UNIVERSITY OF NAIROBI

AN ASSESSMENT OF THE EFFECTS OF CLIMATE VARIABILITY AND CHANGE ON SUSTAINABLE LIVELIHOODS IN TURKANA COUNTY, KENYA

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I54/12386/2018

A Research Dissertation Submitted for Examination in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Science in Climate Change of the University of Nairobi

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DECLARATION

I declare that this dissertation is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi requirements.

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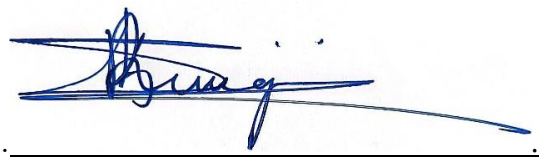

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DEDICATION

This dissertation is dedicated to my family especially my parents, siblings, nieces, nephews and Yussuf. Thank you for your prayers, support and patience.

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LIST OF ABBREVIATIONS

ASALs	Arid and Semi-Arid Lands
CH_4	Methane
CIDP	County Integrated Development Plan
CO_2	Carbon Dioxide
CDF	Constituency Development Fund
DJF	December January and February
EWS	Early Warning System
FAO	Food Agriculture Organization
FGD	Focused Group Discussion
GHG	Green House Gases
GOK	Government of Kenya
HSNP	Hunger Safety Net Program
IPCC	Intergovernmental Panel on Climate Change
JJA	June July and August
KFSSG	Kenya Food Security Steering Group
KI	Key Informant
MAM	March April May
N_2O	Nitrous Oxide

OND	October November December
RCP	Representative Concentration Pathway
SON	September October November
SSA	Sub Saharan Africa
TCG	Turkana County Government

ABSTRACT

Kenya's population significantly depends on climate-based livelihoods which have been negatively affected by adverse climate change effects, leaving most households vulnerable. This study assessed the effects of climate change and variability on sustainable livelihoods in Turkana County. This was done through examining rainfall temporal patterns, evaluating climate shocks on main livelihoods, coping mechanisms applied as well as for opportunities for sustainable livelihoods. Cross sectional research design with a mixed method approach was adopted for the study; where the data collected were both qualitative and quantitative. The study also utilized secondary data of rainfall which was analyzed through temporal trend analysis based on four seasons of December January February (DJF), March April May (MAM), June July August (JJA) and September October November (SON). Primary data from 382 questionnaires were analyzed to get views from households while qualitative data from nine key informant interviews and 12 focused group discussions helped to triangulate data from households. From trend analysis, historical rainfall data showed that MAM and SON seasons had an increasing trend while future rainfall data indicated a decreasing trend for MAM and an increasing trend for SON. Mild drought episodes were observed to occur after every three years with rainfall being erratic and no longer predictable. The study was able to establish that pastoralism, agro-pastoralism, casual labor, business and employment were the main sources of livelihoods. Food aid was the main coping mechanism while traditional coping mechanisms, like migration of livestock, were declining. Other coping mechanisms included borrowing of food, reducing nonfood expenses, and charcoal burning. The study recommended the need to enhance the existing climate information services, capacity building, livelihood diversification, and incorporation of climate-smart agriculture and pasture management well as encourage rural industrialization thus achieving livelihood sustainability.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Climate variability and change manifests through increased temperatures, warming of oceans, decrease in snow cover and erratic rainfall patterns ultimately, becoming a worldwide concern. Agriculture, water resources, health and tourism are some of the sectors that are being affected by climate variability and change. These manifestations continue to increase globally at an unusual rate. This is due to increasing human activities of burning fossil fuels like oil and gas. These fossil fuels have contributed to increased greenhouse gas emissions as well as aerosols making the world warmer(I.P.C.C., 2014). The concentration of greenhouse gases (GHGs) especially Carbon dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O), reached new highs in 2020 with an increase of 149%, 262% and 123% respectively, of pre-industrial levels(U.N.E.P., 2020).

Frequent occurrences of extreme climate events like drought, floods and heat waves; increased disease outbreaks, deforestation and degradation of the environment are some of the risks associated with climate change. These risks are being experienced by numerous systems such as ecosystems, economic and health systems. These systems are crucial for human survival (W.H.O., 2014; Magnan et al., 2021). Although climate variability and change are experienced globally, their impacts vary from one region to another within communities. The communities in the developing countries are the most vulnerable in the world. Low and middle countries rely on natural resources for livelihood like fishing, pastoralism, eco-tourism and rain-fed crop farming which are afflicted by climate variability and change(I.P.C.C., 2022).

Climate variability and change impacts are mostly felt in Africa, even though the continent's contribution to global greenhouse gases emission is minimal (C.D.P., 2020). The continent's past economic activities have not contributed to the global carbon pool, its present anthropogenic emissions are still negligible and future projections indicate that its input will be insignificant (U.N.,2006). However, the region is highly susceptible due to its high exposure to climate extremes and low adaptive capacity. According to projections, temperature increase in Africa will rise faster than the global temperature increase(I.P.C.C., 2022). Climate change impacts threaten to reverse the progress made towards economic growth, food security and poverty eradication. These impacts are felt more because climate variability and change intermingle with social development stressors such as high poverty rates, recurrent diseases and scarce information required for decision making (I.P.C.C., 2014). The Sub Saharan Africa (SSA) Region, is the least able to adapt due to insufficient economic, organizational and technical abilities (U.N.D.P., 2020). The region requires resources to adapt to in order to become resilient in climate change.

Overreliance on natural resource-based commodities like agriculture, mining, forestry and fishing have threatened the economies of countries in Sub Sahara Africa (OECD/FAO, 2020). Agriculture is one of the main economic activities in the continent, contributing 30% to 40% of the GDP in Sub-Saharan Africa (World Bank, 2013). Majority of those practicing agriculture are small-holder farmers who depend on rainfall for moisture and live in the rural areas. These farmers also depend on family resources such as labor for production (NEPAD,2013). The region contributes between 14% and 21% of global cropland and pastureland respectively (OECD/FAO, 2020).

Livestock rearing is one of the agricultural subsectors in developed and developing countries. The subsector contributes between 20% and 40% of total agricultural output respectively. More than 1.3 billion people depend on various livestock products' value chains for their livelihoods (FAO,

2018). Most African rural homes keep livestock as sources of quick income, food and nutrition. Livestock also play a role in crop production by providing draft power during cultivation and manure for soil fertility (Daum & Birner, 2020). In addition, the sector contributes to economic development through exports from the sector as well as meeting local demand for meat, eggs and dairy products (Chandio et al., 2016).

Herrero *et al*., (2013) observed that livestock production in developing countries occur in different forms. Mixed farming is practiced by those who do not have adequate land mainly due to overpopulation. Pastoralism on the other hand is practiced where there is low population and expansive land mass. In Africa, pastoralism is practiced in the dry lands of the Sahel and Eastern Africa Regions. Just like the rest of Africa, pastoralism in Kenya is practiced in the Arid and Semi-Arid Lands (ASAL) and contributes to 30% of Agricultural GDP (MoALFC, 2021). For centuries, pastoralism has been the most reliable livelihood option for majority of households who can make a living from scarce natural deposits (FAO, 2018). Numerous challenges have faced pastoralism. The main one being climate change and variability having several impacts on pastoralists and livestock (Siedenburg, 2021), such as increased livestock morbidity, insufficient water and forage plus increased distances in search of pasture.

Frequent drought and flood occurrences have forced rural households to depend on coping mechanisms, in order to survive food insecurity, which could be hostile to human welfare (IPCC, 2014). Coping mechanisms that have been applied are either food or non-food related in order to overcome looming food and economic crises (INGO, 2014). According to Gentle and Maraseni(2012), sale of property, changing food consumption patterns, dropping out of schools and searching for work are some of the most common coping mechanisms applied by the poor during extreme climate events. Most rural households in developing countries have limited coping

options because of depleting natural resources and assets. Past drought incidences have been disastrous to rural livelihoods in the Horn of Africa. There are reports that protracted drought episodes between 2008 and 2011 left a population 3.2 million in the ASALs in Kenya vulnerable to food and water insecurity. Furthermore, the drought led to a high livestock mortality of about 60 -70% (Huho & Kosonei, 2014). Effects of climate change have been observed to hamper livelihoods of the populations. These effects include declined crop and livestock produce, disease and pest outbreaks, diminishing forage, eventually leading to income losses. Communities have been required to survive with these effects thus they need to become enlightened on climate change adaptation strategies (Nzeadibe, 2011).

Rainfall variability in Kenya has increased, being erratic with uneven distribution in time and space. The long rains of March April May (MAM) have been observed to be decreasing in the Eastern Africa Region resulting in increased vulnerability due to prolonged drought periods (Wainwright, et al., 2019). At the same time above normal rainfall especially during the October November December (OND) short rains have become more frequent resulting to floods (GOK, 2018). Due to loss of lives and livelihoods, food insecurity as well as resource-based conflicts in the ASALs, floods and droughts in the past have been declared national disasters in the country.

Turkana County is the second largest and among the underdeveloped counties in Kenya (TCG , 2018). The county is one of the twenty-three ASAL counties in Kenya meaning, it receives low rainfall and experiences high temperatures (PRISE, 2016). Over time, communities in the ASALs have been applying long established mechanisms that enable them to deal with climate variability and its impacts. Nonetheless, it has been difficult to rely on traditional coping mechanisms due to population pressure, change in land use and increase poverty incidences. Significant efforts have been made by both government and non-government institutions to cushion vulnerable groups

against numerous challenges experienced such as access to food, water, health care and education. Some of these interventions have been successful due to community's dedication to adapt while other efforts were unsuccessful to make any significant change to the beneficiaries. In numerous cases, these interventions do not include all vulnerable individuals exposing them to higher risks of poverty (Nabulsi *et al*., 2020).

Moreover, the increase in the frequency of severe to extreme climate events makes the communities more vulnerable due to inadequate resources to enable them to bounce back to normalcy on time (TCG, 2020). In addition to frequent drought and flood episodes, the county has been vulnerable to emerging hazards especially desert locusts that led to diminishing livestock feed and crops in farms (FAO, 2020). Thus, this study sought to address how climate change and variability affect livelihoods. The study also finds out how livelihoods can be made sustainable in Turkana, as an ASAL county.

1.2 Statement of the Problem

Variations of rainfall and temperature over time are clear indicators of climate variability and change. Rainfall is the most observed climate indicator since most economies in rely on it (Jury, 2002) . Hence changes in rainfall patterns are highly likely to impact productivity on livelihoods since rain fed agriculture is the main economic activity. Households in the ASAL areas are most vulnerable to the impacts of climate variability and change.

Hydrological hazards like moisture stress, floods and droughts have become the norm thus affecting water availability which communities rely on to make a living (IPCC, 2022). These communities are forced to rely on coping mechanisms during extreme climate events. Coping mechanisms applied such as selling household items, borrowing food from neighbors or relatives and relying on government aid, are unsustainable in cushioning them against climate adversity. To avoid loss of lives and livelihoods, the government together with other institutions aid in giving

out humanitarian assistance to vulnerable households. Humanitarian assistance is usually short-term leaving households more at risk, in case of a disaster reoccurring thus disabling them to adapt to climate change.

Past studies on livelihoods, climate variability and change revealed that there was a gap in regards to the socio-economic consequences of changes in precipitation among vulnerable communities that still rely on traditional livelihoods (Opiyo et al., 2016;I.P.C.C., 2022a; Rojas-Downing et al., 2017). There were also insufficient studies that explored sustainable livelihoods in ASALs on a changing climate. Therefore, there is a need to explore how livelihoods can be made sustainable to ensure climate change resilience among households is achieved. This study tried to do this by asking households in Turkana to give their opinions on how livelihood can be made sustainable. It also looked at the current coping mechanisms applied during extreme climate events and how rainfall variability plays a role on livelihoods stability.

It is clear that livelihoods are linked to climate in ASAL areas prompting policy makers to express concerns on the probable effects of climate variability and change on rural livelihood systems. This study sought to show the cause-and-effect relationship between climate variability and change through rainfall variability and livelihoods in Turkana. It also sought to determine opportunities that would assist in attaining sustainable livelihoods in the county.

1.3 Research Questions

The main research question of the study was: What are the main effects of climate variability and change on sustainable livelihoods in Turkana County?

Specific Questions:

1. What are the temporal rainfall trends in Turkana County?

2. How have climate variability and change affected livelihoods in Turkana County?
3. What coping mechanisms are applied by households in Turkana County during extreme climate events?
4. Which opportunities are there to make ASAL livelihoods sustainable in Turkana County?

1.4 Objectives of the Study

The main objective of this study was to assess effects of climate variability and change on sustainable livelihoods in Turkana County.

Specific Objectives:

1. To examine temporal trends of rainfall for sustainable livelihoods in Turkana County
2. To evaluate effects of climate variability and change on main livelihoods of ASAL households in Turkana County
3. To document the coping mechanisms of ASAL households in Turkana County
4. To find out the available opportunities for sustainable livelihoods of ASALs in Turkana County

1.5 Justification of the Study

Turkana is disposed to frequent drought episodes leaving communities exposed to impacts high temperatures and low moisture. Climate projections show that in the coming years, there will be an upsurge of rainfall variability thus increasing severe and frequent climate extreme incidences in the region (IPCC, 2014). This prediction has forced different stakeholders into seeking sustainable and alternative solutions that will help maintain livelihoods as well as cope with the inevitable changes.

In the recent past, numerous development partners in the County have given assistance to households in terms of humanitarian help and adaptation of livelihood activities. Some of these

activities include support of irrigation along the main rivers in the county aiming to diversify livelihood and market linkages for agricultural products.

Numerous challenges are experienced by communities in Turkana County despite their efforts to manage their livelihood activities. These challenges include insufficient funding for development, low technical support to adapt to climate change, geographical marginalization and rainfall variability. Extreme climate events, related to rainfall have direct impact on livelihoods. This means that livelihoods become unstable due to erratic rainfall patterns, forcing communities to apply coping mechanisms in order to make ends meet. With the fluctuations of climate, it is prudent to ensure that livelihoods are sustainable thus cushioning community members against impacts of climate variability and change. Investigating how rainfall affects livelihoods together with household coping strategy in the study area will assist policy and decision makers to plan appropriately as well as ensure that there is adaptation to climate change by facilitating sustainable livelihoods.

1.6 Significance of the Study

The findings of this study highlighted how rainfall has changed over time and how the changes have affected the main livelihoods in Turkana County. The study aimed to contribute towards the realistic mitigation and adaptation approaches that will ensure household resilience against climate variability and change. Therefore, the study helps to achieve national, regional and global sustainable goals. Further, the findings of this study are instrumental in playing a part in achieving Kenya's Vision 2030 especially through social pillar which, emphasizes on improving the quality of life for all Kenyans via water resource management, harvesting and storage programmes; all of which are linked to rainfall.

The study will benefit Turkana County Government towards achieving the Ending Drought Emergencies strategy. The strategy was put in place at both national and regional levels to help build resilience towards drought. Pillars two, three and four of climate proofed infrastructure, human capital and sustainable livelihoods are connected to findings of this study.

This study's findings will also be useful for the Government of Kenya and Turkana County Government to achieve Sustainable Development Goals 1, 2, 6, 11, 13 and17 namely; no poverty, zero hunger, clean water and sanitation, sustainable communities, climate action as well as partnerships to achieve the goals respectively. In addition, the study adds value to the importance of community sensitization on climate change initiatives that is important in achieving sustainable livelihoods. Finally, findings of the study are useful in academia by building to knowledge that can be utilized for future research.

1.7 Limitations of the Study

This study sought to assess the effects of climate variability and change on sustainable livelihoods. It only focused on rainfall as a parameter of climate. Similar studies focusing on other climate parameters such as surface temperature and Lake Turkana levels should be conducted aiming on how they interact with livelihoods. Due to inadequate resources, the study only focused on one ASAL county and three sub counties. A comparable study can be done to link how climate change and variability affects sustainable livelihoods in non ASAL counties. This study only looked into the available opportunities to enable sustainable livelihoods but did not focus on the existing success climate change adaptation strategies that have enhanced sustainable livelihoods in ASALs.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature on the relationship between climate variability and change to livelihoods. It focuses on the main variables of the study specifically; climate variability and change, rainfall, coping mechanisms and sustainable livelihoods. Furthermore, the chapter highlights livelihood and conceptual frameworks as supporting models for this study.

2.1 Climate Variability and Change

Climate is the average state of atmosphere of an area and is determined by the local area's long-term mean of a minimum period of thirty years(I.P.C.C., 2014). Typically, climate is expressed in form of elements such as temperature, wind and precipitation. Climate variability is the fluctuation of climate elements differ from the average. Climate change on the other hand, is the state of the long-term average of climate that can be measured and observed through changes in the mean as well as variability of its properties. Changes observed can be prolonged due to natural and human activities (IPCC, 2022). Global climate has been undergoing observed significant change overtime due to natural processes like solar activities as well as anthropogenic activities like land use change and industrialization increasing emission of greenhouse gases (GHGs). These gases absorb and radiate more heat in the atmosphere hence shifting the global atmospheric temperatures (IPCC, 2014).

Global observation of upsurge in sea and surface temperature, shift in precipitation, sea level rising and high ocean acidity in addition to extreme climate events proofing that climate change exists (Grossman, 2018). Frequent climate extreme episodes continue to sabotage efforts made towards achieving development agendas (Nerini, *et al*., 2019).

Climate variability and change has affected Africa's economy through changes in ecology, human welfare and natural deposits (IPCC, 2014). Rural economies in the continent rely on climate since they contribute highly to national incomes (Araro, 2020). There is evidence of climate variability and change in Kenya; Mutimba and Wanyoike, (2013) reported that depending on the season and area, minimum and maximum temepreatures had risen by 0.7 to 2°C and 0.2 to 1.3 °C respectively. Rainfall in the country has been erratic resulting in prolonged droughts and severe floods. Declining rangelands, sea level rise, water scarcity and loss of species are among the impacts of a changing climate (IPCC, 2022; PRISE, 2016).

2.1.1 Rainfall Variability in ASALs

Extreme rainfall events result into hazards that eventually lead to disasters that have negative consequences to populations living in ASALs. There is a global shift from a reactive to proactive approach to cushion those vulnerable to climate variability and change in order to achieve livelihood sustainability (Yiridomoh, 2020). A proactive approach means that governments have invested in disaster risk reduction approaches that help build economic and community resilience Some of the mechanisms in place include household livelihood diversification, proactive planning in anticipation of disasters through hazard based early warning systems that enable setting up contingency funds, insurance and safety (IPCC, 2014).

Through agriculture, rainfall patterns are directly related to poverty eradication and food security efforts. Moisture requirements for crop production rely on availability of rainfall (Ngetich et al., 2014). Thus, understanding of climate variability and change indicators especially rainfall; can assist in developing socio-economic policies and plans that would assist to cushion rural households especially in sub-Saharan Africa where livelihoods are predominantly rainfall reliant. Seasonal climate forecasts provide an indication of how variable the rainfall might be compared

to past years and is therefore considered as information that could help to prepare for and adapt to climate variability(Goddard et al., 2001; O'Brien and Vogel, 2003).

There is a need to understand rainfall variability by evaluating its characteristics such as amounts, distribution, and number of wet and dry days (Ngetich et al., 2014). Studies on rainfall patterns in the region have mostly focused on annual averages, creating a gap on other seasonal rainfall characteristics (Barron, 2003). There have been challenges in analyzing rainfall in most parts of sub-Saharan Africa considering the main source of data is meteorological data which is scarce and sometimes unreliable (Kisaka, *et al*., 2015).

2.1.1.1 Rainfall Variability in Kenya

Kenya has an intricate climate as evidenced by its changing seasonality across the country. It has two main wet seasons with patterns of climate variability coupled with extremes. These extremes are caused by El Nino South Oscillation (ENSO) that result to El Niño and La Niña, which can bring extreme rainfall, flooding and droughts respectively (Ayugi et al., 2015). In addition, rainfall is influenced further by Inter Tropical Convergence Zone (ITCZ), jet streams, Indian Ocean Dipole (IOD) and Maden-Jullian Oscillation (Ogwang et al., 2014 ; Hogan et al., 2014)

Past studies indicate that there is evidence of spatial and temporal rainfall variability in the country (Mumo et al., 2019; Sagero et al., 2018). Most regions in the country experiaence bi modal rains while others especially Western Kenya experience tri modal rainfall seasons (Sagero et al., 2018). Studies have further demonstrated rainfall variability in the two main seasons of MAM and OND were evident in different counties. The MAM season had a decreasing trend while OND had an increasing trend (Opiyo et al., 2016; Ouma et al., 2018; Sagero et al., 2018). However annual rainfall is projected to increase in Eastern Africa region, where Kenya is located. Towards the end

of the century,short rains season of OND will continue to be wetter than the long seasons of MAM (I.P.C.C., 2022a) .

Majority of the ASALs in Kenya are located in Northern and South Eastern parts. Rainfall in the ASALs is low, inconsistent and highly variable in space and time. In arid areas, annual rainfalls range between 150 -550mm and 500-850mm in semi-arid areas (GOK, 2004). Compared to other areas, precipitation in terms of amount and intensity, is reducing in the ASALs. On the other hand above normal rainfall in the areas casued flash floods thus destroying property (Ongoma et al., 2016).

2.1.1.1 Droughts in Kenya

In over 40 years, extreme climate events have led to disruptive drought events affecting more people globally (FAO, 2017). In simple definition, drought is a natural hazard brought about by inadequate precipitation or moisture over a long period of time. The inadequacy can be due to high evaporation rates, inadequate rainfall distribution and human behavior during the time (NDMA, 2016). Literature indicates that there are four types of droughts. Meteorological drought is defined on the basis of degree of dryness, due to lack of rainfall (NDMA, 2016). It is experienced when there are above normal sunny days. Hydrological drought on the other hand is the dryness of water at surface and sub-surface levels. It is mostly experienced through low levels in river flows, ground water sources and stored water(Van Loon, 2015) . Agricultural drought is observed when moisture is inadequate in the root zone for crop and pasture growth leading to crop failure. Agriculture drought can be a result of climate change as well as land degradation (Wildemeersch et al., 2015). Socio economic drought deals with the impacts of the three aforementioned droughts on human beings and their economic systems. Frequent occurrence of meteorological, hydrological and agricultural drought can set conditions that will lead to negative social and economic impacts to people (Xianfeng, *et al*., 2016).

In Kenya, agricultural production has been vulnerable to drought associated with climate variability and change. From as early as 1928, the country has suffered from droughts leading to famine. The most severe droughts were experienced in 1983-1984, 1999-2000, 2004-2006, 2008-2009, 2015 and 2018 that resulted to loss of lives and livelihoods in addition to government's heavy spending in response to the droughts (Huho & Mugalavai, 2010; Huho & Musyimi, 2016; UNDP, 2005).The frequency of droughts leaves no time for communities to recover until the subsequent shock occurs. Leaving a large portion of households whose majoity are crop farmers and pastarolists unable to be economically self reliant. This results to majority of the population in the ASALs becoming vulnerable to food insecurity since agriculture is their main economic activity (UNDP, 2005).

In Turkana, drought is not a new phenomena to the locals. Drought episodes have been recorded in the study area since the 1952 all through to 2022 (N.D.M.A., 2016; Notenbaert et al., 2006). Drought frequency was observed to have increased from 10 to 2 years (Moso et al., 2016). Due to the current drought 15 - 40 % of the population are food insecure in the county. Sub counties that were most vulnerable to drought were: Turkana East, Turkana South And Turkana Central (KFSSG, 2022).

2.1.1.2 Floods in Kenya

According to IPCC (2012), floods are defined as the overflowing of the normal confines of a water body. Flash floods, river floods and coastline floods are the three main type of natural floods. Floods can also occur due to people manipulating flood plains, drainage basins and watersheds. According to the World Bank (2019), flooding is the most expensive natural disaster globally responsible for 62% of all economic losses from natural disasters from 1990 to 2014. Kenya experienced the negative effects of floods during the 1961-1962, 1997-1998 El Nino, 2003, 2008 and 2018 (Opere, 2013; UNDP, 2005;ACAPS, 2022). These events were associated with the

reversal of the Indian Ocean Dipole atmospheric circulation and temperatures (Hameed et al., 1999). Loss of lives and property, damage to infrastructure, displacement of people as well land degradation through soil erosion, siltation of dams was experienced. Kano plains in Kisumu, Budalangi in Busia and low areas of Tana River are the most susceptible areas to flooding (Opere, 2013).

ASALs like Turkana, Ijara and Samburu are occasionally affected by floods with heavy rainfall filling up river valleys resulting to flash floods. Flash floods occur after long dry spells when rainfall hits hard surfaces that have low infiltration (Kiptum, 2019; Huho and Musyimi, 2016). Loss and damage of property during floods in these areas are high. This is because land along river banks in ASALs are the most fertile land attracting farmers and pastoralists to cultivate and graze livestock within their vicinity.

2.2 Concept of Livelihoods

The word livelihood is described as the combination of social, physical and human resources plus activities that enable a person or family to earn income (Chambers & Conway, 1992). Interrelated numerous activities are undertaken in order to achieve livelihood security. This translates to a household able to provide basic needs. Furthermore, a livelihood system is attained when a household has more resources than the required needs. A system is considered efficient when inputs and resources are always available (Niehof & Price, 2001).

A livelihood system is attained when a household combines different livelihood activities. These activities can follow a systematic order, from planning, decision making and execution thus, forming livelihood mechanisms. Different systems such as the environmental, economic and socio-cultural are interlinked. Pastoralism, agro-pastoralism and fishing are some of the livelihoods practiced by the majority of the population in Turkana County with pastoralism as the

main one. All these are highly dependent on rainfall, thus making community highly vulnerable to rainfall variability.

Historically, nomadic pastoralism was being practiced by households in the county but with climate variability and change, this activity has been under pressure. Loss of livestock through droughts and floods has become more frequent with direct impacts to forage and water availability (TCG , 2018). Recurrent droughts and floods have also led to outbreak of livestock pests and diseases. These diseases usually lead to deterioration of livestock health and death in extreme cases (GOK, 2010).

2.2.1 Livelihoods Framework

The livelihoods framework is a tool illustrating relationships in livelihood systems that are used to guarantee livelihood security. It demonstrates how households make use of available resources in order to make a living. The tool also exhibits how development programmes as well as government policies may affect the available resources and activities besides showing how households relate to them (Majale, 2002).

Climate variability and change in this study is assumed to make the community vulnerable thus affecting different rural capitals. The framework is useful to indicate the connection between climate variability and livelihoods. Climate variability and change, shown through rainfall variability brings out livelihood vulnerability. Impacts of extreme rainfall conditions especially drought and floods, may be seen as the main shocks affecting livelihoods. Rainfall seasonality and trends also play a role in increasing vulnerability among rural households (Figure 2.1).

In order for households to be cushioned against shocks brought by climate extremes, there is need to have an effective livelihood system. This is an integrated approach that brings together inputs like household assets such as livestock, land, human and social resources. Combined with activities

such as farming and animal husbandry, outcome such as household income thus livelihood security is realized. Furthermore, livelihoods are supported by the government through set policies and regulations that assist households to practice and rely on their livelihoods at the same time protecting resources.

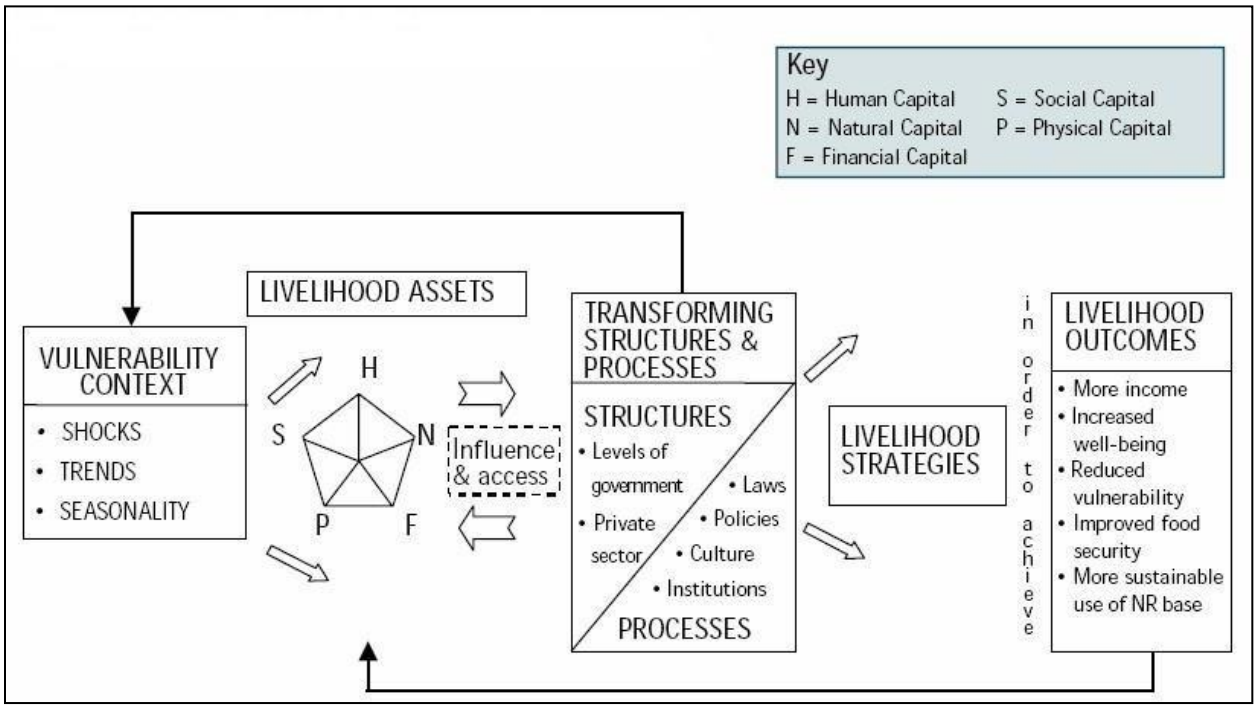

Figure 2. 1: Sustainable Livelihoods Framework (DFID 2001)

Rural assets are categorised into five distinct types. Human capital entails a person's attributes and skills in the process of production. This capital also comprises on human welfare for maximum output, helping households cushion themselves during extremes (Bollman, 1999). According to the Turkana County's annual development plan of 2015, literacy levels were low at 22.2 %. This can be attributed to an array of factors such as inadequate teaching staff, high poverty rates and traditional practices. Literacy levels are further affected by extreme climate events, especially drought (TCG, 2015).

Social capital is shaped by social networking which is key in achieving a community's agenda. Social networks can contribute to improved household income and welfare (Ahmad & Sadaqat, 2016). The theory on social capital denotes that social capital can lead to the development of human capital (Machalek & Martin, 2015). Social ties provide both financial and non-financial services to individuals. Kiboro, Wairire and Gakuru (2017) observed that social networks form as insurance that communities rely on in times of unseen danger. These links are more prominent when there is close to nonexistent institutional support. Traditionally, communities in Turkana have been governed by social institutions that ensured equitable utilization and distribution of resources. These institutions take various forms. The most common ones are family, age sets, kinship, neighborhood and stock associateship (Juma, 2015). However, a study conducted by Omolo and Mafongoya(2019) revelead that currently more women in Turkana belonged to social groups than men, thus social groups were declining.

Since livelihoods in Turkana County are dependent on natural resources conserving these resources is important. Resources like pastureland, livestock, farms, water sources and forests are vital in maintaining household livelihoods. Physical assets in terms of machinery and buildings are important, since they help to add value to natural resources as well as human capital. Financial capital is in the form of finances, enables a family to fund livelihood activities thus improving the economic position of a household (ILO, 2019), which are inadequate in the study area (TCG, 2015). The more assets a household has, the less vulnerable they are to shocks, seasonality and trends; making livelihood more secure. In most cases, an increase in one capital leads to an increase in the other capitals. In other instances, one capital will decrease while another increases.

2.3 Coping Mechanisms for Climate Variability Shocks in ASALs

Developing countries are considered to be the most vulnerable to effects of climate change and variability due to inadequate institutional capacity to cope. IPCC, (2012) has defined vulnerability

as the extent to which a system, institution or individual is at risk from climate change hazards. Vulnerability is determined by a number of concepts such as the system's sensitivity and exposure towards danger. It also encompasses the inadequate adaptive capacity as well as level to cope with climate change adversities (IPCC, 2022). It is argued that sensitivity and exposure towards hazards are inseparable making it a challenge for a system to cope when extreme shocks are repeated over time (Murphy et al., 2015; Smit & Wandel, 2006).

Underdeveloped nations at risk to climate change vulnerabilities due to limited and underutilised resources to handle situations. Climate change continues to wreak havoc with emerging hazards increasing vulnerability levels (Amsalu, 2011; IPCC, 2022). Indigenous knowledge is used by communities in the Africa to predict extreme climate events this helps them apply local knowledge to cope with the situation ahead such as migrating livestock to higher grounds during floods, reduce food consumption when anticipating drought to cope with an upcoming event (IPCC, 2022).

Nowadays, communities are unable to cope with solely relying on indigenous coping mechanisms as climate change events continue to intensify. Coping mechanisms are considered short term methods assisting communities to survive a climate extreme event. Households have managed to apply these mechanisms such as moving livestock to neighboring communities with better pasture during droughts, relocating to the hills during floods and selling of productive assets (Mutu, 2017).

In addition to traditional mechanisms, households in ASALs apply modern mechanisms such as financial measures like using of savings as well as borrowing money from financial and non-financial institutions, although this was at a small percentage (Shibia, 2020). Furthermore, government and non-state organizations have assisted the community through various short term initiatives that help cushion households against climate variability effects. Some of the most

common interventions are food aid, cash transfer, livestock offtake as well as livestock and crop insurance (Logiron et al., 2022; Shibia, 2020; Yodah et al., 2020).

2.4 Sustainable Livelihoods for Communities in ASALs

Livelihoods are considered sustainable when they can cushion households against stresses and shocks while still maintaining capacity and assets, not interfering with the natural resources (Sati et al., 2015) . The overall goal for sustainable livelihoods is to strengthen resilience of livelihoods in communities vulnerable to climate change and variability (GOK, 2015). To be considered to have attained sustainable livelihood, a household should be able to adequately access basic needs of life like food, shelter, clothing, education and healthcare while still making a living by taking advantage of available opportunities (Scoones, 1998). Inadequate access to basic needs can erode capacities of households, when the capacity is inadequate, they fail to acquire and maintain desired livelihoods.

IPCC (2014) report indicated that climate change will negatively impact poverty reduction efforts thereby increasing the poverty gap as well as food insecurity in Sub Saharan Africa. For climate change adaptation to work, mechanisms put in place should be environmentally and socially sustainable; reducing poverty and vulnerability. Sustainability is part of climate change adaptation to ensure that impacts are not only reduced but also do not compromise the future (Chikozho, 2010; I.P.C.C., 2022b).

In the ASALs, organizations have attempted to ensure that livelihoods are sustainable but challenges such as land tenure systems, lack of synergy among development actors and socio-cultural practices (PRISE, 2016). Since pastoralism is the main livelihood strategy in the areas, there is need to look at it in a holistic approach that will enable pastoralists to maintain their way of living. This is through empowerment of pastoralists for decision making through sensitization

on mobility policies as well as synergizing local and modern knowledge (Aberra & Abdulahi, 2015).

2.5 Relationship between Climate Variability and Change to Livelihoods in ASALs Communities

Research on climatic trends at various scopes has supported the extremes and impacts on humans and environment. Precipitation is one of the indicators scrutinized due its direct connection to lives. Uneven rainfall distribution results to negative impacts especially floods and droughts (Kisaka *et al*., 2015). History indicates that, unpredictable rainfall has led to catastrophes especially, moisture related disasters, corrosion and salinity intrusion (Matsumoto, 1988; IPCC, 2022).

With overreliance of climate dependent livelihoods together with low capacity to adapt, climate variability and change impacts are most likely to be felt by developing countries, thus translating to high poverty and vulnerability rates. Hence, climate variability and change are impediments in achieving rural sustainable livelihoods; where most households depend on subsistence production to make a living (Scoones, 2015).

Anthropological practices have had negative impacts to natural resource management. The situation is exacerbated by activities such as livestock overgrazing in rangelands, unregulated deforestation and absence of crop rotation in addition to over dependency on rainfall. These actions have resulted to land degradation, biodiversity change and reduced water retention. In addition, there has been more damage through floods and drought limiting available resources from cushioning communities in case of threats. Rural populations suffer most due to minimal access to amenities and knowledge besides relying on rainfall sensitive livelihoods. In order to reduce effects of climate variability and change, mitigation plus adaptation measures should take a holistic approach through effective environmental conservation and enhancement of human capital (Paavola, 2004).

Rural livelihoods are usually complicated with people relying on natural resource-based activities. The dominant livelihood activities in Turkana are pastoralism, ago- pastoralism, fisheries and employment (KFSSG, 2021). These activities have faced challenges in the last four decades. Climate variability and change are among the major challenges being experienced by the main livelihoods in the county; they are evidenced through extreme events especially droughts and floods (TCG, 2018). These extreme events weaken efforts made towards economic growth and poverty reduction resulting to loss of livelihoods (Horrero , *et al.*, 2010).

Frequent droughts and floods reduce productivity especially for farmers, pastoralists and fisher folk whose livelihoods are climate sensitive. According to Turkana County Government (2018) drought occurs every 1 to 3 years making it difficult for communities to bounce back to normalcy. When a drought occurs, it results to scarcity of resources needed for livelihoods to survive. Water, pasture and food become insufficient and usually lead to pressure of the available resources which can trigger resource-based conflicts among communities (Wato , 2016).

Although drought is the most common extreme climate event in Turkana, the county has also experienced flooding in the recent years; 2006, 2007, 2011 and 2018. Above normal rainfall experienced in most parts of the county result to flash floods (TCG, 2018). River floods along the main rivers of Turkwel, Kawalasee and Kerio, are also common in the county. Both types of floods bring about loss of property especially livestock and crops, loss of lives, disruption of activities, destruction of infrastructure as well as disease outbreak (NDMA, 2016).

Climate variability affects fish productivity through species availability and distribution as well as fish reproduction (Wabnitz, *et al.*, 2018). Climate change and variability also affects water levels thus influencing fish habitat (Gownaris, *et al.*, 2016) therefore affecting fisher folk through diminished fish production translating to low income. Moreover, an increase frequency of drought and flood episodes can prompt changes to the workforce (Gray et al., 2021). In Turkana, on farm

casual wage employment reduces during extreme cliamte events such as droughts (NDMA, 2022). Furthermore, sales of farm and livestock products reduce thus affecting income for both farmers and pastoralists.

2.6 Literature Gaps

A study done by Opiyo *et al*(2016) focuses on climate change and variability on vulnerability and adaptation among pastrolists in Turkana. However, the study did not give attention to sustainable livelihoods and household perception on the same. The study also uses historical rainfall data to analyse climate change and variability but did not obtain projected rainfall data for Turkana. The study further looks into coping mechanisms among the pastoralists but does not look into institutional assistance given to households. In addition to documenting the main livelihoods, this study enquired from respondents on how livelihoods can be made sustainable. Moreover, future rainfall under RCP 4.5 is analysed to give a picture of future rainfall patterns. Furthermore, this study looked into institutional assistance given to the community.

In their research on rainfall variability effects on pastoral pasture availability by Moso et al., (2016), the study area is only limited to Turkana Central. The study pinpoints on pastoral livelihood but does not look at other livelihoods , considering Lodwar, the biggest town in the County is located in Turkana Central. The area of focus in this study was Turkana Central, Turkana South and Loima Sub Counties. In addition to pastoralism, this study identified other livelihoods and how they are affected by rainfall variability.

A study conducted by Wato (2016), explores climate variability effects on livestock production together with coping strategies and their sustainability in Marsabit, one of the ASAL counties in Kenya. It does not look into livelihoods sustainablity . The study did not take into account projected rainfall patterns. This study however not only pointed out coping mechanisms in the

ASAL county of Turkana but also dag deeper into how how sustainable livelihoods can be achieved.

2.7 Conceptual Framework

A conceptual framework is a representation of the relationship between study variables. In this study, climate variability and change can be understood through rainfall variability for the past, present and future times. Based on I.P.C.C., 2022b; Moso et al., 2016 and Sagero et al., 2018, erratic rainfall has become frequent and thus affecting livelihood systems in Turkana County.

In order to survive, communities employ coping mechanisms, some of which are maladaptation practices that have negative impacts on climate. Climate variability and change, coping mechanisms, sustainable livelihoods plus livelihoods are interlinked. Climate variability and change affects how a household in Turkana will make a living as well as how they will cope in times of extreme climate events. At the same time climate variability and change affects how the community will make their livelihoods sustainable as shown in figure 2.2. On the other hand, some livelihood activities and coping mechanisms practiced by households continue to affect the climate. Sustainable livelihoods can ensure that there is a reduction of climate variability and change impacts through climate smart livelihood practices.

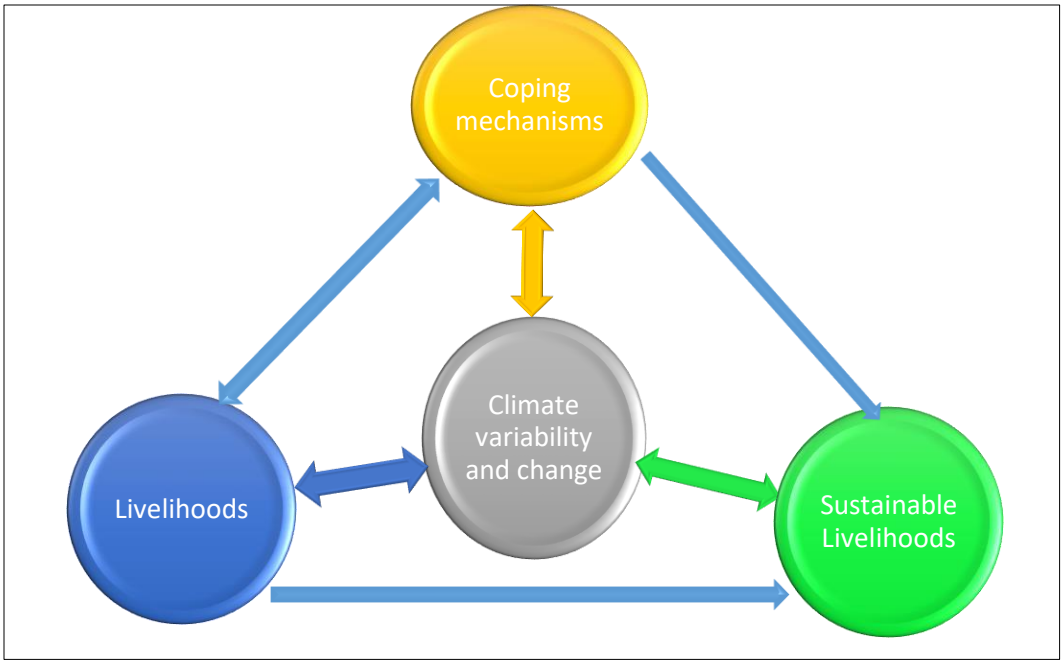

Figure 2.2: Conceptual Model (Source: Author)

CHAPTER THREE

DATA AND METHODS

3.1 Introduction

This chapter presents the study area and the systematic way that the study was carried out, guiding the process of obtaining the data suitable for the study. It explains the research design and addresses the study process of data collection and analysis.

3.1 Study Area

The study area was Turkana County which is located in the North West of Kenya. The county borders Ethiopia to the North East, South Sudan to the North West and Uganda to the west. It also borders Baringo County to the South, Marsabit County to the East, Samburu County to the South East and West Pokot County to the South West (KFSSG, 2020). The county covers an area of 71,597.6 km^2 thus 13.5% of the country's area.

Turkana is among 23 ASAL counties and is classified as an arid county. This means that 80 % of the area is arid. The county lies between Longitudes 34° 30'E and 36° 40'E and between Latitudes 10° 30'N and 50° 30'N. (TCG , 2018) with a total a population of 926,976 of which majority are males at 52% and females at 48% are (KNBS, 2019). Turkana is further subdivided into seven sub counties specifically: Turkana West, Turkana Central, Turkana North, Turkana South, Turkana East, Loima and Kibish.

Lake Turkana is one of the pre dominant topographical features in the county being the largest saline lake in the rift valley, in addition to being the largest permanent desert lake in the world. The main rivers in the county are Turkwel and Kerio (NDMA, 2016). According to the county's

CIDP (2018), the county is enriched with natural resources such as, oil resources, mineral deposits, natural tourist attractions and energy sources from hydro, wind and solar power. Regardless of these resources, 79.4% of Turkana's population lives below the poverty line, in contrast to 31.6 % of the country's average (TCG, 2018), thus making the county the poorest in Kenya.

Due to its aridity, temperatures in the county can be as high as 40°C. The county receives annual rainfall of 120-500mm per year. Nomadic pastoralism has been the main economic activity for most of the population. Pastoralism serves a dynamic purpose for the locals; livestock is a means of transport, form of insurance, a sign of wealth and prestige (Benhke & Muthami, 2011). However, climate change r has endangered pastoralism. Proof of recurrent droughts, disease outbreaks together with catastrophic floods and desert locust swarms, pure pastoralism has become risky (NDMA, 2016).

This study focused on Turkana Central, Loima and Turkana South sub counties (Figure 3.1). The sub counties have some of the county's main livelihoods and markets. Compared to other sub counties, the three sub counties are accessible in terms of road networks. At the same time, River Turkwell, one of the main rivers in the county passes through these sub counties on its way towards Lake Turkana. For this study, Turkana County was selected on account of its geographical location, historical socio-economic marginalization and proneness to climate hazards especially drought and floods.

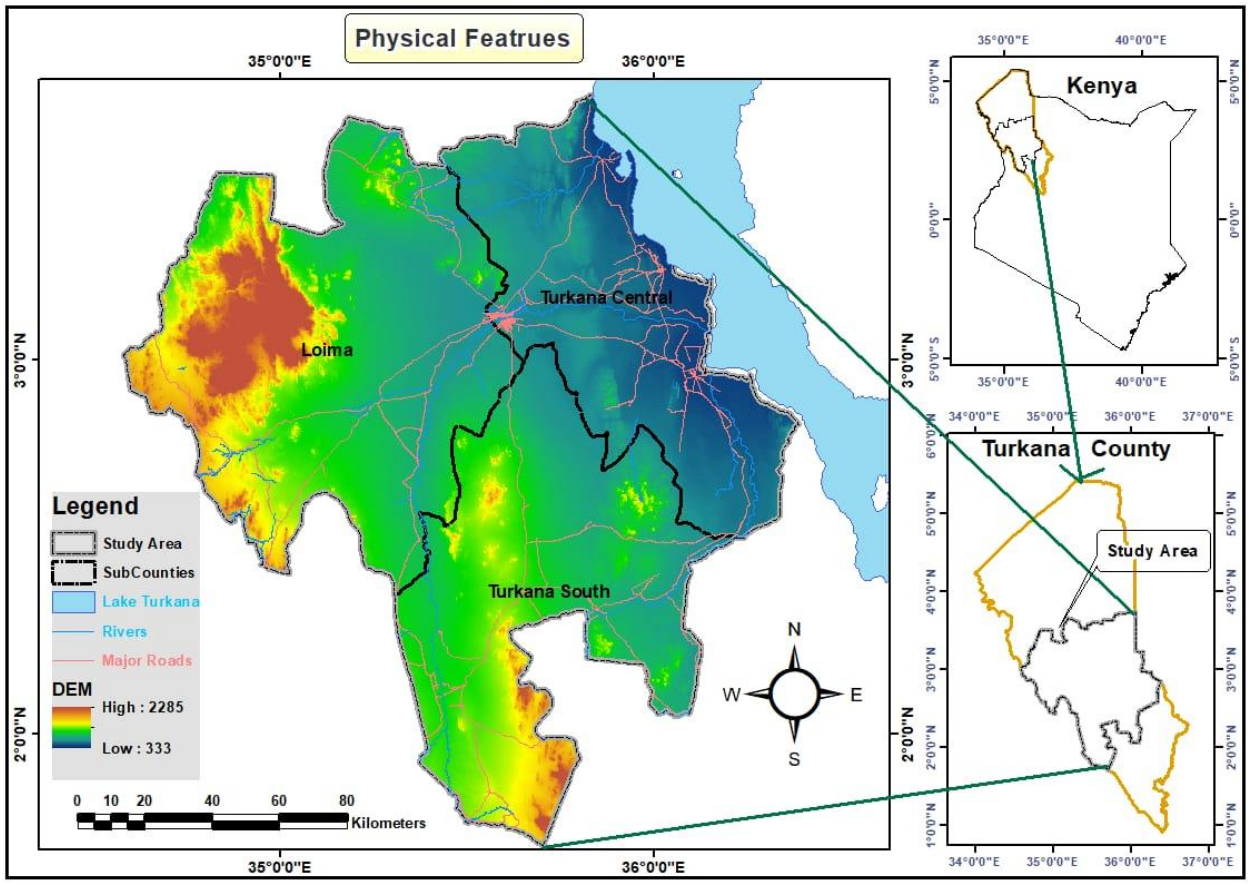

Figure 3. 1 Area of Study : Turkana County, Focusing on Turkana South, Turkana Central and Loima Sub Counties (Author)

3.2 Research Design

The study used a cross sectional research design since the study was population based and data was collected from different sources at one point in time (Setia, 2016). This design was useful in obtaining accurate and systematic data in order to achieve in-depth knowledge on livelihoods, coping mechanisms, livelihood sustainability and respondent's perspective on rainfall variability. Data collection methods utilized in this study were questionnaires, interviews and discussions (Degeling & Rock, 2020).

The study also followed a mixed method approach as it is often associated with studies that contain both qualitative and quantitative data (Aramo-Immonen, 2013). Quantitative data was collected during household survey where respondents had to answer close-ended questions on perception on

rainfall, livelihoods, coping mechanisms and livelihood sustainability. On the other hand, qualitative data was collected in focus group discussions (FGDs) and key informant interviews (KIIs) questions asked were broader seeking opinions of respondents on the same issues in the household survey hence corroborating data collected in the households.

3.3 Sampling Techniques

The study used a multilevel sampling technique; it applied more than one technique of sampling by dividing a large population into smaller groups. The three sub counties of Loima, Turkana South and Turkana Central Sub Counties were purposively selected to represent Turkana County. From literature, major livelihoods in Turkana County include: pastoralism, agro pastoralism, fishing and employment in were practiced in the selected study area (KFSSG, 2020). The three sub counties were also accessible in terms of road and communication due to their proximity to the county's major town of Lodwar.

The household sample size needed for the study area were analytically selected using Krejcie and Morgan formula of finite population as given in equation 1.

$$n=\frac{x^2NP(1-P)}{e^2(N-1)+x^2P(1-P)} \text{.....Equation 1}$$

Where: n is the sample size, χ^2 is the chi square value of 3.841 at 95% confidence level, e is the margin of error at 0.05, P is population proportion at 0.5 (0.5 is assumed to provide maximum sample size of a population) N is the population size.

The total number of households (81,337) was obtained from the 2019 Kenya population and housing census done by the Kenya National Bureau of Statistics (KNBS, 2019). Using the above formula, the sample size for the study was 382 households. Households participating in the study

were further selected using systematic random sampling, where households to be interviewed were chosen at regular intervals of three. Key informants were purposively selected based on their scope of work in climate change and livelihoods. FGDs participants were also purposively selected, determined by their age and gender.

3.4 Data

Two types of data were used in this study; primary and secondary data.

3.4.1 Primary Data

Household survey, key informant interviews and focused group discussions were used as tools for primary data collection. Information from households sampled was obtained through administration of a questionnaire (appendix 1). The questionnaire collected data on various issues related to livelihoods, coping mechanisms, sustainability, rainfall variability and climate variability. To avoid miscommunication, household data was collected with the assistance of local enumerators who interpreted the questionnaire to the local dialect of Ng'arturkana. Selected enumerators had undergone rigorous training on how to administer the questionnaire. This enabled them to further explain questions to the respondents who needed clarity.

Focus group discussions (FGDs) enabled researchers to corroborate data collected at household and key informant interview levels. Members of the focused group discussions were purposively selected to ensure that knowledgeable individuals discuss the subject. Selection of FGDs utilized convenience sampling to target ten individuals who represented four social groups in the village; elderly men (age 36 and above), young men (age 18 to 35), young women (age 18-35) and elderly women (age 36 and above). This was with the assistance of area chiefs and village elders. For ethical reasons, consent was first requested by interviewers to record the discussions, as shown in appendix 3. The study targeted twelve FGDs in the study area.

Participation of the FGDs was achieved through single gendered group discussions; male and female participants were interviewed separately. To get different perspectives, the gender groups were further divided into two with consideration of age groups. This resulted in the formation of four distinct groups in each sub county that comprised of old women, young women, old men and young men. Each group comprised of ten participants. FGDs gave community members a chance to interact and deliberate on issues related to rainfall variability, climate change and livelihoods.

Key informants (KIs) were drawn from stakeholder mapping. Prior to the interviews, stakeholders were identified by their scope of work in Turkana; those who were involved in climate change and livelihood projects in the county as well as area of operation. This study targeted participants from both government and non-governmental organizations. From an analysis of 25, nine informants from national (3 informants) and county (2 informants) governments as well as NGOs (4 informants) participated in the study. Prior to recording the interviews, interviewers first sought for consent from the informants (appendix 2). Qualitative data collected helped validate household survey and focused group discussion data.

3.4.2 Secondary Data

Monthly rainfall data used for this study was obtained from Kenya Meteorological Department for Lodwar station (latitude: 3.117, longitude: 035.617). This data was used to determine temporal characteristics of rainfall in Turkana County. Lodwar meteorological station was chosen for its availability of long-term rainfall data from 1981 to 2018 and its central location in the area of study.

Present and future rainfall for the periods of 2020s, 2050s and 2070s under representative concertation pathway (RCP) 4.5 was also utilised in the study. The RCP was selected for its representation of a stabilized scenario emission scenario; with countries working to limit emissions

with technology and execution of policies aligned to climate change (Said, *et al.*, 2019). Since this study integrated rainfall and livelihoods, RCP 4.5 was ideal since it is the only scenario that indicates the uses of land especially cropland and grassland (van Vuuren *et al.*, 2011). This is based on the valuation of carbon in natural vegetation being part of climate policy. The RCP 4.5 data for Lodwar meteorological station used was derived from CORDEX (Coordinated regional climate downscaling experiment) for the periods 2020s, 2050s and 2070s from the German Climate Computing Center (DKRZ, 2022).

3.5 Methods of Analysis

This section covers how primary and secondary data were analyzed to achieve the study's objectives. The methods of analysis applied included temporal trend analysis, descriptive statistics and content analysis.

3.5.1 Trend Analysis

To determine characteristics of temporal rainfall, the rainfall data from the Lodwar Meteorological station from 1981 to 2018 were analyzed for variability and trends. In addition to trend analysis, decadal mean for the annual precipitation was calculated for the four decades (1981-1990, 1991-2000, 2001-2010 and 2011-2018) to determine rainfall trends. Regression analysis (equation2) was used to find the relationship between rainfall amounts and time.

$$Y = a + bX \text{…….....Equation 2}$$

Where Y is the independent variable, in this case time, a is the intercept, b is the slope of the line and X is the dependent variable thus rainfall amount.

Trends of seasonal rainfall were examined using graphical methods. The method involved plotting a time series and fitting a trend line on seasonal rainfall data. This study looked into present and

future rainfall trends under Representative Concertation Pathway (RCP) 4.5 by analyzing data from the 2020s, 2050s and 2070s.

3.5.2 Variability Analysis

Variability was examined using the standardized anomaly index (SAI). This was computed as the ratio of the difference between the individual seasonal rainfall of a particular year and the long term mean of seasonal rainfall of the available record to the standard deviation of the long-term data available (Equation 3).

$$Z = \frac{x_i - \bar{x}}{s_x} \quad \text{..... Equation 3}$$

Where Z is the standardized anomaly index, x_i is the annual seasonal rainfall of a particular year, $\bar{x}$ is the long term mean of the available data, s_x is the standard deviation. Values of SAI categorizes seasons ranging from extremely dry to extremely wet (Sidhdharam *et al*, 2020) as shown in Table 3.1.

Table 3. 1: Categories of Standardized Anomaly Index in Describing the Level of Wetness or Dryness of a Particular Year or Season of an Area

SAI Value	Category
Z>2.0	Extremely wet
1.5<Z<1.99	Very wet
1.0<Z<1.49	Moderately wet
-0.99<Z<0.99	Near normal
-1.0<Z<-1.49	Moderately dry
-1.5<Z<-1.99	Severely dry
Z<-2.0	Extremely dry

3.5.3 Descriptive Statistics

To achieve specific objectives two, three and four, raw primary data were systematically organised to allow analysis through descriptive statistics. Descriptive statistics were most suitable for this study to summarize household data collected in a form of simple quantitative measures like

frequencies, percentages as well as measures of central tendencies like mean, median and mode (Keilyadan & Kulkarni, 2019). They can also be in form of visual representation like bar and line graphs as well as pie charts.

Data was presented through bar graphs and pie charts for non-continuous variables and use of means (equation 4), percentages and frequencies, such that data was presented graphically using charts and tables.

$$\bar{x} = \frac{\sum x_i}{n} \text{ …….. Equation 4}$$

Where $\bar{x}$ is the mean $\sum x_i$ is the sum of x, x_i is the sum of x, n is number of sampled data. Descriptive statistics were suitable in this study because they enabled the categorization of the respondents based on socioeconomic characteristics, livelihood activities and coping mechanisms using Statistical package for Social Sciences (SPSS) version 26 and MS Excel 2016.

3.5.4 Content Analysis

To achieve this study's specific objectives two, three and four content analysis was used to analyze qualitative data collected from responses of open-ended questions. These were mainly extracted from focused group discussions and key informant interviews. Recorded interviews from focused group discussions were first transcribed from Ng'arturkana to English. Key informant interviews were transcribed also to English from a mixture of Kiswahili and English. For easier analysis, responses were then coded to common themes of: climate variability and change, rainfall, livelihoods, coping mechanisms as well as sustainable livelihoods.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter the results of data analysis of each specific objective: temporal rainfall characteristics, communities' main livelihood activities, effects of rainfall on livelihoods as well as coping mechanisms and ways of making livelihood sustainable.

4.1 Socio Demographics of the Respondents

Three hundred and eighty-two respondents all representing their respective households were interviewed from Turkana Central, Turkana South and Loima Sub Counties. Two hundred and forty-four (64%) of the respondents were heads of their households, out of which, 55% were male and 45% were female as shown in figure 4.1. The rest of the respondents were either spouses or off springs of the household heads. Total male respondents were 155 (41%) while the rest were female at 227 (59%) making the sex ratio of male to female respondents 41:59. The disparity in the male to female respondent ratio was due to the fact that during the time of survey adult males in the household had migrated with livestock in search of forage and water. Traditionally, it is the duty of the male members of the family to migrate with livestock during extreme cases of drought.

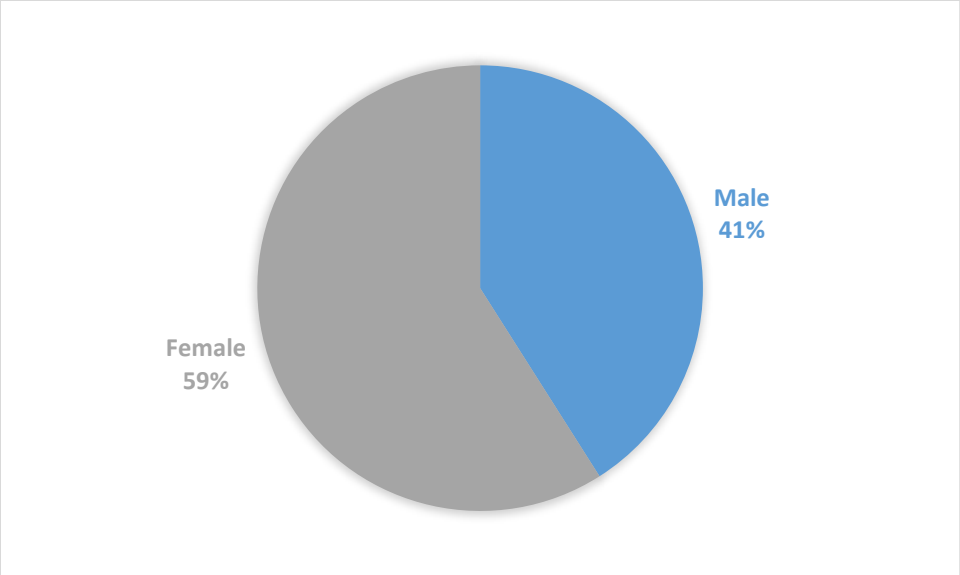

Figure 4.1: Household Respondents' Gender in Turkana County

Figure 4.2 shows that the age of the majority, (35%) of the respondents ranged between 41 and 50 years, those who were 30 years and below were 28.5% while 26.4 % were between 31 and 40 years. Those between 51 and 60 years made up 7.6% while those above 61 years were 2.4%.

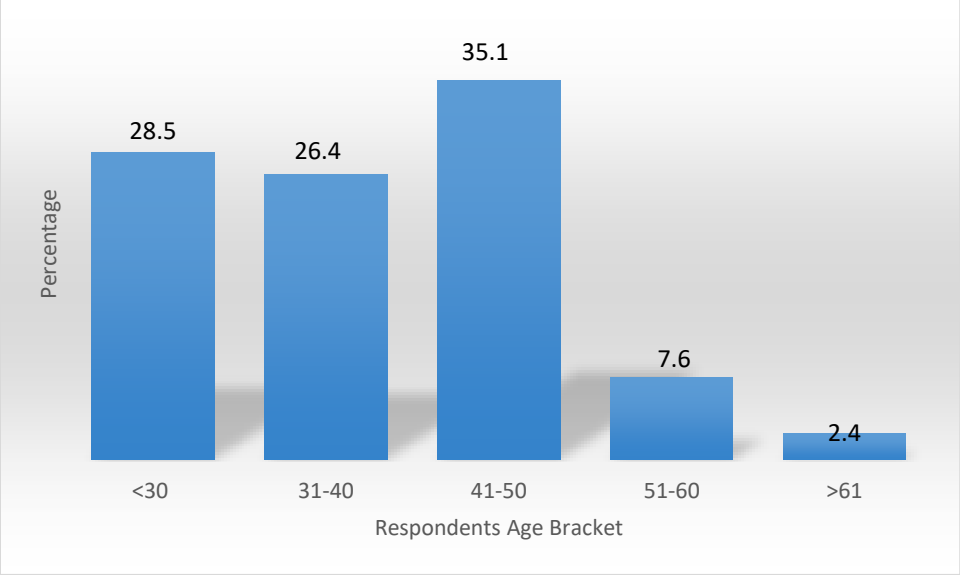

Figure 4.2: Household Respondnets's Age Bracket in Turkana County

Regarding residency, most respondents (42%) had lived in the area for less than 20 years, 37 % had lived in the area for between 21 and 30 years, 13% had lived in the area for between 31 and 40 years, while the remaining 9% had lived in the area for more than 41 years. This is shown in figure 4.3.

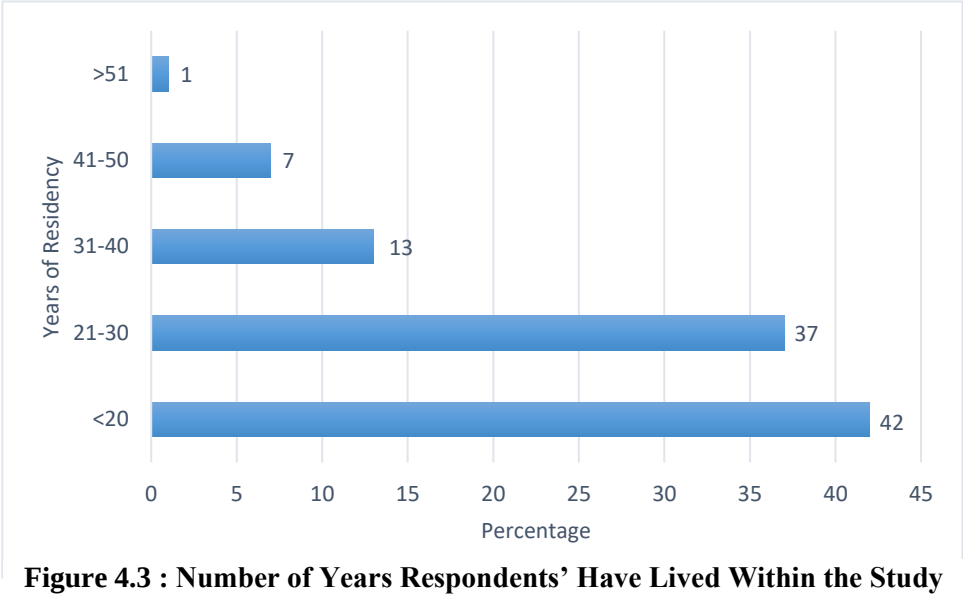

Figure 4.3 : Number of Years Respondents' Have Lived Within the Study Area

Most respondents had no formal education background (35%) while 18 % had tertiary level of education. Respondents with primary and secondary school level of education were at 19% while those with adult education were at 8%, as shown in table 4.1. Majority of female respondents had no formal education compare to male respondents.

Table 4.1: Household Respondents' Highest Level of Education per Gender in Turkana County

	Primary	Secondary	Tertiary	Adult Education	No formal Education
Male	7%	9%	9%	3%	12%
Female	12%	10%	9%	5%	23%
Total	**19%**	**19%**	**18%**	**8%**	**35%**

From the figure 4.4, majority of the households interviewed (48%) depended on pastoralism as their main source of income. Households' other main sources of income were: agro pastoralism (13%), salary (13 %), casual labour (10%), business (10 %) and fishing (6%).

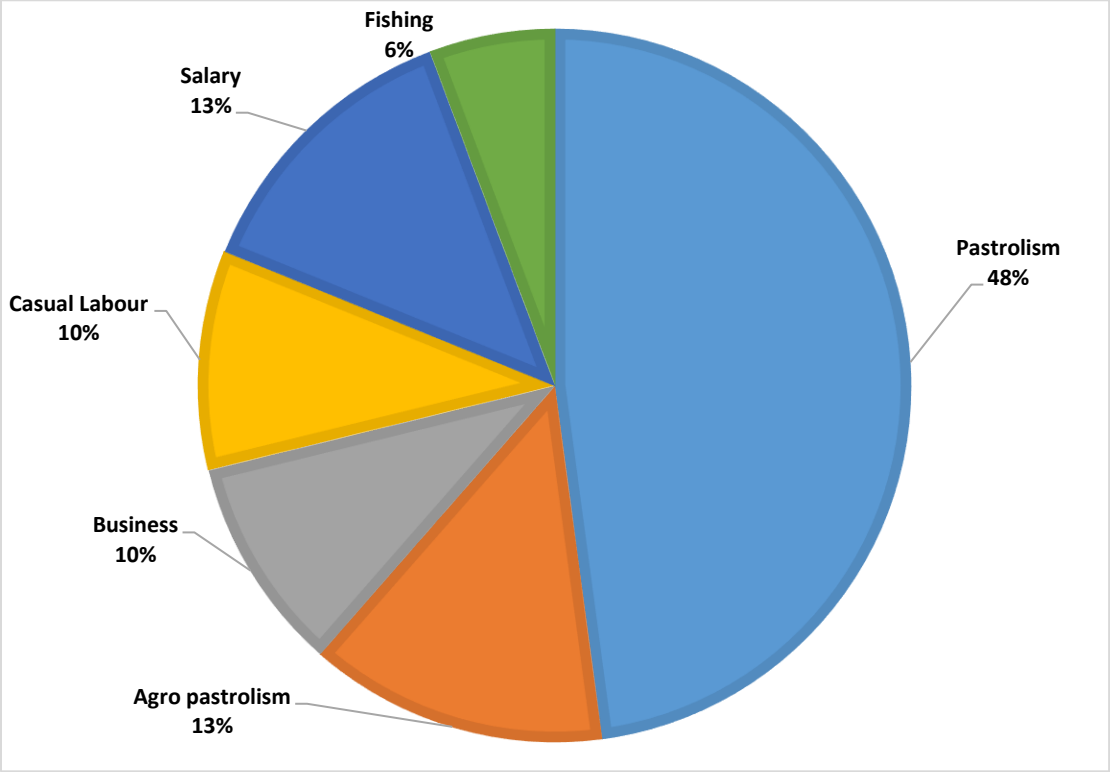

Figure 4. 4: Households' Main Livelihood Sources in Turkana County

Most of the Household monthly income ranged between Kshs 1001 to 5000 at 38 % while 21% of the household income ranged between Kshs 5001 to Kshs 10000 (Figure 4.9.). Other households'

monthly income were below Kshs 1000 (17%), above Kshs 30,000 (12%), between Kshs 10001 to 20000 (10%) and Kshs 20,001 to 30,000 (2%)as indicated in Figure 4.5.

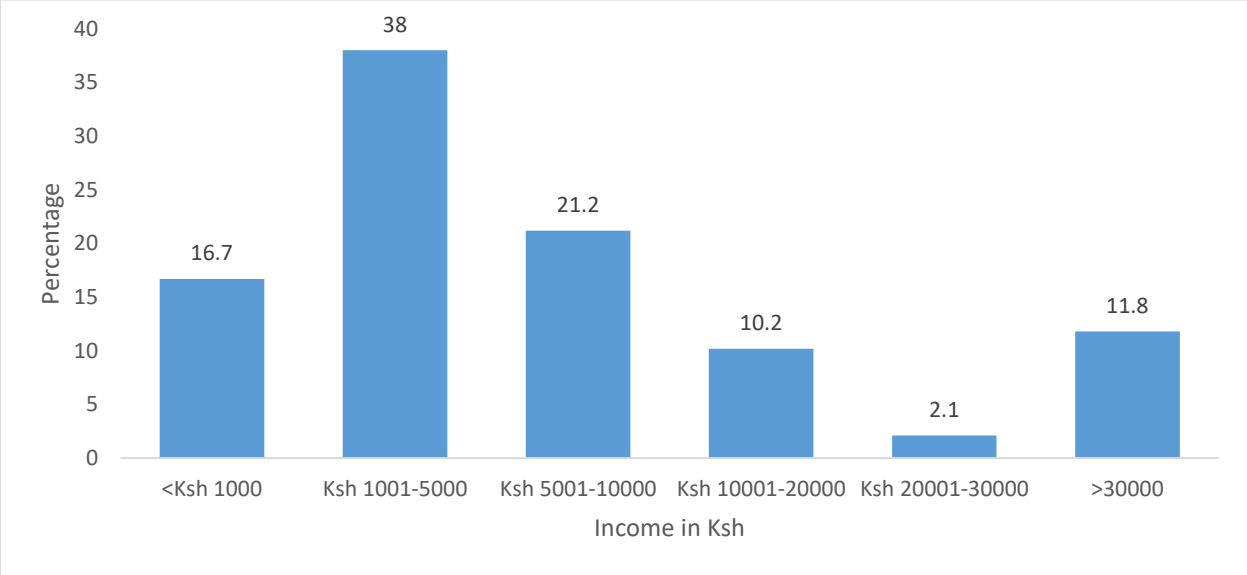

Figure 4. 5: Estimated Household Monthly Income for Turkana County

4.2 Temporal Characteristics of Rainfall in Turkana County

This section discusses the findings from rainfall data as well household perception on rainfall in the study area.

4.2.1 Temporal Trends Analysis of Rainfall

Figure 4.6 shows a time series of annual rainfall data. The mean annual rainfall over the 37 years was 210.9mm. From the figure, the highest annual amounts were experienced in 1982 (655.1mm), followed by 1988 (393.7mm) and 2012 (399mm). These findings tally with El Nino years of 1982 and 1988 that have been associated with high rainfall in Kenya. On the other hand, lowest rainfall amounts were recorded in the years 1984 (54.2mm), followed by 1992 (68.4mm) and 1995 (74.1mm), corresponding to La Nina related drought years of 1984, 1990 to 1992 and 1995.

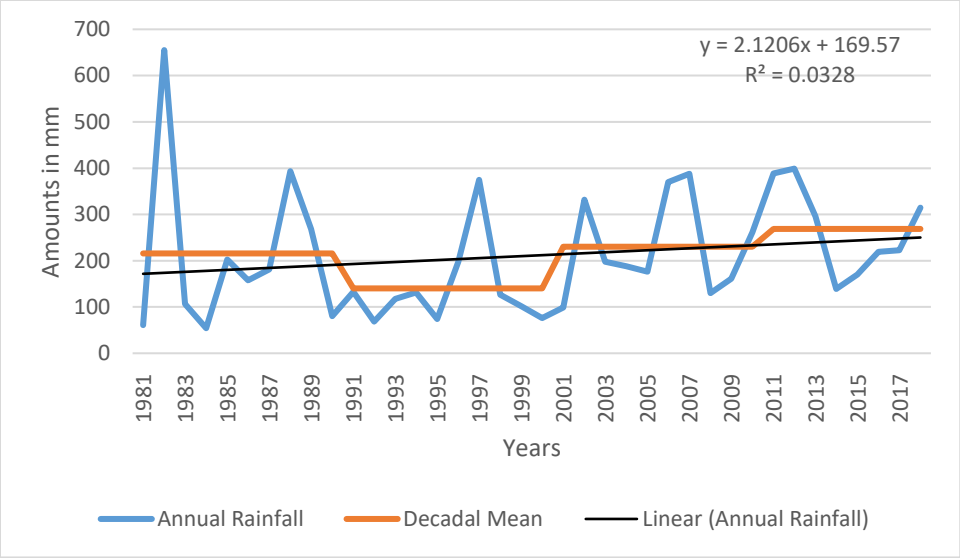

Figure 4.6: Time Series of Annual Rainfall for Turkana County from 1981 -2018 Showing an Increasing Trend and Decadal Rainfall Variability

To investigate for signals of climate change, data was averaged in four decades of 1981-1990, 1991-2000, 2001-2010 and 2011-2018. From the analysis, the decadal means was seen to decrease by 75.9mm from first to second decade, increase by 90.1mm from second to third decade, and a further increase of 38.4 mm from the third to fourth decade as shown in Table 4.2. This was a clear signal of climate change in the study area.

Table 4.2: Decadal Mean Difference Observed Rainfall Amounts Between 1981 to 2018

Decade	Decadal Mean (mm)	Decadal Mean Difference (mm)
1981-1990	216.1	
1991-2000	140.2	-75.9
2001-2010	230.3	90.1
2010-2018	268.7	38.4

Rainfall data was further analyzed along the four traditional seasons with the results shown in Figure 4.7. The results show that different seasons exhibited different trends during the period of study. The two rain seasons of March-April-May (MAM) and September-October-November

(SON) indicated an increasing trend as shown in Figures 4.7a and 4.7b respectively. The highest amounts recorded were 275 mm in 2002 and 282.5 mm in 2011 for MAM and SON seasons respectively. The lowest amounts on the other hand were recorded in 2000 at 9.5 mm and 0mm in 2003 during the same seasons. From the regression analysis conducted, to show relationship between time and rainfall amounts, results showed that rainfall increased over the years during the MAM season while there was no relationship between rainfall over the years during SON. The two seasons had a *p-value* of 0.02 and 0.29 respectively as indicated in table 4.3.

The drier seasons of December-January-February (DJF) and June-July-August (JJA) showed decreasing trends as shown in Figures 4.7c and 4.7d respectively. The highest amount of rainfall recorded during DJF were 174.6mm in 2009 while the years 1996, 1998 and 2010 recorded rainfall amounts of 0mm. For JJA, the highest rainfall of 406.2 mm was experienced in 1982, on the other hand, the years of 1990, 20028 and 2009 recorded 0 mm rainfall amounts. Regression analysis conducted from table 4.3, showed that DJF had a *p-value* of 0.03 while JJA had a *p-value* 0.01. This meant that the seasons got drier as the years passed.

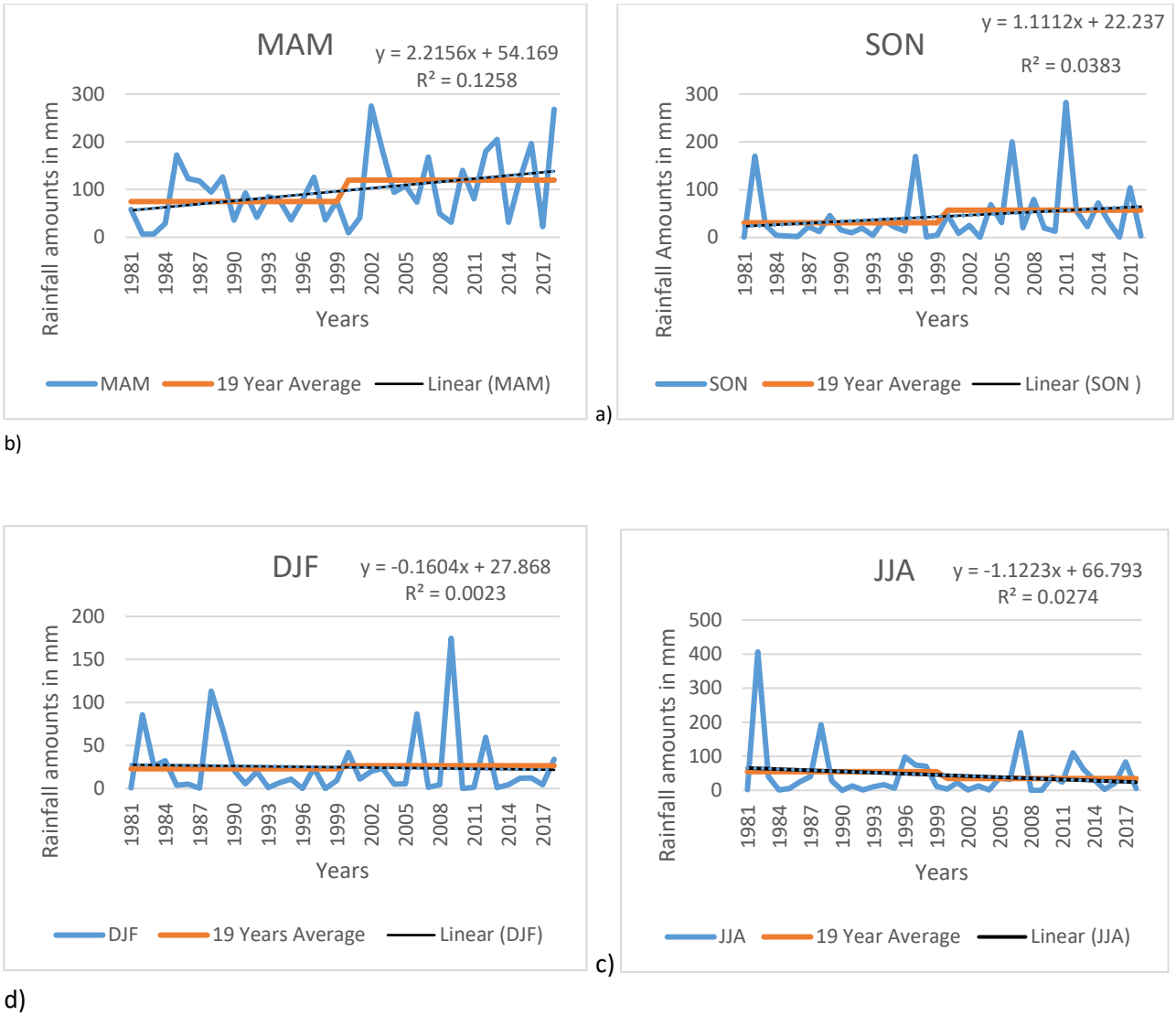

Figure 4.7:Seasonal Rainfall Timeseries Showing Trends Over the Period of Study

Table 4. 3: Regression Results between Rainfall Amounts and Years

SON								
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	22.23697	20.75163	1.071577	0.29	-19.8493	64.32323	-19.8493	64.32323
Years	1.111208	0.927577	1.197968	0.238757	-0.77001	2.992422	-0.77001	2.992422
MAM								
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	54.16856	21.77448	2.487709	0.02	10.00788	98.32925	10.00788	98.32925
Years	2.215647	0.973298	2.276433	0.028868	0.241708	4.189586	0.241708	4.189586
DJF								
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	27.8677	12.47366	2.234124	0.03	2.569942	53.16545	2.569942	53.16545
Years	-0.16041	0.55756	-0.2877	0.775229	-1.29119	0.970377	-1.29119	0.970377
JJA								
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	66.79275	24.92787	2.67944	0.01	16.23668	117.3488	16.23668	117.3488
Years	-1.1223	1.114251	-1.00722	0.32055	-3.38211	1.137506	-3.38211	1.137506

From these results in figure 4.7 an increasing trend in rainfall was observed in the two rainy seasons of MAM and SON, during the study period of 1981 to 2018. MAM season had a higher magnitude of increase at 2.21mm annually compared to SON at 1.11mm. On the contrary, rainfall had a decreasing trend in the drier seasons of DJF and JJA with a low magnitude of -0.16mm and -1.12mm per year. Therefore, the wet seasons were getting wetter, similar to the results of a study done by Moso *et al.*, (2016) while the dry seasons were getting drier. This implies that there is need to invest in climate proofed water infrastructure that will be able to harvest enough water during dry seasons.

Average rainfall were lower in the first 19 years (1981-1999) compared to the next 19 years (2000-2018). During the first 19 years, average rainfall for the seasons of DJF, MAM and SON were

23mm, 75 mm and 31 mm. Subsequently, average rainfall for the same seasons in the next 19-year period were 27mm, 120 mm and 57mm respectively. On the other hand, JJA showed a decrease in average rainfall amounts from 55 mm in 1981 -1999 to 35mm in 2000-2018, as shown in Figure 4.7. There was change in mean from the first 19 years to the next in the two main rainfall seasons of MAM and SON showing that two seasons were getting wetter. Nevertheless, the drier season of DJF had also become wetter, yet it is considered a dry period. JJA was the only season with decrease in rainfall amounts showing that the season was getting drier, translating to less water availability.

In order for water to be available for both livelihood and domestic needs during dry spells, there would be a need to set up water conservation structures that can cushion communities against water scarcity. These structures should be climate proofed, to serve households across seasons.

4.2.2 Rainfall Variability in Turkana County

Rainfall data was subjected to standardized annual anomaly (SAA) to evaluate rainfall variability (Figure 4.8). Out of the 37 years, it was observed that 14 years had experienced near normal to extremely wet rainfall conditions (SAI 0.06 to 3.41 respectively) while 23 years experienced near normal (SAI of -0.06) to moderately dry conditions (SAI -1.2). This is an indication that the county was mostly dry over the study period. Prolonged dry period was experienced between 1990 and 1996 compared to other dry periods. The wettest year was 1982 with SAI of 3.4 (extremely wet) while the driest year was 1984 SAI of-1.2 (Moderately dry). In concurrence to this study, Ghebrezgabher, Yang, and Yang,(2016); Ondiko and Karanja, (2021) observed that Kenya experienced severe drought in 1984 owing to La Nina , this was after the 1982 El Nino . The UNDP (2005), further narrowed down that north western Kenya was among the most affected regions.

From Figure 4.8, up to the year 2001, the driest conditions were experienced 5 years consecutively, an indication of prolonged drought. However, drier conditions were shorter from the year 2003, with the study period experiencing near normal rainfall (SAI values -0.99<Z<0.99). Implying that flood incidences had increased while drought frequency had decreased. From Figure 4.8, it was observed that rainfall varied from near normal to moderately wet conditions in 2010 to 2013. Despite the increase in flood frequency, from the year 2002, there were years after that the county received below normal rainfall. These years included 2003 to 2005, 2008 and 2009, 2014 and 2015, were consecutively dry. This implied that households might have applied coping mechanisms for a longer period of time during these years. The Kenya Food Security Steering Group reported that communities withdrew children from schools and borrowed or purchased food on credit in 2014 (KFSSG , 2015)

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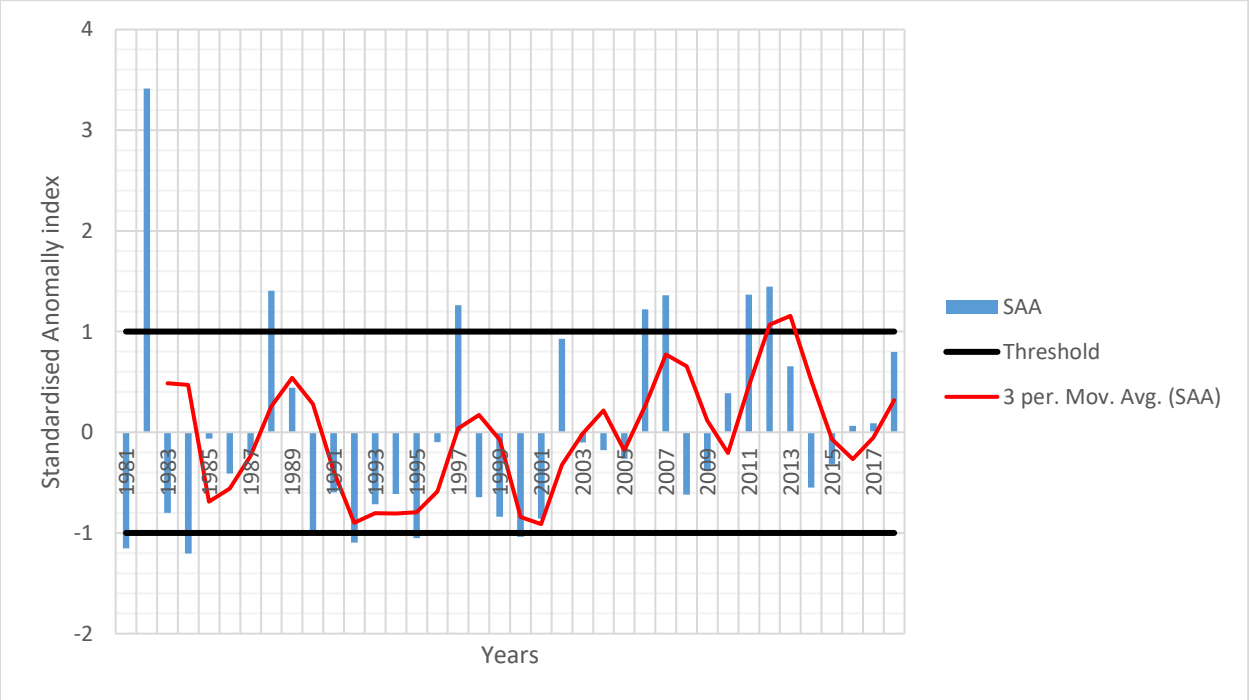

Figure 4.8: Lodwar Rainfall Standardized Annual Anomaly (1981-2018)

4.2.3 Household Perception on Rainfall Variability in Turkana County

Figure 4.9 shows that 53% of the respondents agreed that rainfall had become more unpredictable while 19% observed both unpredictability of rainfall as well as prolonged and frequent drought episodes. A mere 14% of the respondents only observed that drought episodes have become longer and more frequent. Another 14% were not sure if they had observed any changes.

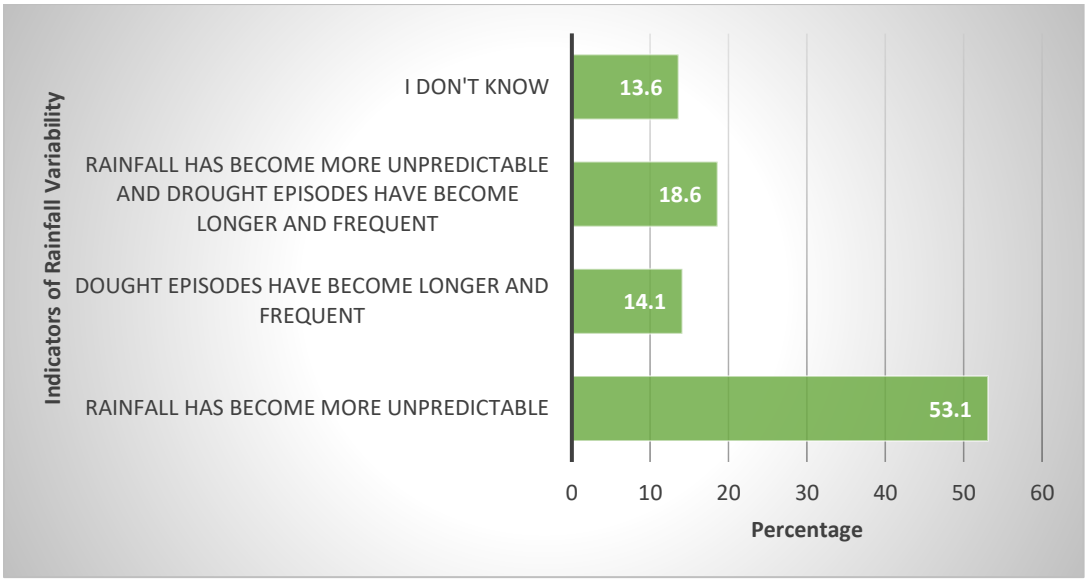

Figure 4.9: Household Perceptions on Rainfall Predictability in Turkana County

When probed further on how rainfall had become unpredictable, majority (67%) observed that there was a decrease in rainfall days, 13% observed that rainfall onset was late, 4% observed an increase in rainfall days while 2% observed that rainfall onset was earlier than usual. Others at (14%) did not know in what aspects rainfall had become unpredictable (Figure 4.10).

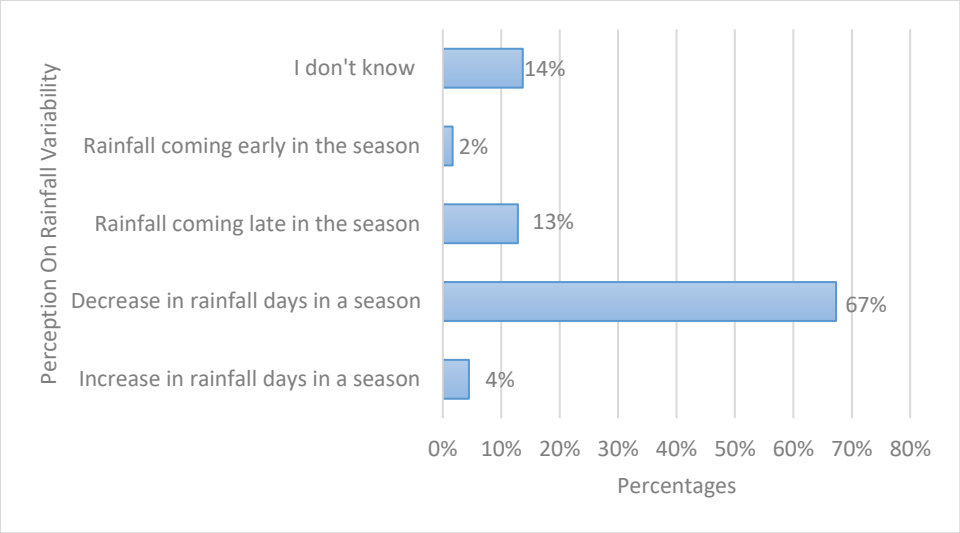

Figure 4.10: Households' Perceptions on Rainfall Variability in Turkana County

An observation of unpredictable rainfall and decrease in rainfall days as shown in Figures 4.9 and 4.10 clearly indicates that there was rainfall variability in the study area. This means that temporal rainfall distribution was poor, thus leading to prolonged episodes of droughts and severe floods, once it rains. With rainfall coming late into the season, as experienced by 13% of the respondents, meant that there was change on the onset of rains thus further prolonging dry seasons causing water stress to the available operational water points for serving a large population.

In addition to respondents from household survey observations, that rainfall had become unpredictable, the participants in the focused group discussions confirmed that rainfall variability brought about negative impacts of drought, floods, desert locust and strong winds.

Rain was inadequate with fewer rainy days. "*We used to have regular seasons: dry season, rainy season, season with light showers, and season when grass grows. These days it is different. Seasons are unpredictable*," elderly male community members, Turkana Central. "*Since around 1998, rainfall patterns have drastically changed. February and March of every year marked the onset of the rainy season and which would extend to June. Since then, nowadays there is no guarantee on the onset of rain because the rainfall pattern has become unpredictable*," elderly

male community members, Loima. From these perceptions, it is clear that households had to cope longer with frequent, intense drought and flood episodes. Past literature support perceptions from the FGDs that former Turkana District was among the most hit areas during the 1999-2001 drought as reported by Aklilu and Wekesa (2002). This implied that Turkana was among the areas that received response interventions such as livestock slaughter offtake and food assistance that supported households against adverse effects of drought. Households also applied their own coping methods such as out migration of livestock from their usual pasture fields within the county to Uganda and assisting each other with food or money.

4.2.4 Future Rainfall Projections for Turkana County

Figure 4.11 shows the results of future rainfall trends in the 2020s, 2050s and 2070s periods under RCP 4.5. The results show that the future rainfall in Turkana will have a decreasing trend for MAM (Figure 4.11a), an increasing trend in the SON season (Figure 4.11b). The drier season of DJF and JJA will have little to no change, since the trend line is straight throughout the periods as indicated in Figure 4.11c. The JJA season on the other hand will be drier as indicated by the trend line in Figure 4.11d.

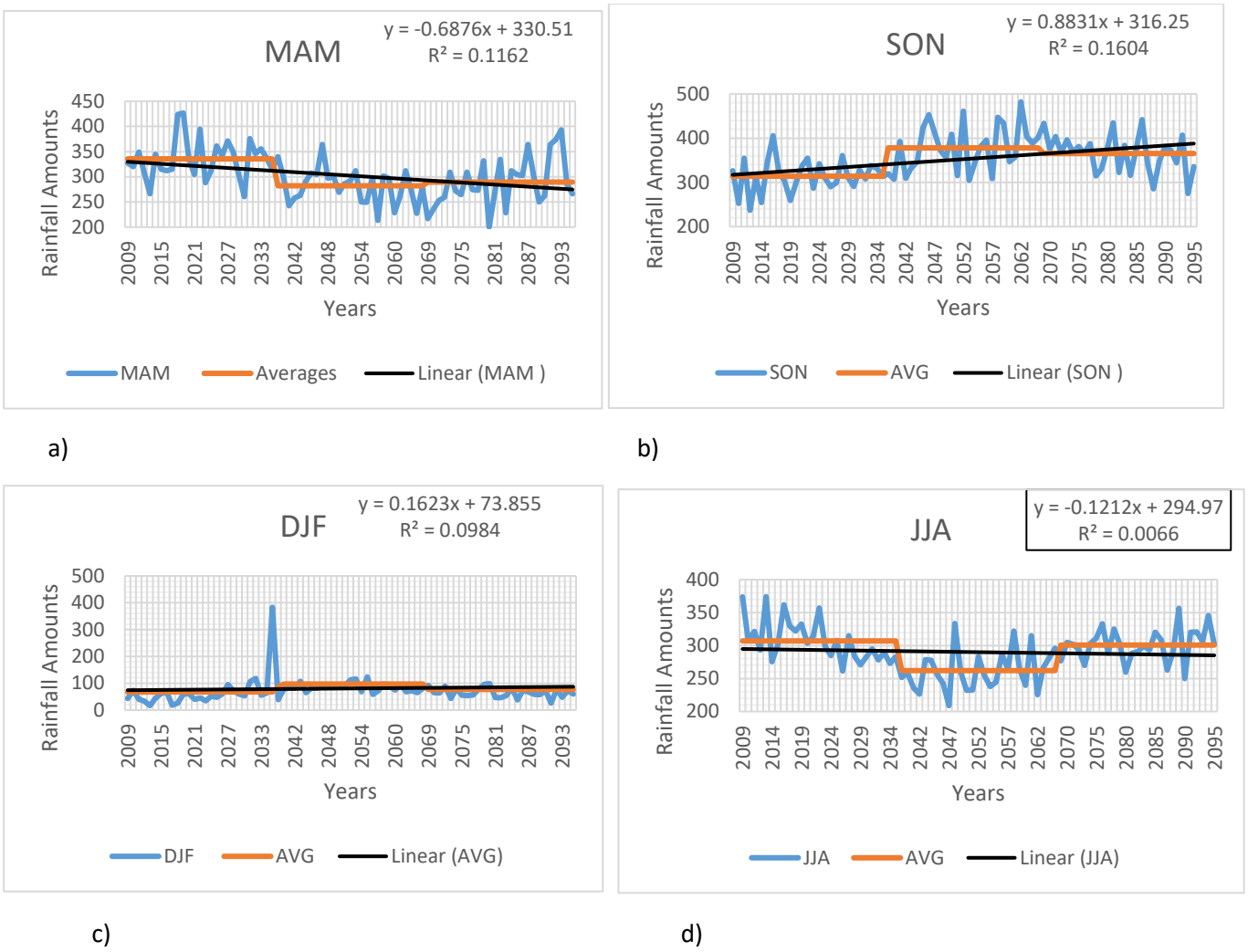

Figure 4. 11: Future Seasonal Rainfall Projections in Turkana County

Climate change through rainfall variability continues to be present with future rainfall showing SON being the only season with an increasing trend. MAM, which is currently the most reliable season will have a decreasing trend especially in the period 2050s. Findings from the analysis corroborate with NEMA (2015) specifically that rainfall in the 2060s would increase especially during short rains of SON. To further support the findings of this study, Liebamann *et al*., (2014) reported that warming of the Western Indian Ocean, a temporary phenomenon, would be the most probable cause of increase of rainfall during SON. On the other hand, Yang, Seager, Cane, and

Lyon, (2015) observed that natural decadal variability in East Africa would be the main reason for decrease in MAM rainfall as shown in figure 4.11a.

Further to establishing that rainfall will decrease in Northwestern Kenya, (Mumo et al., 2019) reported that there will be a higher increase in rainfall in the 2050s than in the 2070s as also observed by the results in Figure 4.11b. Figure 4.11a shows that prolonged dry season will be experienced starting in the 2050s with decrease in rainfall during MAM and continues on to JJA (Figure 4.11d) with average rainfall of 282mm and 262mm respectively; affecting water availability for the study periods. Compared to past rainfall amounts represented by figure 4.7, future average rainfall amounts for the periods 2020s, 2050s and 2070s will increase as shown in table 4.4. From the table, only DJF will be the driest season across the periods. Additionally, figure 4.11 c indicates that DJF will have above normal rainfall of 383mm in the year 2035 showing high chances of flooding within the study area, since rainfall will not be anticipated.

Table 4. 4:A Comparison of Past and Future Rainfall Seasonal Averages

	1981-2018	**2020s**	**2050s**	**2070s**
MAM	97mm	336mm	282mm	289mm
SON	44mm	314mm	378mm	365mm
JJA	45mm	307mm	262mm	301mm
DJF	24mm	67mm	97mm	77mm

4.3 Livelihoods in Turkana County

This study was interested in documenting the main livelihood activities found in Turkana as well as estimated monthly income of households.

4.3.1 Livelihood Sources

In addition to documenting the main livelihood activities further analysis was conducted, to understand where the different livelihoods were practiced in the sample area, as shown in Figure

4.12. All livelihoods were practiced in Turkana Central and Loima. Apart from pastoralism, all the other livelihoods were minimal or absent in Turkana South Sub County.

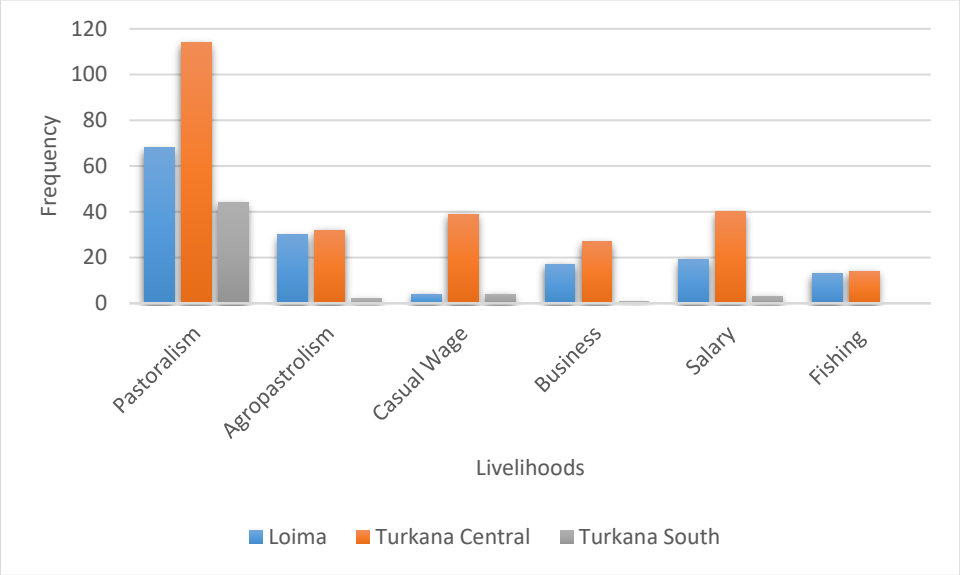

Figure 4.12: Household Main Livelihoods in Turkana Central, Turkana South and Loima Sub counties

Three of the main livelihoods; pastoralism, agro-pastoralism and fishing are directly dependent on natural resources thus affected directly by climate variability and change. Traditionally, households have been practicing nomadic pastoralism due to the severe environmental conditions in the county (TCG , 2018). The aridity in most areas of Turkana was unsuitable for crop production but support livestock keeping. Livestock are able to utilize the scarce natural resources available like shrubs and water. Livestock species kept were goats, sheep, cattle, poultry, donkeys and camels as shown in table 4.5. Small stock species of goats, sheep and poultry were kept by majority of households compared to large stock species of cattle, donkeys and camels. Compared to cattle, camels and donkeys, small stock was cheaper in the market thus making them easier to sell. In addition, goats were more drought resilient than other livestock species since they depended on shrubs to survive.

Table 4. 5: Number of Livestock Species kept by Households in Turkana County

	Frequency					
Numbers Kept	**Cattle**	**Goat**	**Sheep**	**Camel**	**Donkey**	**Poultry**
<10	37	70	67	35	46	66
11-20	10	48	11	3	0	12
21-30	10	35	32	0	0	8
>30	0	49	17	0	0	1
Total	**57**	**202**	**127**	**38**	**46**	**87**

With time, physical assets have become scarce due to frequent drought, making loss of livestock unavoidable. Households have been forced to spread their risks through practicing other livelihood activities that are not climate sensitive such as business, casual labour and salaried employment as shown in figure 4.4. From figure 4.12, majority of households who engage in livelihoods that are not climate sensitive, live around Turkana Central Sub County as also observed by Opiyo *et al* (2014). This can be attributed to urbanization that has enabled households in Turkana Central to practice other livelihood activities.

Agro pastoralism which was the second most practiced livelihood at 13% includes both livestock rearing and crop production. Crop farming is dependent on water availability, arable soil and skilled labour, which are inadequate in the county. Respondents from this study were able to mention that maize, sorghum, millet and vegetables are the main crops grown as shown in Figure 4.13 as also reported by MoALFC (2012) but these crops were for subsistence use. Despite the study area experiencing frequent drought, majority of the households planted maize crop, which was not drought tolerant. On the contrary, sorghum and millet which were drought tolerant crops were being planted at a minimal rate. This was a clear indication that households are yet to fully adapt to climate smart agriculture practices that encourage the production of drought tolerant crops in drought prone areas. The low adaptability to climate smart agriculture can be attributed to

inadequate resources , inadequate knowledge on climate smart practices as also observed by (Autio et al., 2021).

Households in the county practiced both rain fed and irrigated crop production. Rain fed crop production was unreliable due to rainfall variability. Table 4.6 shows that most agro pastoralists used irrigation to water their crops. Irrigation was most popular in Turkana Central while rain fed farming was practiced mostly by those in Loima Sub County. The findings also show that source of water for Irrigated farms were river wells, rivers, piped water and boreholes. River wells were only used in Loima while piped water, boreholes and rivers were used in Turkana Central.

Irrigation was least practiced in Turkana South as well as rain fed crop production. It was evident that rainfall was unreliable for crop production as indicated by majority of the households watering their crops through irrigation. Moreover, sub surface water sources through boreholes and river wells was the most common source of water, an indication that surface water from sources like River Turkwell was underutilized for production. This can be attributed to the high cost incurred for irrigation machinery needed to pump water from the river to the farms.

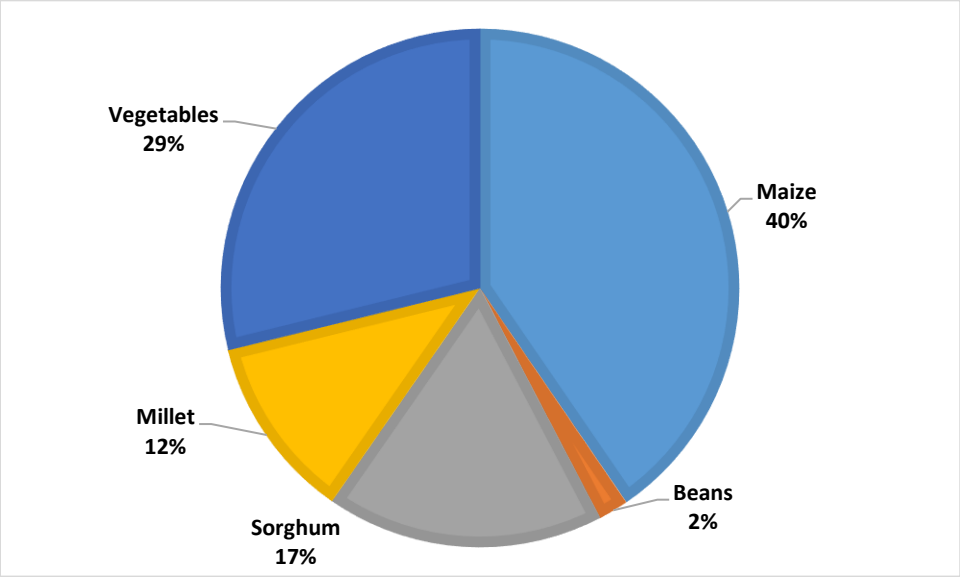

Figure 4.13: Main Crops Grown by Farmers in Turkana

Table 4. 6: Sources of Water for Crop Production Used by Household Respondents

		Frequencies			
		Loima	**Turkana Central**	**Turkana South**	**Total**
How Do You Water your Crops	**Rainfall**	9	4	0	13
	Irrigation	13	27	2	42
	Total	22	31	2	55
Water Source for Irrigation	**Boreholes**	2	6	2	10
	Shallow Wells	1	0	0	1
	River	0	11	0	11
	Piped Water	0	7	0	7
	River Wells	13	0	0	13
	Total	**16**	**24**	**2**	**42**

Figure 4.12 shows that casual wage was mainly located in Turkana Central, where Lodwar, the biggest urban center in the county is located. This implies that with urbanization, there is high demand for casual wage labour. The figure further shows fishing was the least practiced livelihood because it was mainly practiced along the main water bodies of Lake Turkana and River Turkwell within the sampled area. The finding is in tandem with Carr (2017) who found out that, fishing was considered as a last option means of attaining a livelihood by most pastoralists. Minimal fishing was further attributed to poor infrastructure, inadequate technology, fluctuating water levels, market inaccessibility and a poor fish-eating culture among the locals as Watete *et al*., (2016) stated.

Moreover, Figure 4.12 shows that salary earned through employment was prominent in Turkana Central and Loima. This can be attributed to sociopolitical factors like urbanization, formal education and devolution, which have provided suitable environments for the population to venture into formal employment. This was also reported by GCRF (2020) that pastoralists were embracing education as a long-term strategy to maintain livelihoods. Additionally, devolution of the

government that occurred under Kenya's new constitution of 2010 opened up the county to provide employment opportunities to educated local community members who were able to earn income from salaries as indicated in table 4.1.

From the results in Figure 4.4, 10 % of the households practiced business especially in Turkana Central and Loima. Traditionally, batter trade was the main form of business in the county, as indicated by one of the KIs. With urbanization in the study area, demand for various commodities within the main urban centers in the county has created business opportunities for local traders. "*Entrepreneurship was ventured with a particular community and opening manageable shops who used to conduct what we call batter trade,"* a key informant from Turkana County Government.

From the focused group discussions conducted, it revealed that the main business carried out by women was basketry and weaving. Households made brooms and mats from *Hyphaene Compressa* a locally available plant that provided the material. Basketry and weaving were primarily practiced by women who live near Lake Turkana and River Turkwell where the materials are readily available as reported by RPLRP (2017). Additionally, Men were also involved in the selling of baskets produced; they exported them to other counties at a large scale. Compared to other business ventures, weaving and basketry were relatively new to the community as pointed out during a focused group discussion.

"I do carry the basketry products to Homa bay. These products of basketry are exported to towns such as Eldoret," elderly male community member, Turkana Central.

"Mostly we depend on brooms for our needs which is never enough for all our needs," said an elderly female community member. "*These small businesses of selling the brooms and mats were not there before, they started practicing them around 1997- 1998."* elderly male community member, Loima.

From further interrogation in the focused group discussion, this study found that men also ventured into the business of buying and selling of livestock. "*After selling basketry products, one can use the money to buy a goat and sell it in a butchery,"* Elderly male community members, Turkana South.

Men are usually involved in transporting, marketing and selling of animals, particularly sheep and goats. For large stock animals (cattle and camels), men are fully involved from the livestock keeping to the selling stage, thus enhancing pastoralism and business ventures. This was stated by elderly male respondents in Turkana South, "*Regarding livestock business, there are no animals to buy. To get a good one requires one to travel far into places where pastoralists migrated to. Travelling process is also dangerous, one might encounter enemies/raiders who might kill or take your property forcefully. To avoid such risks, one has to hire people to help in moving with animals, which again is very expensive. This business is full of setbacks. For example, some time back when we were transporting goats for sale, and on the way our vehicle had a breakdown, we way attacked by raiders who took our goats and burnt down our vehicle."* According to MoALFC (2021), 81 to 100 % of the population depend on sheep and goat value chain in Turkana; an indication that majority of households keep the two livestock species, which were easily sold compared to large stock animals.

In addition to basketry products and sale of livestock, households also engaged in charcoal burning and sale of firewood. This came out during the focused group discussion: "*Here, we sell firewood and livestock to get food,"* male youth community members, Loima.

"*One can have no way of getting money to buy food, so they cut down the trees, and when the tree dries, they burn them to make charcoal and sell, male youth community members*," Turkana Central. This business venture was not sustainable; unregulated charcoal burning and sale of firewood contributed to environmental degradation through deforestation in an area that was

already arid. Both sources of fuel were mostly used in the whole county. Charcoal production contributed up to 72% of income of poor households in the county showing that charcoal was a paramount business venture in the study area. Charcoal was mostly sold in urban areas as confirmed by TCG (2018).

4.4 Effects of Rainfall on Livelihoods in Turkana County

Explaining how rainfall variability had affected their livelihood acitivites, majority (55%) observed a decrease in fodder, while 21% observed low farm yields. A mere 10% observed a decline in business and casual work, 6 % observed increase in fodder, 5% experienced decrease in fish catch while 3% experienced high crop yields (Figure 4.14).

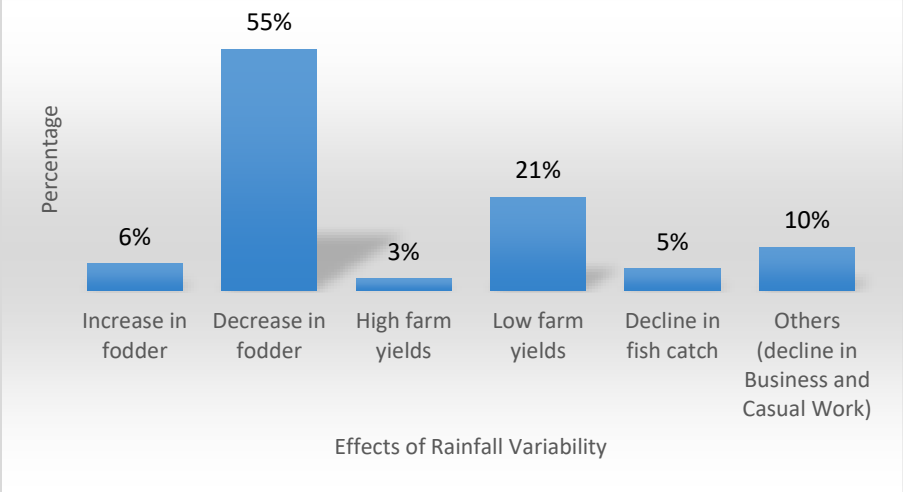

Figure 4. 14: Effects of rainfall variability on different livelihoods in Turkana County

Observations by households on the decrease of fodder, farm yields, casual work, business as well as fish catch can be attributed to the increase in drought frequency and severity as well as the intense occasional flooding. Pastoralism, being the dominant livelihood at 48%, was negatively affected by rainfall variability through a decrease in fodder for their livestock. Figure 4.11 indicates rainfall variability of consecutive moderate drought years as well as moderate to near normal wet

years in a row, affecting pasture availability in the study area. Pasture availability was affected in terms of quality and quantity as also determined by Okoti, Obando, and Kung'u (2014).

Recurrent droughts meant low crop yields to agro pastoralists. In extreme cases, total crop failure is experienced from inadequate moisture to sustain crops in farms. Furthermore, flood occurrences led to water logging that is unfavorable for forage and crop growth. Crop yields also reduce when floods wash away irrigation equipment and crops in farms near rivers as also observed by IFRC (2018).

Both business venture and casual wage employment were affected by rainfall at 10 % as presented in figure 4.14; most opportunities were dependent on pastoralism and crop production. Low forage and crop yield would translate into low business opportunities for those who sold livestock and farm produce. Low livestock and crop production also led to low demand for casual labour in pasture fields as well as farms.

Figure 4.15 show results of rainfall impacts on livelihoods. Households had experienced challenges during drought and flood episodes on their livelihoods. Majority suffered from human diseases (38%), livestock pests and diseases (26%), crop pests and diseases (17%), livestock deaths as well as flooding cutting access to markets each at 7%, crop failure (6%), low business operations, increase in food prices and conflicts with neighbouring communities at 4% each, low demand for casual labour (3%).

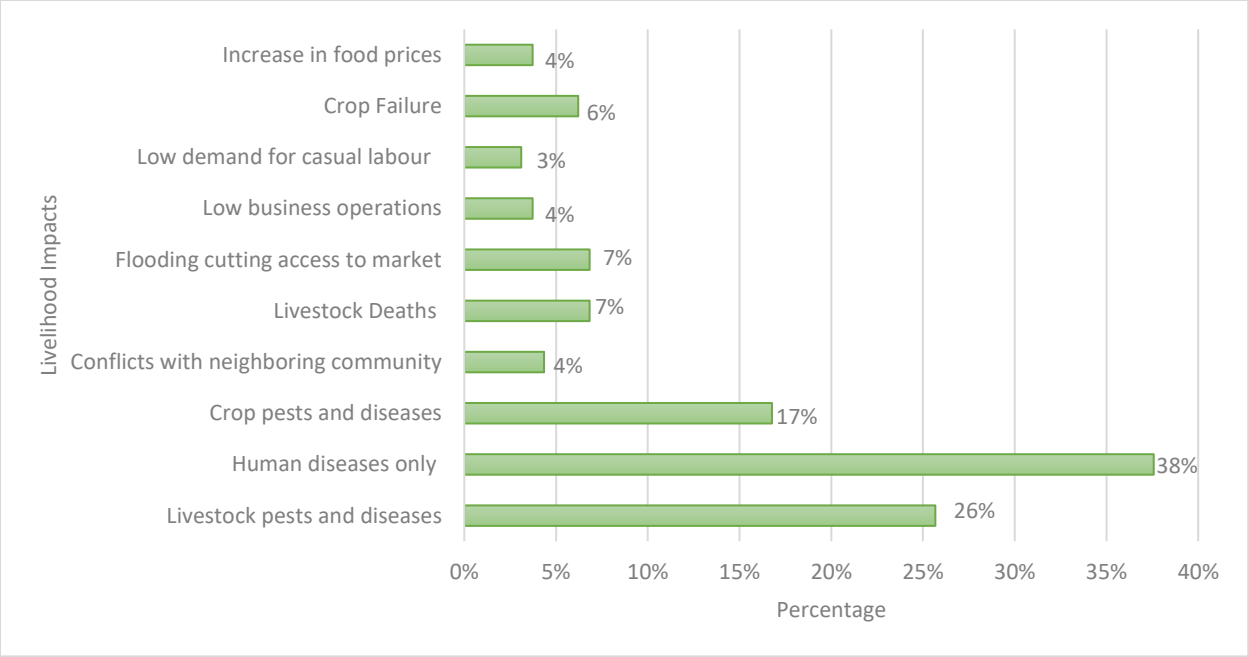

Figure 4. 15: Impacts of Rainfall Extremes on Livelihood in Turkana County

From the results in Figure 4.15, the main impacts of rainfall extremes experienced by respondents were related to human welfare and assets. Humans, livestock and crops diseases were the biggest challenges during extreme climate events. Extreme climate events like droughts and floods brought about outbreaks of seasonal disease like cholera and diarrhea. Human health was further influenced by malnutrition. During extreme climate events, availability and accessibility of food was a challenge leading to high malnutrition rates among the population.

Results from Figure 4.15 also show livestock diseases being the second major impact of rainfall extremes on livelihoods at 26%. This is attributed to pastoralism being the main livelihood practiced by most households, as shown in Figure 4.12. If diseases were not treated on time, livestock deaths would be inevitable. Seven percent reported livestock deaths as another impact on livelihoods. In addition to livestock disease, mortality can be attributed to drought that brought about inadequate pasture and water to maintain healthy livestock body conditions; this was also verified by Zwaagstra *et al*., (2010). Inadequate pasture and water meant that households had to

move their livestock to neighboring communities, thus encouraging conflicts with host communities at 4%. Moreover, livestock were also vulnerable to flood since they were washed away during above normal rainfall.

Extreme climate events also led to crop failure at 6%. Drought enhanced drying up of premature crops while floods washed away crops in the farm. Crop pests and diseases at 17% also contributed to crop failure. Pests and diseases tend to lower crop productivity, if not mitigated on time. This meant that communities were unable to harvest subsistence food crop and cash crop. Consequently, the food security situation was compromised through inadequate food and lack of money to buy food.

Without money to buy food and other basic needs, their well-being as well as of their assets were at risk of malnutrition. Without food in stores, merchants take advantage of the high demand of food commodities and increase food prices as shown in figure 4.15 at 4%. Since most households cannot afford to buy food, low business operations were experienced by those who depended on business as a livelihood at 4%. Additionally, during floods, access to markets (at 7%) was a challenge since roads were washed off, this meant that households could not sell or buy products, further paralyzing business operations.

4.5 Household Coping Mechanisms During Extreme Climatic Events

Figure 4.16 shows the coping mechanisms applied by households during extreme climate events. From the figure, the main way of coping was food aid at 32%, followed by reduction on expenses of none essentials at 25%, other income generating activities such as charcoal burning and leasing of fish lines at 18%, sale of livestock at 17 %, borrowing of food and money at 5%, and out migration of livestock at 3%.

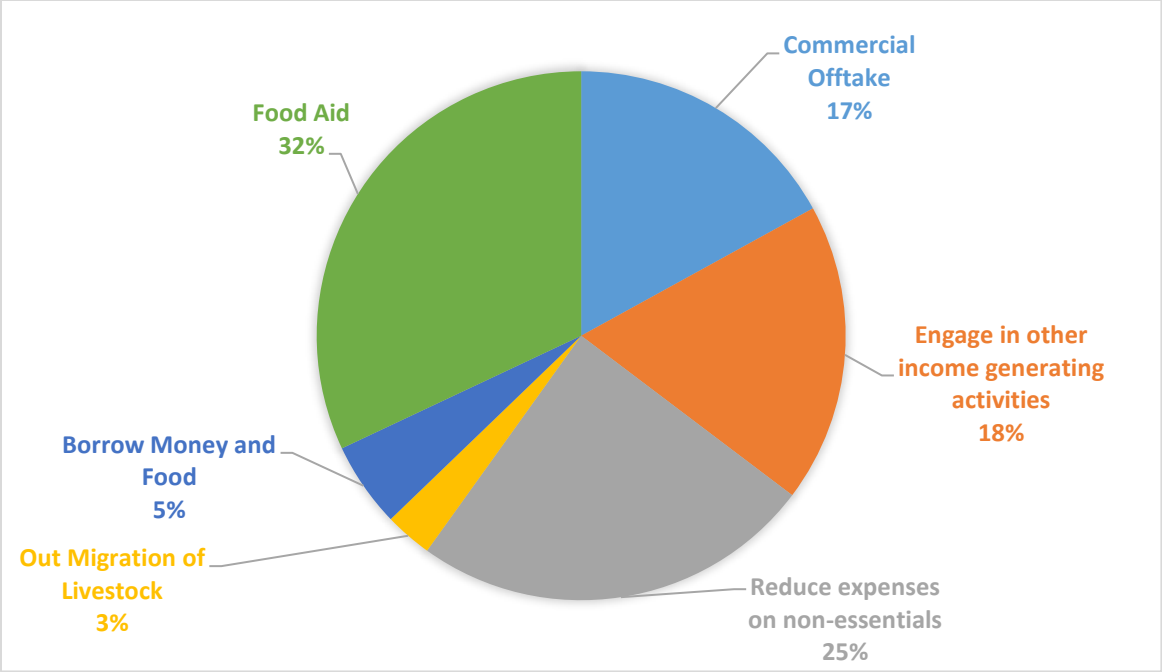

Figure 4. 16 : Household Coping Mechanisms during Extreme Climate Events in Turkana County

During extreme climate conditions, households apply coping mechanisms that assist them to endure effects of droughts and floods. These mechanisms are usually short term. Some of the mechanisms applied have negative impacts on both the environment and human life in general like charcoal burning. This study noted that there are mechanisms applied that can be termed as both short term and long term. Short term mechanisms in this case are food aid, livestock offtake, reducing expenses on non-essentials and borrowing food or money. Long term mechanisms are, out migration of livestock as well as engaging in other income generating activities as also noted by (Opiyo *et al.*, 2014).

Figure 4.16 shows that, food aid was the most common (32%) coping mechanism applied by households. Food Aid is termed as a formal coping mechanism that was offered by donors who are not part of the community. Although it is a common form of humanitarian assistance, food distributed to needy households is inadequate to sustain a family during prolonged harsh climate events.

Since some of the households already practiced livelihood activities that were previously deemed as ways of coping; a good example was charcoal burning and sale of fire wood, which were currently being practiced as normal livelihood activities. If these coping mechanisms turned livelihood activities do not cushion households, food aid becomes the alternative way to survive as seen in Figure 4.16.

Respondents also reduced expenses on non-essentials at 25 %. Non essentials include non-food items as well as medical expenses. This had a negative impact on the families that practiced this kind of mechanism. Though nonfood items were considered as not essential, they played a part in boosting human welfare. Medical expenses on the other hand, meant that those who are sick would continue to be sick, leading to loss of live and prolonged human suffering thus affecting human resource. Figure 4.15 further supports this by showing human health was highly impacted at 38 %. This was also verified with a study done by Lubeka, Kimiywe, and Nyambaka (2020).

The results of this study found that out migration of livestock was the least practiced coping strategy at three percent. Out migration outside the county have become common even during what was expected to be a wet season. Historically, communities used to migrate to better areas with livestock in search of forage and water which was what nomadic pastoralism entails. Normal movement of livestock was usually within the community's borders and designated grazing areas. Drought forced pastoralists to move outside their normal grazing areas to other regions where water and forage was available. Out migration of livestock as a coping mechanism was applied during droughts. It was practiced by male members of the family who moved with livestock to furthest areas like neighboring counties and countries (Uganda and South Sudan); this explains why most respondents from this study were female at 59% as shown in figure 4.1. From this study, it is evident that this coping strategy was on the decline and attributed by the livestock species

kept. Table 4.5 shows that small stock livestock of sheep and goats, which did not migrate, were being kept more than large stock livestock that did migrate during drought events.

Five percent of the respondents borrowed food and money as a way of coping. Borrowing of food and money was putting households in debt cycles; worsening the economic position for both the debtor and small-scale retailers who are usually the creditors. Wato (2016) observed that those who were in debt did not know how long they were going to apply the coping mechanism for they did not know when they would bounce back to normalcy.

4.6 Enabling Environment for Sustainable Livelihoods

4.6.1 Institutional Support

Households applied some coping mechanisms that needed institutional support. This study probed further the type of institutional support given to respondents. There was a clear indication of presence of both Government and Non-Governmental Organizations (NGOs) in the study area. With devolution in Kenya, public services have become more accessible to communities through the Turkana County Government. Although still new, this form of governance has faced some challenges that have made some of the public to not fully feel its impact attributing to the 33% (Figure 4.17) who are yet to benefit from formal institutions. Due to its socio-economic issues, Turkana County has benefitted from the presence of different non-governmental organizations that have set up projects to improve lives and livelihood through development projects.

Figure 4.17 shows the source of primary external support given to the communities. An estimated 29% of the respondents observed that the county government alone gave the primary support, 24% said both county government and non-governmental organizations, 9% said non-governmental organizations alone while 5% accredited the national government.

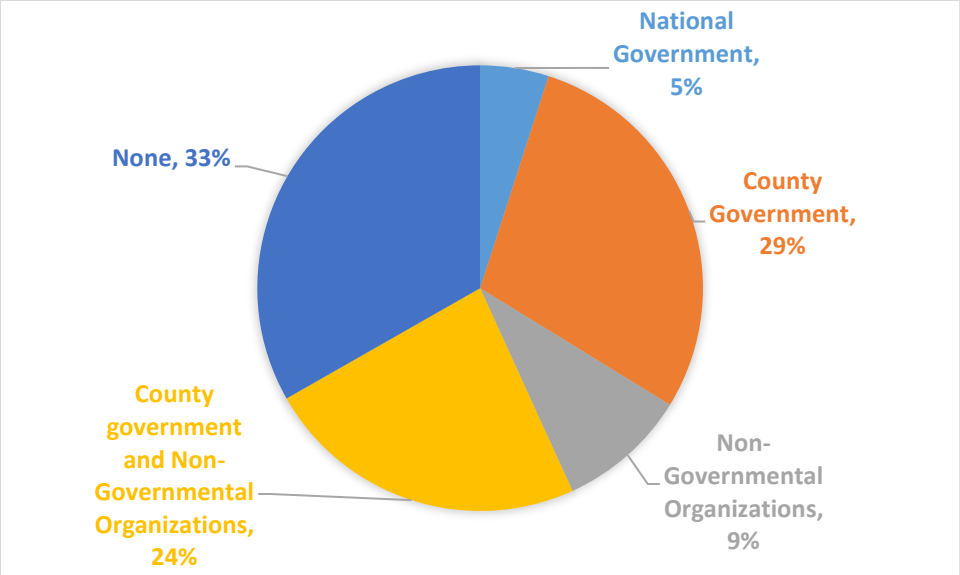

Figure 4.17: Institutions that Offer Households Support in Turkana County

From the results in Figure 4.17, the county government gave the biggest support to respondents. This was attributed to the functions of the county governments as stipulated in the 2010 constitution. One of the objectives of devolution is to promote social and economic development as well as the provision of proximate, easily accessible services throughout the country (GOK, 2010). Under the same constitution, government is both at national and county levels. Most functions that are development led are under the county government this explains why support from national government is minimal at five percent.

Similarly, 24 % of the respondents had benefitted from support from both county government and NGOs. This can be attributed to strategic partnerships between governments and NGOs, commonly known as public private partnerships (PPPs). Partnerships between these two entities are meant to meet common goals that serve vulnerable households. Mukami and Muturi (2018) reported that the Kenyan Govenment has set up PPPs as a resource mobilization startegy that helps provide quality and affordable services to the public. On the other hand, NGOs can fully support communities independently through development and humanitarian projects.

Figure 4.18 shows the types of interventions received from the various organizations. Food aid was the main intervention supported by external sources at 32%, followed by seed aid at 28%, infrastructure development at 17%, cash transfer at 15%. Dissemination of timely climate information, market linkages and capacity building were also interventions received. Further probe during focused group discussions validated the findings with respondents identifying food aid from government as the main assistance. *"The only thing that the Government does is to bring maize. Each person gets one kilogram of maize which is not enough for everyone and those who are absent will get nothing,"* elderly female community members, Turkana Central.

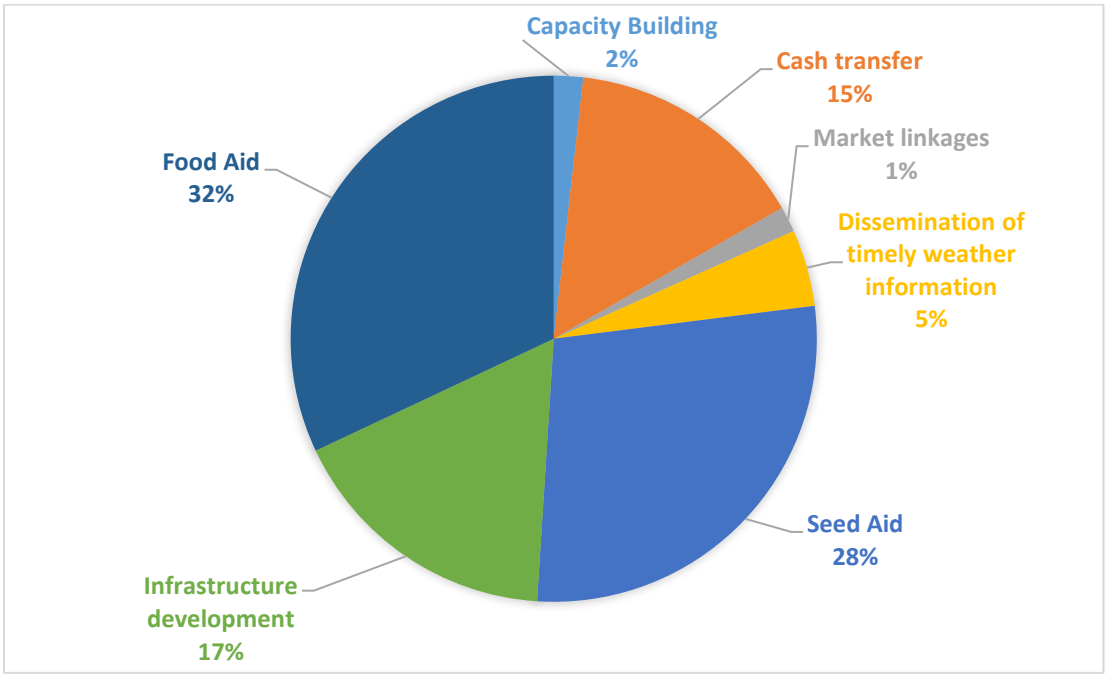

Figure 4.18: Types of Support Given to Households by Institutions in Turkana County

When probed further, respondents acknowledged that there were challenges in accessing interventions. The main challenges were poor access to service, inadequate training and information, inadequate financial capital and inequality of distribution of resources.

As shown in Figure 4.18, the government and other organizations played a role in cushioning households against impacts of extreme climate events especially during drought and floods through humanitarian interventions of food aid, seed aid and cash transfer. However, portions of food aid distributed to beneficiaries were inadequate thus feeding a family for a few days or meals. Not all all vulnerable households benefited from the support given, with majority being left out of the programmes. Food and seed aid brought dependency syndrome that negatively affected livelihood systems as also pointed out by Wato (2016), thus undermining community resilience building initiatives.

Cash transfer was given by both Government and Non-Government Organization. This type of humanitarian assistance was getting popular since it gave vulnerable households dignity compared to food aid. It also gave households a chance to be economically empowered by giving them a chance on how to spend money given. In most cases, cash transfer is unconditional; given to households that financially disadvantaged, without any conditions for the beneficiaries. The most common in the study areas were older people's cash transfers, persons with severe disability and hunger safety net programme. The main driver of cash transfer was the different types of vulnerabilities, such as high malnutrition rates and low income which are high in the study area. It was unclear for how long the cash transfer programmes were running and how sustainable they were.

Development interventions were being supported by external actors through infrastructure development, capacity building, dissemination of climate information and market linkages as seen in Figure 4.18. Although these interventions were at a minimal scale, this was clear evidence of resilience building initiatives that can assist households to be independent and their livelihoods being sustainable.

4.6.2 Livelihoods Sustainability in Turkana

Figure 4.19 presents household opinion on livelihood sustainability, with 58% of the respondents from the household survey saw that there was a need for community information, awareness and sensitization. Others desired more funding opportunities through business loans and grants (16%). There was also need for equity in terms of equal distribution of resources (10%), livelihood diversification (9%), capacity building (5%) and infrastructure development (2%).

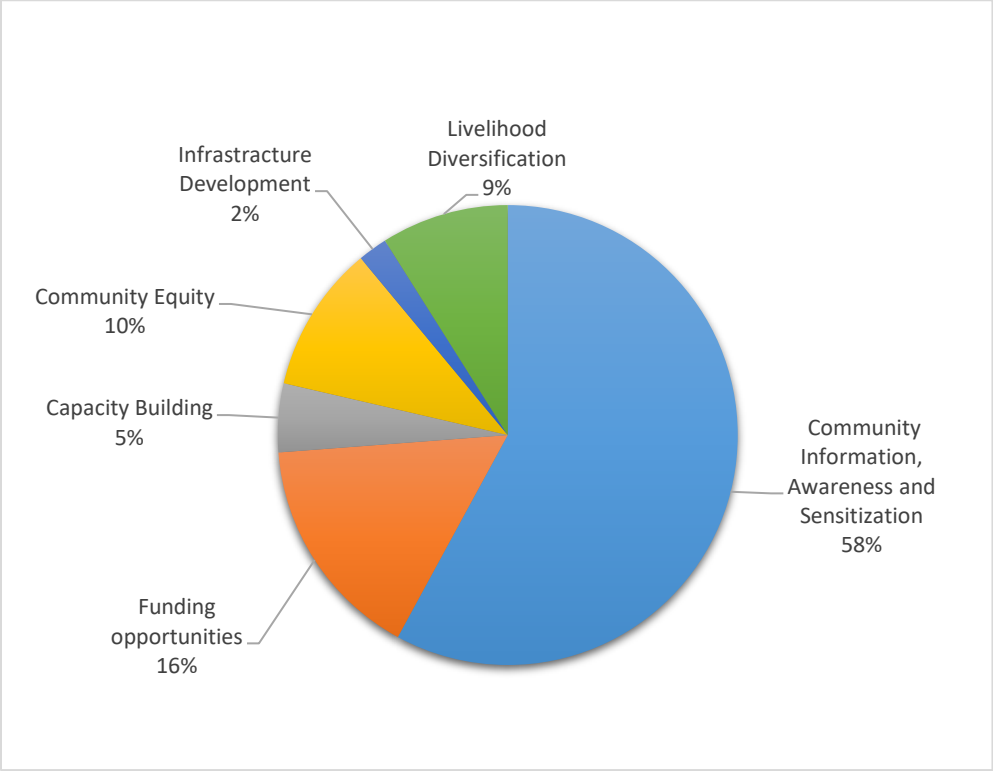

Figure 4.19: Household Opinion on Livelihood Sustainability in Turkana County

Access to information assists communities to make conscious decisions regarding development. Timely dissemination of information and awareness creation especially on climate change is relevant for households to take early action. It is obvious that climate change hazards are among the major challenges causing livelihood instability among the majority in Turkana. Although dissemination of timely climate information by external actors existed, it was at a minimal rate of five percent. For a county that experiences droughts and floods, proportion of households that

receive the information were dismal. These findings are equally depicted by (Mercy Corps, 2019) where they reported that type of dissemination channels used and low institution capacities attributed to low household utilization of information in Africa.

Government and other actors should have an effective plan that will ensure that people receive and utilize information disseminated. In order to reach the targeted communities, information should be customized to meet their needs and this can only be achieved by knowledge of information needs and communication systems of those targeted as stated by Kamba (2009) and Mercy Corps (2019).

Community members were ready to be trained to diversify their livelihoods. Pastoralists were willing to learn about crop production and business enterprises. Capacity building through trainings knowledge and innovation transfers, will enable households to diversify their livelihoods. Community empowerment can be built by increasing knowledge and skills at household level. Findings from the survey were validated by focused group discussions with both the male and female groups viewing capacity building as a way of achieving livelihood sustainability.

"We are pastoralists and we rely heavily on livestock. We have not been trained well on agriculture. We are seeking for training on irrigation and business," elderly male community members, Turkana Central. "*Just to add on what has been said, we will welcome ideas/training on ways of improving and running businesses, Farming and climate change in order to improve our lives*," elderly man at Lokichar. *"Now that we have plots it will be good that you educate us on farming*," elderly female community members Turkana South. This is a clear indication that the communities are willing to learn new skills in order to survive.

For livelihood sustainability to be ensured, physical infrastructure like machinery as well as financial support like loans and insurances will require building knowledge together with skills;

as shown in Figure 4.19, with respondents viewing capacity building, infrastructure development and funding opportunities at 5, 2 and 16 % respectively. Therefore, capacity building is not only through human resource but also through institutional and organizational development. Merino and Carmenado (2012) posit that external actors can help locals by building financial, technical, political and social skills that can assist in reducing vulnerability to climate change.

Financial support (16%) can be in various forms like provision of capital for business and insurance for lost assets due to extreme climate events. It was in the view of the respondents that those involved in business activities are rarely supported. Most businesses in the study area were small scale. Sometimes, these businesses fail due to inadequate capital and knowledge. Those who would want to start businesses are restrained as well due to poverty; especially after directly losing assets to drought and floods or to other impacts related to extreme climate conditions. "*We lack of money to start up a business. Business people can also be supported and empowered*," Loima young men at FGD.

Pastoralism and agro pastoralism are some of the main economic activities in the study area at 48 and 13 % respectively as shown in Figure 4.4. Support through loans for business capital and asset insurance can assist pastoralists and agro pastoralists to sustain themselves. Financial support should not only be in monetary terms but also through trainings on financial management. In addition, Prizzon (2020) underlined that access to finance is one of the main challenges facing enterprises in rural areas especially those engaged in agriculture. This is due to avoidance of formal financial institutions providing substantial financial services to rural population mainly due to their lending terms and low monthly incomes shown in Figure 4.5. Mbai and Maina,(2016) highlighted that rural households in general are considered not credit worthy due to the perception that they are poor. However, technology especially mobile money has made it easier for financial institutions to reach those in rural areas. GOK has made efforts to avail funds to the youth and

women through the Youth Enterprise Development Fund and Women Enterprise Fund but Nabwala and Ombui, (2016) explained that the uptake of these loans was low on account of the rigid requirements and prolonged procedures.

Compensation of assets lost during extreme climate events is another way of ensuring households retain their livelihoods activities. Participants from focused group discussion saw the importance of compensation: "*During the last floods, our goats were washed away by flooded streams. The government reacted and brought blankets and plates. The same calamity befell the residents of Kalapata. They were properly compensated. Victims received Ksh 40,000 each. That is a good amount and it is equivalent to 20 goats,"* Lokichar elderly man.

Although pastoralism remained the livelihood of choice for most in Turkana (48%), households were willing to diversify their livelihoods (9%), as shown in Figure 4.14. This study notes that livelihood diversification is already taking place in Turkana, although on a small scale. The most common form of livelihood diversification is non-farm activities of business and wage labour (10%). Due to high poverty rates in the county, small scale businesses were higher, practiced by low-income households.

Modern practices like industrialization can help vulnerable community members to diversify their livelihoods. Rural industrialization can contribute to household economic stability in three ways: through creation of employment especially for the local youth thus reducing dependence on climate based livelihoods as shown in Figure 4.8, improving the welfare of the population since human health was mostly impacted by rainfall variability at 38% (Figure 4.12), and enhancing production by using local raw materials which help sustain livelihoods as accentuated by Al Siddiq, Saputra, and Untari, (2019), Kapur, (2019), Degoma, (2018).

Setting up local industries that promote main livelihood activities especially pastoralism, agro pastoralism and fishing will also increase access to markets of locally available products; as one of the key informants proposed:

"If there was like the Kenya Meat Commission (KMC) we have value addition of where they can easily access ready markets with good prices then it means everything will improve," KI from NGO.

If industries are established locally within Turkana, change, in terms of income and development will be experienced. Firstly, locals will be encouraged to attend schools and acquire required skills needed for employment in the industry. Secondly, infrastructure development in terms of roads, telecommunication services and electricity connectivity will occur thus opening up the county for more business opportunities. This will be advantageous to the population who pointed through focused group discussions that the is need for education in addition to other developments

"We need schools, hospitals and more developments," young female respondents Turkana South FGD

Our children also need to be taken to school especially those who are joining secondary school, elderly female respondents Turkana South FGD.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter concludes the study and gives recommendations to findings in relation to the four specific research objectives.

5.2 Conclusion

The study concludes that climate variability and change affect sustainable livelihoods in Turkana. Climate variability is evidenced by the increasing rainfall trends in the wet seasons of MAM and SON. Shift in precipitation patterns were also observed with there were reduced dry conditions and frequent flood incidences. Climate Change on the other hand, is demonstrated by the shift in trend in future rainfall estimates, where SON would be the most reliable rainfall season due to its increasing trend as compare to current situation of MAM being the most reliable season.

The study also observed that due to rainfall variability, both floods and drought episodes have become frequent affecting the different livelihoods in the study area. This meant that livelihoods of the majority of the respondents were at risk; through decrease in production in farms and livestock. These extreme climate events were detrimental to human and social welfare as well as household assets, leading to low productivity that might have long term negative impacts. Some of the sources of income led to maladaptation practices that were harmful to the environment, in the long run contributing to climate variability and change, especially through deforestation.

Most of the coping mechanisms applied by households were detrimental to development. Food and seed aid at 32 and 28 % respectively, brought about dependency syndrome. Reduction of non-food expenses, such as medication as a coping mechanism also posed a risk to the households' members' welfare. Human welfare is prominent in ensuring that a person contributes optimally to the economy.

The study concludes that in order to make livelihoods sustainable, all interventions proposed by households would need external support. To achieve sustainability, there is need to create synergy between the main stakeholders (government, NGOs and community). Moreover, integration of all stakeholders in decision making processes would help streamline livelihood sustainability

5.3 Recommendations

The following are recommendations for this study.

5.3.1 Recommendations for Policy and Decision Making

- With rainfall variability evidenced in figure 4.8, there is need to enhance climate information services such as early warning systems. This should be through utilization of clear lines of information such as using community gate keepers, local leaders to enable dissemination to vulnerable households in order to assist in preparedness of extreme rainfall events, whose livelihoods depend on it as shown in figure 4.12.
- Vulnerable households should be encouraged to diversify their livelihoods through venturing in in alternative livelihoods such as entrepreneurship, which can be achieved through technical and vocational trainings, since most livelihoods are climate reliant and rainfall has negative effects on livelihood as indicated in figure 4.14. Enhancing existing livelihoods through pasture management structures, encouraging households to keep drought tolerant livestock species like goats and camels, together with climate smart agriculture practices such as production of drought tolerant crops, setting up of water and soil conservation structures, will also ensure households maintain their livelihoods at the same time creating resilience.
- From figure 4.16, most households depend on food aid as a coping mechanism, enhancing programmes that will discourage dependency syndrome and encourage climate change

adaptation. This can be achieved by supporting asset creation initiatives that will enable community members to be independent.

- From figure 4.19, there is need for capacity building of households through training together with financial assistance would help households increase their adaptive capacity through livelihood independence. Additionally, setting up stable value chains for locally available products for weaving products, fish and livestock would create opportunities for a bigger population.

5.3.2 Recommendation for Further Study

- From the FGDs conducted, this study observed that women relied on the business of broom making. It would be prudent to explore how this business is sustainable, in order to ensure a substantial source of income. The raw material used for broom and basket material (*Hyphaene Compressa),* is a natural product sourced at the banks of Lake Turkana and River Turkwell. There is a need to find out if the availability of this raw material is sustainable, in order to avoid future livelihood erosion.

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APPENDICES

APPENDIX I: Household Survey Questionnaire

Introduction:

This is collaborative research being implemented by a team from the University of Nairobi (UoN) and the Technical University of Kenya (TUK), under the "Building REsearch Capacity for sustainable water and food security in drylands of sub-Saharan Africa (BRECcIA)" project. The research is titled "Assessing resilience of drylands communities to shocks associated with rainfall extremes under changing climate and land use conditions in Turkana County". This research will assist stakeholders in identifying the current and future climate change adaptation mechanisms applied in Turkana.

Enumerator: _____

General Information:

County: Sub County:

Ward: Sub Location:

GPS Coordinates: Latitude: _____ Date:
Longitude:_____

Household Code:

1.0 Respondent's Socio-Demographic Characteristics

Name of Respondent:_____

1.1 Are you the head of this household? 01 Yes [___] 02 No [___]

1.2 If no, what is your relationship with the household head?

01 Spouse, 02 Son 03 Daughter 04 Other (specify)_____

1.3 Gender of respondent:

1. Male [___] 2. Female [___]

1.4 How many members are in this household?

_____

Male _____ Female_____

1.5 Respondent's Age bracket: (tick where appropriate)

01) < 30 years [__] 02) 31-40 years[__] 03) 41-50 years [__] 04) 51-60 years [__] 5) 61> years[___]

1.6 What is your highest level of education?

1. Primary [___] 2. Secondary [___] 3. Tertiary (University/College) [___] 4. Other [___] specify _____

1.7 What is your main source of income?

01 Crop Farming [___] 02 Pastoralism [___] 03 Agro-pastoralism [___] 04 Fishing [___] 05 Business [___]

06 Salary [___] 07 Wages [___] 08 Remittances [___] 09 Sale Charcoal [___] 10 sale of firewood [___]

11 Other [___] (Specify _____

1.8 What is the approximate monthly income for the household?

1. < ksh 1000[__] 2. Ksh 1000 – 5000[__] 3. Ksh 5000 – 10000[__] 4. Ksh 10000 – 20000[__] 5. Ksh 20000 – 30000[__] 6. >ksh 30000[__]

1.9 How long have you lived in this area? (tick where appropriate)

01) < 20 years [__] 02) 21-30 years[__] 03) 31-40 years [__] 04) 41-50 years [__] 5) 51> years[___]

2.0 Climate Variability and Rainfall

2.1 have you observed any changes in rainfall in the last 30 years? 01 Yes [___] 02 No [___]

2.1.1 If yes, what kind of change have you observed?

01. Increase in rainfall days in a season [___] 02 Decrease in rainfall days in a season [___]

03 Rainfall coming late in the season [___] 04 Rainfall coming early in the season [___]

2.1.2 Which of the following statements are true about observed changes in rainfall in your area?

01 Rainfall has become more unpredictable [___] 02 There are more wet days in a year [___]

03 Drought episodes have become longer and more frequent [___]

04 Drought episodes have become shorter and less frequent [___]

05 any other observed changes [___] (Specify) _____

2.2 Have these changes affected your economic activities in any way? 01 Yes [___] 02 No [___]

2.2.1 If yes, what changes have you observed?

01 Increase in fodder [___] 02Decrease in fodder [___] 03 High farm yields [___]

04 Low farm yields [___] 05 Increase in fish catches [___] 06 Decline in fish catches [___]

07 Others [___] (Specify) _____ _____

3.0 Household Livelihood Activities

3.1 Does your homestead have any livestock? 01 Yes [___] 02 No [___]

3.2 If yes what type of livestock and how many?

01 Cattle < 10 [___] 11-20 [___] 20-30 [___] >30 [___]

02 Goat < 10 [___] 11-20 [___] 20-30 [___] >30 [___]

03 Sheep < 10 [___] 11-20 [___] 20-30 [___] >30 [___]

04 Camel < 10 [___] 11-20 [___] 20-30 [___] >30 [___]

05 Donkey < 10 [___] 11-20 [___] 20-30 [___] >30 [___]

06 Poultry < 10 [___] 11-20 [___] 20-30 [___] >30 [___]

07 Others [___] (Specify)_____

3.3 Do you get any product from the livestock? 01 Yes [___] 02 No [___]

3.3.1 If yes, which products are these?

01 Meat [___] 02 Milk [___] 03 Eggs [___] 04 Hide [___] 05 Others (Specify)_____

3.3.2 Do you sell any livestock and livestock products? 01 Yes [___] 02 No [___]

3.3.3 How do you use the income from the sale of livestock and livestock products?

01 Purchase of food [___] 02 Purchase of non-food items [___] 03 Payment of school fees [___]

04 Payment of hospital bills [___] 05 Other [__] (Specify) _____

3.4 Do you grow any crops in your homestead? 01 Yes [___] 02 No [___]

3.4.1 If yes, which are the main crops that you grow?

01 Maize [___] 02 Beans [___] 03 Sorghum [___] 04 Millet [___] 05 Green grams [___] 06 Cowpeas [___]

07 Vegetables [___] 08 Fruits [___] 09 Others [___] (Specify) _____

3.4.2 How do you water your crops? 01. Rainfall [___] 02. Irrigation [___]

3.4.3 If irrigation, what is the main source of water?

01 Borehole [___] 02 Shallow Well [___] 03 River [___] 04 Pipeline [___] 05 Dams and Pans [___]

06 Natural Springs [___] 07 River Wells [___] 08 Others [__] (Specify) _____

3.5 Do you normally sell the harvest? 01 Yes [___] 02 No [___]

3.5.1 If yes, how do you use the income from the sale of crop harvest?

01 Purchase of food [___] 02 Purchase of non-food items [___] 03 Payment of school fees [___]

04 Payment of hospital bills [___] 05 Other [__]
(Specify)_____

3.6 Is there anybody in your household who is engage in any form of employment?

01 Yes [___] 02 No [___]

3.6.1.1If yes, what kind of employment and how many?

01. Permanent [__] < 2 [___] 2-3 [___] 3-4 [___] >4 [___]

02. Casual [__] < 2 [___] 2-3 [___] 3-4 [___] >4 [___]

03. Self [__] < 2 [___] 2-3 [___] 3-4 [___] >4 [___]

04. Others [___] (Specify_____

3.6.2 How is the income from employment used?

01 Purchase of food [___] 02 Purchase of non-food items [___] 03 Payment of school fees [___]

04 Payment of hospital bill [___] 05 Other [___] (please
specify_____

3.7 Has your household always been practicing livelihoods mentioned above? 01 Yes [___] 02 No [___]

3.7.1 If no, what household activities were you practicing previously?

3.7.2 What made you change your livelihood activities?

4.0 Household Coping Mechanisms

4.1 What are the main extreme climate events experienced in this area? (Multiple answers allowed)

01 Drought [___] 02 Floods [___] 03 Desert Locust [___] 04 Other [___] (Specify) _____

4.2 Does your household experience any challenges in productivity during extreme climate events?

01 Yes [___] 02 No [___]

4.2.1 If Yes What kind of challenges do you experience? (Multiple answers allowed)

01 Livestock pests and diseases [___] 02 Human diseases [___] 03 Crop pests and diseases [___]

04 Conflicts with neighboring community [___] 05 Other [___] (please specify) _____

4.2.2 What alternative activities does your household engage in to survive extreme climate events?

01 Sell livestock [___] 02 Engage in other income generating activities [___]

03 Reduce expenses on non-essentials [___] 04 Withdraw children from school [___]

05 Sell household assets (electronics, furniture, bicycle, motorbike, sewing machine, etc.) [___]

06 Migration of entire household [___] 07 Migration of livestock [___] 08 Borrow money/food [___] 09 Remittances [___] 10 Other [___] (Specify) _____

4.3 Are there institutions in your area that assist your household against challenges of extreme climate events? 01 Yes [___] 02 No [___]

4.3.1 If yes, what category of institutions are they?

01 National Government [___] 02 County Government [___] 03 Non-Governmental Organizations [___]

04 Community group [___] 05 Private Sector [___] 06 An individual [___]

07 Other [___] (Specify) _____

4.4 What type of assistance has been put in place by these organizations?

01 Infrastructure development [___] 02 Cash transfer [___] 03 Market linkages [___]

04 Dissemination of timely climate information [___] 05 Capacity Building [___] 06 Aid (Food/seed) [___]

07 Other [___] (Specify) _____

4.5 What challenges have you faced in accessing the assistance?

01 Inadequate financial capital [___] 02 Inadequate training and information [___]

03 Little access to essential services(markets) [___]

04 Other [___] (Please specify) _____

4.5.1 In your opinion what can be done to assist you to permanently avoid the above challenges?

4.6 Do you belong to any social group (Chama)? 01 Yes [__] 02 No [__]

4.6.1 If yes, how many of them?

01 One [__] 02 two [__] 03 three [__] more than three[___]

4.6.2 What is the main purpose for the social groups (chamas?) (multiple answers allowed)

01 savings/Table banking/loans [__] 02 Social support (during weddings, circumcision, funerals) [__]

03 community work [__] 04 Other[___] (please specify) _____

5. Market Access

5.1 What is the name of your nearest market?

01 Lokichar [__]

02 Lodwar [__]

03 Kalokalor [__]

04 Turkwell [__]

05 Kainuk [__]

06 Lorugum [__]

07 Kerio [__]

08 Kalemngorok [__]

09 Katilu [__]

010 Other(Please Specify)_____ [__]

5.2 How far is the market from your homestead? 01) 01) 0-5 Km [___]02) 6-10 Km [___]03) 10-15Km [___] 04) >15 Km [___]

5.3 Do markets operate throughout the year? 01)Yes [___] 02) No [___]

5.4 If no, what are the main causes?

01 Conflicts/Insecurity [___] 02 Poor infrastructures [___] 03. Quarantine [___] 04. Commodities are not readily available [___] 05. Others [___] (Please Specify) _____

5.5 What are the main food commodities sold in the market? (multiple answers allowed)

01 Cereals (E.g. Maize and Beans) [___] 02 Livestock [___] 03 Livestock products [___] 04 Fish [___]

05 Others [___] (Please Specify) _____

5.6 What are the main nonfood items sold in the market?

01 Clothing [___] 02 Medicine [___] 03 Toiletries [___] 04 Construction Material [___]

05 Others [___] (Please Specify) _____

Thank you for your participation

APPENDIX II: Key Informant Interview Guide

Introduction

This is a collaborative research being implemented by a team from the University of Nairobi (UoN) and the Technical university of Kenya (TUK), under the "Building REsearch Capacity for sustainable water and food security In drylands of sub-Saharan Africa (BRECcIA)" project. The research is on "***Assessing resilience of drylands communities to shocks associated with rainfall extremes under changing climate and land use conditions in Turkana County***". This research will assist stakeholders in identifying the current and future climate change adaptation mechanisms applied in Turkana.

1	Rainfall Pattern and stream flow
1.1	In your opinion, what changes in rainfall patterns have you noted?
1.2	In relation to your previous response, what is the impact of these changes on the community's livelihood activities?
1.3	From your experience, how have the changes in rainfall patterns

affected the water levels of the rivers in this area?

2 Land Use Change

2.1 What are the main land uses in this area?

2.2 What are the main changes in land use activities in the community? (Multiple choices allowed)

2.3 What are the main impacts of land use change in the community's livelihood?

2.4 In your opinion, are the current land use activities more favorable to livelihood activities than those of the previous 30 years?

2.4.1 Please explain your answer further

2.5 In your opinion, have the changes in land use affected the stream flow patterns in this area?

2.5.1 Please explain your answer

3.0 Livelihood Activities

3.1 What are the common livelihood activities in this area? (Rank 1 to 8 from main livelihood to minor livelihood)

3.2 From your experience, have there been changes in livelihood activities in the last 30 years?

3.3 Please explain your answer

3.4 In your opinion, what factors are responsible for the changes in livelihood activities?

3.5 In your opinion, what challenges do the communities face in

carrying out their livelihood activities?

What, in your view, could be done to alleviate these challenges?

4.0 Coping Mechanisms

4.1 From your experience, do the local communities apply any coping mechanisms during extreme climate events?

4.2 If yes, what are the main coping mechanisms employed?(Multiple Answers allowed)

4.3 In your opinion, are there initiatives that cushion households against loss of livelihoods during extreme climate events?

If yes, what are these initiatives?

4.4 What are the main intervention measures put into place by your organization?

4.5 In your opinion, what measures can be put in place to ensure that livelihoods in this area are sustainable?

5.0 Market Access

5.1 Do markets in this area operate throughout the year?

5.2 If no, what are the main causes?

5.3 What are the main food commodities sold in the market? (multiple answers allowed)

5.4 What are the main nonfood items sold in the market?

Thank you for your participation

APPENDIX III: Question guide for Focused Group Discussion

Question guide for an FGD with community members on the resilience to extreme climate events
Community name: _____
Sub County: _____
Date: (DD/MM/YYYY) ____ / ____ / _____
Facilitators: _____
Group name/description: _____
# of male participants: _____ # of female participants: _____

General introduction:
This is a collaborative research being implemented by a team from the University of Nairobi (UoN) and the Technical University of Kenya (TUK), under the "Building REsearch Capacity for sustainable water and food security In drylands of sub-Saharan Africa (BRECcIA)" project. The research is titled "Assessing resilience of drylands communities to shocks associated with rainfall extremes under changing climate and land use conditions in Turkana County". This research will assist stakeholders in identifying the current and future climate change adaptation mechanisms applied in Turkana.
We are in your community to hear your opinions and views about climate extremes in the face of climate change and your coping mechanisms. We understand you may be worried about the effects of climate change on your livelihoods. We are here to get your views to help us understand your concerns so that we can recommend measures to be taken to cushion you and others from the ravages of climate and landuse changes
The information provided in this discussion will only be used by the research team and the wider BRECcIA project to improve the resilience to climate extremes in the face of climate and land use changes. Your participation in this discussion voluntary and there is no obligation to respond, you can stop and withdraw at any point. No personal data will be shared with others and the information provided will be analyzed anonymously and used confidentially. Your views are valuable and important and will contribute to ensuring our recommendations meet your needs.
At the end of the discussion we will try to answer your own questions about the effects of climate and land use changes on water and food security. Our group discussion will last about 60 to 90 minutes.

Do you have any questions? Are you willing to participate in the group?
Consent:
Do you provide consent to document, use, store and share the information provided for reporting and communication purposes?
☐ YES ☐ NO (if NO, say thanks and let the person leave)
May I begin now?

	Question	Answer
1.	Rainfall Pattern	
i.	Based on your knowledge and experience, what are rainfall patterns in this area?	

ii. Would you say there have been changes in the rainfall patterns in the last 30 years? If so, what are these changes?
iii. In your opinion, what could be the cause of these changes if any?
iv. How have the changes in rainfall patterns, if any, affected the community's water and food availability and access?

2. Land Use Change

i. What are the main uses of land in this area?
ii. Based on your knowledge and experience, would you say that the current use of land in this area is different from what it was 30 years ago? If so, what was the original use land in this area?
iii. How has the change in the use of land affected the community's water and food availability?

3. Livelihood Activities

i. What are the main livelihood activities in this area?
ii. Based on your knowledge and experience, would you say that livelihood activities have changed in the last 30 years? If so, what are some of the most outstanding changes?
iii. In your opinion, what could be the cause of these changes in livelihood activities?
iv. Are there challenges experienced by the communities in carrying out their current livelihood activities? If yes, what needs to be done to alleviate the challenges?

4. Coping Mechanisms

i. What are the main climate-related disasters experienced in this area?

ii. What factors make your household/community vulnerable to the above risks?
iii. What mechanisms do the communities apply to cope with these disasters?
iv. Have you lost any assets due to the climate induced hazards?

v. Would you say that the current coping mechanisms are the same as those applied 30 years ago? If not, what are main changes in the coping mechanisms?
vi. In your opinion, what informed the changes in the coping mechanisms?
vii. Are there challenges faced applying new coping mechanisms? If so, what needs to be done to alleviate the challenges?

5. Climate Change Adaptation mechanisms

i. Whenever you here about climate change, what pictures come to your mind?
ii. In your opinion, what are some of the ways a change in climate is likely to affect the livelihood activities in this area?
iii. What type of interventions would you suggest that could alleviate the effects of climate change in this area?
iv. Have you received any external support to help you cope with the effects of the hazard? What kind of support did you receive?

6. Market Access

i. What are the main market centres in this area?
ii. Are there any challenges faced in assessing the market centres?

iii. What are the main food commodities traded in the markets?
iv. What are the main nonfood commodities traded in the market?
v. Has the trade in the markets changed in the last 30 years? If so, what could be the cause of these changes?
vi. What interventions would you suggest to alleviate the effects of changed in trading patterns in the markets?

Thanks for your time and feedback