, due to their sensitivity and exposure to climate variability, coupled with low adaptive capacity of pastoralist community tend to increased vulnerability, that result to huge loss to community thus increasing community poverty index. Respondents reported that in term of household size, household size was noted to influence community adaptation to effects of climate change. The small size household can adapt to climate change compared to large size household. Investment on climate-proof infrastructure that protect pastoralist from being exposed to climatic variability were key in cushioning communities in ASAL from adverse impacts of climate related hazards.

Table 4.5: Relationship between vulnerability to impacts of climate change and Level of sustainability of pastoral livelihood system

	Level of Vulnerability pastoral livelihood system				
Variables	Unsustainable	Sustainable	Difference	X2	P-Value
Water, vulnerable %	44.0	49.2	5.2	6.492	0.011**
[7]Pastures, vulnerable %	48.2	49.0	0.8	2.131	0.144
[7]Livestock Production, vulnerable %	46.9	50.0	3.1	1.554	0.212
Forest cover, vulnerable %	46.6	46.9	0.3	1.797	0.180
[7]Livestock Population, vulnerable %	48.4	50.0	1.6	0.595	0.440
[7]Crop Production, vulnerable %	43.5	40.4	-3.1	6.735	0.009***
Trend of livestock production changes in the last 30 years, increased (%)	13.0	31.4	18.4	35.054	0.000***
Trend of crop production changes in the last 30 years, increased (%)	19.5	36.0	16.5	16.664	0.000***
Are there weather changes that you observed? yes (%)	44.3	45.3	1.0	0.280	0.597
Does effects of climate change increase or decrease?, Increased (%)	43.8	43.8	0.0	1.167	0.280
Duration of stay in the locality=Below 5 years, yes (%)	8.1	7.6	-0.5	0.209	0.648
[7]Duration of stay in the locality= 5-10 years, yes (%)	12.8	14.8	2.0	0.437	0.508
Duration of stay in the locality= 11-30 years, yes (%)	11.2	15.9	4.7	3.307	0.069*
Duration of stay in the locality=Over 30 years, yes (%)	16.9	12.8	-4.1	4.214	0.040**
Size of the household=1-3 members, yes (%)	7.6	9.1	1.5	0.409	0.523
Size of the household=4-7 members, yes (%)	21.6	19.3	-2.3	1.623	0.203
Size of the household=8-11 members, yes (%)	14.8	13.3	-1.5	0.877	0.349
Size of the household=11 and above members, yes (%)	4.9	9.4	4.5	5.336	0.021**
[7]Climate extreme events=Drought, yes (%)	38.8	18.0	-20.8	75.875	0.000***
Climate extreme events, Floods and lightning strikes, yes (%)	3.9	15.4	11.5	30.189	0.000***
Climate extreme events=Landslide, yes (%)	1.3	2.6	1.3	1.525	0.217
Climate extreme events, Pests and Livestock diseases, yes (%)	4.9	15.1	10.2	22.727	0.000***
Time started experiencing climate change problem=less than 5 years, yes (%)	24.2	33.1	8.9	9.214	0.002***
[7]Time started experiencing climate change problem= 6-10 years, yes (%)	14.8	10.7	-4.1	4.462	0.035**
Time started experiencing climate change problem= 11-15 years, yes (%)	3.6	3.4	-0.2	0.097	0.755
Time started experiencing climate change problem=Over 15 years, yes (%)	6.2	3.9	-2.3	2.749	0.097*
Causes of livestock deaths=Livestock	30.8	17.5	-13.3	0.006	0.940

diseases, yes (%)					
Causes of livestock deaths=Harsh climatic conditions, yes (%)	24.2	18.0	-6.2	2.978	0.084
Causes of livestock deaths=Other causes, yes (%)	9.0	0.5	-8.5	9.225	0.002***
Causes of crop failure=Pests and Crop diseases, yes (%)	13.2	21.4	8.2	23.081	0.000***
Causes of crop failure=Harsh climatic conditions, yes (%)	44.1	17.3	-26.8	20.450	0.000***
Causes of crop failure=Other causes, yes (%)	2.7	1.4	-1.3	0.174	0.677
Overall score Vulnerability to climate change[1]					
Mean	73.94	65.16	t=-8.78	5.61	0.00***
SD	13.83	16.63			
Std. Error of Mean	1.01	1.19			

X^2 - Pearson Chi-Square score; t – t- test score; and SD – Standard Deviation, std. Error – standard error.

**p<0.1 **p<0.05 ***p<0.01 Significant at 90%; 95% and 99% confidence level Red means negative significant Green means positive significant and No colour means no significant difference between the households with unsustainable and Sustainable pastoral livelihood system.* The Cronbach's Alpha is 0.372 using 7 vulnerabilities to impacts to climate change variables which is below fair value for testing internal consistency but had some elements of consistency (Check superscript 7 behind the 7 variables).

Source: Field Data, 2020

This study agrees with Thomas and Twyman (2005), who noted that high levels of vulnerability and low adaptive capacity have been linked to factors such as a high reliance on natural resources, limited ability to adapt financially and institutionally, high poverty rates and a lack of safety nets. The World Bank (2010), reported that climate change was expected to reduce productivity; livestock productivity may be lower by 50% in 2050s compared to those without climate change scenario. Agricultural GDP with climate change may be lower by 3%to 30% than without climate change agricultural GDP in 2050. Climate change increases the number of people looking for food aid by 30%. The finding also noted that ASAL area that was home to pastoralist has continued experiencing increasing temperatures and decreasing rainfall that contributes to reduce livestock production due to land degradation.

4.8 Pastoralist Exposure to Climate Change

The study assessed level of respondents perception on exposure to climate change (59.5%), of the respondents indicated that exposure was high (23.2%) medium (13.3%) low, and (4%) no change, this implies that, when community exposure was high, then the community was more susceptible to climate change. Exposure of pastoralist to effects of climate change increases their vulnerability to climate extreme events. Pastoralists who are predominantly in arid and semi-arid area are seriously exposure to impacts of climate shocks, Figure 4.12. As indicated by respondents' reviews on exposure to climate change it was noted that pastoralists were highly exposed to effects of climate extreme events, such as drought, floods and landslides. (IIRR & Cord Aid, 2013), found that Degree of exposure varied for the different elements at risk of climate change impacts (Human and non-human economic assets, institutions, and critical service which provide facilities, example Productive assets e.g., livestock and farmland/crops.

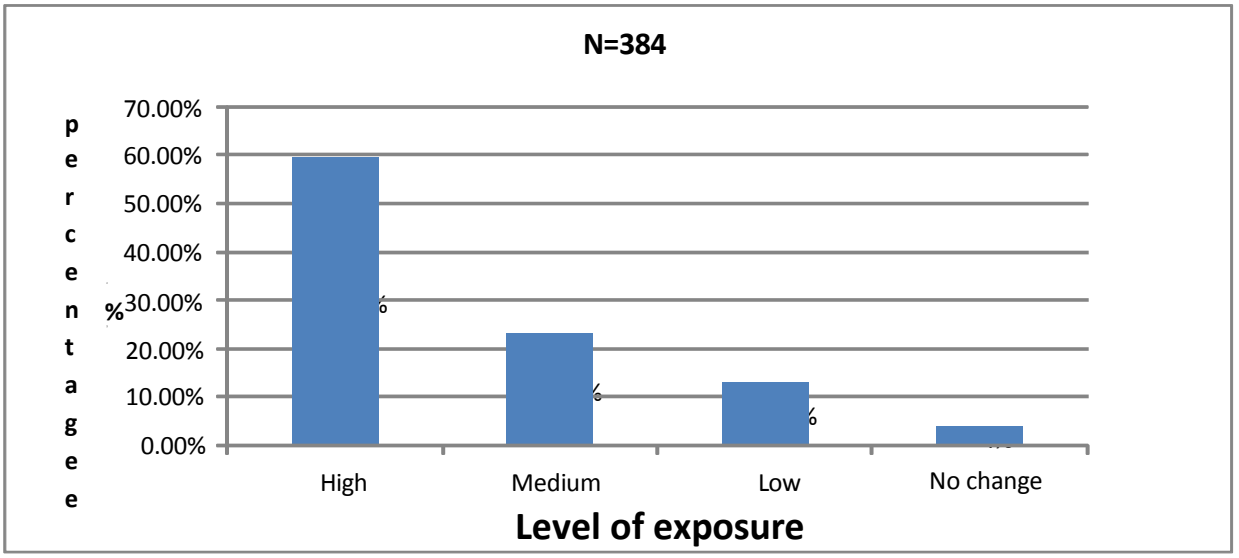


Figure 4.12: Respondents perception on exposure to climate change

Source: Field Data, 2020

The study found that exposure to climate change involve climate variation and chronic climate extreme events that impacts negatively on critical natural resource such as pasture, water, forest and vegetation cover. Key informants reported that frequency of extreme events, rise in temperature, environmental destruction and dryness-ASAL of an area, are some of the factors that exposed pastoralists to adverse effects of climate change, the study agree with GOK, (2007), that revealed that arid and semi-arid lands (ASALs) make up 80% of Kenya's land area and that droughts are a common

phenomenon ASAL counties, where the dryness is most pronounced and the drought frequency has increased. This study was further supported by Focus group discussion who reported that recent landslides and flood disasters in West Pokot County was as result of poor land-use, settlement on hazardous area and high level of deforestation that expose community to impacts of hydrological and geological disasters. Furthermore, environmental degradation compromises community resilience to climate variability. The study was supported by Orindi *et al.,* (2008), who noted that climate extremes have resulted in immense losses of resources that affect livelihoods of many people who depend on the ecosystem for survival, particularly the pastoralists. This affects forage quality and quantity, the time it takes to grow and it also affects water quality and quantity. As a result of this, livestock productivity goes down and sometimes the livestock die.

4.9 Indicators of Exposure to Climate Change

During county steering group meeting, respondents identified various variables factors that exacerbated pastoralist to effects of climate change. As indicated in table 4.6, exposure to climate change was determined by various indicators that influence pastoralist intensity to effects of climate extreme events, it was these indicators that determine how community was exposed to effects of climate change.

Table 4.6: Indicator of exposure

Frequency of extreme events	Temperature	Environmental destruction	ASAL-dryness
Chronic climate extreme event in West Pokot County like drought exposes pastoralist of extreme effects of climate related disaster.	Increased temperature couple with short rain or dry spell tends to increase pastoralist vulnerability to drought.	Interference of ecosystem, vegetation, and environment in general, always compromises community resilience various hazard that is triggered by climate change.	Geographical condition and climatology of an area, is key in determining adaptation and susceptibility of community in arid and semi-arid area to effects of climate change.

Source: Field Data, 2020

4.9 Pastoralist livelihood Sensitivity to Climate Change

The study assessed respondents' perception on sensitivity of pastoral livelihood to climate change by seeking the opinion of the respondents on the community on the sensitivity of pastoralist livelihood to effects of climate variability. Respondents indicated as follows (63%) high (20%), medium (12%) low, and (5%) no change. When the sensitivity to climate change is high, then the community is more vulnerable to the impacts of climate change and natural disasters. Based on the findings, it can be said that pastoralist livelihood in West Pokot County was more sensitive to climate change; thus, increasing community susceptibility to effects of climate variability, Figure4.13. It was further found that natural resources that support pastoralism in arid and semi-arid lands are highly sensitive to climate variation, example water, pasture and forest.

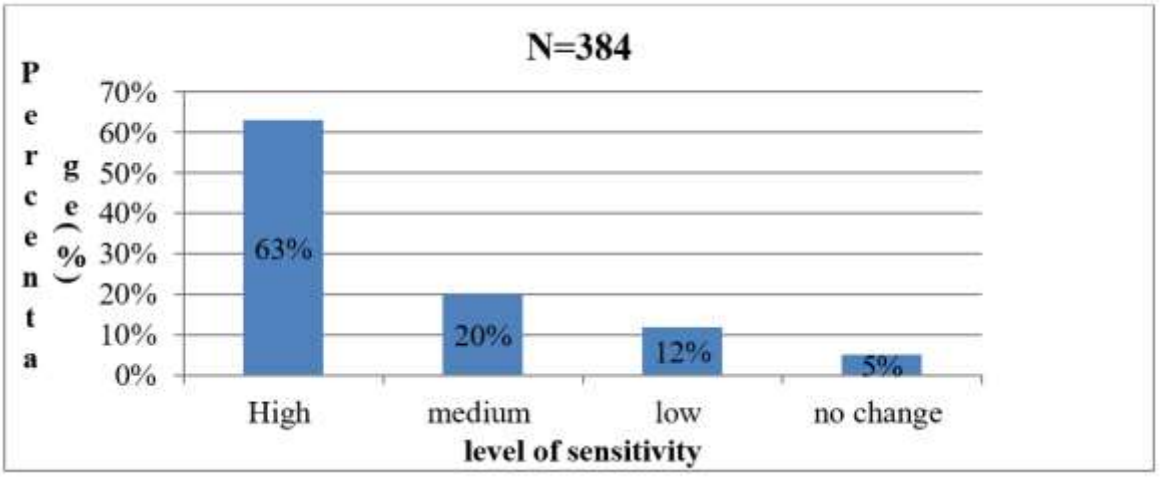


Figure 4.13: Respondents perception on sensitivity of their livelihood to climate change

Source: Field Data, 2020

The key informants revealed that sensitivity to climate change depends on main livelihood and natural resources that support the livelihood. The study indicated that among the direct effects of climate change are higher temperatures and changes in rainfall patterns, translating in an increased spread of vector-borne diseases and macro parasites of animals and emerging of new disease. The study found that West Pokot County being semi-arid county was prone to drought that increases the community's exposure to adverse impacts of climate variability. It was projected that increased trends of temperatures and less reliable rainfall increases community vulnerability to droughts in West Pokot County, resulting to diminished pasture and water crisis.

West Pokot County was noted to be sensitive to climate variability. Water, pasture, forage and rainfall are the primary natural resources influenced by climate variability thus, increasing sensitivity to climate variability. The County's economy is highly dependent on reliable rain for pasture generation and livestock access to water. During FGD, it was found that that the original Pokot animals breed was resilience to drought and had high yield of milk, but this breed was more susceptible to east coast fever that use to be the most threatening livestock diseases in West Pokot in early 1990s, especially indigenous cows, *Angoria,* therefore local pastoralist had to change their livestock breed by embracing local zebu cows from highland that had developed immunity to east coast fever *cheptuyoi,* the east coast fever was noted to be mainly highland disease, but because of climatic variability the diseases spread to low land (ASAL) where it was not use to be, This therefore exposed local pastoralist to severe outbreak of east coast fever resulting to great loss of cattle. The study therefore proposes diversification of livestock breed to promote pastoralist sustainability to climate shocks, the pastoralist to have more camels, shawl and goats that prove to be more resilience livestock's in ASAL area, in terms of pasture, seasonal grazing area and pasture development form part of key adaptation measure to pastoralist in context of climate shocks.

4.9.1 Indicator of Sensitivity to Climate Change in West Pokot

The study evaluated various indicators of sensitivity to climate change; this was noted well during county steering group meeting, when respondents revealed that pastoralist livelihoods are more sensitive to impacts of climate change. It was noted that key natural resources that are highly depended by livestock are sensitive to climatic variability, as show in table 4.7.

Table 4.7: Indicator of sensitivity

Pasture	Water	Forage	Rainfall
Pasture re-germination depends on rainfall performance; therefore failure of rainfall increases livestock To effects Of drought.	Availability `of water depends on performance of rain, therefore poor or failure of rainfall always jeopardizes pastoralist, more so their livelihoods depend on water for survivals.	Forage is key naturals resources that is always influences by rainfall performance and it is what support pastoralist livelihood, in ASAL area like West Pokot this resource is prone to drought thus exposing livestock to extreme effects of climate change.	The performance ofrainfall influences access of livestock to natural resources like water, forage and pasture, therefore low or poor performance of rain contribute to pastoralist being adversely affected by climate extreme events.

Source: Field Data, 2020

4.10 Pastoralist Adaptive Capacity to Climate Change

The study assessed respondents' perceptions on level of pastoralist adaptive capacity to Climate change, the respondents' indicated (4.5%) high, (5%) medium, (87%) low and (3.5%) no change. It was therefore noted that, when the adaptive capacity to climate change is low, then the pastoralists are highly susceptible to the impacts of climate change. Adaptive capacity of pastoralist community support climate resilience livelihood and strengthen the ability of vulnerable community to climate change impacts. Lack or low adaptive capacity of pastoralist community increases their susceptibility to effects of climate variability.

Based on respondents' views, it reveals that pastoralist in West Pokot County have low adaptive capacity to climate change; this therefore indicated that communities in this area

are vulnerable to climate extreme events. From FGDs and KII, it was shown that majority of the residence of West Pokot County have low adaptive capacity to climate change, this was attributed to low level of understanding of climate variability. Climate change was reported to be new phenomena among the pastoralist; therefore, communities require knowledge, education, and training on climate change adaptation.

This study was supported by Nderitu (2018), who found that if adaptive capacity is high then the community internal response mechanisms are enough to address the climate change impact. It was further noted that the capacity accessed allow individuals and communities to shape their future by reducing climate change risk, and capacity assessment was to identify the existing capacities, the required capacities to cope in the face of the climate change impact and the gaps/ capacity was classified into the following categories; Human Capabilities (knowledge, skills, attitude, Economic (assets e.g. livestock, farm land money), Natural (forests, rivers, water sources) and Social (institutional, cultural, political, and ideological.

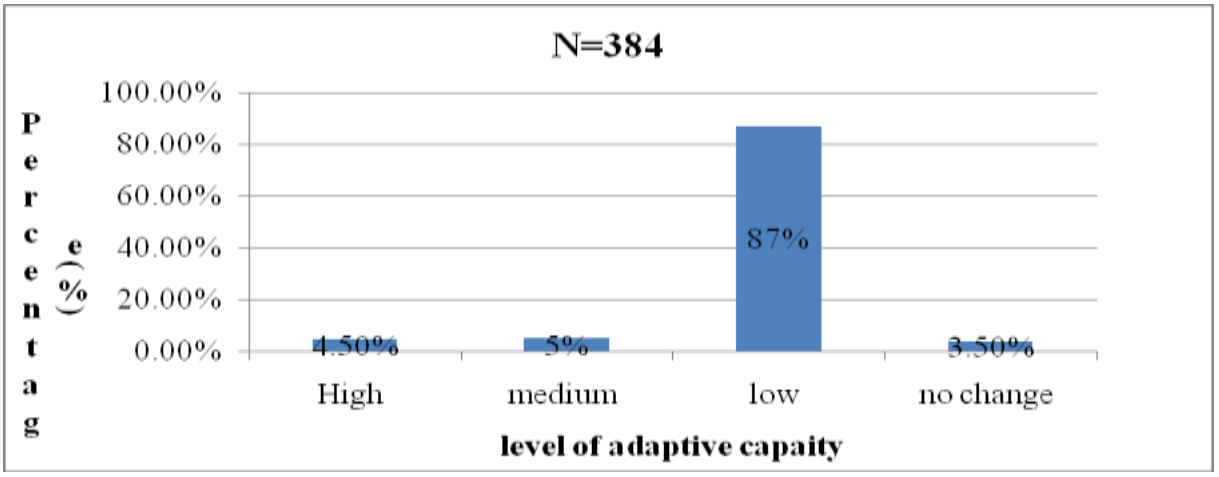


Figure 4.14: Respondents perceptions on level of their adaptive capacity to climate change

Source: Field Data, 2020

During KII with county steering, it was noted that, access to information on climate help strengthen community adaptive capacity. Climate change risk reduction measure enhances community understanding of new approaches of addressing effect of climate variability that pose a threat to livestock keepers, although to achieve adaptive capacity was a combination of various factors such technology, infrastructure, natural resources, financial, knowledge and skills. The study noted that social and economic disparities that, include poverty, illiteracy, cultural believes, poor governance and weak institutions are the underlying drivers of low adaptive capacity to impacts of climate change in West Pokot County. The study also indicated that adaptive capacity of a household was based on pastoral livelihood assets access and control. These assets strengthen community capacity to cope, adapt and withstand the effects of climate shock by building resiliency to its effects. Therefore, women and children with limited access and control of these assets are more vulnerable to climate variability compared to man.

Table 4.10.1: Indicator of adaptive to Climate Change in West Pokot

Governance and Institution	Technology	Knowledge	Economic	Diversification of livestock	Water structures
Participatory and inclusiveness Community engagements on decision making, strong governance system, coordination among multi government non-state actors, Opportunity for community to use their local-based solution in mitigating effects of climate change	Technological advancement that aim at reducing risk associated with climate change or enhancement of technological adaptation measures, help in promoting adaptation of a community	An enhanced capacity of community on climate change adaptation information , through training or impacting knowledge or skills on how to combat effects of climate change, this help promote adaptation	Economic resources gives an individual or community greater opportunity of taking adaptive measures through, investing of programs that reduces impacts of climate change	Investing on diversification of livestock tend to give pastoralist option of having new breed of animal that adapt or cope with effects of climate extreme events, therefore this enhances pastoralist adaptation	Water is key resources to pastoralist therefore investment in water structures guarantees pastoralist an opportunity of adapting with risk associated with water crisis that use to be triggered by drought

Table: 4.8: indicator of adaptive capacity

Source: Field Data 2020

The evaluated various the indicator influence adaptive capacity to climate change; this was noted well during FGD, when respondents revealed that pastoralist community has low adaptive capacity to impacts of climate change. It was noted that key natural resources that was highly depended by livestock are sensitive to climatic variability, as show in table 4.8. The expression of perception on adaptive capacity as actions that lead to adaptation can serve to enhance a system's coping capacity and increase its coping range, thereby reducing its vulnerability to climate hazards. The adaptive capacity represents the set of resources available for adaptation, as well as the ability of that system to use these resources effectively in the pursuit of adaptation. Such resources may be natural, financial, institutional or human, and might include access to ecosystems, information, expertise, and social networks. The study further assessed the influences of demographic characteristics of respondents to exposure, sensitivity, and their adaptive capacity to climate change, as shown in figure 4.18.

The results shows that all the sub-counties in West Pokot are exposed to climate change impacts, the respondents indicated that there is a strong relationship between the exposure to climate change index and geographical location of the respondents. KIIs and FGDs reported that as the drought worsens, animals start to browse less palatable shrubs/vegetation, as livestock body start deteriorating drastically. It was further noted that frequency of natural disaster have also increased, thus posing threat to pastoralist in the study area. This therefore means that sustainability of pastoralist livelihood was seriously threaten by climate extreme events, that directly affected pastoralist livelihood and natural resources that are highly depended by livestock. This study was supported by (NDMA, 2017), that during emergency phase of drought all indicators always get out range, especially natural resource and this is evidence by vegetation condition index (VCI of 10 and below).

4.11 Rainfall variability in West Pokot

The study reviewed the secondary data on rainfall performance in West Pokot County, it was found that trends in rainfall variation was mostly evident as effects of the climate changes occurring in earth's climate system and the extremes in rainfall variability was showing a great concern to the pastoralist and livestock rearing that was climate sensitive sector with high dependency on rainfall.

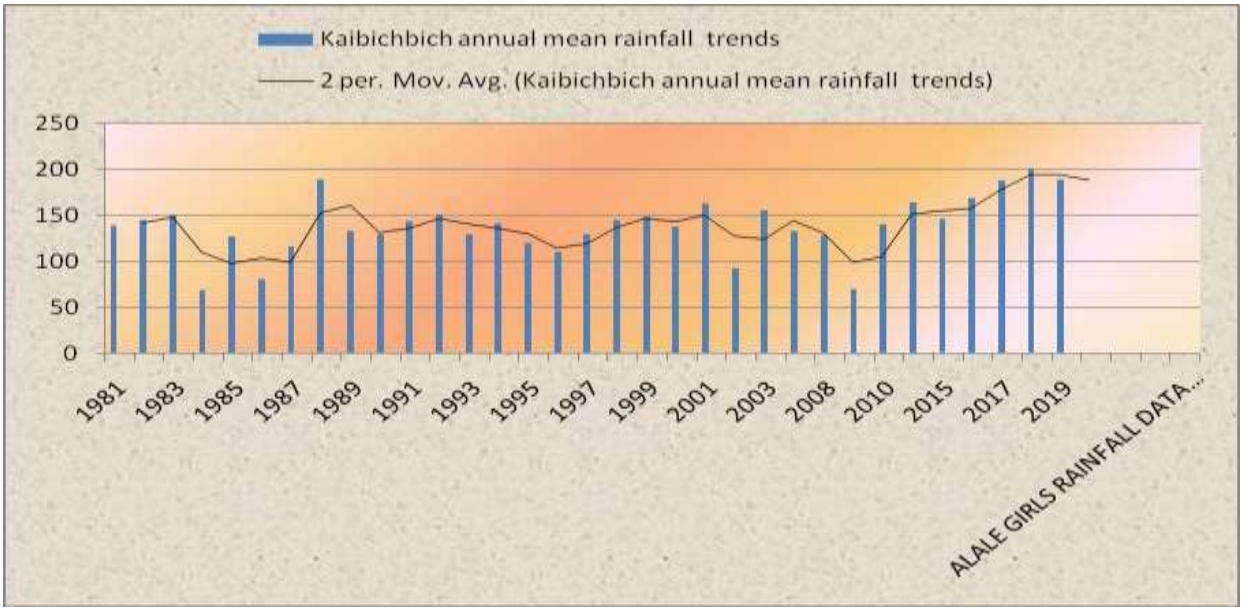


Figure 4.15: Rainfall trends in West Pokot County

Source: Field, 2020

From the figure 4.15, the study revealed that the rainfall trend was showing an increase since 2010 as shown in figure 4.15, although in the past rainfall pattern indicated to have fluctuated, varying from one year to another. In the recent past the trends has been on increase and this confirm the reason why West Pokot has been experiencing frequent hydrological and geological hazards of high magnitude and intensity such landslides and floods, that claimed lives, environmental destruction and generally loss of livelihoods. During FGD it was reported that climate extremes keep on changing and the new emerging disasters with no warning compared to chronic drought and livestock diseases are rapidly being experienced in West Pokot County.

Disasters such as landslide, lightning strike and floods have emerged to be the most threatening climate related extremes in West Pokot between 2010-2020. A key informant reported that,

"*In the year 2015-2016 lightning strike killed hundreds of animals, floods caused havoc in Ortum, Kongelai and Sigor displacing many households and in 2019-2022, landslide in Tapach claimed many lives, and loss of animals. Crops, environmental destruction and entire livelihood of residence, the floods in Chesegon-Pokot Central, 2020 displaced hundreds of households, many lives loss, entire market town was swept ways, many people became homeless and their livelihood completely destroyed".*

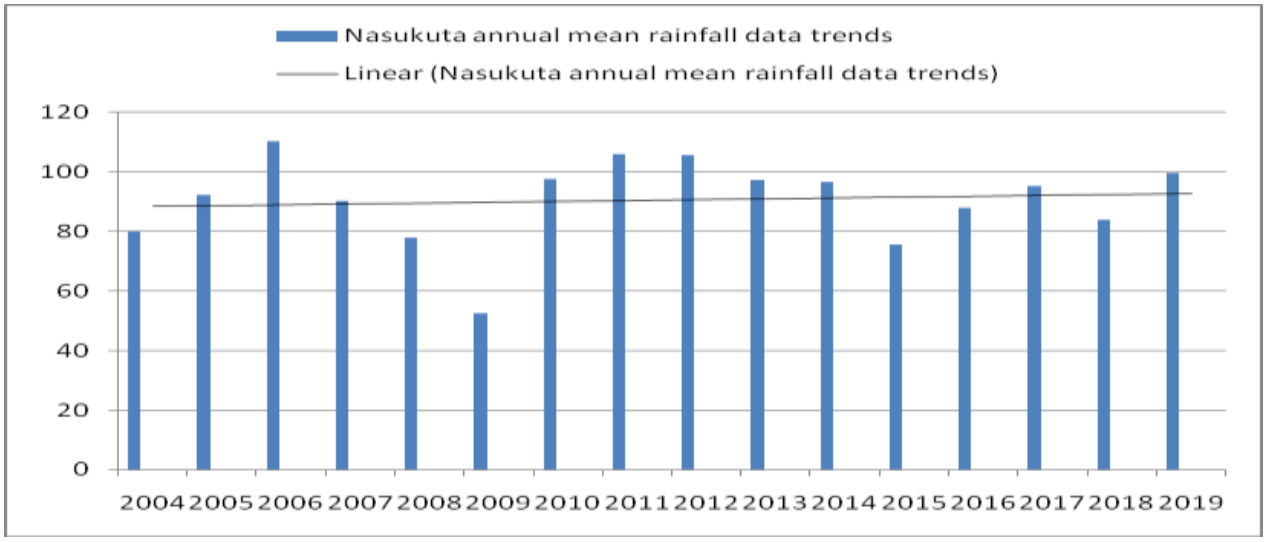


Figure 4.16: Rainfalls trends from Nasukuta rain gauge station

Source: Filed data, 2020

At Nasukuta, the study found that rainfall trends show an increase of 2.5mm mean annually since year 2004, this mean that rainfall has been on increase trend with area like Nasukuta that is semi-arid reporting increased rainfall. The key informant reported that in the recent past this area have become wetter, than before, heavy rainfall was being experienced in the two seasons of the year, March-April –May (MAM) and October-November and December(OND), sometime even December that was to be dry season had received rain.

a) Rainfall data for Sigor

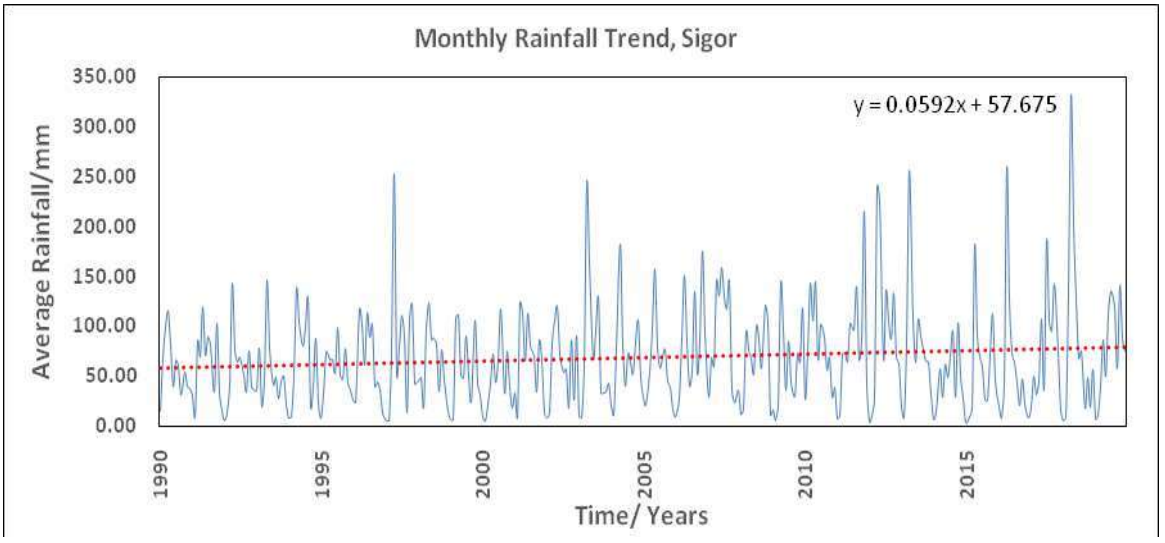


Figure 4.18: Monthly rainfalls trends for Pokot Central Sub-County

Source: Field Data, 2020

As from the figures Figure 4.18, the study revealed that 1999 -2019 the area received variable rain. It was therefore noted that from the findings there was no consistent rainfall trend observed overtime in West Pokot suggesting that the yearly rainfall trends were unpredictable. The study found that rainfall has been in an increased trend since 1990-2019 in all the sub- counties of West Pokot County, as shown in figure 4.18.

The key informant indicated that almost the entire County was expected to see an increase in extreme precipitation as it warms. This was as results of global temperatures rise; much more rain is expected to trigger hazard such as extreme storms, floods, landslides and lightning strike. The warmer the atmosphere, the more moisture that can hold, this therefore mean that extreme rains along with the flooding, landslides and other devastation and deadliest weather events are expected to be on increased with increased rainfall. The key informant stated that due to increase in temperature, the earth warms more than usual, thus enhancing precipitation and moisture that trigger erratic rainfall. The findings indicated that Pokot South and Kapenguria had significance increase in rainfall trends compared to this other sub-counties, Kacheliba 0.012, Kapenguria 0.004, Pokot South 0.004 and Sigor 0.006. The p values were <0.05 confidence level, which was an indication of high level of significance of the rainfall trends experience, at 90% confidence level. The seasonal rainfall pattern in West Pokot was found to be tri-modal; this was as result of high- pressure system during June-August that triggered rainfall season that was not in the seasonal calendar of the West Pokot County.

The high-pressure system in central and eastern part of Uganda that increased precipitation, that result in increased wet season between June-August, thus triggers tri-modal rainfall pattern inWestern part of Kenya especially West Pokot County and other Counties along the Western part of Kenya. Although this study disagrees with (West Pokot CIDP, 2018-2022 and NDMA, 2020), that indicated that West Pokot County experience bi-modal rainfall manly long rain (March –May) and short rain (October-December).During focus group discussions one respondent revealed that:

"*We use to have two rain seasons (long rain (March-may) and short (October-December), but of late we have been experiencing heavy rain between June to August that was never use to be. I suspect that Turkwel Dam might be influencing or altering rain pattern in West Pokot, however, I understand that there is climate variability that*

also interfere with normal rainfall pattern".

The key informant from meteorology revealed that Congo air mass was found to have great influences on the tri-modal rainfall pattern in Western part of Kenya, because of increased moisture that move toward Uganda and Western part of Kenya. The Lake Victoria was also noted to have increased moisture that triggers heavy rain in north rift especially Cherangany hill and Nandi hills, this has enhanced formation of relief rainfall in Rift valley. The Turkwel Dam that have expanded and it was noted to have contributed to micro-climate change that enhanced moisture in high altitude of West Pokot especially Kapenguria and Pokot South. This study was supported by Ogwang, *et al., (*2014), who noted that Congo airstream was completely unstable and storms easily form and develop moisture that mostly influences rainfall in Western parts of Kenya. They further argued that air masses and pressure patterns also have a major influence on the Kenyan Climate. Pressure belts shift with the movement of the overhead sun thereby causing seasons, the greatest isolation obtained directly below the overhead sun creates lowest pressure which is known as a convergence zone. Semazzi (2006), who found that due to raised topography that results in orographic lifting of moist air masses from the Indian Ocean due the dominant south easterlies, lifting of the Congo forests air mass for the West due to a quasi-permanent dynamic low-pressure cell that oscillates around the Congo Forest, that greatly influences rainfall pattern in Uganda and Western part of Kenya. The study was in agreement with Mary Kilavi (2012), who noted that the Western parts of the Kenya experience significant rainfall during the period June-August associated with influences from the tropical south Atlantic and incursions of moist Congo air mass when the meridional branch of Intertropical Convergence Zone ITCZ that create maximum eastward displacement over the region.

4.12 Comparison of Seasonal Rainfall Pattern (1990-2019) in West Pokot Sub-Counties From the scale, Pokot South received highest rainfall in the County, followed by Kapenguria, Sigor and Kacheliba respectively. Kacheliba was noted to receive lowest rainfall in the County due to its altitude, Kacheliba is lowland area that doesn't attract moisture and like Pokot South, Kapenguria, upper part of Sigor and Pokot South is continuation of Charangany hills and extension of Embobut forest that gets a lot of moisture that triggers rainfall.

Pokot South being the highest ground in West Pokot County, that has low pressure in the County, also attracts erratic Columbus cloud that triggers thunderstorm, hence leading frequent cases of lightning strikes in area. NDMA (2017), stated that highland part of West Pokot, especially Pokot South receive normal to above normal rainfall through the year. This result was strongly supported by key informant from meteorology department who stated that:

"Kacheliba and Sigor are lowland areas in West Pokot, while Kapenguria and Pokot Southare high land areas that attract high pressure from low land, therefore, has high moisture. Generally, rainfall trends show that there was an increase annually, this therefore informs the recent catastrophic disasters of landslide and floods that West Pokot County experienced".

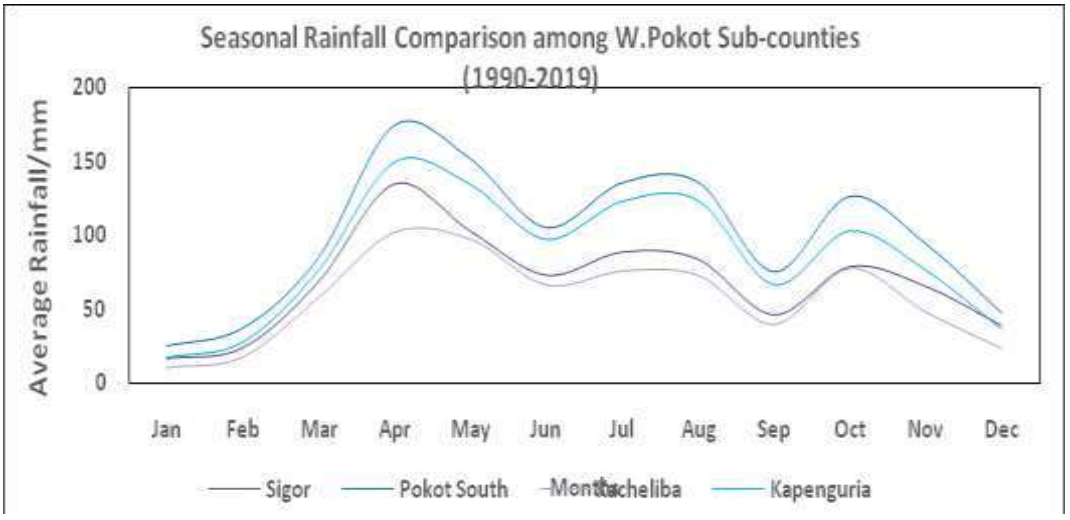


Figure 4.19: Seasonal rainfalls in West Pokot Sub-Counties

Source: Field Data, 2020

4.13 Temperature analysis

The study assessed the temperature through the secondary data from meteorological department analysis, and found that the minimum and maximum monthly daily temperature for West Pokot County was collected and average daily temperature per month and per year calculated in the study area, that covers all the livelihoods zones. It was noted that rivers are drying at high rate than before due to high evaporation. The study therefore revealed that temperature was on increasing trends as evidence. The general trends of temperature show increase in heat intensity that was attributed to global warming, figure 4.18, under MAM period of the year an increased trends was observed

throughout the year, but for OND there has been some fluctuation and this was an indication of dynamic of climate extreme events that trigger server drought or heavy rainfalls that lead to floods and landslides. The study was supported by Ogutu *et al*., (2007), who found that the mean daily temperatures in Lodwar fluctuated overtime, statistical analyses of the change of mean temperature show that there was an increase of 0.12°c during this period; the rise in surface temperature seems to be consistent with trends for Kenya. During FGD it was revealed that temperature has risen, and the earth was getting hotter than before. The key informant reported that:

"Some human and animals' disease outbreak has increased due to raise in temperature that provides favorable condition for vector or parasites that cause or transit diseases".

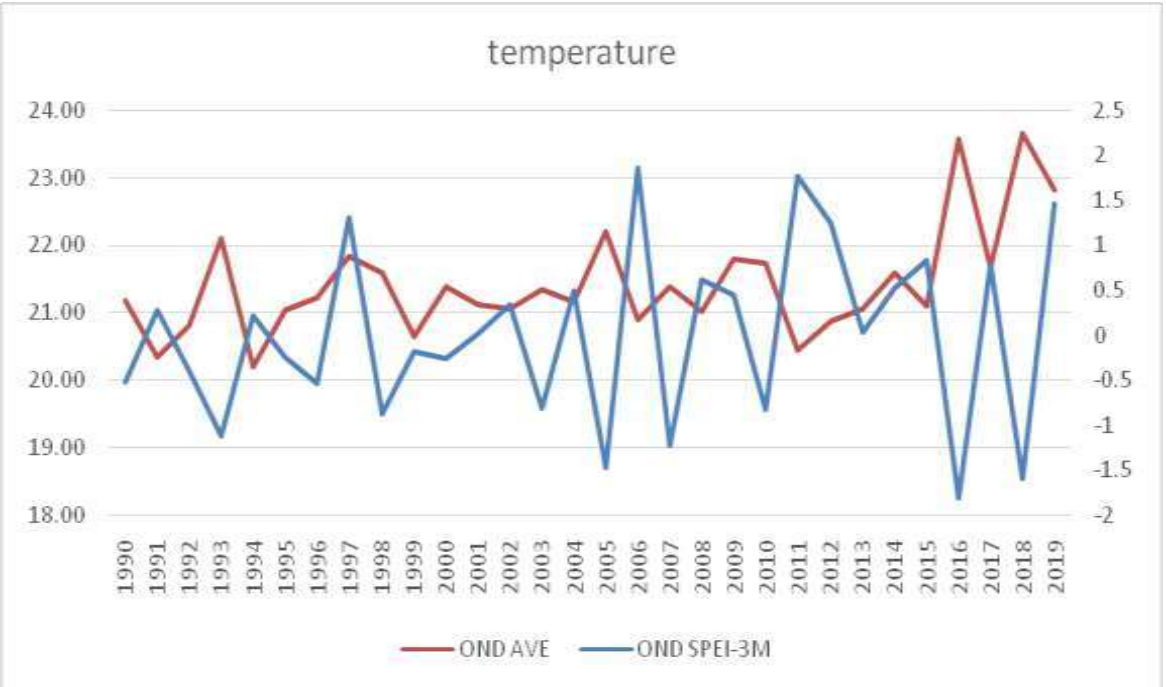


Figure 4.20: Temperature trends

Source: Field Data, 2020

CHAPTER FIVE
IMPACTS OF CLIMATE CHANGE ON LIVELIHOODS AND LIVESTOCKPRODUCTION

5.1 Introduction

This chapter presents findings on implication of climate change on livestock production. The study examined threats of pastoralist food insecurity caused by climatic variability. The finding assessed impacts of climate change on livestock production in West Pokot County and exposure of pastoralist livelihood to impacts of climate change.

5.2 Impacts of Climate Change on Livestock production

The study investigated impacts of climate change on pastoral livelihood, and the results indicate that climate change affect pastoralist with high magnitude in terms of area coverage that was affected and intensity in term of the loss, deaths and destruction brought by climate extremes events. It further reveals that pastoral production was highly susceptible to climatic variability and different animals are impacted differently by climate change.

The study assessed effects of climate and it was found that pastoralist were the mostly affected by climate extremes with 71.4% of the respondents indicating very high, while the mixed farming was found to be less affected with 12.2 % of the respondents indicated very high. In term of animals affected by climate change, it was found that sheep and cow are the most vulnerable animals to effects of climate change with 57%and 48% respectively because they are grazers, as shown in table 5.1. This implied that cows and sheep breed reared in West Pokot are more susceptible to climate extremes, compare to other animals such as camel, goat and donkey which were perceived to be more resilient to harsh climatic condition associated with climate change, due to their browsing nature of their feeding. This means that, pastoralists are more exposed to climate variability compared to those with multiples sources of livelihoods. The livelihood of pure pastoralist was found to be more sensitive to climate change related hazards, with climate extremes of high magnitude and intensity reported every year. In term of the ecological zone and animals most affected by climate extreme, the results shows that pastoral zone is the most vulnerable and adversely affected compared to other ecological zones, animals such as cows and sheep are the most susceptible to effects of climate shock, table 5.1 show that the colored columns indicates the most affected by climate change.

Table 5.1: Distribution of different livelihood zones based on vulnerability levels (low, medium, high)

		Very high	High	Moderate	low	Very low	Not affected	Don't know
Which ecological zone is mostly affected by climate change?	Pastoral	71.4	17.4	6.3	0.5	1.3	0.3	2.9
	Agro-pastoral	14.8	50.0	22.1	1.8	1.6	1.0	8.6
	Mixed	12.2	12.8	57.8	7.8	1.8	1.6	6.0
Which ecological zone is least affected by climate change?	Pastoral	39.1	17.4	18.5	7.8	13.8		3.4
	Agro-pastoral	10.9	38.3	27.3	11.5	2.1	1.3	8.6
	Mixed	18.0	16.7	45.8	7.6	2.6	2.6	6.8
Which animals are mostly affected by climate change?	Cow	48.2	30.2	12.8	4.9	3.6	0.3	
	Goat	7.0	21.6	50.8	5.5	2.9	10.4	1.8
	Sheep	57.8	20.6	11.7	6.3	1.0	0.8	1.8
	Camel	1.6	3.4	16.1	8.9	22.7	20.1	27.3
	Donkey	14.3	12.0	12.0	6.8	8.9	9.1	37.0
Which animals are least affected by climate change?	Cow	37.5	27.6	8.9	8.6	17.2		0.3
	Goat	14.8	21.9	44.0	5.2	2.6	9.1	2.3
	Sheep	35.2	22.4	15.4	8.3	16.9	0.3	1.6
	Camel	15.1	3.1	13.8	7.0	13.3	19.5	28.1
	Donkey	12.2	5.5	12.5	12.0	12.0	8.6	37.2

Source: Field Data, 2020

In terms of animals breed resilience to climate change, the findings show that goats, camels, and donkey were least affected by climate change hazards, indicating that these animals are more adaptive and resilient to climate change impacts. The study is consistent with Jones *et al*., (2009), who stated that West Pokot County has a diversity of ecological zones, all affected differently by climate variability impacts. The study shows that pastoral zone was found to be the adversely affected by climate change.

5.3 Implication of Climate Change on Different Pastoral Livelihood

The finding shows that climate change impacts different livelihood zone differently. It was indicated that 88.8% of respondents are pastoralist, 64.8% agro-pastoral and 57.8% mixed framers, Figure 5.1. The results show that pastoral zone was the most vulnerable livelihood to impacts of climate change compared to other livelihood zones, due to their feeding nature of being grazers. This reveals that communities living in pastoral zones are threatened by climate variability.

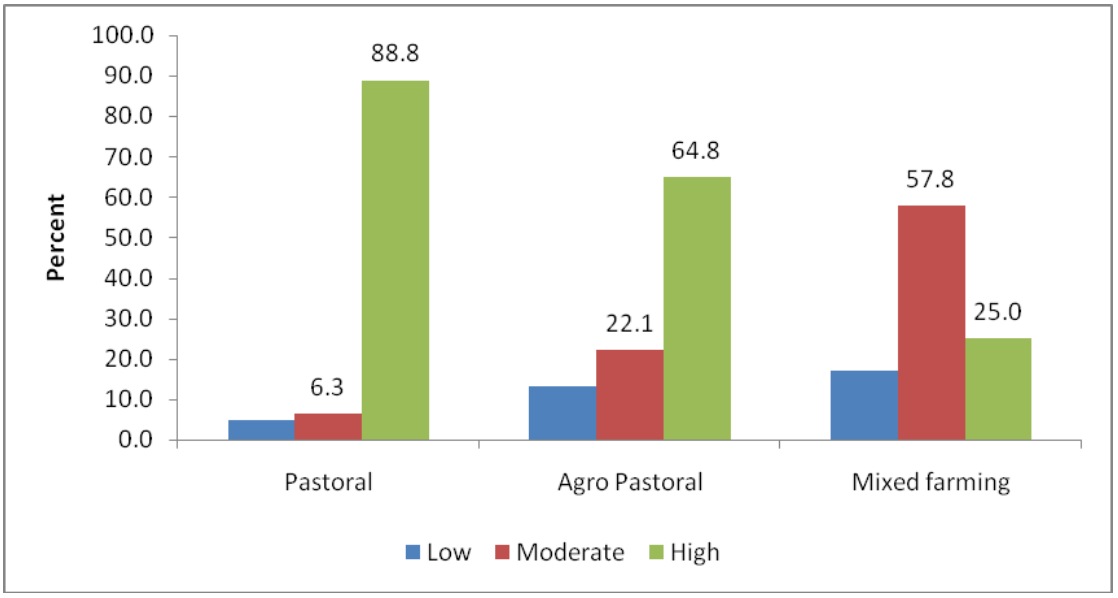


Figure 5.1: Impacts of climate change on different livelihood zones in West Pokot County

Source: Field Data, 2020

Communities in agro-pastoral and mixed farming have adaptive capacity and they are able to cope with the impacts of climate using their local available resources and people herein understand adaptation strategies that reduce risk posed by the climate change. The study agreed with Behnke (2008), who found that livelihood diversification promote community resilience through creating multiple option that community can depend on during climate shock. Neumann *et al (*2002), further revealed that communities in ASAL who dependent on one source of livelihood (livestock) are more vulnerable to drought, because their main source of food security is also more susceptible to drought impacts.

5.4 Standard Precipitation Index (SPI)

Standard Precipitation Index (SPI) is standardized anomaly, equivalent to the statistical Z-score, representing the precipitation deficit over a specific time scale, such as 3, 6, 9, or 12 months, relative to climatology McKee *et al*., (1993), shows that rainfall pattern have been fluctuating as shown in Table5.2. This study shows that SPI was classified basing on severity, their threshold and magnitude of the drought. This finding from NDMA SPI data analysis reveals that drought in West Pokot County keeps on fluctuating from one phase to another as indicated by SPI, Table 5.2. Key informant reported that West Pokot County report every year one-two phase of drought, drought phases include alert, alarm or emergency phase.

Table 5.2: Drought classifications by SPI-3month values and their thresholds

Color	SPI Values	Rainfall Category
	> +1.5 or more	Strongly above normal
	1 to +1.5 and above	Above normal
	-1 to 1	Normal
	-1.5 to -1	Below normal
	<-1.5	Strongly below normal

Source: NDMA, 2020

The study revealed that frequency of drought directly affects livestock production, the sensitivity of the natural resources depended by livestock to enhance production are what contribute to reduced livestock production. During FGD, it was reported that drought and livestock diseases are some of the challenges that affect livestock production. Key informant from NDMA indicated that SPI fluctuate from above normal to below normal depending on performances of long and short rain of March, April, May and October, November and December (MAM and OND) of that year. This study was consistent with NDMA (2017), that drought directly affects livestock production in ASAL, due to sensitivity of pasture and water that influence productivity; it was further indicated that concentration of livestock in water sources.

5.4.1 Vegetation Condition Index

The study examined the secondary data from nation drought management authority and further assessed the indicators such as biophysical, means of production and in term of trade. The study found that drought was classified basing on VCI values, the smaller the value, the higher the drought impacts or severity. It was also found that indicator used in measuring the status of pasture and vegetation cover help assess grazing resources (pasture) available to livestock. The vegetation condition index is based on the relative VCI change with respect to minimum and maximum historical VCI value as shown in table 5.3. The VCI of a given week was compared to the minimum VCI found in the archive of that week. It was therefore found that vegetation cover indicators were suitable in measuring the status of pasture and can still be used to assess other natural resources that support livestock sector. Respondents reported that drought in West Pokot has increased its frequency of occurrence, from previously noted of five years to two or less. Key informants reveal that drought used to strike and take a period of ten year before

another drought strike, but recently drought has intensified and occurred almost yearly basis. It was also reported that when drought strike pastoralists are more susceptible to its affects. This means that the climate change has rendered many people poor, because of the great loss they get from severe impacts of droughts.

Table 5.3 Drought classification by VCI-3month values and their thresholds

Color	**VCI values**	**Drought Category**	**Drought phase**
	3-monthly average		
	≥50	Wet	Normal
	35 to 50	No drought	Normal
	25 to 34	Mild Drought	Alert t
	10 to 24	Severe	Alarm
	<10	Extreme Drought	Emergency

Source: NDMA, 2020

The study found that drought was classified based on certain thresholds that inform drought level and severity that directly affect different livelihood zones in different magnitude. During KIIs with NDMA officers, it was found that vegetation condition index falls between different arranges that inform the phase of drought. It was further indicated that drought phases vary with its intensity and magnitude, as the phases move from normal, alert, alarm to emergency, the severity, intensity and magnitude continues increasing as shown in table 5.3.

The study further indicated that monthly report on VCI varies with rainfall being the determinant factor on vegetation condition report, the more rainfall, the high the VCI and the less the rainfall the lower the VCI in the county. This study was supported by Shisanya *et al.,(2011),* who fund that the driest years has lowest VCI values while the wettest years had maximum NDVI values for the same.

This means that the higher the rainfall, the better the livelihoods of pastoralist and the healthy the livestock. During FDGs it was reported that West Pokot County experienced severe drought in 2011, 2017 and 2021which had devastating effects on pastoralist and

this was noted by Kenya for Kenya initiatives in 2011 for drought response and declaration of drought as national disaster in 2017 and 2021 by the president of Kenya as the years that Kenya reported drought of high magnitude and intensity that seriously affect livelihood and food security systems. The community member reported that,

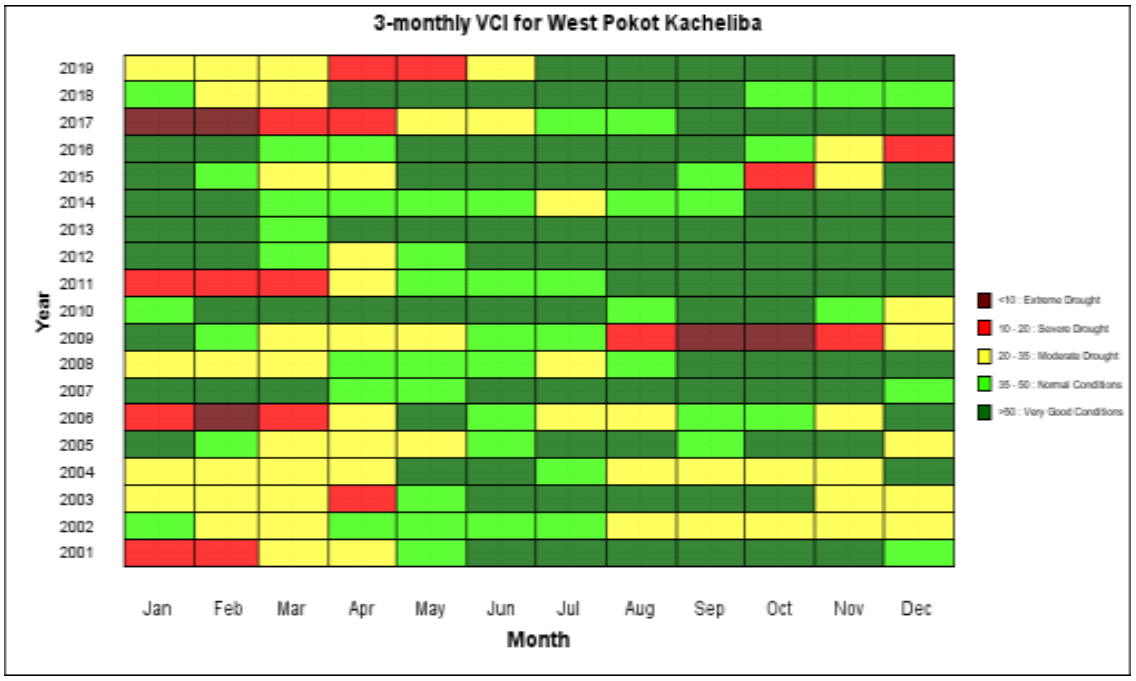
‘’*It was in 2017 that our livestock migrated to Lake Kiyoga in Uganda in search of pasture and water. Many livestock, especially cattle and sheep died during the period compared to other stocks’’.*

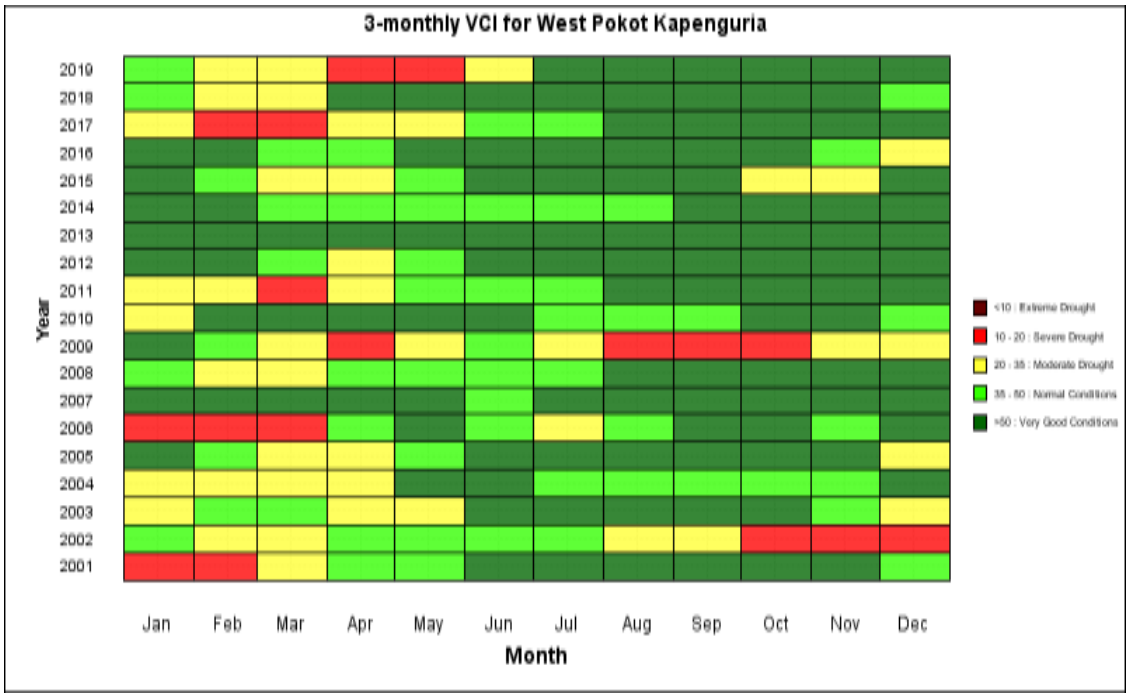
5.4.2 Impacts of Climate Change on Vegetation Cover in West Pokot County

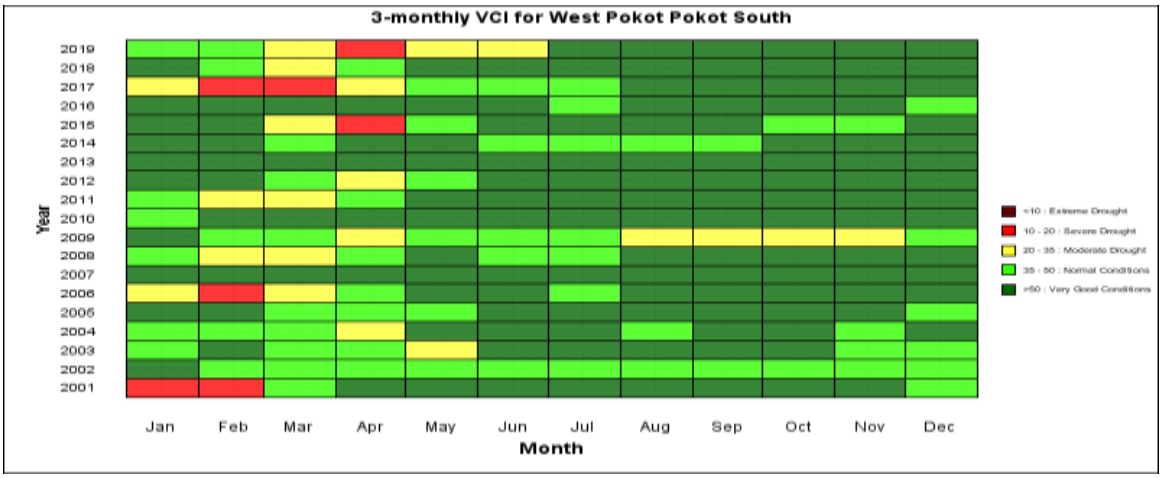
The study indicated that vegetation cover has been experiencing climate variability that triggers drought in the four Sub-counties of West Pokot County. For example, Kacheliba reported difference phases of drought at different months, ranging from alert, alarm and emergency, between January to April, severe drought was reported in 2011, 2017 and 2018, and however severe drought was also reported in 2009 August to December. In Sigor, drought was reported in 2000, 2008 and 2017, although server drought was noted in 2009 August to October. However, 2013 was found to be the wet year throughout the 12 months. This implies that drought can occurs ant month of the year, event those months that community anticipate for rain season example March –May long rain season and June-August short rain season.

Kapenguria experienced drought in 2001, 2006 and 2017 from January to March, it was also noted that 2009 drought was experienced between the months of August to October and 2002 August to December. It was again found that 2013 was a wet year throughout the 12 months of the year. In Pokot South, drought reported was experienced in 2017 January to March and 2001 January to February, it was also found that 2007, 2013 and almost 2010 were wet years throughout the 12 months in Pokot South as shown in Plate 5.1, shows West Pokot situation in terms of vegetation cover fluctuation on monthly basis throughout the year and at sub- county level.

Generally, the findings revealed that there was drought in the year 2009 and 2017 in West Pokot with four sub-counties indicated to have experienced server impacts of drought. However, the county reported 2013 as the wet year, with four sub-county reporting high level of vegetation index that inform the good performance of rainfall. This means that rainfall variability was common problem in context of climate change that affects pasture re- germination, which directly have impacts on pastoralist community.


3-monthly VCI for West Pokot Kacheliba
Year
2019
2018
2017
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
<10 : Extreme Drought
10 - 20 : Severe Drought
20 - 35 : Moderate Drought
35 - 50 : Normal Conditions
>50 : Very Good Conditions


3-monthly VCI for West Pokot Kapenguria
Year
2019
2018
2017
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
<10 : Extreme Drought
10 - 20 : Severe Drought
20 - 35 : Moderate Drought
35 - 50 : Normal Conditions
>50 : Very Good Conditions



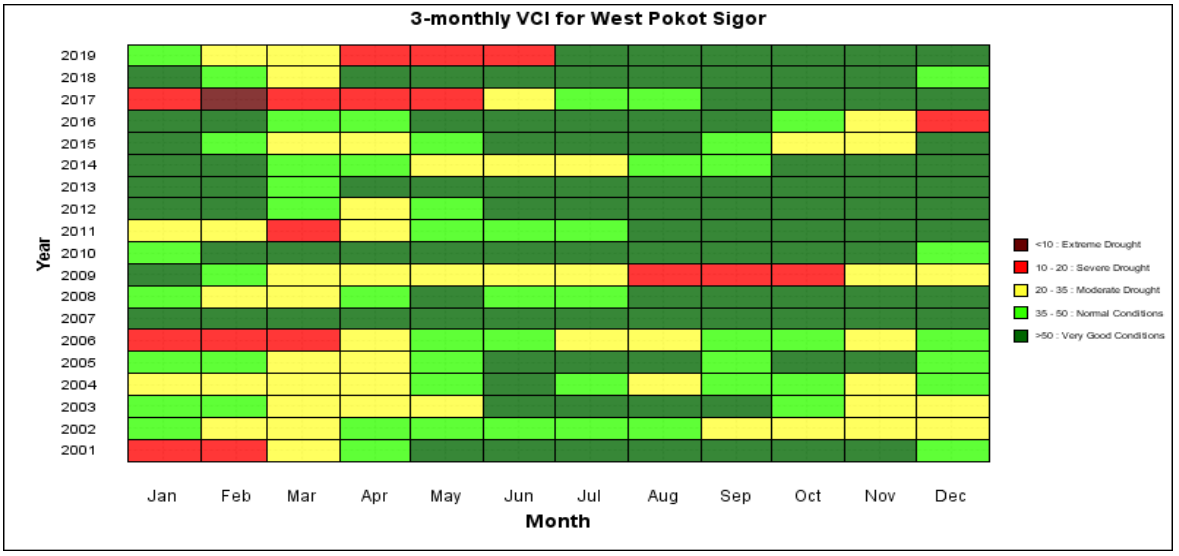


Plate 5.1: Vegetation cover conditions situation in West Pokot County

Source: NDMA, 2020

Vegetation covers inform pasture situation and development in pastoral livelihood zone. During the FDGs, respondents reported that the vegetation condition fluctuated in different phases of drought ranging from normal-alert-alarm and emergency, as the phase progressed toward alarm the pasture start deteriorating and water crisis start to be experienced, at emergency all natural resources that was depended on by livestock are completely out of range. For example in 2017, West Pokot County was reported to have experienced severe drought that led to massive death of livestock. From the plate 5.1, the drought cycle/ frequency have reduced to almost yearly.

Drought was reported in most seasons of the year that ranges between alert-emergency phases, except 2013 and 2007 for Kapenguria and 2007, 20013 and 2010 for Pokot South that was found to be wet throughout. The study was supported by NDMA (2018) that revealed ASAL counties experience at least one of the drought phases within the twelve months of the year. FAO (2013), indicated that drought cycle in ASAL counties have become frequent, to almost yearly, within the twelve months of the year, ASAL counties experience alert phase of drought, if not alarm and emergency.

5.4.3 Climate Change Impacts on Vegetation Cover

The study analyzed vegetation cover change detection using Geographical Information System (GIS), and it was noted that, vegetation cover in early 1990s was so thick and green when it was assed using remote sensing, but as you approach 2000 onward forest cover drastically had reduced, due to destruction of forest for land use and crop farming and settlement due to population increase that trigger demand for settlement and agricultural land, The respondents indicated charcoal burning and cultivation as the main threat to vegetation covers.

Forest cover has rapidly reduced in the entire county as shown in table 5.5, example in 1995 forest was at 14.13%, 2015, it was at 7.07% and 2019 it was at 5.11%, as forest reduce crop land increases, this mean that deforestation was being practice at the expense of expansion of cropland or farming activities. This finding agreed with key informant who revealed that,

"*All the area that our animals use to graze was now under crop plantation, people now days preferred to have huge track of land under crop farming that take more space than grazing area".*

The study therefore deduces that there are many human activities that pose threat to environment, and this was practiced without understanding its implication that exacerbating climate change extreme events. During the field work, it was observed that that charcoal burning and opening new land for settlement and crop farming was rapidly increasing, especially in North Pokot and Pokot Central.

Table: 5.4: Change in vegetation cover from 1995-2019

Vegetation Cover	Area in Hectares (Ha)			Percentage of Vegetation Cover		
	1995	*2015*	*2019*	*1995*	*2015*	*2019*
Forest	49108.3	24651.9	17818.2	14.13	7.07	5.11
Closed Scrubland	93131.1	187976	172053	26.79	53.91	49.34
Open Scrubland	126793	110251	104127	36.47	31.62	29.86
Crop land	78589.3	25804.9	54685.1	22.61	7.4	15.68
Total	347621.7	348683.8	348683.3	100	100	100

Source: Field data, 2020

The study further analyzed land use cover change, shown by plate, 5.1and 5.2. It shows that up to 1995 and below, West Pokot used to have good vegetation cover compared to 2000s, the finding indicated that increase in population demand more area for settlement, change of livelihood from pure pastoralist to agro-pastoralist and mixed farming that was associated with serious destruction of forest cover. Although historically, West Pokot in 1984experienced serious drought that impacted negatively on environment and their livelihood, this was couple with cholera outbreak due to people feeding on animals carcasses of death animals' as result of drought. This study agree with Aklilu *et al*.,(2013), stated that severe drought result to direct impact on the growth of palatable grass species, with increased in human population that increase pressure on natural resources. The study analyzed vegetation cover for four areas, namely Alale, Kacheliba, Kapenguria and Sigor, his was a representation of the ecological zones in West Pokot County , example Alale and Kacheliba represent pastoral, Kapenguria Sigor-agro-pastoral. The study indicated that the two ecological zones were impacted differently by climate change and forest cover destruction was noted across the ecological zones. It was further revealed that resilience of community depends on exposure of their livelihood to effects of climate change and how sensitive was their livelihood to climate extreme events. It also further found that livelihood zone with more than one option of livelihood (Mixed farming and agro-pastoral) was found to be more resilient compared to the one that

depend on one livelihood (pastoral) that was noted to susceptible to impacts of climate change.

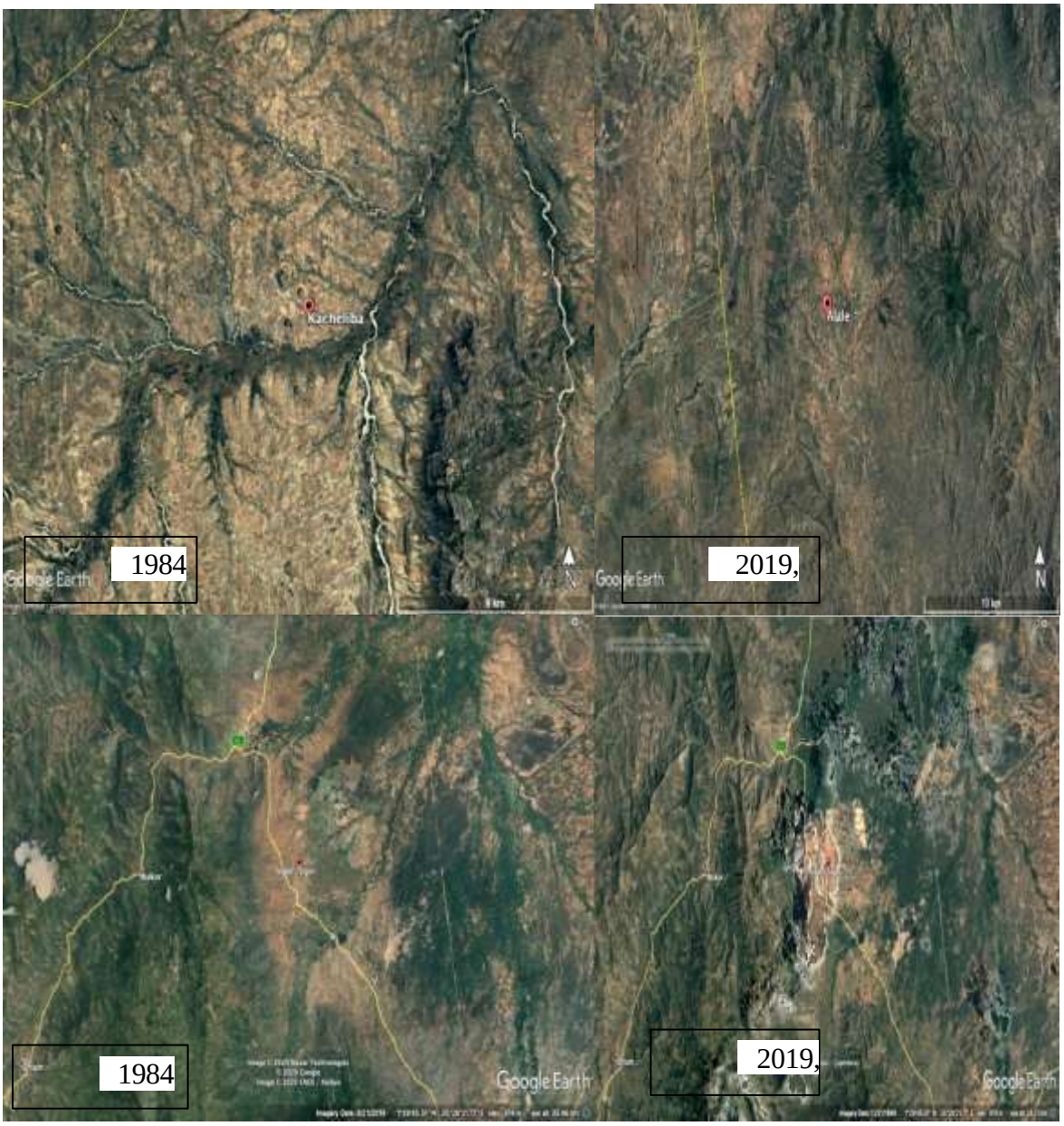


Plate 5.2a: Land use change detection

Source: Researcher 2020

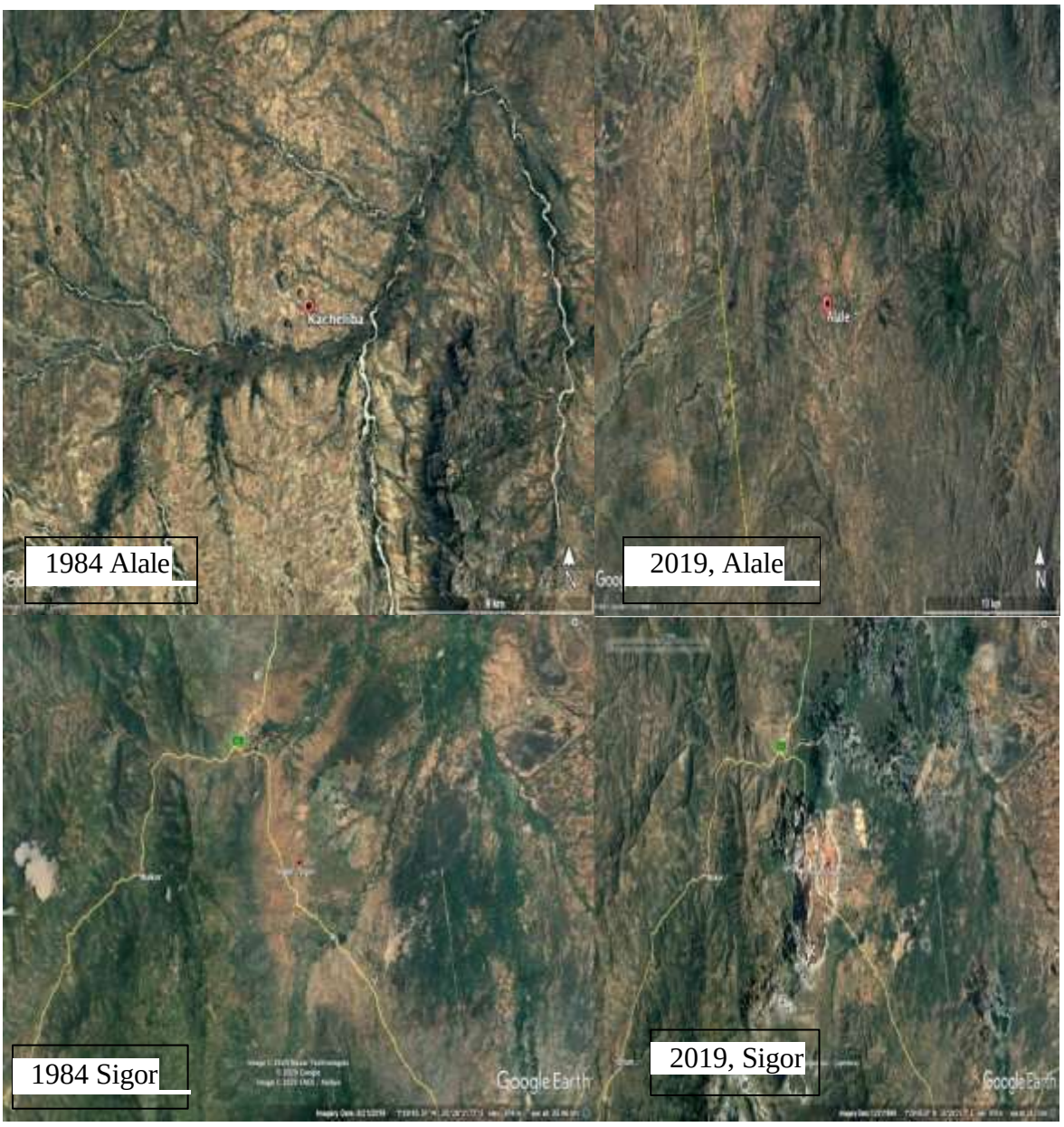


Plate 5.2b: Land use change detection

Source: Researcher 2020

5.4.4 Impacts of Climate Change on livestock Production

The study assessed respondents' perception and understanding on livestock body condition during climate extremes such as drought. It was revealed that climate change adversely impacts livestock pasture by 39.1% of the respondents indicating completely drying up, 38.3% deteriorating, 21.1% in fair and 1.6%good. These results indicated that most part of West Pokot experienced serious pasturescarcity during drought

period Figure 5.2. This result was evident when most respondents indicated to have experience completely dried pasture. The findings mean that pasture was very sensitive and more exposed to effects of climate variability when there was severe drought pasture dried up completely.

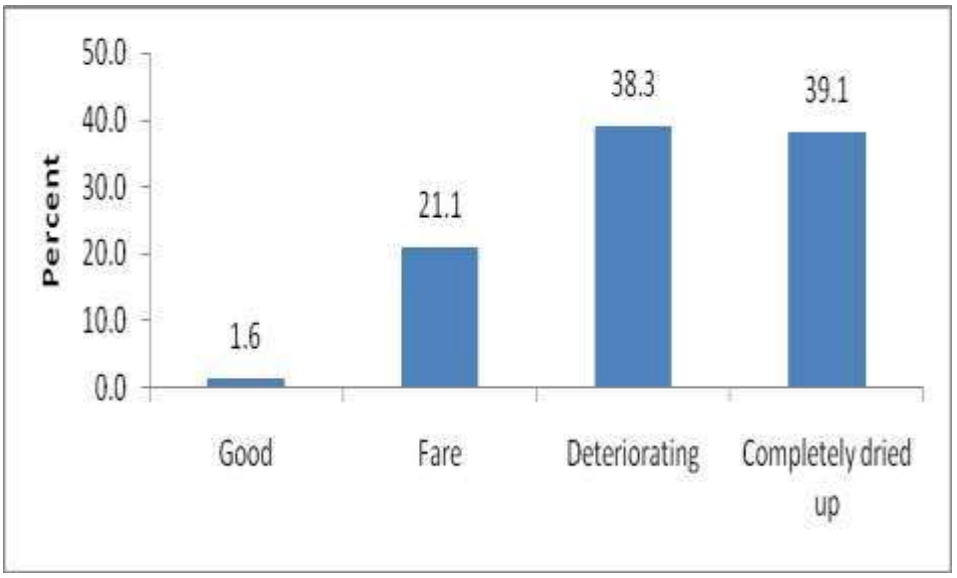


Figure 5.2: Pasture condition during drought period

Source: Field Data, 2020

Finding from key informants' interview, it was indicated that ASAL area was noted to experience completely dried up of pasture when drought persist for more than three months, whereas only agro-pastoral area was where pasture was reported to be in deteriorating condition and mixed farming was in fair condition with support of community climate change mitigation measures.

5.4.5 Invasive and Plants species that Threaten Pasture Development

The study indicated that invasive plants species that hinder pasture germination are on the increase in West Pokot County. For example, sansiveria and acacia plants were found to be the notorious plant species that threat pasture development in ASAL area. The study was supported by NDMA (2016), stated that grass land was being occupied by invasive plant species that suppress pasture germination and other desert plants that is a threat to pasture, couple with recurrent drought that affect pasture re-germination.

The study during FGD meetings indicated that sansiveria and acacia are on increase, and this was attributed to climate variability. This means that these plants have been on the

rise covering large areas of grazing land, hindering pasture germination as indicated in plate 5.2 and table 5.3. During field work, these plants were noted to cover large area of grazing land in North Pokot, lower part of West Pokot and Pokot Central Sub-County; these are areas that practice pure livestock rearing as their main source s of livelihood. Key informant from regional pastoral resilience project reported that,

"Our focus on livestock is pasture reseeding and clearing invasive plants that have hinder pasture growth, example sansiveria plants, we have budget for bush clearing targeting these notorious plants that affects pasture development in pastoral zones".

As shown in plate 5.3, pastures does not grow, this therefore indicate that, no pasture can grow or germinate under this plan pieces, because it was reported to suppress pasture and shrubs, an increase in this plants (sensiveria and acacia pose more threat to pasture development and pastoral livelihood. It was further reported that this plant was ever green event during severe drought, because of its adaptive nature to harsh climatic condition. The respondents indicated that this plant have given rise to increase shrubs instead of pasture, it was further revealed that event hills that use to be grazing area with good pasture, it is full of shrubs and other plants spices that never use to be and animals does not feed on.

Plate 5.3: Sanasiveria plants
Source: Field Data, 2020

5.5 Climate Change and Livestock Body Condition

The study evaluated impacts of climate change on livestock body condition using scale and ribs counting. The results shows that 71.4% are in deteriorating condition, 26.8% are in fair category and 1.8% was in good condition, Figure 5.5. These results indicate that many livestock bad body conditions during drought period are deteriorating, while a few are in fair condition, which always pose food insecurity threats due to reduced livestock production, as many households in West Pokot depend mainly on livestock as source of food security. The study illustrated that cow and sheep are most affected during drought season, this is because this animals feed on pasture that is sensitive to drought, compared to camel and goat that feed on brewers, this implies that pasture is very sensitive and more exposed to effects of drought compared to forage.

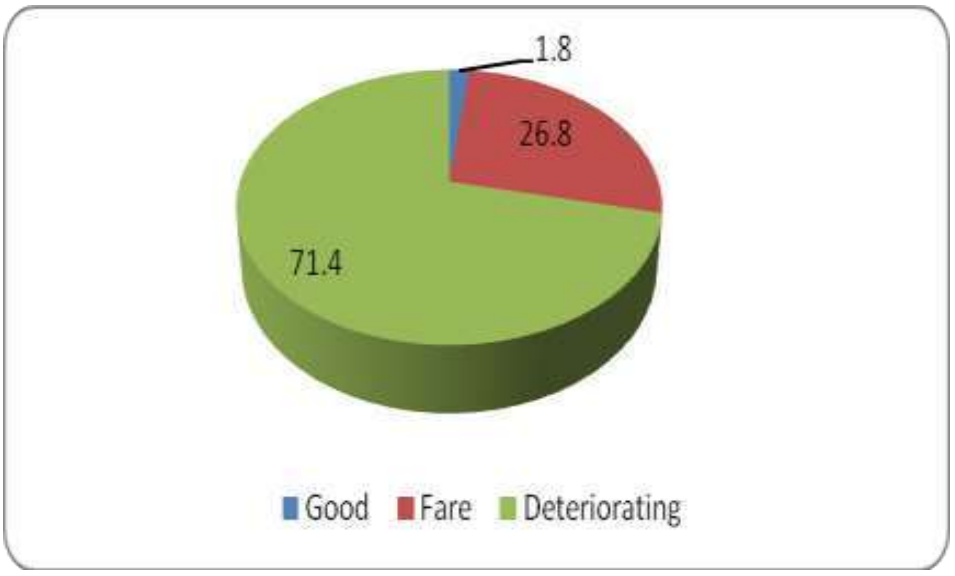


Figure 5.3: Livestock body condition during drought

Source: Field Data, 2020

It was reported that most livestock in Pokot North and Pokot Central and part of West Pokot sub-counties are always emaciated during drought period. The two sub-counties are pastoralist area, where community source of food security was on livestock product. From field transect it was noted that most parts of Pokot North, Pokot Central and part of West Pokot had bare ground with no pasture, which indicate lack of pasture, while Agro-pastoral and mixed farming which mainly cover Pokot South and part West Pokot sub-counties was noted to be in good-fair vegetation condition with pasture in livestock paddocks areas. This means that the communities in Pokot South and part of West Pokot are more resilience to climate change compared to North and Pokot Central.

The focus group discussion reported that during dry season the price of livestock goes down by 83.3% due to poor livestock body condition, at this time pastoralist experienced economic loss. It was further found that a bull that could be sold at Ksh 60,000 was sold at Ksh 10,000- 15,000. Key informant indicated that breed diversification and livestock off-take was the best measure for drought risk reduction, but it was noted that pastoralists are not utilizing this strategy due cultural believes that pastoralist in West Pokot perceived. Key informant from the NDMA indicated that during dry season livestock prices are low due to poor livestock body condition that were emaciated, thus fetching/attracting little money. NDMA (2017) reported that during alarm and emergency phase of drought, the prices of food commodities and livestock are inversely proportional, example when prices of animals are low, food prices are high thus compromising pastoralist bargaining power and exchange in terms of trade.

During FGD the participants revealed that during dry season one cow of Ksh 15,000 can buy 2.8bags of maize at Ksh 5,000 per bag of 90Kg compared to rain season when bull can be sold at Ksh 60,000 and converted to 30 bags of at Ksh 2,000 per bag of 90kg. According to (Silvestri *et al.*2012), the price of cattle was reported to decline during drought periods due to poor condition of the cattle. Further, during this time many households were trying to sell their livestock to earn income for living expenses and meet food security demand.

5.6 Impacts of Climate Change on Different Animals Species

The finding shows how various animals are affected by climate change. The results categorize these findings into high (those adversely affected) and low (those not

adversely affected). In terms of 'high', cow was noted to be highly affected by climate change with 91.1%, sheep 90.1%, goat 79.4%, donkey 38.3% and camel 21.1%. The respondents indicated that cows and sheep are the most vulnerable animals to impacts of climate variability. It was further indicated that goats were noted to be moderately less affected by climate change, Figure 5.7, while camels and donkeys were indicated by respondents to be less affected by climate variability. This means that the camels and Donkey are more resilience to droughts. In terms of low impacts, respondents indicated that 69.8% donkey and 68.0% camel are less affected by climate change.

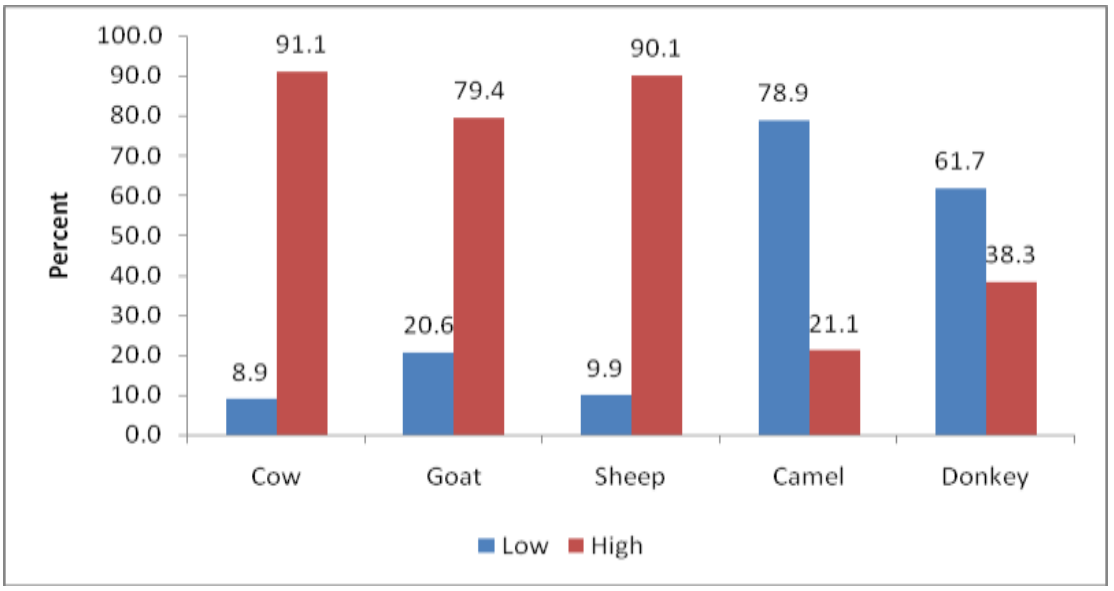


Figure 5.4: Impacts of Climate Change on Different Animals

Source: Field Data, 2020

As indicated in Figure 5.8, climate affects different animals. This was assessed by sort of respondents' opinion on impacts of climate change on various animals. From key informant interview it was unanimously agreed that the cow was the most vulnerable animal to climate simply because cows feed only on pasture which is sensitive to climate extremes such as drought. NDMA (2020) and GOK (2018), stated that different livestock species are affected by climate extremes differently, with some severely affected while other less affected.

Camels was reported to be more resilience because they depend on forage that are less affected by drought more so forage on top of trees where other animals cannot reach, although from interview with key informants it was reported that camel, goat and donkey

were more resilience to climate change compared to other livestock, they have slow recovery times after severe droughts, averaging 10 to 15 years. Recovery can be further prolonged, if interrupted by other climatic shocks, which are most likely to occur under scenarios of recurrent droughts that demonstrated the highest vulnerability to climate variability in arid environments. The study was supported by Recha & Radeny (2017), who stated that cross- breeding higher yielding animals with indigenous breeds enable the farmer to have more climate-resilient livestock whilst also producing more milk and meat than pure indigenous breeds. NDMA (2017) further indicated that camel and goat were noted to be more drought tolerant animals compared to cows and sheep that are noted to be very susceptible to drought impacts.

The study indicated that in Pokot North camel rearing was being embraced by the local community because of its resilience to drought. The respondents' further indicated goats are the most reared livestock in Pokot North and Pokot Central compared to sheep, this was because of their ability to cope and withstand effects of drought in the two sub-Counties that are pure pastoral and more vulnerable to risk associated with climate change.

5.7 Community Perception on Effects of Climate on Livestock Production

Climate change impacts negatively on livestock production. During the key informant interview and focus group discussion, respondents indicated that various factors that affect livestock production. The respondents further ranked the factors basing on the most threatening factor to livestock production. Livestock disease was ranked the most threatening factor as shown in table 5.4. Other factors that influence livestock production is pasture and water shortage, increased conflicts, and increased livestock mortality. During focus group discussion it was found that livestock production was directly affected by these factors, resulting to emaciation of animals and health deterioration. Conflicts resulted to loss of animals to cattle rustlers and deaths, thus compromising pastoralist food security and complete loss of livestock production. The study was consistent with GOU (2015),state that climate change is expected to result in fall in productivity; livestock productivity may be lowered by 50% in 2050s compared to without climate change scenario.

It was also found that long distance of animal's trucking in search of pasture and water couple with high heat intensity increased livestock stress in arid and semi-arid, which directly affect livestock productivity. According to Rowlinson (2008), indicated that increasing temperatures and decreasing rainfall reduce yields of rangelands and contribute to their degradation. Higher temperatures tend to reduced animal feed intake and lowers feed conversion rates. Aklilu *et al*., (2013), further revealed that changes in the patterns of rainfall and ranges of temperature affect feed availability, grazing ranges, feed quality, pests and disease incidences. High production animals are subjected to greater influence by climatic factors, particularly those under tropical conditions, due to high air temperatures and relative humidity.

The respondents were asked to rank impacts of climate change on livestock production, from the most threatening to production system and results are as shown on table 5.4 below. This confirms that livestock production was found to be highly affected by natural shocks triggered by climatic variability. During FGD, it was indicted that livestock production directly affected by depletion of pasture, water, and outbreak of diseases. It was further found that such shock result to massive livestock deaths and failure of livestock production system.

Table 5.4: *Effects of climate on livestock production and its ranking*

Effects	**percentage %**	**Rank**
Livestock Diseases	40	1st
Shortage of pasture	28	2nd
Water shortage	15	2nd
Increased Conflicts	9	4th
Increased livestock mortality	8	5th

Source: Field Data, 2020

Respondents indicated that water and pasture scarcity influences livestock production. Water and pasture dependents on rainfall hence have direct impacts on livestock production. The study indicated further that scarcity of pasture; water and increased violence conflicts that trigger cattle rustling among the neighboring communities due to

competition and scramble over pasture and water also threaten livestock productivity. Increased livestock mortality caused by water scarcity, exacerbated livestock deaths couple with hydrological and geological hazards such as floods and landslide. Although this study partially disagrees with (Gauly *et al.,* 2013), who found that a thermal environment was a major factor that can negatively affect milk production in dairy cows, further found that changes in climatic factors such as temperature, precipitation and the frequency and severity of the climate extreme events directly affected livestock yields. The adversity of prolonged exposure to thermal stresses can be further worsened by water shortage during the dry period and low forage water content, as well as poor feed quality that reduces feed intake and increases fermentative heat.

In term of respondents' opinions on climate change as threat to pastoral livelihoods, 49.2% agree, 45.6% strongly agree, 3.6%disagree and 1.6% partially agrees. The finding shows that respondents unanimously agree that climate change pose serious threat to pastoral livelihoods. On respondents' opinion on effects of climate change on livestock production, the results show that 78.6% of the respondents agree that livestock production is adversely affected by climate variability, as shown on table 5.6. The finding implies that climate change poses serious threat to pastoralist livelihoods. It further indicates that livestock production was adversely affected by climate change, thus compromising food security of pastoralists. Respondents further reported that livestock body conditions during drought period are in deteriorating condition; with 71% of the respondents' indicating drought affect mainly body condition of livestock that directly impact on milk production. In terms of source of water for livestock, 74.5% of the respondents revealed that river was the main source of water; this means that river and other surface source of water are adversely affected by climate extremes, with many rivers being seasonal in West Pokot County. Key informant from water department indicated that river was the most vulnerable source of water to drought and recommended for investment on groundwater surface for sustainable water access.

Table 5.5: Climate change and livestock in Different Livelihood Zones

Variable	Response	Number (N=384)	Percent
Pastoral livelihood is the most vulnerable to climate change	Agree	189	49.2
	Strongly agree	175	45.6
	Disagree	14	3.6
	Partially agrees	6	1.6
Does climate change affects livestock production system?	Yes	302	78.6
	No	82	21.4
This area is under which ecological	Pastoralist	183	47.7
Zones	Agro-pastoralist	122	31.8
	Mixed farming	79	20.6
Do you agree that community inthis area experience problems of food insecurity	Agree	155	40.4
	Strongly agree	174	45.3
	Disagree	22	5.7
	Strongly Disagree	3	0.8
	partially agrees	30	7.8
How is body condition of your livestock during drought season?	Good	7	1.8
	Fair	103	26.8
	Deteriorating	274	71.4
What is the state of pasture during dry season?	Good	6	1.6
	Fair	81	21.1
	Deteriorating	150	39.1
	Completely dried up	147	38.3
What is the state of pasture during wet season?	Good	283	73.7
	Fair	87	22.7
	Deteriorating	7	1.8
	Completely dried up	7	1.8
Climate change is the major threat to livestock production in this community	Agree	202	52.6
	strongly agree	170	44.3
	Disagree	3	0.8
	Strongly Disagree	1	0.3
	partially agrees	8	2.1
Where do you livestock access water from?	River	286	74.5
	Borehole	44	11.5
	Dam	18	4.7
	Water pans	24	6.3
	Sand dams	12	3.1

Source, Field data, 2020

5.8 Variations in Milk Production

Climate change result into reduction and fluctuation of milk production. The respondents indicated that milk production varies with season and ecological zone, and it was noted to be influenced by availability of pasture and water. During focus group and key informant interviews, it was revealed that milk increases during wet season because there is plenty of pasture and water that directly influence milk production, as shown in table 5.6 and 5.7. This means that milk production increases with increased rainfall which influences pasture germination and increases livestock access to water. This means that livestock production is influenced by the availability of pasture and water. This study was in agreement with (Sangeda 2017), who found that the lower milk yield was associated with inadequate feed in quantity and nutritional quality leading to general weakness and lower production in their cattle, it further impacts on milk production and livestock body condition have been reported in other semi-arid areas. The study was supported by Digambar (2011), who stated that climate change directly impact on the growth of palatable grass species and that regeneration of fodder species in pasture and forest fodder leading to a decrease in milk and meat production.

It was therefore found that pastoralists' food security during wet season was assured due to plenty of pasture and water, while food security during dry season was compromised due to reduced pasture and water access. The pastoralist livelihood is therefore greatly affected by climate extreme events. Sustainability of pastoral livelihood was found to be directly affected by climate variation. This study was supported by Mwiturubani, (2010), who found that livestock production and productivities was one of the most susceptible sectors to climate change due to changes in hydrological cycle, temperature balance and rainfall patterns which have a negative impact on livestock production and productivity. The study found that reduction in milk yield was due to sensitivity of animals to thermal stress, which result to milk production losses. The lactating animals were noted to be adversely affected by climate variability of high temperature. This implies that Climate variability has a direct impact on the growth of palatable grass and the regeneration of fodder. Pasture and vegetation have been decreasing because of less rainfall or fluctuating rainfall, leading to the decrease in livestock population which has further affected production of milk, milk products and meat. The drought also affected livestock when pasture and water sources dry. The study was further supported by Abdela & Jilo, (2016),

who found that adapting to climate change require farmers to invest on livestock breed diversification on high milk yield animals and climate resilience, proper natural resource, and rangeland management practices.

CHAPTER SIX
COMMUNITY-BASED ADAPTATION AND COPING STRATEGIES TO MITIGATE THE IMPACTS OF CLIMATE CHANGE, WEST POKOT COUNTY, KENYA

6.1 Introduction

This chapter assessed community-based climate change adaptation strategies. It also focused on the pastoralists coping mechanisms to the impacts of climate change, how pastoralist mitigate, adapt and cop with climate change related risk. These findings are presented in graphs, tables, bar charts and pie charts.

6.2 Pastoralist Adaptation to Effects of Climate Change

In order to understand the existing adaptation strategies in West Pokot County, the study engaged stakeholders and community through FGD and County Steering Group (CSG), and it was revealed that due to pastoralist exposure to numerous shocks of climate change and pastoralist being survivors of the climate extremes, this has prompted pastoralist community to initiate indigenous adaptation strategies to effects of climate shocks, as indicated in Table 6.1.

During KIIs and FGDs, respondents ranked the adaptation measures based on what was commonly practiced in West Pokot County. Pasture establishment (Hey and Napier grass) was found to be the most practiced in some parts of the West Pokot sub-county which is an agro-pastoralist area. However, conservation of livestock feeds was found to be embraced by the community as households' initiative. This study agreed with Berardi (2016), who stated that local communities seek to adapt to new challenges such as climate change through designing their solutions that aimed at responding to climate change problems.

The study also found that the community had their local strategies for grazing management that was found to be embraced by the community with large herd of cattle, although this strategy was revealed to be threatened by land demarcation and change of land tenure system, from communal to private. During FGD, respondents revealed that every location have seasonal grazing area for dry and wet seasons, this strategy was found to be practiced by pure pastoralist with large herds of cattle. Pasture establishment, conservation of crop residues and silage making was part of community climate change adaptation strategy, although this was mostly practiced in agro- pastoralist and mixedfarming, mainly known for dairy cows. The study was supported by Mongi *et al.*,

(2010), who found that the increased impacts of climate change and variability make the rural pastoralist to practice various adaptation and coping strategies, which include mainly indigenous knowledge and wide variety of skills developed outside the formal education over a long period of time among the rural communities.

During severe droughts, when the entire county experience water crisis, water trucking was initiated to support livestock access to water and strategic livestock feeds reserves was identified to cushion community from drought shocks. Livestock off-take was found to be adaptation strategies, although this was not preferred by pastoralist because of the cultural believes, pastoralist preferred to die with their animals rather than off- taking, as it was reported by respondents that,

"Sale of animals before drought strike could mean that you are a witchcraft, who predict or pray for bad things to community, and sale of animals proof that you are deviant in community who need not to live with other people', (chelolosion-in Pokot dialect).

During the FGDs and CSG meeting, the key adaptation strategies were identified and ranked, starting with what was noted to be sustainable and can easily be practiced by pastoralist community, although some are being practiced by the community, as summarized in table 6.1.

Table 6.1: Effects of climate on livestock production

Effects	**percentage %**	**Rank**
Livestock Diseases	40	1st
Shortage of pasture	28	2nd
Water shortage	15	2nd
Increased Conflicts	9	4th
Increased livestock mortality	8	5th

Source: Field Data, 2020

The study further found that supplementary animals' feeds was used as livestock feeds during the drought emergency response, and this was utilized as intervention measure and it was found to be a short term strategies in Pokot North and Pokot Central sub-counties, however, were noted to have done less on combating effects of climate change; this was attributed by community low level of education, lack of understanding on climate variability and the need to cushion community livelihoods through embracing

risk reduction strategy. Jonathan D. (2008) revealed that pastoralists are exploring various climate adaption measures such natural resource management, diversification of livestock breed and rotational livestock grazing pattern.

This finding indicates that knowledge was key in decision making on climate change adaptation measures. The focus group discussions revealed that pastoralists have traditional natural resource management strategies that provide the capacity to adapt to harsh environmental conditions including climate change and climate variability, as well as rangeland system and seasonal grazing pattern.

6.3 Community-Based Coping Mechanism to Climate Change Extremes

The study assessed local-based coping mechanism to effects of climate change, where it was found that communities in West Pokot County had their own coping mechanisms to climate change extremes. After the community had been exposed to effects of climate change, the community initiated their own strategies aimed at reducing community risk to effects of climate variability. During FGDs and KIIs, respondents identified various community coping mechanisms that promote community resilience to effect of climate change, as shown in table 6.3 and plate 6.2. The most preferred and more sustainable coping mechanisms practices were ranked and it was found that conservation of crop residues was identified as most suitable short-term practice that communities in West Pokot are embracing. The use of tree branches as livestock feeds was used mainly during drought period, when all pastures have dried up. Due to chronic problems of drought, it was noted that the community had to embrace some practices that cushion livestock from climate extreme events, as shown in table6.3.

Table 6.2: Community-based Coping mechanism to climate change

Coping mechanism	Percentage	Ranking
Livestock migration	34	1
Use of tree branches as livestock feeds	30	2
Supplementary livestock feeds	24	3
Conservation of crop residuals	7	4
Accelerated livestock off-take	3	5
Water trucking to livestock	2	6

Source: Field Data, 2020

The finding indicated that migration was the most preferred coping mechanism to climate shocks by pastoralist in West Pokot County. It further shows that feeding on tree branches as livestock breed was reported by respondents during FGD, this finding was supported by Key informant and FGD stated that when pastoralists experienced drought, cutting of tree branches were used as livestock feeds. Key informant from NDMA further stated that under emergency drought response, livestock are given supplementary feeds to alleviate livestock from extreme effects of drought, some of the livestock feed supplements are hey, drought pellet and range cubes. Accelerated livestock off-take helped pastoralists reduce animal's loss to drought where pastoralists reduce their livestock population by selling some instead of losing large herd of livestock. This was consistent with Francis Opiyo, *et al,* (2015) ,who found that livestock off-take at different stages of a drought's development was an important adaptation strategy used by pastoralists.

It was further noted that some pastoralist in West Pokot practice herd splitting during drought period, with an objective of increasing chances of their livestock surviving, example in case of raids which was common during dry season, another herd can be safe if the others are stolen, again small herd can be manageable during the hard time of drought. This was cultural and community strategies that use to exist among the Pokot, some of the animals were given to the poor members of the community, those with less or no animals, the study was supported by NurAbd Mohammed (2010), who found that pastoralist use their experience and survival techniques in adapting the adverse effects of climate change, such as migration, splitting their herds and some embrace livestock off-take to reduce loss to natural calamities like drought.

During KIIs with local community, it was indicated that some communities were discouraged to embrace pasture establishment because of the large herds of cattle, hay cannot feed like 50 or 100 herds of cows, therefore community perceived that such strategies is for the "poor'' urban people, with 1-3 cows.

Plate 6.1: Conserved Crop Residues at Propoi and Morupus Area

Source: Field Data, 2020

Plate 6.2: *Tree branches used by pastoralist as livestock feeds at poole in Riwo ward*

Source: Field Data, 2020

6.4 Livestock and Climate Change Risk Reduction Measures

The study investigated pastoralist risk reduction measures during drought period. The results showed that, 63.5% migrate, 35.2% stay at home, 1.0% take to parks and 0.3% distributed to friends and relatives. This finding meant that pastoralists in West Pokot County prefer to migrate their livestock during drought extreme events. It was further indicated that some of them prefer also to retain some animals at home (milking cows). While a few take their animals to parks and distribute to friends and relatives, as shown on Table 6.3. From the KIIs, it was found that some of the pastoralists in West Pokot County prefer to move their livestock to Uganda and Trans-Nzoia County during dry season.

This study was supported by FGD, whereby it was revealed that pastoralists have been facing extreme impacts of drought; hence they preferred to migrate to other areas for pasture and water. The study by Ajani *et al.,* (2013), who revealed that local communities use this knowledge to inform their decisions when responding to climate change impacts. Therefore, the integration of indigenous knowledge with new technologies to deal with climate change might assist communities in effectively responding to impending climate changes. This implies that local community knowledge has been strengthening to countering the effects of climate change. The study was further supported by Notenbaert *et al*., (2007), who found that Pokot community as pastoralists have traditionally used risk-spreading strategies over the years such as diversifying economic strategies to include livestock, bee keeping, agriculture and poultry farming. The livestock species kept include camels, cattle, sheep, goats, and donkeys, all of which have different forage and water requirements and variable levels of resilience to drought. The camels, cattle, and goats provide milk, which was consumed by the households.

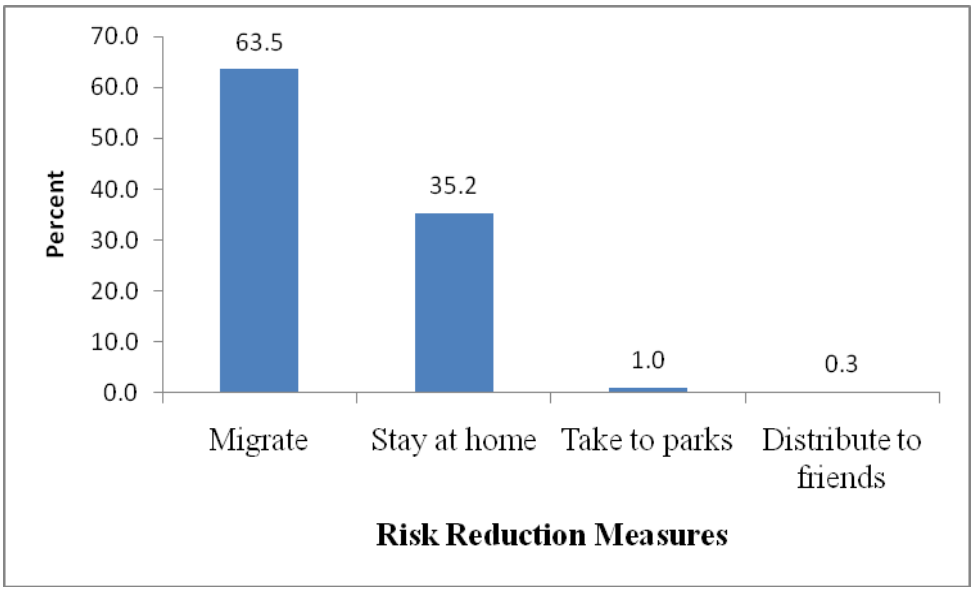


Figure 6.1: Climate risk reduction measures

Source: Field Data, 2020

6.5 Pastoralist Adaptation Strategies to Livestock Disease

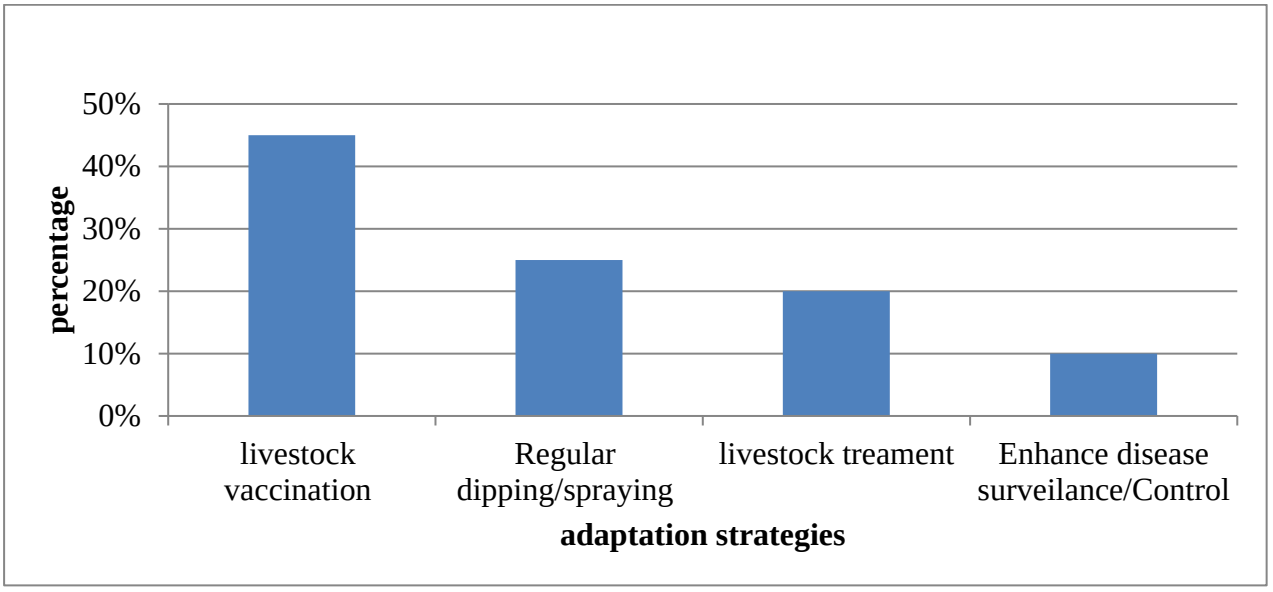
Livestock in West Pokot experience numerous disease outbreaks, during dry season that expose them to risk of drought and increased livestock vulnerability to death associated with drought. It was indicated that FMD, CBPP and PPR are the most common threatening livestock diseases during drought episode. This informs that during drought period many animals concentrate at water points, grazing areas and migratory routes, thus exposing livestock to diseases infection and spread of contagious disease.

The study investigated pastoralists' livestock disease adaptation strategies that were being practiced in West Pokot County. When pastoralists are exposed to livestock diseases, the community argued that they had to initiate local-based strategies that reduces risk posed by livestock diseases and it was indicated that 45% of the respondents preferred livestock vaccination, 25% of the respondents appreciated regular dipping and spraying as effective in disease control, while 20% indicated livestock treatment as their remedy and 10% said enhancing disease surveillance was done as a strategy, as shown in figure 6.2. The study further found that livestock vaccination was preferred as priority in addressing livestock disease adaptation, regular dipping/ spraying was also identified by a section of respondents as a strategy to practice, because it protect livestock from attack by vectors and parasites that transmit livestock diseases, Vaccination enables livestock gain immunity against anticipated disease (prior to disease outbreak).

The key informant revealed that livestock treatment required being the last option, because it was about addressing diseases when livestock are infected with disease. Disease surveillance and control measures were found to be important strategy because it enables early detection of disease outbreak for early action. FGDs reported that vaccination of livestock has been effective in management of livestock diseases. This was further indicated that vaccinated livestock reported less deaths of an average 2-5 livestock per household, compared to those that were not vaccinated, that report an average of 24-50 livestock per household, whereas regular spraying of livestock reduce livestock exposure to risk of disease. Although it was found that most vaccine are monopolized by government and local animal health officers cannot access, especially vaccines for most threatening livestock diseases such as Peste des Petits Ruminants (PPR), Contagious caprine pleuropneumonia (CCPP), lumpy skin disease (LSD), foot and mouth disease (FMD) and Contagious Bovine Pleuropneumonia (CBPP). The study agreed with Coetzer (2008), who found that an effective and sustainable animal health service is was important and surveillance and an emergency preparedness system was based on sustainable animal disease control and prevention programs. OIE (2010) also found that disease surveillance was important in ensuring the early detection and rapid response to emerging and re-emerging animal diseases. The study further found that pastoralists have inadequate livestock health extension services personnel who are key players in disease surveillance and control mechanisms. This therefore affects the ability of disease early detection for early vaccination (ring vaccination).

Weather variation with increased erratic rainfall provided favorable condition for the spread of ticks. It was found that during wet season, pastoralists experience outbreak of tick related diseases. This was because during wet season ticks increase due to favorable habitat in pasture and shrubs that enhance diseases outbreak such as east coast fever (ECF) and heart water disease that was found to be exacerbated by ticks. This study was supported by Coetzer (2008), who found that the development of an effective and sustainable animal health service was important, sustainable animal disease control and prevention programs (vaccination campaigns against rift valley fever (RVF), and bluetongue), was perhaps the most important and most needed adaptive strategy among the pastoralist, and need to be considered to safeguard livestock populations from the threats of climate change, OIE (2010), further found that veterinary officers are

responsible for ensuring the early detection and rapid response to emerging and re-emerging animal diseases and that capacity building was required in order to strengthened and enhance veterinary service to pastoralist.



\\

Figure 6.2: Preferred adaptation strategies for livestock diseases

Source: Field Data, 2020

During FGD, the study revealed that restriction from veterinary board on non-trained veterinary person to provide health service to animals contributes to vulnerability of pastoralist to livestock diseases. Although it was further found that due to pastoralist exposure to numerous livestock disease outbreak and through this experience, pastoralists are able to understand symptoms and signs for specific livestock diseases. The pastoralist can walk into an agro-vet, purchase animal's drugs and treat their animals without the help of veterinary officer, this call for enhancing community capacity on participatory disease surveillance and community capacity built on disease symptoms and signs especially emerging livestock disease among the pastoralist. This study was in agreement with Aklilu *et al*., (2013), who found that pastoralist are able to detect livestock diseases and even the symptoms and signs to treat their animals and this was link with their long experiences in assessing livestock diseases and interaction with numerous outbreak of livestock diseases.

The key informant reported that quarantine of infected animals to prevent spreading of the disease to other livestock, creation of awareness and sensitizing pastoralist on possible

measures to reduce their livestock exposure to disease outbreak and enhance community capacity on decision making concerning livestock disease control are some of the measures that reduce livestock exposure to disease. This measure was supported by key informant, who reported that,

"Once the disease was reported in one area, awareness creation was conducted to ensure that areas which had not reported the disease incidences are protected, whereas areas with infected animals are quarantined to reduce the spread of the disease to other livestock that are not infected".

The study was further supported by NDMA (2017), who indicated that, control of livestock diseases outbreak was through enhancing capacity of community diseases reporters and creating a link between the pastoralist and livestock drugs providers.

This meant that the only long-term solution to pastoralist on diseases risk reduction was enhancing pastoralist capacity through training on participatory diseases surveillance for them to acquire animal health skills and knowledge management, now that ratio of field veterinary officers and demand of their services to pastoralist are not merging. Although practicing seasonal grazing area, zero grazing and padlocking reduces livestock exposure to disease infection and spread of diseases.

CHAPTER SEVEN
SUSTAINABLE PASTORAL LIVELIHOOD FRAMEWORK, POLICIES AND PRACTICES

7.1 Introduction

This chapter presents the evaluation of Pastorals livelihood systems, Frameworks, Policies and Practices that promote or enhance the sustainability of pastoral livelihood in West Pokot County. The focus was on examining and analysis of sustainable livelihood approaches using pastoralist lenses and best practices that enhance the sustainability of pastoral livelihoods. The findings are presented in graphs, tables, bar charts and pie charts.

7.2 Pastoral Livelihood Adaptive System

The study assessed relationship between Pastoral Livelihood and its **s**ustainabilit**y** to provide an understanding of the livelihoods of pastoralists, considering the various challenges that they are currently facing in the context of climate change. The findings indicated that pasture and water are significantly sensitive to drought (p-value of <0.01) This implied that those pastoralists that dependent on free-range and surface water are not sustainable to pastoralists, because it prove to very sensitive to heat intensity, therefore investment in modern pasture establishment and water harvesting technology was what can guarantee sustainability of pastoralist access to such natural resources. On the other hand, certain breed of animals was found to be resilient to drought. Respondents indicated that camels, goats and donkeys are the most adaptive animals to climate extremes in West Pokot, this was evident with a p-value of <0.01. This informs that cows and sheep are susceptible animals to the impacts of drought. This implies that sustainability of pastoral livelihood was influenced by livestock breed; camel goat and Donkey prove to be the most suited livestock species in ASAL. The study further revealed that there was strong correlation between natural resources such as water with p-value of < 0.002. The study further revealed that social factors such as literacy level and economic status of respondents, with p-value of < 0.045 and <0.037 respectively, determine level of pastoral livelihood sustainability as shown on table 7.1.

The study assessed livelihood system and factors that support or enhance the realization of sustainable pastoral livelihood; this was because West Pokot County has different livelihoods that were noted to be affected differently by climate change. It was indicated

that there are key variables that show significance to the sustainability of pastoral livelihood such as literacy, economic level, water access, pasture, livestock production and forest cover are some of the key assets that enhance the sustainability of pastoralist community livelihood.

The findings also revealed that sources of livelihood show significance with impacts of climate that influence or compromise sustainability of livelihood. Pastoralists were found to have specific assets that drive the realization of sustainability of their livelihoods. During FGD respondents reported that all these assets are exposed to the effects of climate change and they are sensitive to high temperature (heat stress).
The study further indicated that there was another underlying factor that was exacerbated by the dynamics of climate change which posed a great threat to pastoral livelihood systems such as livestock disease especially emerging diseases in this context of climate change. It was indicated by respondents that the emergence of new livestock disease coupled with sensitive ASAL area to climate variability, increase the vulnerability of pastoralists to climate change impacts thus compromising their ability to realize sustainability of pastoral livelihood systems. The resilience of the pastoralist was based on enhanced adaptation strategies and protection of pastoral assets from exposure to climate extreme events.

Adaptive capacity was found to be important in climate change risk reduction, but this was noted to be influenced by other common problems in pastoral areas, especially in more marginalized areas, where there was high illiteracy level, high poverty index, and environmental destruction, pasture and water crisis among the challenges faced by pastoralist in ASAL area. The study agreed with Ajani *et al., (*2013), who found that adaptation practices to climate change by the local communities are grounded on their indigenous knowledge, this knowledge was embedded in the socio-cultural context of the community. Local communities use this knowledge to inform their decisions making, when responding to climate change impacts. Therefore, the integration of indigenous knowledge with scientific to deal with climate change may assist communities effectively in responding to impending climate changes.

Table 7.1: Relationship between Pastoral Livelihood System (Dependent Variable) and livelihood zones

[1]Type of crop grown, Fruits	33	0.0	5.2	3.4	32.87	0.000***
[1]What is the state of rivers in your locality during dry seasons?	178	8.6	19.0	18.8	131.664	0.000***
Where livestock are taken during the dry season, Migrate	244	43.2	17.4	2.9	146.18	0.000***
[1]Where livestock are taken during dry season, Stay at home	135	4.2	14.3	16.7	134.148	0.000***
[1]Pastoral livelihood is the most vulnerable to climate change, disagreed	20	0.5	1.3	3.4	26.825	0.000***
[1]Community in West Pokot experience problems of food insecurity disagreed	55	1.0	7.6	5.7	42.618	0.000***
[1]Milk produced during dry season, yes	335	38.5	29.2	19.5	13.147	0.000***
[1]Body condition of your livestock during drought season? Good	110	6.0	10.2	12.5	63.66	0.000***
[1]What is the state of pasture during dry season? Good	87	4.4	7.0	11.2	64.194	0.000***
[1]Where do your livestock access water from? River	286	25.0	29.9	19.5	89.198	0.000***
[1]Where do you livestock access water from? Borehole	44	8.9	1.6	1.0	17.475	0.000***
[1]Where do your livestock access water from? Dam	18	4.7	0.0	0.0	20.743	0.000***
[1]Where do your livestock access water from, Water pans	24	6.0	0.3	0.0	23.875	0.000***
[1]Where do your livestock access water from? Sand dams	12	3.1	0.0	0.0	13.605	0.000***
[1]Are livestock in West Pokot Resilience to climate change? yes	233	29.7	17.2	13.8	3.775	0.000***
[1]Livestock breed resilient to impacts of climate change, Cow/Bull	54	4.2	3.6	6.3	22.365	0.000***
Livestock breed	91	16.9	5.7	1.0	31.479	0.000***

resilient to impacts of climate change, Camel						
[1]Livestock breed resilient to impacts of climate change, Goats	207	25.5	19.8	8.6	8.146	0.000***
[1]Livestock breed resilient to impacts of climate change, Sheep	27	0.5	2.3	4.2	31.022	0.000***
[1]Livestock breed resilient to impacts of climate change, Donkey	5	0.5	0.3	0.5	1.213	0.000***
2OVERALL INDEX SCORE: PASTORAL LIVELIHOOD SYSTEM[3]						
Mean	384	26.08	33.83	40.38	F = 78.18	0.000***
Standard Deviation (SD)	384	8.79	9.52	7.90		
Level of sustainability of pastoral livelihood system[4]						

The Cronbach's Alpha is 0.666 using 40 Pastoral Livelihood variables which is a good value for testing internal consistency (Check superscript 1 behind the 40 variables). The Pastoral livelihood system or index score is categorized into two namely; unsustainable and sustainable.

Source: Field Data, 2020

7.3 Climate Change and Level of Sustainability of Pastoral Livelihood System

The study revealed that rainfall and landslide show a high level of significance, this was evidenced by d=5.5, p-value <0.082, d=4.9 and p-value<0.04, this therefore, indicates that the sustainability of pastoral livelihood depends on rainfall. It also reveals that rainfall influences natural resources such water that was found to be the important players in the realization of sustainability of pastoral livelihoods. Delay in rainfall results in drying up of pasture, water sources and vegetation, which has direct impacts on livestock as shown in Table 7.2. The study further found that landslides had an impact on the level of sustainability of the pastoral livelihood system; this finding was validated by recent landslides in Pokot South where several livestock were lost. Whenever landslide occurs, the livestock sector was found to be the most affected. Landslide result in massive deaths of livestock, destruction of water sources, pasture and vegetation covers. The study was in agreement with Walton and van Aalst (2020), who found that during geological hazards such as landslide and floods, environmental destruction, loss of community livelihood and destruction of ecosystem.

Table 7.2: Relationship between climate change and Level of sustainability of pastoral livelihood system

Climate change variables	**Level of sustainability of pastoral livelihood system**				
	Unsustainable	**Sustainable**	**Difference**	**X2**	**P-value**
Rainfall	33.6	39.1	5.5	3.025	0.082*
Temperature	30.7	32.0	1.3	0.000	0.998
Humidity	19.8	21.1	1.3	0.032	0.858
Droughts	33.6	37.5	3.9	1.099	0.294
Floods	37.8	39.8	2.0	0.048	0.826
Pests and Livestock diseases	34.4	38.0	3.6	0.878	0.349
Landslides	9.4	14.3	4.9	4.215	0.040**
Gullies	28.9	30.7	1.8	0.054	0.817
Forest land	40.1	40.9	0.8	0.205	0.651
Closed shrub land	40.4	35.2	-5.2	9.557	0.002***
Open shrub land	42.4	41.4	-1.0	2.207	0.137
Cropland	36.7	38.5	1.8	0.013	0.908
Pasture/grazing land	32.6	34.6	2.0	0.081	0.775
Wet land	25.0	29.4	4.4	1.680	0.195
Water body	26.6	31.2	4.6	1.911	0.167
Bare land	32.8	34.4	1.6	0.005	0.946
Traditional plants and animals	33.3	31.8	-1.5	1.441	0.230
Overall score: climate change[6]					
Mean	64.64	65.70	1.1	t=0.367	0.714
Std. Deviation	27.09	29.01			
Std. Error Mean	1.98	2.07			

**p<0.1 **p<0.05 ***p<0.01 Significant at 90%; 95% and 99% confidence level Red means negative significant Green means positive significance and No colour means no significant difference between the households with unsustainable and Sustainable pastoral livelihood system. The Cronbach's Alpha is 0.899 using all the 17 climate Change variables which is a good value for testing internal consistency*

Source: Field Data, 2020

The study further assessed the relationship between the background factors and the level of sustainability of pastoral livelihood systems. These factors show that there was a significant relationship between respondents' demographic characteristic and sustainability of pastoral livelihood systems.

7.4 Resilient Breeds of Livestock to Effects of Climate Change

The study investigated respondents' perception on resilience of different animals to the effects of climate change. The results shows that 38.9% of the respondents indicated goats was resilient, 28.0% camels, 9.1% cows, 7.0% sheep and 17% donkeys. This finding implies that the goat was considered to be most resilient animal to the effects of climate change and the sheep was more susceptible to climate variability, as shown in figure.7.1. This reveals that livestock diversification for better resilience breed to climate variability enhances sustainability of pastoralism in this context of climate change. It was further found that goats and camels survive in harsh climatic conditions. This, therefore, encourage pastoralist to embrace livestock breed improvement strategy to promote their adaptation to effects of climate change. The study agreed with Recha & Radeny (2017), who found that one of the pastoralist adaptation measures was a cross-breeding of goats and sheep with more climate-resilient breeds, such as Galla goats, Cross-breeding promote higher-yielding and more climate-resilient livestock whilst also produce more quality meat than pure indigenous breeds.

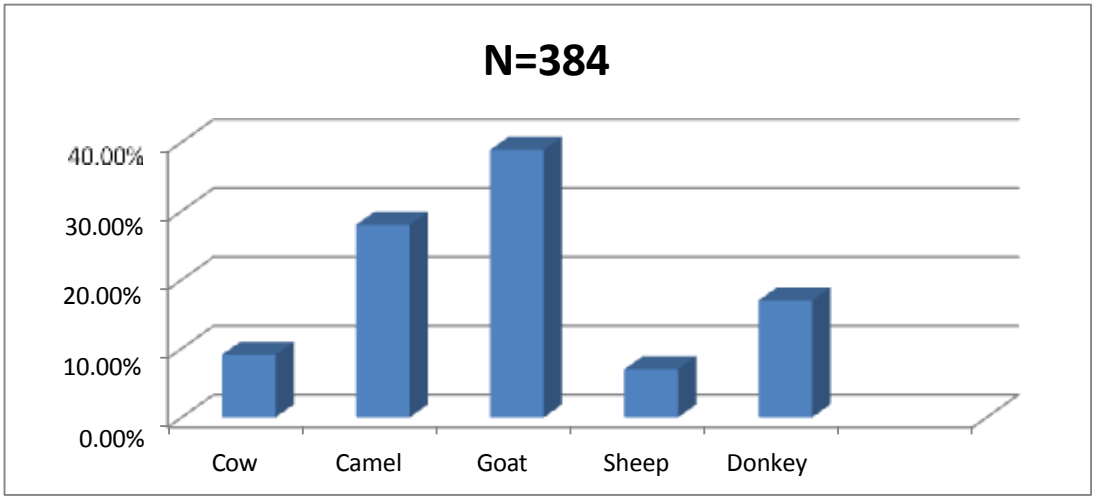


Figure 7.1: Prioritization of the livestock type's resilience to impacts of climate change

Source: Field Data, 2020

According to Hoffmann (2008) there was a need to improve local genetics through the cross- breeding of livestock with heat and disease tolerant breeds. If climate change was faster than natural selection the risk of survival and adaptation of the new breed becomes greater. This study was again in agreement with Speranza (2010), who indicated that some animals are adaptive to effects of climate change. The sustainable pastoral development must be founded on the understanding that adaptive capacity was what sustain pastoralism, restoring and enhancing adaptive capacities must therefore be central to development plans.

7.5 Practices That Enhance Livestock Disease Control

The study through FGDs, KIIs and CSG meeting identified various practices that were found to enhance pastoralist sustainability on disease control measures, through discussion and engagement with stakeholders, it was indicated that county stakeholders has been promoting practices that aim at building pastoralist resilience to an outbreak of diseases, as shown on table7.4. During the engagement with the stakeholders, strategies were identified and ranked based on the most preferred for the pastoralist and an effective one in reducing livestock exposure to diseases and enhance sustainable adaptation measures to pastoralist. The study was supported by Ayal *et al.*, (2015), who stated that high mobility of livestock caused by shortage of pasture and water aggravates the spread of contagious diseases, such as bovine pleuropneumonia, Pasteurellosis due to contact between animals from different regions, including wild animals.

The study revealed that the risk of climate change requires dynamic strategies that reduce the susceptibility of the livestock sector to weather changes and the risk associated to it. Strengthening and promoting new approaches that built livestock resilience to disease outbreak associated with climate change was identified, such as disease surveillance to enable the veterinary officers detect diseases early for quick response to reduce livestock exposure to disease and mass vaccination promotes livestock immune to anticipated disease. The study further supported by Stark *et al.,* (2011), who found that livestock health problems are exacerbated by climate change such as the high prevalence of Trypanosomiasis, emerging of new types of foot and mouth disease and other respiratory diseases in the lowlands are among other challenges that affect livestock fertility.

Livestock extension service was about having extension officers in the field that regularly monitors diseases outbreak, training pastoralists on disease detection through observation of symptoms, tick control and disease reporting. The establishment of lab-test, diagnosis, screening and detection promote sample tests for disease identification. The study indicated that Community participation in disease control was empowerment to the community on their capacity to understand various measures and strategies for disease control and protection of livestock from exposure to the risk of diseases and vectors that transmits the disease. Strengthening pastoralist capacity on disease monitoring, surveillance and treatment were found to be the long-term strategy in addressing various outbreaks of livestock diseases. It was further noted that few community members have been trained on disease surveillance and reporting, but even after reporting disease outbreak to the relevance agencies/ and departments, response take a long time and very little can be done to save livestock, as reported by one of the key informants,

"We require to get knowledge on various symptoms, treatment, drugs and monitoring these emerging livestock disease so that we can treat our animals without necessarily calling for veterinary office, who normally delay till when we have lost many of animals is when they come for treatment".

The study agreed with OIE (2015), who established that effective livestock disease control was based on investing in programs such as effective surveillance and early detection of disease. It was further argued that effective active surveillance was the systematic collection and analysis of data for the timely dissemination of information for early an action to be taken, it was further urged that it enables the timely detection and identification of an incursion of a disease infection in each area for prompt treatment.

Table 7.3: Livestock disease control programmes

Disease control	Frequency	Ranking
Train local community on participatory disease surveillance	29	1
Frequent Mass vaccination	27	2
Promote livestock extension service	14	3
Establishment of disease lab test and diagnosis	12	4
Disease screening and detection	10	5
Train pastoralist community on disease report and monitoring	8	6
8		
6		

Source: Researcher, 2020

7.1 Practices for Pastoralist Mitigation Effects of Climate Change

The study explored various community strategies that promote community resilience to climate change. During county steering group meetings and focus group discussions, it was found that strengthen community capacity to adapt with climate change problems such as promoting livestock breed diversification to ensure that livestock reared by pastoralists can adapt with the effects of climate change. During FGD it was found that in West Pokot County, communities are currently getting interested in Somalia breed camel that was drought tolerant animals and also with high productivity yield in terms of milk production, whereas gala goats were also found to be embraced by pastoralists. The community either prefer to geta male breed for cross breeding or both male and female for goats. The two animals are known for milk production and its value addition; they fetch good money compared to local goat breeds or Turkana camel breeds that are small in size and produce a low yield in terms of milk production. Livestock was found to be prone to the water crisis; therefore, increasing access to water among the pastoralist was noted to be important. Water is among the natural resource that is sensitive to drought; hence require infrastructural development and more so water harvesting technology to assure the community of the availability of water for their livestock. The study was in agreement with (UNDP, 2013), which found that communities in ASAL counties can reduce their vulnerability to climate change through the enhanced adaptive

capacity to climate extreme events.

Table 7.4: Strategies for building resilience to climate change

Strategies	Percentage %	Ranking
Pasture establishment	26	1
Practicing grazing management	24	2
Increase water access to livestock	18	3
Establishment of feed reserve	15	4
Livestock breed diversification	12	5
Conservation of crop residuals	5	6

Source: Field Data, 2020

7.2 Climate change policy framework

County climate change policy was developed county government and other stakeholders to facilitate coordinated and effectively response to the local challenges attributed to climate variability and opportunities presented by climate change. Mainstreaming climate change approach has been adopted to ensure integration of climate change into county development planning, budgeting, and implementing in all sectors and all levels of government, this aims to enhance adaptive capacity and built community resilience to climate change, while promoting a low carbon development pathway. The study was supported by Berehanu, (2007), who found that the livelihoods framework provides comprehensive and complex approaches in understanding how people make a living alongside coping with effects of climate change.

The study found that the development of a policy framework that mainstreams climate change and adaptation activities into a county development plan that is anchored on county integrated development plan, annual development plan and budgeting process that enhance sustainability of climate change adaptation . The development of county climate change action is some of the key components of climate change risk reduction measure that enhances community adaptation to climate change-related hazards. The study agreed with Bruno *et al.,* (2008), who revealed that the sustainable livelihood framework is a tool for understanding the livelihood strength and strategies of a particular population.

This framework also assists government and non-government agencies to implement their development goal for a given community.

Pastoralist communities have been exposed to violent conflicts resulting from competition over imitated natural resources that are threatened by climate variability, development of conflicts framework that is anchored on values of peace dialogues, negotiation and promote resource sharing among the pastoralist and government and non-state actors to invest on water harvesting structures to increase access to water for livestock and household needs.

The study was in agreement with Odero (2008), who found that sustainable livelihoods framework was based on understanding pastoral access to assets that typically include natural, human, social, physical and financial capital. The study also found that reducing environmental degradation and destruction by improving access to natural resources for grazing through drought risk reduction was vital in protecting pastoral livelihoods.

7.3 The Climate Change Governance Approach

The study assessed community perception on climate change governance and policy and it was revealed that development of the policy framework on climate change risk management strategies with (31%) of the respondents revealed to embrace climate-smart crop farming and livestock rearing (20%), breed diversification (19%), community sensitization (18%) and climate change action plan (12%). This indicates that the community calls for the government to enhance governance and legislation on climate change policy and promote climate-smart agriculture for enhanced pastoralist adaptation to climate-related shocks as shown by Figure7.2. The study indicated that for the sustainability of pastoral livelihood, climate change governance through development of framework or legislation was key.

During the CSG meeting, it was revealed that some policies and laws needed to be enacted to enhance implementation and provide guiding principles to climate change adaptation measures. It was further noted West Pokot lack key policies such as climate change and adaptation policy, no allocation of funds toward climate change adaptation and mitigation. The key informant indicated that for sustainable adaptation and reduction of climate threats, investment on long term measures and making every sector climate

sensitive. The priority was based on mainstreaming climate change adaptation activities. It was further noted that developing a policy framework on climate change adaptation and county climate change action plan to enhance implementation of community climate change adaptation action plan.

Diversification of livelihood and livestock breed increases the community resilience to impacts of climate change by providing communities with alternative sources of livelihood and improving livestock breed through cross-breeding. Climate-smart agriculture and livestock rearing are some of the approaches that ensure communities are climate-sensitive.

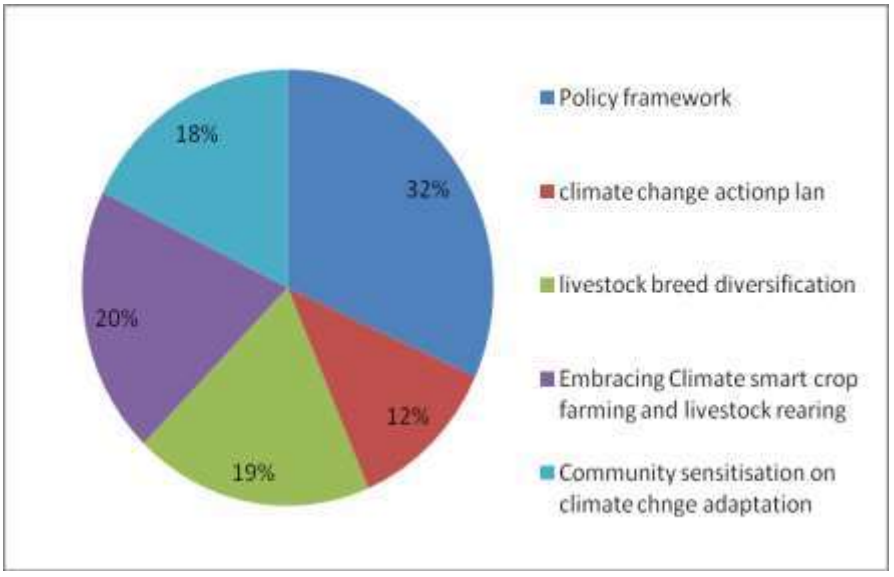


Figure 7.2: Climate change governance approaches

Source: Field data, 2020

7.4 Climate Change and West Pokot County Integrated Plan 2018-2022

The study evaluated the West Pokot integrated plan 2018-2022and noted that key priorities that protect sectors from effects of climate change, such as water, environment and livestock were not given the required attention and action plan in the document.

The study revealed that the CIDP focused on investment in water structures such as boreholes, water pans, surface dams and upgrading boreholes into solar power and enhancing the livestock sector through improved breeding targeting cows, camels, goats and sheep. From the study assessment, the 2018-2022 CIDP did not outline key strategies that promote climate change adaption and its mitigation measures in West Pokot County; instead, it just identifies anthropogenic activities, such as deforestation, illegal timber logging and forest encroachment that increased community vulnerability to impacts of

climate variability. It further highlighted key climate extreme events that are associated with climate change, such as landslides, lightning strikes, floods and drought, but did not develop five-year implementation framework for climate change adaption measures.

The study found that the West Pokot CIDP borrowed heavily from the national climate change action plan 2018-2022, by focusing on priorities for implementation, but the study noted that it lack strategies and implementation matrix of mainstreaming the climate change action into sector- specific. The document was silent on disaster risk reduction despite the existence of the disaster management Act of 2016, and Disaster Risk management policy and also the County being disaster-prone. This indicates that the development of this document was not inclusive in terms of multi-disciplinary. The study found that domestication of the national climate change action plan requires critical analysis of county-specific climate-related hazard for designing specific action and implementation framework that is practical for West County climate change problems. During the interview with the key informant, it was noted that first and second county integrated development plans were silent on climate change adaption strategies and disaster risk reduction strategies.

The study found many challenges that existed as the gap in West Pokot CIDP such as the process being not being participatory as required in order to incorporate stakeholders' views that give home-based solution to chronic problem of drought. The ending drought emergency which was 10-year framework of providing implementation guides for achieving drought risk reduction, this framework was required to be mainstreamed to county integrated plan and its priorities considered in an annual development plan for line County and national government departments. On disaster risk reduction, West Pokot has established a county disaster management policy that provides a guiding framework on the implementation of Sendai framework action. County disaster management Act 2016, regulates disaster response and funds meant to provide humanitarian assistance during disaster response , despite the existence of this policy and disaster regulation, the key informant indicated that implementation of the county policies was a major problem, it was noted that disaster was well understood at response instead of investing on disaster risk reduction and preparedness, therefore funds allocated to disaster-related programme are meant for response(humanitarian assistance) and instead of addressing the whole four

phases of disaster management,(Mitigation, prevention , response and Recovery), this implies that climate related hazards are addressed at response level, not at migration and long-term measures that enhance community adaptation to effects of climate related shocks.

The key informant indicated that realization of climate change-related risk reduction may not be achieved due to inadequate funds directed toward climate change adaptation, although this was disputed by other respondents who stated that West Pokot County since its inception has not developed a policy framework on climate change or enacted law related to climate change adaptation. This implies that disaster management was known at humanitarian or reactive strategies, not proactive. Investments on disaster preparedness require advocacy and community sensitization on climate change adaption-related programs as priorities during public participation and budget hearing.

The study further deduce that stakeholders and more so county assembly lack basic understanding of what it meant by climate change, disaster management and event priorities for these common phenomena in West Pokot, capacity building of stakeholders on climate change and disaster risk reduction strategies, for more understanding and increase knowledge on how to combat natural hazards associated to climate change. The climate change policy and establishment of county climate change action plan that guiding implementation of climate change adaptation and mitigation measures that are in line with national government strategies.

The government of Kenya commitment on achieving nation contribution determinant determine of 30% by 2030 as commitment to Paris agreement, this has not been realized at the County level. The study further noted community has not appreciated the facts that challenges and problems being experienced are as results of climate change. It was also found that awareness creation, community sensitization on development of community action plan for enhanced community resilience to climate shocks.

7.5 Policies and Framework Priorities in West Pokot County

The study evaluated existing climate change-related policies in West Pokot and the study found that Kenya has developed national climate change Act 2016 and national climate change action plan 2018-2022, that forms a basis for the County government to

domesticate or mainstream such policies based on their local climate extreme events that threaten the community livelihoods. Climate change action plan provides a wide range of activities, actions and strategies aimed at mainstreaming climate change adaptation measures to each sector in order to climate-proof all the sectors exposed to the threat of climate variability.

The West Pokot Disaster Management Act of 2016, and disaster risk management policy 2021, provides a guideline on how to achieve disaster risk reduction. The study revealed that West Pokot CIDP 2028-2022 provide both long term and short-term plan for County priorities, but this study found a huge gap in this document, on issues of climate change and adaptation, but did not provide comprehensive action and priorities on climate change risk reduction measures. The EDE framework that target ASAL Counties through NDMA, outline key strategies that reduce risk posed by drought among pastoralists in the ASAL area.

The sustainable development goal number 2 on end hunger, achieve food security and improved nutrition and promote sustainable agriculture, goal number 6 on ensuring availability and sustainable management of water and sanitation for all and goal number 13 on taking urgent action to combat climate change and its impacts, form part of the County government priority action on climate change adaptation. The study revealed that these entire frameworks have not been achieved due to lack of clear implementation framework among the players (County and national government and non-state partners). Theses importance strategies lack key implementation matrix and mainstreaming guideline into sectors specific and synergy of the stakeholders in addressing extreme effects of climate change.

CHAPTER EIGHT

THESIS SYNTHESIS AND DISCUSSION

8.1 Introduction

This chapter merges together findings of the study to shows relationship of the objectives and the title.

On objective 1**:** "To Evaluate vulnerability of pastoralist Community to effects of climate change'',

Pastoralists in West Pokot County are threatened by various climate change hazards, with drought being the most common climate extremes that exacerbated pastoralist vulnerability to climate extreme events, other climate extremes include: livestock diseases, floods, landslides and lightning strikes were found to be the most common problems that affect pastoralist, this was catalyzed by deforestation and poor farming methods that exposure community to the vulnerability of hydrological and geological hazards.

During drought episodes, livestock are exposed to feeding poisonous plants that pose a serious threat to animals' health. The Cocklebur plant was the most common dangerous poisonous plant that had killed many animals and this was well reported in the study area. The pastoralism is very sensitive to climate changes shocks. The pastoralist adaptive capacity to climate change was found to be very low implying that their livelihood was highly susceptible to the impacts of climate change. Pastoralist in West Pokot experiences numerous livestock disease outbreaks during the dry season that increases livestock vulnerability to death associated with drought and shared watering points

On objective 2: *"To examine Impacts of Climate Change on Livelihoods and Livestock Production System"*

The study investigated impacts of climate change on pastoral livelihood and production; the climate changes affect pastoralist livelihood production with high magnitude and intensity of climate extremes. The frequency of drought directly affects livestock production and the sensitivity of the natural resources to climate shock and the vegetation cover has been experiencing climate variability that triggers drought in West Pokot County.

The vegetation covers inform pasture situation and development in pastoral zone and it fluctuate in different phases of drought ranging from normal-alert-alarm and emergency, and as the phase progressed toward alarm, the pasture start deteriorating, and water crisis start to be experienced. West Pokot experienced serious pasture scarcity during drought period and this shows that pasture was very sensitive and more exposed to effects of climate change. Livestock poor body conditions during drought period were found to be deteriorating, which always poses food insecurity threats due to reduced livestock production. The reduction in milk yield was due to sensitivity of animals to thermal stress, which result to milk production losses. The lactating animals were adversely affected by climate variability due to high temperature. This implies that climate variability has a direct impact on the growth of palatable grass and the regeneration of fodder.

Climate change affect different livelihood zone differently, with pastoral zone being the most vulnerable livelihood to impacts of climate change compared to the other livelihood zones, due to their feeding nature of being grazers. The underplaying condition and factors tend to increase pastoralist community vulnerability to climate triggered hazards, thus compromising sustainability of the pastoralist livelihood. Therefore, enhancing their capacity and designing polices and action plans that directly builds community adaptive capacity to climate change shocks.

On objective 3:"*To examine Community-Based adaptation and Coping Strategies that pastoralists adapt to mitigate the Impacts of Climate Change, West Pokot County, Kenya"*

During drought, when the entire county experiences water and pasture crisis, animals usually migrate to Ugandan for these resources. The most preferred and more sustainable coping mechanisms practiced by pastoralist in West Pokot were: pasture management, seasonal grazing management, diversification of livelihood and livestock breeds. Livestock diseases can be mitigated through vaccination, frequent ticks control dipping/ spraying.

Vaccination was found to be the solution to frequent outbreak of livestock that threaten pastoralist livelihood. Vaccinated livestock reported fewer deaths, compared to those that were not vaccinated. The most preferred and more sustainable coping mechanisms practices were conservation of crop residues, seasonal grazing area management.

Livestock breed improvement zero grazing and pasture establishment. Acceleration of livestock off-take helped pastoralists reduce animal's loss to drought where pastoralists reduce their livestock population by selling some instead of losing large herd of livestock. These are some of the strategies that aim at strengthening pastoralist livelihood for its sustainability and ensuring that communities in ASAL are resilience to climate shocks through community-based solution.

On objective 4: "*To evaluate the existing framework, policies and practices that enhances sustainability of the pastoral livelihood in West Pokot County, Kenya".*

The sustainability of pastoral livelihoods systems can be achieved through mainstreaming climate change actions into various sector of development and ensure that all departments are climate proofed. Investment on natural resource such as water harvesting, pasture establishment and seasonal grazing pattern guarantee sustainability of pastoralism in West Pokot. On the other hand, the specific breed of animals was found to be resilient to drought such as camel, goat and donkeys are the most suitable animals to pastoralist living in drought prone areas.

The climate change policy development and the development of a policy framework that mainstreams climate change and adaption activity into a county development plan that is anchored on county integrated development plan, annual development plan and budgeting process was importance in realization of the sustainable pastoralism.

The West Pokot county climate change action plan and priorities are some of the key components of climate change risk reduction measure that enhances community adaptation to climate change-related hazards. Reducing environmental degradation, destruction and improving management of the natural resources is vital in protecting pastoral livelihoods. The sustainability of pastoral livelihood can be achieved through development framework legislation and strengthening county climate change governance.

The County integrated development plan (CIDP) focused on water structures investment such as boreholes, water pans, and surface dams and upgrading boreholes into solar power boreholes and enhancing the livestock sector through improved livestock breed targeting cows, camels, goats and sheep. The ending drought emergency priories form

part of the important strategies in reducing the risk posed by drought among the pastoral the ASAL area. The big four agenda of the national government focused on climate-proofing the four priorities to adapt the dynamic of the climatic variability.

Kenya is signatory to implementation of sustainable development goal and other international framework for climate change adaption including Paris agreement on climate change and adaptation. The sustainable development goal, 2, 6 and 13, form part of the county priority action on climate change adaptation. Development and implementation of national and county framework on climate change adaptation promote better outcome of the prioritized activities, such as water harvesting, Pastures establishment, and livestock breed diversification, seasonal grazing area management and rangeland management system.

From this study, climate change increases pastoralist vulnerability, with adverse effects reported in all spheres of developments. However, impacts of climate change directly affect main source livelihood for pastoralist in West Pokot, with livestock production being one of the most affected sector, because Pokot community have survived numerous shocks of climate extremes, this has enable them initiate community-based adaptation measure that enhance their resilience to climate change. The effects of climate change tend to threatened and jeopardize sustainability of the pastoralist livelihood during this time of increased climate extremes. However, sustainability Pastoralist livelihood is guaranteed through improving livestock breeds and management of natural resources such as pasture and water, livelihood diversification, enhance disease surveillance and frequent mass vaccination. The county government need to be in forefront in developing frameworks that guide implementation of key strategies for climate change adaptation, the same framework ensure synergy among development partners in county and work toward contributing to enhancing sustainability of pastoralist livelihood.

CHAPTER NINE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

9.1 Introduction

This chapter presents a summary of each objective and conclusion of the main findings from each objective and gives recommendations for further studies.

9.2 Summary of the Key Findings

The study revealed that the rainfall trend has gradually increased in the recent past and the temperature has been increasing yearly. The West Pokot County is prone to various climate change-related shocks that threaten pastoralists and pose risk to community livelihood, such as livestock disease and drought; drought is classified to be the most threatening climate extremes. A poisonous plant emerges to pose serious threats to pastoralist that lead to mass death of livestock, community exposure to climate change is high and livelihoods are very sensitive to climate change shock, the pastoralist adaptive capacity to Climate change was found to be very low. The vegetation cover has drastically reduced to due threats from human activities, such as destruction of forest for land use and crop farming, settlement, charcoal burning and the invasive plants species that hinder pasture germination and they are on increasing in West Pokot county. Migration of livestock to Uganda is the most practiced adaptation strategies among the pastoralist in West Pokot. Vaccination is the most suitable strategy of mitigating livestock disease, because it enables livestock to gain immunity against anticipated disease (before disease outbreak), Some animal breeds such as camel and goats are resilience to effects of climate.

In terms of climate change policy development, development of a policy framework that mainstreams climate change and adaption activity into a county development plan that is anchored on county integrated development plan, annual development plan and budgeting process. The County climate change action plan and priorities are some of the key components of climate change risk reduction measure that enhances community adaptation to climate change-related hazards. The CIDP 2018-2022didn't outline key strategies that promote climate change adaption among the pastoralist. Strengthening of community on disaster preparedness and building community resilient to effects of common disasters is key in promoting community preparedness to climate extremes.

9.3 Conclusion

The pastoralists are more exposed to the effects of climate change and their livelihood is very sensitive to impacts of climate extreme events, with the low adaptive capacity of pastoralist community that greatly influences their adaptation strategies to climate change. Drought and livestock diseases are the most common climate extreme events that pose a serious threat to the pastoralist community. Migration remains to be the most preferred adaptation strategies by pastoralist, although other strategies are emerging such as pasture establishment, seasonal grazing area management, livestock off-take, crop residues conservation and livestock insurance cover. The invasive plants have become a threat to pasture development, it hinders pasture germination, and this means that these plants have been on the rise covering large areas of grazing land. The livestock body condition during drought is always in deteriorating condition, thus compromising livestock production.

The sustainable pastoral livelihoods systems can only be realized when pastoralists embrace diversification of livelihood and livestock breeds, pastures establishment and rangeland management system.

9.4 Recommendation

The study revealed that pastoralists community in West Pokot County are adversely affected by climate change and due to exposure to climate shocks, community need to embracing local-based adaptation strategies that cushion their livelihood from threats of climate extreme events. Therefore: There is a need for stakeholders within West Pokot County to strengthen pastoralist community's capacity on rangeland management system for enhanced pasture development, livestock breed diversification and Promote community sensitization and advocacy on livestock off-take in order to reduce los to climate extremes. There is need for county government of West Pokot enhance investment on water harvesting technology for increases water access for livestock and human being

There is need for County Government of West Pokot and other stakeholders to train local community on control of *Checkechir* poisonous plants; there is need for County Government of West Pokot and other stakeholders strengthen pastoralist capacity o n

participatory diseases surveillance in order to enhance early warning and early action for livestock diseases.

There is also need for county government of West Pokot to enhance legislation on climate change policy and promote climate-smart agriculture for enhanced sustainability of pastoral livelihood.

9.5 Suggestions for Further Study

The study, therefore, recommends further research to evaluate the future of pastoralist livelihoods in the context of climate change in the same study area and explore possible emerging livelihoods among the pastoralist due to influences of climate change.

REFERENCES

Abayineh Amare and Belay Simane (2017), Climate Change Induced Vulnerability of Smallholder Farmers: Agro-ecology-Based Analysis in the e Muger Sub- Basin of the Upper Blue-Nile Basin of Ethiopia. American Journal of Climate Change, 2017, 6, 668-693http://www.scirp.org/journal/ajcc ISSN Online: 2167-9509

Abdela, N. & Jilo, K. 2016. Impact of climate change on livestock health: a review. Global Veterinaria, 16(5): 419-424

Abdela, N., & Jilo, K. (2016). Impact of climate change on livestock health: A review. Global Veterinaria, 16(5), 419-424.

Adan AbassTawane & Edward Mugalavai (2018) Evaluation of Mitigation Strategies for Climate Change Adaptation in Mandera County, Kenya, MSC thesis Masinde Muliro university of science and technology: Department of Emergency and Humanitarian Assistance

ADM (2017) The Sustainable Livelihoods Approach, DOI 10.1007/978-981-10-0983-9_5, retrieved on 10the December 2020.

Adenew, B. (2006) Effective Aid for small Farmers in sub-Saharan Africa: Canadian Food Security policy Group; *www.fao.org ›*, retrieved on 10th August 2019.

Ajani, N. E., Mgbenka, N. R. and Okeke, N. M (2013): Use of Indigenous Knowledge as aStrategy for Climate Change Adaptation among Farmers in sub-Saharan Africa: Implications for Policy. InJournal of Agricultural Extension, Economics and Sociology 2 (1), pp. 23–40

Aklilu A, Desalegn W, Mesfin K, Negash T (2013). Climate change impacts on Pastoral Women in Ethiopia:Some evidences from the Southern lowlands. PHE Ethiopia Consortium.1-6p.

Alberini, A., A. Chiabai, and L. Muehlenbachs, 2006: Using expert judgment to assess adaptive capacity to climate change: evidence from a conjoint choice survey. Global Environmental Change, 16(2), 123-144

Alexandratos N, Bruinsma J, (2012). World agriculture towards 2030/2050: the 2012 revision. FAO, Rome, Italy

Allen, K., (2003) Vulnerability reduction and the community-based approach. Natural Disasters and Development in a Globalising World, 170-184

Amundson JL, Mader TL, Rasby RJ and Hu QS (2006).Environmental effects on pregnancy rate in beef cattle. Journal of Animal Science 843415–3420.

Anyah, R.O. and F.H.M. Semazzi. 2006. Variability of East African rainfall based on multiyear Regcm3 simulations. Inter J. Climatol. 27:357-371

ASAL Policy (2012). National Policy for the Sustainable Development of Northern Kenya and other Arid Lands

Ayal, D. and Muluneh, A. (2014) , "Smallholder farmers' vulnerability to climate variabilityin the highland and lowland of Ethiopia: implications to adaptation strategies", Doctoral thesis, University of South Africa, Geography Department.

Ayal, D., Solomon, D. and Lance, R. (2015), "Institutional assessment for climate change adaptation, Didahara, Borena, Southern Ethiopia", ILRI Project Report, Nairobi, Kenya, International Livestock Research Institute (ILRI).

Balgis Osman Elasha, Nagmeldin Goutbi, Elhassan, Hanafi Ahmed, andSumaya Zakieldin (2005),Sustainable Livelihood Approach for Assessing Community Resilience to Climate Change: Case Studies from Sudan.

Barribeau P., Butler, B., Corney, J., Doney, M., Gault J., Gordon J., Fetzer, R., Klein, A., Rogers, C.A., Stein, I.F., Steiner, C., Urschel, H., Wagoner, T., &Palmquist, M. (2015) Survey research. Colorado State University, USA

Baylis, N. and Githeko, A.K. (2006), "The effects of climate change on infectious diseases of animals. T7.3. Foresight. Infectious diseases: preparing for the future. Office of Science and Innovation". Available from: http://www.foresight.gov.uk/Infectious%20Diseases/t7_3.pdf.

Beckam, M., van An, L. and QuangBao, L.(2002) Coping and Adaptation Strategies of Households and Local Institutions in Central. *https://www.tandfonline.com › doi ›abs. retrieved on 20th May 2019*

Bernard Bett, Johanna Lindahl, and Grace Delia (2009) Climate Change and Infectious Livestock Diseases: The Case of Rift Valley Fever and Tick-Borne Diseases ,International Livestock Research Institute, Nairobi, Kenya

Berehanu E. (2007), Livelihood strategies of smallholder farmers and income poverty in draught prone areas: the case of Gena-Bosa woreda, SNNPRS. An M.Sc. thesis presented to the School of Graduate Studies of HarUmaya University

Burugu Anthony N. (2016) Assessing the Impact of Climate Change on Food Security of Communities in Turkana County.MSC thesis, University of Nairobi department of geospatial and space technology

Bruno Locatelli, HetyHerawati ,Maria Brockhaus , Monica Idinoba Markku Kanninen (2008) Methods and Tools for Assessing the Vulnerability of Forests and People to Climate Change.www.cifor.org › publications ›pdf_files ›WPapers › WP43Locatelli: retrieved on 7th Jul, 2019

Behnke, R. and Muthami, D. (2011) 'The Contribution of Livestock to the Kenyan Economy'. IGAD LPIWorking Paper 03–11. Nairobi: IGAD Livestock Policy Initiative

Behnke, RH. (2008). The economic contribution of pastoralism: case studies from the horn of Africa and Southern Africa. Nomadic Peoples 12(1): 45–79.

Bekele, S. (2017). Impacts of climate change on livestock production: A review. *Journal of Natural Sciences Research, 7*(8), 53-59.

BoneyaUdessa,(2013)Impacts of Climate Change on Pastoral Communities in DugdaDawa District, Borena Zone, Oromia Region, South Ethiopia, Msc Addis Ababa University, College of Natural Science Center for Environmental Science

Bo Limerika S.-Siegfried, Ian B. Elizabeth and Malonesaleemul Huq (2014) Adaptation policy frameworks for climate change: developing strategies, policies and measures, published by the press syndicate of the university of Cambridge

Carlos E. Ludena Sang Won Yoon (2015) Local Vulnerability Indicators and Adaptation to Climate Change A Survey: inter American development Bank IDB

Care (2012) Community Based Adaptation**:** An Empowering Approach for Climate Resilient Development and Risk Reduction. https://careclimatechange.org › 2014/08 › retrieved on 22nd May, 2019

Cairo, FAO, Verner, D.2012. Adaptation to a Changing Climate in the Arab Countries – A Case for Adaptation Governance and Leadership in Building Climate Resilience. Washington, D.C., World Bank

CCD, (2008) Commission on climate change and Development, climate change and Dry lands. Retrieved on 23rd July 2019 http://www.ccdcommiss ion.org

Capper, J.L. (2011). Replacing rose-tinted spectacles with a high-powered microscope: The historical versus modern carbon footprint of animal agriculture. Anim. Front. 1(1):26–32

Capra, A., Consoli, S., & Scicolone, B. (2013). Long-term climatic variability in Calabria and effects on drought and agrometeorological parameters. *Water Resources Management*, *27*(2), 601-617.

Chantarat, S., Mude, A. G., Barrett, C. B., and Carter, M. R. (2013) Designing Index-Based Livestock Insurance for Managing Asset Risk in Northern Kenya. Journal of Risk and Insurance, 80(1), 205-237.

Connolly-Boutin, L. &Smit, B., (2015). Climate change, food security, and livelihoods in sub-Saharan Africa. *https://link.springer.com › article*. Retrieved on 3rd June 2019.

Creswell, J.W. (2008), Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd ed., Sage Publications, Thousand Oaks,

Daniel S. (2015), Impact Of Climate Change On Indigenous Peoples' Livelihoods: A Case of Loodo Kilani Maasai, Kajiado County. Msc Thesis Climate Change of the University of Nairobi

Davidson, H. (2018) 'Climate change is exacerbating world conflicts, says Red Cross president'.TheGuardian.21October.(https://www.theguardian.com/world/2018/oct/21/climate-change-is exacerbating-world-conflicts-says-red-cross-president)

Desalegn Yayeh Ayal, Maren Radeny, Solomon Desta and Getachew Gebru (2018) Climate variability, perceptions of pastoralists and their adaptation strategies: Implications for livestock system and diseases in Borana zone, International Journal of Climate Change Strategies and Management

De Onis, M. and M. Blossner, (2003), "The World Health Organization Global Database on Child Growth and Malnutrition: methodology and applications," International Journal of Epidemiology 32(4): 518-526.

DFID(2000), Sustainable Livelihoods Guidance Sheets. Department for International Development.http://www.livelihoods.org/info/info_guidancesheets.html (20th, March 2020)

DFID (2004) The impacts of climate change on the vulnerability of the poor. https://www.unpei.org› sites › default › files › PDF › resource efficiency. *retrieved on 7th November, 2019.*

Djikeng, A., Rao, I. M., Njarui, D., Mutimura, M., Caradus, J., Ghimire, S. R., Johnson, L., Cardoso, J. N., Ahonsi, M., and Kelemu, S. (2014) Climate-smart Brachiaria grasses

for improving livestock production in East Africa. Tropical Grasslands- Forrajes Tropicales, 2(1), 38-39.

Digambar, D. S. (2011).Impact of Climate Change on Livelihood and Biodiversity in Rural Communities (A casestudy of Siddhi Ganesh and Nepane Community Forestry User Groups of Sindhupalchwok District ofNepal).

Eakin, H., Luers, A.L., (2006). Assessing t he vulnerability of social–environmental systems. Annual Review of Environment and Resources 31, 365–39

Ebei P., Oba G., & Akuja T. (2007). Long-term impacts of droughts on pastoral production andtrends in poverty in north-western Kenya: An evaluation of 14-year drought early warning data series.

Ekitela R.J & Moru June (2010), adaptation to Climate Variability among the Dry land PopulationIn Kenya: A Case Study Of The Turkana Pastoralists

FAO (2018), Impacts of Climate Change on Faming System and Livelihoods in the Near East and North Africa: With a special focus on small-scale family farming

FAO (2017).Improving pasture management in arid and semi-arid lands in the Horn of Africa through Pastoralist Field Schools

FAO, (2016a). Climate change, agriculture and food security. The state of food and agriculture No. 2016. Rome, FAO. 173 pp. [also available at www.fao.org/3/a-i6030e.pdf]

FAO (2016c.) Regional Overview of Food Insecurity in the Near East and North Africa, FAO Regional Office for the Near East and North Africa, Cairo, Egypt. [also available at http://www.fao.org/3/a-i6860e.pdf]

FAO (2016) Climate Change and Major Projects: Outline of the climate change related requirements and guidance for major projects in the 2014-2020 programming period

FAO (2012) Agricultural technologies for climate change mitigation and adaptation in developing countries: policy options for innovation and technology diffusion, ICTSD–IPC platform on climate change, agriculture and trade

FAO. (2009), State of food and agriculture - livestock in the balance. Rome,

FAO. (2015). The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture, edited by B.D. Scherf& D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome.

FAO. (2010). Forests and climate change in the Near East region. Forest and Climate Change Working Paper 9. Rome, FAO. FAO. 2011a. FAO-Adapt - FAO's framework programme on climate change adaptation. Rome, FAO.

FAO. (2009b). Food security and agricultural mitigation in developing countries: options for capturing synergies. Rome, FAO.

FAO. (2009c) Livestock keepers – guardians of biodiversity. Animal Production and Health Paper. No. 167. Rome, FAO.

FAO. (2009d.) The state of food and agriculture 2009. Livestock in the balance. Rome, Italy FAO.

Fisher, M., M. Chaudhury, B. McCusker, (2010) "Do Forests Help Rural Households Adapt to Climate Variability? Evidence from Southern Malawi," World Development 38(9), 1241-1250.

Fisher A.A., Laing J. E., Stoeckel J.E and Townsend J.W (1991).Handbook for Family Planning Operations Research Design 2nd ed. p43. Population Council. New York, USA Available on: www.popcouncil.org

Field, C.B., Barros, V.R., Mach, K. and Mastrandrea, M. (2014) 'Summary for policy makers', in Climate change 2014: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the IPCC. Cambridge and New York: CUP.

Francis Opiyo Oliver Wasonga Moses NyangitoJanpeter Schilling and RichardMunang(2015) Drought Adaptation and Coping Strategies among the Pokot community Pastoralists of Northern Kenya

Füssel, H., (2010), "How inequitable is the global distribution of responsibility, capability, and vulnerability to climate change: A comprehensive indicator-based assessment," Global Environmental Change 20(4): 597-611.

Füssel, H.-M. (2007). Vulnerability: A Generally Applicable Conceptual Framework For Climate Change Research. Global Environmental Change, 17, 155-167

Gauly, M., H. Bollwein, G. Breves, K. Brügemann, S. Dänicke, G. Daú, J. Demeler, H. Hansen, J. Isselstein, S. König, M. Lohölter, M. Martinsohn, U. Meyer, M. Potthoff, C. Sanker, B. Schröder, N. Wrage, B. Meibaum, G. von Samson- Himmelstjerna, H. Stinshoff, and C. Wrenzycki. 2013. Future consequences and challenges for dairy cow production systems arising from climate change in central Europe—A review. Animal, 7: 843–859

Gachohi JM, Njenga MK, Kitala P et al (2017) Correction: modelling vaccination strategies against Rift Valley fever in livestock in Kenya. PLoSNegl Trop Dis 11:e0005316. https://doi. org/10.1371/journal.pntd.0005316

Galvin, K.A., Boone, R. B., Smith, N. M. and Lynn, S.J. (2001). Impacts of climate variability on East African pastoralists: Linking social science and remote sensing. Climate Research 19: 161–172

Gallopín, G. C. (2006). Linkages Between Vulnerability, Resilience, And Adaptive Capacity. Global Environmental Change, 16, 293-303

Gebre Michael Y. and Kifle M. (2009). Local innovation in climate-change adaptation by Ethiopian pastoralists. Addis Ababa: PROLINNOVA-Ethiopia and Pastoralist Forum Ethiopia, Pp. 25

Goldman, M.J., and Fernando Riosmena. 2013. Adaptive capacity in Tanzanian Maasai land: Changing strategies to cope with drought in fragmented land scapes. Global Environmental Change23 (3): 588–597. https://doi.org/10.1016/j. gloe nvcha. 2013.02.010.

Gwambene, B and Majule, A.E (2009): Strengthening local agricultural innovations to adapt to climate change in Botswana, Malawi, South Africa and Tanzania. Implications of climate change and variability on rural livelihood and household food security in panganiDistrict .

GOK (2018). National Climate Change Action Plan (Kenya): 2018-2022.

Gupta J, Van Der Grijp N, eds. (2010,) Mainstreaming climate change in Development Cooperation: Theory, Practice and Implications for the European Union. 1st ed. Cambridge: Cambridge University Press; 303–341

GOK (2018) National Climate Change Action Plan (2018-2022), Draft for Discussion: Version 4 Ministry Of Environment and Forestry, Climate Change Directorate

GOK. (2016b). Economic Survey Annual Report 2016, Government of Kenya. *https://www.knbs.or.ke › download › economic-survey*. Retrieved on 12th October, 2019.

GOK (2018) Kenya Climate Smart Agriculture Implementation Framework 2018-2027. https://www.ke.undp.org › kenya › docs › energy_and_environment. Retrieved on 2ndSeptember 2019.

GOK). (2010). National climate change response strategy: Executive brief. Retrieved from http://www.environment.go.ke/wp, retrieved on 15th September, 2019.

GOU, (2015) Economic Assessment of the Impacts of Climate Change in Uganda Case-study on agricultural production in the Karamoja region

Hans-Martin Füssel(2009) Review and quantitative analysis of indices of climate change exposure, adaptive capacity, sensitivity, and impacts: Potsdam Institute for Climate Impact Research

Hannah Reid, SaleemulHuq and Laurel Murray (2010) Community Champions: Adapting to Climate Challenges: Fourth International Conference on Community-Based Adaptation Dar es Salaam, Tanzania, 2010

Harvell, C. D., Mitchell, C. E., Ward, J. R., Altizer, S., Dobson, A. P., Ostfeld, R. S.,(2002). Ecology - Climate warming and disease risks for terrestrial and marine biota. Science 296, 2158-2162.

Herrero, M., Addison, J., Bedelian, C., Carabine, E., Havlík, P., Henderson, B., ... & Thornton, P. K. (2016). Climate change and pastoralism: impacts, consequences and adaptation. Rev Sci Tech, 35(2), 417-433.

Herrero, M. T., Ringler, C., Steeg, J. V. D., Thornton, P. K., Zhu, T., Bryan, E., ... & Notenbaert, A. M. O. (2010). Climate variability and climate change and their impacts on Kenya's agricultural sector.

Hoffman, T., and Vogel. C. (2008). Climate change impacts on African rangelands. Rangelands 30:12–17

Hoffmann, I. (2010). Climate change and the characterization, breeding and conservation of animal genetic resources. Anim. Genet., 41: 32–46.

Homewood, K., Kristjanson, P. and Trench, P.C. (2009) Staying Maasai?Livelihoods, conservation and rangelands. New York: Springer.

Hughes, Lotte (2006). Moving the Maasai: A Colonial Misadventure. St Antony's Series. Basingstoke,UK: Palgrave Macmillan

HPG (2009), Understanding livelihoods to reduce the vulnerability of pastoral communities

Huho, J., Ngaira, J. and Ogindo, H. (2011), "Living with drought: the case of the Maasai pastoralists of Northern Kenya", Educational Research, Vol. 2 No. 1, pp. 779-789.

ICEM, (2013).Climate Change Impact and Adaptation on Livestock. Prepared for the United States Agency for International Development by ICEM.

Ingrid Hartmann, Ahmed J. Sugulle, Ahmed I. Awale (2010).The Impact of Climate Change on Pastoralis in Salahley and Bali-gubadle Districts,Somaliland.https://ke.boell.org retrieved on 9th October 2019.

IPCC, 2007). Contribution of Working Groups I, II and III to the Fourth Assessment Report. Geneva, Switzerland. pp 104

IPCC (2017) Understanding and measuring vulnerability to climate change: Fifth Assessment

IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

IPCC (2014), Summary for policymakers. In: Climate change (2014) Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change UK and New York, USA. pp 1–32

IUCN (2012) Supporting sustainable pastoral livelihoods: A global perspective on minimum standards and good practice. 2nd Edition. IUCN ESARO Office, Nairobi.

ICPAC). (2007). Climate Change and Human Development in Africa: Assessing the risks and vulnerability of climate change in Kenya, Malawi and Ethiopia (Draft Report). HumanDevelopment Report Ofce Occasional Paper. Retrieved from http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/igad.pdf

IGAD (2013a) 'IGAD Drought Disaster Resilience and Sustainability Initiative: The IDDRSI Strategy'. Nairobi: IGAD.

ILR (2007) Kenya Adaptation to Climate Change in the Arid Lands: Anticipating, Adapting to and Coping with Climate Risks in Kenya - Operational Recommendations for KACCAL

IFPRI. (2017) Global food policy report. Washington, DC. International Food Policy Research Institute. [also available at http://www.ifpri.org/ publication/2017-global- food-policy-report]

IISD (2009). Climate related vulnerability and adaptive capacity in Ethiopia's Borana and Somali communities' Final assessment report.https://www.iisd.org. retrieved on 8thNovermber ,2019.

IUCN (2004), Sustainable Livelihoods & Climate Change Adaptation. A Review of Phase One Activities for the Project on, "Climate Change, Vulnerable Communities and Adaptation"

Janet C. Koske (2014). Vulnerability to Climate Change and Conflict, Its Impact on Livelihoods and the Enjoyment of Human Rights Case Study: Pastoral Communities in Northern Kenya (Turkana, Pokot and Samburu Districts)

Janpeter Schilling1, Francis EO Opiyo, and Jürgen Scheffran1 (2012) Raiding pastoral livelihoods: motives and effects of violent conflict in north-western Kenya

Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L., Daszak, P. (2008). Global trends in emerging infectious diseases. Nature, 451: 990–994

Jonathan Davies Michele Nori (2008) Managing and mitigating climate change through pastoralism see discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/228417188

Jun Wang, Yang Wang, Shuangcheng Li and Dahe Qin (2016)Climate adaptation, institutional change, and sustainable livelihoods of herder communities in northern Tibet

Kenneth K. Mwangi and Felix Mutua (2015) Modeling Kenya's Vulnerability to Climate Change – A Multifactor Approach. International Journal of Science and Research)

Kennedy Mkutu (2001) Pastoralism and conflict in the Horn of Africa : Africa Peace Forum/Safer world/University of Bradford

Ketiem, P.K., Njunie M. N. and Wafula, B.W (2009): Emerging Responses to ClimateChange Adaptation Strategies in Arid and Semi-Arid Lands of Coastal Kenya.

Krätli, Saverio, Huelsebusch, Christian, Brooks, Sally, and Kaufmann, Brigitte. (2013). Pastoralism: A Critical Asset for Food Security under Global Climate Change. Animal Frontiers Vol. 3 No. 1.

Lenyayon G. Lelenguyah, (2013), Effects of Climate Variability on Pastoral Livelihoods in Marigat District, Baringo County, Kenya. Msc Thesis Kenyatta University EnvironmentalStudies (Climate Change and Sustainability).

Lesnoff, M., Corniaux, and C., Hiernaux, P. (2012). Sensitivity analysis of the recovery dynamics of a cattle population following drought in the Sahel region. Ecological Modelling 232, 28

Lunde, T.M., Lindtjørn, B. (2013). Cattle and climate in Africa: How climate variability hasinfluenced national cattle holdings from1961–2008. PeerJ 1, e55. DOI: http://dx.doi.org/10.7717/peerj.55

LPP, LIFE Network, IUCN–WISP & FAO. (2010). Adding value to livestock diversity – marketing to promote local breeds and improve livelihoods. FAO Animal Production and Health Paper, no. 168. Rome, FAO

Mario Herrero, Jane Addison, Claire BedelianandElizabeth Carabine, (2016), Climate change and pastoralism: impacts, consequences and adaptation: -EN- -FR- Le change climatique pastoralisme: effects, consequence set adaptation -ES- Cambioclimáti.

Madan ML and Prakash BS (2007). Reproductive endocrinology and biotechnology applications among buffaloes. In: Reproduction in Domestic Ruminants VI, (Nottingham University Press) Nottingham, United Kingdom 261-281

Mary Kilavi, 2012 — KENYA's CLIMATE.... Tropical Convergence Zone (ITCZ).www.liverpool.ac.uk › QWeCI,science,talk,Mary,Kilaviretrived on Janauray 2021.

McKeon .G. S. Stone, J. I. Syktus, J. O. Carter , N. R. Flood and D. G. Ahrens (2009) Climate change impacts on northern Australian rangeland livestock carrying capacity: a review of issues

M. Herrero J. Addison C. Bedelian E. Carabine P.Havlík B. Henderson J. van de Steeg (&
P.K. Thornton (2016) Climate change and pastoralism: impacts, consequences and adaptation: - EN- -FR- Le changementclimatique et le pastoralisme : effects, conséquenceset adaptation -ES- Cambio-climáti

M. Okoti1, J. Kung'u and J. Obando (2014), Impact of Climate Variability on Pastoral Households and Adaptation Strategies in Garissa County, Northern Kenya

Moiko Stephen,(2004)Climate change sciences - the status of climate change science today:https://unfccc.int › backgrounders › application › pdf › press_factsh_sciences, retrieved on 17th August , 2019.

M. Herrer J., Addison C. Bedelian E., Carabine, P. Havlík , B. Henderson, J. van de Steeg and P.K. Thornton(2016) Climate change and pastoralism: impacts, consequences and adaptation Rev. Sci. Tech. Off. Int. Epiz., 2016, 35 (2), 417–433

Molu Wato (2016) Effects of Climate Variability on Livestock Production and Coping Strategies in Maikona Location, Marsabit County, Kenya: Msc Thesis Kenyatta University School Of Environmental Studies

Mistry, J. and Berardi, A (2016): Bridging Indigenous and Scientific Knowledge: Local Ecological Knowledge Must be Placed at The Centre of Environmental Governance. In Science 352 (6291), pp. 1274-1275

Muhamad, N. J ,W.B. Massey, R. E, Okoola, Opere A. O., J. R. Mukabana, W Nyakwada, S. Aura, M.M. Manene and B. A. Chanzu., (2012) Survey on the Utilization of Weather Information and Products for Selected Districts in Kenya. J. Meteorol. Rel. Sci., 6, 51 –58

Mude, A., Ouma, R., van de Steeg, J.A., Tipilda, A. and Kariuki, J. 2007. Kenya adaptation to climate change in the arid lands. Anticipating, adapting to and coping with

climate risks in Kenya: Operational recommendations for KACCAL. Report submitted to World Bank

Mugenda, O.M and A.G. Mugenda(1999). Research Methods – Quantitative and Qualitative Approaches. African Centre forTechnology Studies (ACTS) Press. Nairobi,Kenya

Nardone, A., Ronchi, B., Lacetera, N., Ranieri, M.S., and Bernabucci, U., (2010). Effects of climate changes on animal production and sustainability of livestock systems. Livestock Science130, 57–69

NejashAbdela and Kula Jilo (2016) Impact of Climate Change on Livestock Health: AReview Global Veterinaria, Jimma University, Jimma Ethiopia 16 (5): 419-424, 2016ISSN 1992-6197

Nardone, A., B. Ronchi, N. Lacetera, M.S. Ranieri and U. Bernabucci, (2010). Effects of climate changes on animal production and sustainability of livestock systems. Livest. Sci.,130: 57-69

Nelson, D. (2010). Resilience and Vulnerability: Complementary Or Conflicting Concepts? Ecology and Society, 15

Neely, C. and S. Bunning. (2008). Review of Evidence on Dry land Pastoral Systems and Climate Change: Implications and opportunities for mitigation and adaptation. FAO – NRL Working Paper. Rome, Italy.

NEMA (2014) Integrated Programme to Build Resilience to Climate Change & Adaptive Capacity of Vulnerable Communities in Kenya. https://www.adaptation-fund.org. retrieved on 27thSeptember, 2019.

Neumann C., D. M. Harris, and L. M. Rogers. (2002). Contribution of animal source foods in improving diet quality and function in children in the developing world. Nutr. Res. 22(1–2):193–220

Nori M, Taylor M, Sensi A 2008. Browsing on Fences: Pastoral Land Rights, Livelihoods and Adaptation to Climate Change. IIED Issue Paper 148, May 2008.

Ngaina, J., and Mutai, B. (2013) Observational evidence of climate change on extreme events over East Africa. Global Meteorology, 2(e2), 6-12.

Njiru, B. N. (2012). Climate change, resource competition, and conflict amongst pastoral communities in Kenya. In Climate change, human security and violent conflict (pp. 513-527). Springer, Berlin, Heidelberg.

Notenbaert, A., P. Thornton, and M. Herrero. (2007). Livestock development and climate change in Turkana District, Kenya. Discussion paper No. 7—Targeting and innovation. International Livestock Research institute (ILRI), Nairobi

Nursey-Bray, M., D. Fergie, V. Arbon, L. Rigney, R. Palmer, J. Tibby, N. Harvey, and L. Hackworth, (2013) Community Based Adaptation to Climate Change: The Arabana. National Climate Change Adaptation Research Facility, Gold Coast,133pp.https://www.nccarf.edu.au/publications/community-based-adaptation-arabana]. Retrieved on 18th July, 2019.

Obwocha, Everlyne B. (2015) Assessment of Impacts of Climate Change And Variability On Food Security In West Pokot County, Kenya, Msc Thesis Kenyatta University

Odero, K.K., (2008). Information capital: 6th asset of sustainable livelihood framework. Discovery and Innovation 18, 83–91

Odufuwa, B.O. Odufuwa, B.A. And Fasina, S.O (2012) Climate Change And Livelihood: The Two Sides of a Coin, Engineering and Environmental Studies, OlabisiOnabanjoUniversityDepartment of Home Economics, Tai Solarin College of Education Fasina, S.O

Ofoegbu, C., Chirwa, P., Francis, J. &Babalola, F.2017. Assessing vulnerability of rural communities to climate change: A review of implications for forest-based livelihoods in South Africa. International Journal of Climate Change Strategies andManagement, 9(03): 374–386

OIE. (2010).World Organisation for Animal Health, Plurithematic issue of the Scientific and Technical Review 29 (3), http://www.oie.int/fileadmin/home/eng/ about us/docs/pdf/ 5th_startplan _2010_last.pdf

OIE (2015). Animal diseases prevention and control oie/j.bonwittwww.oie.int retrieved on 20 January,2021.

Ogwang, B.A. et al., 2014. The influence of Topography on East African October to December climate: Sensitivity experiments with RegCM4 Key Laboratory of Meteorological Disaster, Ministry of Education , Nanjing University. Advanced Meteorology, 2014, pp.1–27.

OgalSabil Ali Maalla1, Ali Musa Abakar ,Yousif M.Hamdi2 , Maruod E. Maruod and Osman Elsaidadlan(2018). The impact of Climate change on pastoralist's livelihood in South Kordofan State, SudanJournal of Novel Applied Sciences: Availableonline atwww.jnasci.org

Omondi. S. P., Kidali. J. A..Ogali. I., Mugambi, J. M., and Letoire, J. (2014) The status of livestock technologies and services in the Southern Maasai rangelands of Kenya. African Journal of Agricultural Research, 9(15), 1166-1171

Opiyo, FEO, SM Mureithi, and RK Ngugi. 2011. The influence of water availability on

'pastoralist's resource use in Kitui and Mwingi districts of Kenya. Journal of Human Ecology 35(1): 43–52

O'Brien, K., Leichenko R. and Kelkar U. (2004): Mapping vulnerability to multiple stressors: climate change and globalization in India. Global Environmental Change, 14(4), 303-313.

Orindi, V.A., A. Nyong and M. Herrero (2007). Pastoral livelihood adaptation to drought and institutional interventions in Kenya. In: United Nations Development Programme. Human Development Report 2007–2008: Fighting Climate Change: Human Solidarity in a Divided World. Human Development Report Office, Occasional Paper 2007/54

Patz, J.A., Confalonieri, U.E.C., Amerasinghe, F.P., Chua, K.B., Daszak, P., Hyatt, A.D., Molyneux, D., Thomson, M., Yameogo, L., Lazaro, M.M., Vasconcelos, P., RubioPalis, Y., Campbell-Lendrum, D., Jaenisch, T., Mahamat, H., Mutero, C., Waltner Toews, D., Whiteman, C., (2005a). Human health: ecosystem regulation of infectious diseases. In: Ecosystems and Human Well-Being. Current State and Trends, vol. 1. The Millennium Ecosystem Assessment. http:// www.millenniumassessment.org (Chapter 14)

Paz, S. (2015). Climate change impacts on West Nile virus transmission in a global context. Philosophical Transactions of Royal Society B, 370.

Parry, M., C. Rosenzweig, Livermore M., 2005, "Climate change, global food supply and risk of hunger," Philosophical Transactions of the Royal Society of London B: Biological Sciences, 360(1463): 2125-2138.Tol, 2002).

Pedersen, J., and T. A. Benjaminsen (2008). One leg or two? Food security and pastoralism in the Northern Sahel. Hum. Ecol. 36:43–57

Peter John Mjata(2015) The Impact Of Climate Change On Rural Livelihoods In The North Nguu Mountains, Kilindi District, Tanzania (Phd) Thesis Open Universityof Tanzania

Peterson, A.T. (2006). Ecologic Niche Modeling and Spatial Patterns of Disease Transmission. Centers for Disease Control and Prevention, 22(12): 1822-1826

Pinto, J., Bonacic, C., Hamilton-West, C., Romero, J. &Lubroth, J. (2008). Climate change and animal diseases in South America. Revue Scientifique et Technique, 27(2): 599-613

P.K. Thornton, J. van de Steeg, A. Notenbaert, M. Herrero (2009) The impacts of climate change on livestock and livestock systems in developing countries: A review of what we know and what we need to knowwww.fao.org › tempref › Reserved › DAD-Net › Livestock

Porter JR, Xie L, Challinor AJ, Cochrane K, Howden SM, Iqbal MM, Lobell DB, TravassoMI, (2014). Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York,NY, USA

Philip K. Thornto and Mario Herrero(2015)Adapting to climate change in the mixed crop and livestock farming systems in sub-Saharan Africa

Philip Aniaha, Millar Katherine Kaunza-Nu-Demb, Ikpe Emmanuel Quacouc, Joyce AdongmaAbugred, Bernard Awinbugri Abindawe (2016) The Effects of Climate Change on Livelihoods of Smallholder Farmers in the Upper East Region of Ghana

Raphael P. Magal (2016),Risk Assessment of The Coping And Adaptation Mechanisms for Pastoralists to Climate Change and Variability: A Case Study of Kongelai Ward, West Pokot County, Kenya. MSC Thesis University of Nairobi. Department of Geography and Environmental Studies, Faculty of Arts

Riché, B., Hachileka, E., Awuor, C.B. and Hammill A. (2009). Climate-related vulnerability and adaptive capacity in Ethiopia‘s Borana and Somali 84communities. Retrieved from http://reliefweb.int/node/352113 on 6th October,2019.

Robinson S, Strzepek K, Cervigni R (2010). The Cost of Adapting to Climate Change in Ethiopia: Sector-Wiseand Macro-Economic Estimates. ESSP working paper 53.1-23

Rourke, J. M. (2011).Seasonal prediction o f African rainfall with a focus on Keftya (Doctoral dissertation, UCL (University College London).

SAFERWORLD, (2009) Climate change and conflict Lessons from community conservancies in Northern Kenya.

Sarah Taylor, Michael Knight and Andy Harfoot (2014) National biodiversity climate change vulnerability model: Natural England Research Report NERR054

Sadler, K., E. Mitchard, A. Abdi, Y. Shiferaw, G. Bekele, and A. Catley. 2012. Milk matters: The impact of dry season livestock support on milk supply and

child nutrition in Somali Region, Ethiopia. Feinstein International Center, Tufts University, and Save the Children Addis Ababa, Ethiopia.

Saidu O. and Omedo B., (2010). Climate change, genetics of adaptation and livestock production in low input systems. 2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions. August 16 - 20, 2010, Fortaleza - Ceará, Brazil. 1-12p.

Sidahmed, A.E., Nefzaoui, A. & El- Mourid, M.(2008). Livestock and climate change: coping and risk management strategies for a sustainable future. In P. Rowlinson, M. Steele & A. Nefzaoui, eds. Livestock and global change, pp. 27-28. Proceedings of an international conference, Hammamet, Tunisia, 17-20 May 2008. Cambridge, UK, Cambridge University Press

Schilling, J., Opiyo, F. and Juergen, S. (2012). Raiding Pastoral Livelihoods: Motives and Effects of Violent Conflict in North-western Kenya. Pastoralism, Policy, Research 2(25): 1-16.

Shambel Bekele(2017)Impacts of Climate Change on Livestock Production: A Review Journal of Natural Sciences Research www.iiste.org ISSN 2224-3186 (Paper)
ISSN 2225- 0921 (Online)Vol.7, No.8

Shepardand Frank Thomalla((2014) Livelihood resilience in the face of climate change

S.Mahendra (2011) Climate Change, Rural Livelihoods And Agriculture (Focus On Food Security) In Asia-Pacific Region Indira Gandhi Institute Of Development Research, Http://Www.Igidr.Ac.In/Pdf/Publication/WP-2011-014.Pdf

Smith, B., Pilifosova, O., Burton, I., Challenger, B., Huq, S., Klein, R. and Yohe, G. (2001). Adaptation to climate change in the context of sustainable development and equity

Silvestri, Silvia, Elizabeth Bryan, Claudia Ringler, Mario Herrero, and Barrack Okoba.(2012).Climate change perception and adaptation of agro-pastoral communities in Kenya. Regional Environmental Change12 (4): 791–802.https://doi.org/10.1007/s10113- 012- 0293-6

Solomon Tirunehand FirewTegene (2018) Impacts of climate change on livestock production and productivity and different adaptation strategies in Ethiopia

Sprott, L.R., Selk, G.E., Adams, D.C., (2001. Factor affecting decision on when to calve beef female. Prof. Anim. Sci. 17, 238–246 Also, the severity and distribution of livestock diseases and parasites is conditioned by climate change

Speranza, C.I. (2010). Drought coping and adaptation strategies: Understanding adaptations to climate change in agro-pastoral livestock production in Makueni District, Kenya. European Journal of Development Research 22(5): 623–642

Tran, M. (2011). Investment in pastoralists could help combat East Africa food crisis. The Guardian, 2 Sept. 2011.

Tarhule, A. A. 2007. Climate information for development: An integrated dissemination model. Africa Development, Vol. XXXII, no 4, 127-138, CODESREA.

Taffese, M. and Samson, S. (2009), Indigenous Veterinary Practices of South OmoAgro-Pastoralist Communities, 1st ed., Apple Printing Press, Addis Ababa

Thornton, P.K. & Gerber, P. (2010). Climate change and the growth of the livestock sector in developing countries. *Mitigation and Adaptation Strategies for Global Change*, 15: 169-184.

Thomas and Twyman, (2005) Mapping poverty and livestock in the developing world. Nairobi, Kenya: International Livestock Research Institute:https://cgspace.cgiar.org › handle. Retrieved on 14th June , 2019.

Thornton, P. K. (2010). Livestock Production: Recent Trends, Future Prospects. CGIAR/ESSP Program on Climate Change, Agriculture and Food Security (CCAFS), International Livestock Research Institute (ILRS) 365, 2853- 2867

Thornton, P. K., Jones, P. G., Alagarswamy, A., &Andresen, K. (2008). The temporal dynamics of crop yield responses to climate change in East Africa. Global Environmental Change.

USAID (2018), Designing Climate Vulnerability Assessments: Climate Change Adaptation, Thought Leadership and Assessments

UNDP, 2007, Human Development Report 2007/2008. United Nations Development Programme, New York. Livelihoods are means through which people eke a living

UNDP (2015) combating desertification n Kenya, emerging lesson from empowered community: https://www.undp.org› environment-energy › country- specific-evidence.Retrieved on 10th may, 2019.

UNDP (2013) Adaptation to Climate Change in Arid Lands ttp://www.adaptationlearning.net/country-profiles/ke

USAID (2017)Vulnerability, Impacts And Adaptation Assessment in The East AfricaRegion Von Grebmer.

Victor A. Orindi, Anthony Nyong and Mario Herrero (2015) Pastoral Livelihood Adaptation to Drought and Institutional Interventions in Kenya

Van Dijk, J., Sargison, N. D., Kenyon, F., & Skuce, P. J. (2010). Climate change and infectious disease: helminthological challenges to farmed ruminants in temperate regions. *Animal*, *4*(3), 377-392

Waalter lealfilho (2015) Climate change adaptation handbook: Faculty of Life SciencesHamburg University of Applied Sciences Hamburg, Germany, ISBN 978-3-642- 38669-5

Walton, D., & van Aalst, M. (2020). Climate-related extreme weather events and COVID-19. *A first look at the number of people affected by intersecting disasters. Geneva: International Federation of Red Cross and Red Crescent Societies*.

Watson, R. T., Zinyowera, M. C., and Moss, R. H. (eds): (1998).The Regional Impactsof Climate Change: An Assessment of Vulnerability, A special report of the

Walter Lea lFilhoA.nthonyObutiatiaEsilabaK. P. C. RaoSridhar Gummadi **(**2016).Adapting African Agriculture to Climate Change http://www.researchgate.net/publicationCentre

WWF, (200 6). Climate Change Impact on East Africa: A Review of Scientific Literature,Gland, Switzerland

Yusman Syaukat (2015) the impact of Climate Change on Food Production and Security andIts Adaptation Programs in Indonesia, Agricultural University

Yohannes, (2008), "Global Hunger Index: The Challenge of Hunger 2008," Available at:http://www.ifpri.org/sites/default/files/pubs/cp/ghi08.pdf

APPENDICIES

*Appendix I**: Questionnaire for Household Survey***

My name is Lolemtum Joseph Timu, PhD student of University of Nairobi; I'm conducting Research on the "***Impacts of Climate Change on Sustainable Pastoral Livelihood of Pokot Community in West Pokot County, Kenya***". I would like to get your views on this. I hope that you will respond to all of my questions. The information you provide will be used for academic research purposes only and will be treated with the privacy and confidential it deserves. None of this information will be disclosed to any authority nor the identity of respondent revealed. If you would like to have a question clarified, feel free to ask. Your response will be highly appreciated

RESPONDENTS BIO DATA

Please tick where appropriate / fill in as accurately as possible (To be filled byinterviewer).
Which part of Pokot County do you reside?

(01)= Pokot North (02)= West Pokot (03)= Pokot Central (04)= Pokot South

Age {18-25} {26-35} {36-45} {46 and above}

Gender (01) =male (02) =female

Education (01) = primary (02) = secondary (03)= college/ university(04)=None
(To be filled by respondent or research assistant)

Division..... location..... sub- location Marital status () Married ( ) single parent () single ( ) widowEconomic level ( ) Employed ( ) Unemployed ( ) Self Employed

Objective one

How long have you lived in this locality? 5 years ( ) 10 years () 20-30 years ( ) Over 30 Years()
What is your household size? ---------- ----------
How many are Male? ------
How many are female?

How many of them are in the school to learn (give options)?

3.8 What is your occupation?Livestock keeping

Business Employed Casual labour Crop Framing Sand harvesting
If not state ----

What is status of the following sectors in relation to climate changes? Tick where possible

Sectors	Increased	Decreased	No change
Watr			
Pastures			
Livestock production			
Forest cover			
Livestock population			
Crop production			

4bExplain you're above observation of increase, decrease or no change in relation toclimate change------

3.8.1 n the recent years (within the last 30 years), were there any changes in theproduction of your livestock? Yes; No

5b If yes, what was the trend?i Increase
ii Decrease

3.8.2 In the recent years (within the last 30 years), were there any changes in cropproduction? Yes No

5b If yes, what was the trend?i Increase
ii Decrease

3.8.3 Are there weather changes that you observed? Yes or No

7b if Yes what are those observation? --------

3.8.4 Does effects of climate change increase or decrease? give reason why----------

3.8.5 What contribute to your household vulnerability to climate change in WestPokot? ------- 10. Is your

livelihood affected by climate change in this locality? Yes or No

10b if yes how is it affected? ----------

11. Which is your main livelihood? ---------- ------

11b State other livelihoods that you depend on?

11c. Do your livelihoods are affected by climate change in your opinion? Yes or no 11dIf yes why? -----
11e If yes how? ------

12. When did you start experiencing climate change problem?-(tick one option)

i. 1-5 years

ii. 6-10 years

iii. 11-15 years

iv. Over 15 years

13. Which climate extreme events are common in your area? ----------

14. Are there livestock deaths due to climate extreme events? Yes or No

14b If yes state some of common causes of livestock deaths----------

15. Are there agricultural crop failure in your locality which is attributed to climatechange? Yes or No

15b If yes state some of common causes of crop failure? ----------

16. Which are crops usually grown in your locality? ----------

17. What is the state of wetland or rivers in your locality?

i. Dry

ii. Flowing

iii. Swampy

18. Where do you take your animals when you experience impacts of climatechange?

i. Migrate

ii. Stay at home

iii. Take to parks

iv. Distribute to friends

Objective two

1. What is the main livelihood here? ----------

2. Pastoral livelihood is the most vulnerable to climate change

(a) Agree (b) strongly agree (c) Disagree (d) Strongly Disagree (e) partiallyagrees

3. Does climate change affects livestock production system? Yes or No

3b If yes briefly explain------

4. This area is under which ecological zones

(a) Pastoralist

(b) Agro-pastoralist(c) mixed farming

5. Community in West Pokot experience problems of food insecurity

(a) Agree (b) strongly agree (c) Disagree (d) Strongly Disagree (e) partiallyagrees.

6. How many litters of milk do your cows produce per day during dry season? ---------

7. How many litters of milk do your cows produce per day during wet season? ---------

8. How is body condition of your livestock during drought season?

i. Good

ii. Fare

iii. Deteriorating

9. What is the state of pasture during dry season?

i. Good

ii. Fare

iii. Deteriorating

iv. Completely dried up

10. What is the state of pasture during wet season?

v. Good

vi. Fare

vii. Deteriorating

viii. Completely dried up

11. Climate change is the major threat to livestock production in West Pokot

(a) Agree (b) strongly agree (c) Disagree (d) Strongly Disagree (e) partiallyagrees.

12. Where do you livestock access water from?

i. River

ii. Borehole

iii. Dam

13. Which ecological zone is mostly affected by climate change? Rank them

i. Pastoral

ii. Agro-pastoral

iii. Mixed

14. Which ecological zone is least affected by climate change? Rank them

i. Pastoral

ii. Agro-pastoral

iii. Mixed

15. Which animals are mostly affected by climate change? Rank themCow

Goat Sheep Came Donkey

16. Which animals are least affected by climate change? Rank themCow

Goat Sheep Came Donkey

17. How your production has been in the last five year? Increasing or decreasing

4. During drought which livestock system is affected

i. Production

ii. Trade

iii. Body condition

Objective three

1. How do you cope with effects of climate change? ----------

2. Are there common climate change adaptation strategies; Yes or No

2b. If yes state those strategies.....

3. Are there community-based adaptation mechanisms to climate change? Yes or No 3b. If yes list those mechanisms.....

4. How do you withstand adverse effect of climate change ----------

5. How do you rescue your animals from severe impacts of drought ----------

6. Are there strategies of adapting to climate change in your area? ----------

7. Are there climate change mitigation strategies that has been initiate here; yes or No if

7bIf yes state those mitigation measures.....

8.Which of the following climate change coping strategies do you practice(rank them)

a. livestock diversification

b. livestock migration

c. Migration to urban centers

d. Engage on mining

e. Reduce number of meals

f. Engage on casual labour

g. Charcoal burning

h. Brewing of alcohol

i. Sale of allover a

J. Sand harvesting

k. Others specify..... ----------

9. Are livestock in West Pokot Resilience to climate change? Yes or No

    9b briefly explain for any of above answers .....

10. Which livestock bread do you think is resilience to impacts of climate change ---------- ?

Objective four

1. What do think can work for West Pokot County in addressing climate change adaptation,rank your answers
    - Develop Policy framework on climate change adaptationDevelop county climate change action plan
    - Livelihood diversification
    - Creation of awareness on climate change adaptation strategiesIncrease access to resources for enhanced resilience Embracing climate smart agriculture and livestock rearing
2. Are you aware of policy or framework that address impacts of climate change yes or No2b.If yes state.....

3. What suggestions do you have to address the problem of climate change extreme eventslike drought and floods in West Pokot.....

4. Are there traditional or indigenous mechanisms that help building community resilience toeffects of climate change Yes or No

    5b If Yes states those mechanisms...

6. What do think can help mitigate effects of climate change in West Pokot County

Appendix II: Questionnaires for Key Informants

My name is Lolemtum Joseph Timu, PhD student of University of Nairobi, conducting Research on the "***Impacts of Climate Change on Sustainable Pastoral Livelihood of Pokots in West Pokot County, Kenya***". I would like to get your views on this. I hope that you will respond to all of my questions. However, you do not have to respond to every question and I would appreciate if you would answer all questions. The information you provide will be used for academic research purposes only and will be treated with the privacy and confidential it deserves. None of this information will be disclosed to any authority nor the identity of respondent revealed. If you would like to have a question clarified, feel free to ask. Your response will be highly appreciated

1. Position-----

2. Professional back ground?

3. Academic qualification?

4. What do you think is the main contributing factor to vulnerability community in West Pokot to effects of climate change? ----------
5. How do Climate change threaten Pastoralist livelihood?

6. I your aware of government policy on climate change? yes or No,

   6b if yes briefly explain-----

7. I you aware of any framework on climate change adaptation? yes or No, if yes briefly explain

8. How do climate change impacts negatively on livestock and crop production

9. Are there livestock and crop diseases associated with climate change? Yes or No 9b if yes list those livestock disease----
10. Are there climate change adaptation practiced in West Pokot County? Yes or No 10b, If yes briefly explain

11. State some of the community-based adaptation strategies ----------

12. How best can we building community resilience to impacts of climate change------

13. What do think will work for West Pokot county in addressing climate change impacts---
14. How can we impacts knowledge of climate change to community in West Pokot County
15. How can we address impacts of climate change on livestock production? ------

16. Does a climate change affect livestock breading? Ys or No if yes briefly explain ----------

Appendix III: Interview Schedule for Metrological Department

My name is Lolemtum Joseph Timu, PhD student of University of Nairobi, conducting Research on the "***Impacts of Climate Change on Sustainable Pastoral Livelihood of Pokots in West Pokot County, Kenya***". I would like to get your views on this. I hope that you will respond to all of my questions. However, you do not have to respond to every question and I would appreciate if you would answer all questions. The information you provide will be used for academic research purposes only and will be treated with the privacy and confidential it deserves. None of this information will be disclosed to any authority nor the identity of respondent revealed. If you would like to have a question clarified, feel free to ask. Your response will be highly appreciated.

1. Professional background ----------

2. Academic level ----------

3. What is the trend in rainfall in West Pokot County?

i. Increasing

ii. Decreasing

4. What is the trend in temperature in West Pokot County

i. Increasing

ii. Decreasing

1. What do you think is the future scenario ----------

2. What do you think can be done to cushion pastoralists from impacts of climate change in West Pokot County?----------

3. How is rainfall distribution in West Pokot and ecological zones?

4. Pastoral----------

5. Agro-pastoral----------

6. Mixed farming----------

7. What can you recommend to pastoralist on climate change adaptation?---------

8. Is there climate change policy or framework in West Pokot County?-------

9. In recent years (within the last 30 years), were there any changes in the production of your livestock? Yes No

10b, If yes, what was the trend?i Increase

ii Decrease

2. In your opinion, have there been changes in rainfall rates in recent years?i Yes

ii No

3. If yes, what changes did you observe?i Increase

ii Decrease

4. Please briefly explain the nature resulting to above observation ----------

5. In your opinion, were there are changes in temperature pattern in recent years? Yes or No

If yes, what changes did you observe...

Appendix IV: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **715252**

Date of Issue: **20/January/2020**

RESEARCH LICENSE

This is to Certify that Mr.. JOSEPH LOLEMTUM TIMU of University of Nairobi, has been licensed to conduct research in Westpokot on the topic: IMPACTS OF CLIMATE CHANGE ON SUSTAINABLE PASTORAL LIVELIHOOD OF POKOT COMMUNITY IN WEST POKOT COUNTY, KENYA for the period ending : 20/January/2021.

License No: **NACOSTI/P/20/3370**

715252

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix V: Research Authorization Letter by Ministry of Interior and Coordination

THE PRESIDENCY
MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telegrams: "**DISTRICTER**"
COUNTY COMMISSIONER
Telephone
Email: ccwestpokot@gmail.com

County Commissioner's Office
West Pokot County,
P.O BOX 1-30600,
KAPENGURIA.

REF: OOP.CC.ADM.15/14 VOL.I/300

29TH JANUARY, 2020

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION
JOSEPH LOLEMTUM TIMU –ID NO 27486276

Reference is made to the Director General National Commission for Science/Technology & Innovation letter No. 715252 dated 20TH January, 2020 on the above subject.

This is to inform you that the above named persons have been duly authorized to carry out research on ***Impact of climate Change on Sustainable Pastoral Livehood of Pokot Community in West Pokot County, Kenya***

The purpose of this letter therefore, is to request you to accord him your cooperation, guidance and necessary assistance he may require during his tour of research

(APOLLO O. OKELLO)
COUNTY COMMISSIONER
WEST POKOT COUNTY

Copy to:

DIRECTOR OF EDUCATION
WEST POKOT COUNTY

Appendix VI: West Pokot County Authorization Letter

REPUBLIC OF KENYA
COUNTY GOVERNMENT OF WEST POKOT

WHEN REPLYING PLEASE QUOTE
EMAIL: OCS@westpokot.go.ke
WEBSITE: www.westpokot.go.ke

P.O BOX 222 - 30600
KAPENGURIA

OFFICE OF THE COUNTY SECRETARY.

6th February,2020

TO WHOM IT MAY CONCERN.

RE: AUTHORITY TO UNDERTAKE RESEARCH IN WEST POKOT

This is to notify you that the bearer of this letter, Mr. Joseph Lolemtum Timu has been granted permission to undertake research on the topic: **IMPACT OF CLIMATE CHANGE ON SUSTAINABLE PASTORAL LIVELIHOOD OF POKOT COMMUNITY IN WEST POKOT COUNTY, KENYA** as per National Commission for Science, Technology and Innovation Research Licence Ref. No. 715252 dated 20/1/2020 for the period ending 20/1/2021.

Any assistance granted him is highly appreciated.

AG. COUNTY SECRETARY
10 FEB 2020
P. O Box 222 30600,
KAPENGURIA
COUNTY GOVERNMENT OF WEST POKOT

MR. JOHN KARAMUNYA
Ag. COUNTY SECRETARY WEST POKOT COUNTY

Appendix: VII Ant-Plagiarism Report

Prof C.K.K. Gachene

01/12/2023

Turnitin Originality Report

- Processed on: 30-Nov-2023 06:51 EAT
- ID: 2241877232
- Word Count: 34969
- Submitted: 2

IMPACTS OF CLIMATE CHANGE ON SUSTAINABLE PASTORALIST LIVELIHOODS OF POKOT COMMUNITY IN WEST POKOT COUNTY, KENYA" By Joseph Lolemtum

Similarity Index

13%

Similarity by Source

Internet Sources: 10%

Publications: 4%

Student Papers: 5%

< 1% match (Internet from 02-Oct-2022)
https://nadre.ethernet.edu.et/record/667/files/journainclimet.pdf?download=1
< 1% match (student papers from 18-May-2023)

< 1% match (student papers from 16-May-2023)
Submitted to University of Namibia on 2023-05-16
< 1% match (Internet from 05-Oct-2022)
https://ijcrr.info/index.php/ijcrr/article/view/567
< 1% match (Internet from 08-Nov-2023)
https://smujo.id/aif/issue/download/198/46
< 1% match (Internet from 14-Dec-2018)
http://www.mmu.ac.tz/papers/research_3_2017.pdf
< 1% match (Internet from 31-Aug-2022)
https://mahb.stanford.edu/wp-content/uploads/2014/07/Climate-Impacts-on-Food-Security-and-Nutrition-2012.pdf
< 1% match (Internet from 08-Oct-2022) https://ncc-website-2.s3.amazonaws.com/documents/05.0-2022-P211-Climate-vulnerability.pdf

< 1% match (Internet from 30-Sep-2022)
http://www.greenbeltmovement.org/sites/greenbeltmovement.org/files/Detailed%20GBM_IKI_%20%20Approved%20%20MRV%20TORS_0_0.pdf
< 1% match (Christopher Simeon Awinia. "The Sociology of Intra-African Pastoralist Migration: The Case of Tanzania", Frontiers in Sociology, 2020)
Christopher Simeon Awinia. "The Sociology of Intra-African Pastoralist Migration: The Case of Tanzania", Frontiers in Sociology, 2020
< 1% match (Internet from 30-Oct-2023)