

**EFFECTS OF DROUGHT ON HOUSEHOLD LIVELIHOODS AND ADAPTATION  
STRATEGIES IN LAIKIPIA WEST SUB-COUNTY, KENYA**

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of the Degree of Doctor of Philosophy in Geography of Egerton University.

**EGERTON UNIVERSITY**

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## DECLARATION AND RECOMMENDATION

### Declaration

This thesis is my original work and has not been submitted for a degree or any other award in any other University.

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### Recommendation

This thesis has been written under our supervision and submitted for examination with our approval as supervisors.

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## **DEDICATION**

I dedicate this thesis to my late dad David Karanja Gitau and Mum Mary Njeri who sacrificed their time and resources to educate me.

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## ABSTRACT

Prolonged and severe droughts have affected many parts of sub-Saharan Africa, increasing cases of crop failure, hunger and destruction of habitats. Kenya has experienced worse droughts since the turn of the 20<sup>th</sup> century, with increased frequency in the recent decades. This study assessed effects of drought on household livelihoods and adaptation strategies in Laikipia West sub-County. The specific objectives of the study were to: analyze temporal drought trends in Laikipia West sub-County from 1984 to 2014; determine the impact of drought events on household livelihoods; establish the household perceptions to drought disasters; evaluate the household and community drought adaptation strategies and drought adaptation determinants; evaluate the role of institutions in managing local level drought adaptations in Laikipia West sub-County. The study adopted mixed research design where quantitative and qualitative approaches were used. The study utilized three sets of data, rainfall amount data (1984-2014), household surveys (N=196) and key informant interviews (N=8). Standard Precipitation Index, logistic regression, trend analysis, Kendall rank, chi square and percentages were used during data analysis. The severe drought years identified were; 1984, 1985, 1987, 1991, 2005 and 2009. The study also established that the average drought cycle in the study area is 3 years. On drought perception 53% of the households felt that the 2009 drought was moderate, while 47% felt that it was severe. Household drought perception was significantly related to source of income, land ownership and the length of engagement in farming activities. According to respondents, the 2009 drought impacted crops (75%), livestock (78%). Drought adaptations determinants are source of income, land ownership, training on agriculture and age. Household drought adaptation strategies in Laikipia West sub-County are: seasonal migration with animals (25%), search for employment (15%), off-farm practices (15%) and reducing the herd (14%). Community drought adaptation strategies are; stock cereals and grains (27%), change of cropping patterns when drought is predicted (13%) and drilling of boreholes (9%). Both formal and informal institutions perform the following roles: encouraging crop farmers to plant early maturing varieties and advise pastoralist on the need for emergency livestock off takes. The study recommends adoption of drought resistant crops such as sorghum and green grams and early maturing crop varieties. The study also recommends creation of awareness on the need to insure crops and livestock against drought risk. Future studies should analyze the role of indigenous knowledge on drought adaptation strategies in Laikipia West sub-County.

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## LIST OF ABBREVIATIONS AND ACRONYMS

<b>AEZs</b>	Agro Ecological Zones
<b>ASALs</b>	Arid and Semi Arid Lands
<b>ASDSP</b>	Agriculture Sector Development Support Programme
<b>CBOs</b>	Community Based Organizations
<b>CDIDP</b>	County Development Integrated Development Plan
<b>CJPC</b>	Catholic Justice and Peace Commission
<b>CETRAD</b>	Centre for Training and integrated Research in ASAL Development
<b>CIP</b>	International Potato Centre
<b>COPs</b>	Conference of Parties
<b>CWDI</b>	Community Water Deficit Index
<b>ENSO</b>	El Niño Southern Oscillation
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>GDP</b>	Gross Domestic Product
<b>GoK</b>	Government of Kenya
<b>HFA</b>	Hyogo Framework for Action
<b>IFPRI</b>	International Food Policy Research Institute
<b>IOD</b>	Indian Ocean Dipole
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>ITCZ</b>	Inter Tropical Convergence Zone
<b>KALRO</b>	Kenya Agriculture and Livestock Research Organization
<b>KARI</b>	Kenya Agricultural Research Institute
<b>KII</b>	Key Informant Interview
<b>KCCAP</b>	Kenya Climate Change Action Plan
<b>KFSSG</b>	Kenya Food Security Steering Group
<b>KMS</b>	Kenya Meteorological Service
<b>KNBS</b>	Kenya National Bureau of Statistics
<b>KWS</b>	Kenya Wildlife Service
<b>MAM</b>	March April May
<b>MoSSP</b>	Ministry of State for Special Programmes
<b>NALEP</b>	National Agriculture and Livestock Extension Programmes
<b>NEMA</b>	National Environment Management Authority

<b>NCCAC</b>	National Climate Change Awareness Campaign
<b>NCCRS</b>	National Climate Change Response Strategies
<b>NDVI</b>	Normalized Difference Vegetation Index
<b>ODI</b>	Overseas Development Institute
<b>OND</b>	October November December
<b>PCEA</b>	Presbyterian Church of East Africa
<b>PFE</b>	Pastoralist Forum of Ethiopia
<b>REGLAP</b>	Regional Learning and Advocacy Programme
<b>SCC</b>	Small Christian Community
<b>SCF</b>	Seasonal Climate Forecast
<b>SPI</b>	Standard Precipitation Index
<b>TIK</b>	Transparency International Kenya
<b>UN</b>	United Nations
<b>UNDP</b>	United Nation Development Programme
<b>UNFCC</b>	United Nations Framework Convention on Climate Change
<b>UNCDD</b>	United Nations office to Combat Desertification and Drought
<b>UNISDR</b>	United Nations International Strategy for Disaster Reduction
<b>WEDO</b>	Women’s Environment and Development Organization
<b>WMO</b>	World Meteorological Organization
<b>WRMA</b>	Water Resources Management Authority
<b>WFP</b>	World Food Programme



## OPERATIONAL DEFINITION OF TERMS AND CONCEPTS

**Adaptation:** is the process of adjustment to actual or expected climate variability and its effects (IPCC, 2014). In this study adaptation was defined as specific actions taken by households to overcome effects of drought.

**Climate variability:** refers to fluctuations in climatic conditions from the long-term meteorological average over a certain period of time (IPCC, 2014). In this study climate variability is defined as variation in precipitation leading varying levels of drought.

**Community:** social group whose members reside in a specific locality and share government and have a common cultural and historical heritage.

**Community level factors:** refers to social relationships occurring within the neighborhood that influence individual's adaptation to drought.

**Disaster:** It is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses (UN, 2009). In this study focused on the impacts of drought on household livelihoods such as crop failure, loss of livestock, decreased crops and livestock production leading to hunger and increased poverty.

**Drought:** is a deficiency in precipitation below the norm over an extended period of time usually a season or more which results in water shortage. It is classified as meteorological, agricultural, hydrological and socio-economic drought (UN, 2009). This study refer to meteorological drought which is defined by deficiency in precipitation over a predetermined period of time. The SPI value for drought is  $\leq -1$

**Drought adaptation determinant:** These are household socioeconomic characteristics that support or limit the adoption of drought adaptation strategies.

**Drought adaptation strategies:** These are deliberate actions in place to transform drought challenges into opportunities.

**Drought characteristics:** These are elements of drought such as frequencies, quantity and magnitude in Laikipia West sub-County from 1984-2014.

**Drought trend:** This is the graphical representation of the observed drought years from 1984 to 2014 in Laikipia West sub-County.

**Drought tolerant crops:** These are crops that can withstand drought which are sorghum, dolichos and green grams among others.

**Economic effect:** it refers to the consequences of drought on the household income in Laikipia West sub-County.

**Early warning systems:** refers to the set of capacity needed to generate and discriminate timely and meaningful warning information to enable individuals, communities and organizations threatened by hazards to prepare and act appropriately in sufficient time to reduce the possibilities of harm or losses (UN, 2009).

**Effects of drought:** refer to the consequences of drought on livelihoods. In this study consequences of drought was analysed in terms of economic effects which are; herd losses, decreased crop yields, crop failure, decreased milk yield, social effects: Mobility inside and outside the sub County and health effects: livestock diseases, human diseases and malnutrition. These effects were measured in percentages.

**Health effect:** it refers to the consequences of drought on the household health status in Laikipia West sub-County.

**Household:** is used in the study to mean a composition of a person or group of persons residing together within the same compound and has a household head in charge of decision making.

**Household adaptation:** These are deliberate actions that are put by the households to transform drought challenges into opportunities and increase crop and livestock productions.

**Household characteristics:** refers to composition by of household which are; household head, source of income, land size and land ownership.

**Household level factors:** refers to household history and biological factors that influence household behaviour and increase the likelihood of adapting to drought. They include source of income, household size among others.

**Household source of income:** refers to a measure of the combined incomes of all people sharing a particular household. In the study it was operationalized to mean; government employment, business, maize farming, dairy farming, pastoralism and wheat farming.

**Income levels:** refers to an economic measure of a household income. In the study income levels were operationalized as lower, middle and upper income groups.

**Individual level factors:** refers personal history and biological factors that influence how individual behaves and increase their likelihood of adapting to drought. In the study they were operationalized as age, level of education and agriculture training

**Informal education:** refers to acquisition of knowledge without enrolling in a school.

**Institution:** refers to the systems of rules that shape individual and collective decisions and actions. In the study institutions were operationalized to mean non- Government

organizations, elders, church organizations and government of Kenya agencies

**Land ownership:** refers to legal regime in which land is owned by an individual and has legal documents.

**Land size:** refers to the number of acres of land an individual household holds

**Level of education:** It is the level of schooling one has attained. It was operationalized as informal, primary, secondary and tertiary education

**Livelihoods:** is defined as assets and endowment and socio-economic strategies meant to promote or protect household's well-being (Finan, West, Austin, & McGuire, 2002). In this study livelihood refers to crop farming, salary, business and livestock keeping with an aim of getting food and income.

**Perception:** in this study perception is a cognitive process of receiving information on drought and transforming it into response and adaptation strategies. The respondents were asked to describe the recent drought in the area. They described the 2009 drought as severe or moderate.

**Social effects:** refers to the consequences of drought on the social fabric of the community and well-being of the individual and families.

**Agriculture Training:** refers to dissemination of agriculture knowledge to farmers in workshops, trade fair, field day and chief *barazas*.

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

Climate variability is one of the greatest challenges of our time (COP, 2009) and is one of the biggest issues facing the world today (IPCC, 2014). Climate variability is expected to increase the frequency and the severity of extreme weather events, such as extreme precipitation, heat waves, and extreme drought, storms, tornadoes, and hail (Van Dorland *et al.*, 2011). The concerns are on impacts and adaptations of climate variability on agricultural production and water availability because globally agriculture and water availability is strongly influenced by weather and climate. Climate variability is expected to impact on agriculture, potentially threatening established aspects of farming systems (Clark, Gornall, Betts, Burke, Gornall, & Camp, 2010).

Climate variability results in fundamental alterations to ecosystem structures and functions (Melese, Munyae, & Mulinge, 2013). These in turn affects human land-use and livelihoods and have the potential to make pastoralists more vulnerable (Galvin, Thornton, Boone and Sunderland, 2004). Climate change is a major contributing factor to conflicts, particularly those concerning resource scarcity (Boko *et al.*, 2007). In southern Europe crops prevalent such as maize, sunflower and Soya beans could become viable further north and at higher altitudes (Hildén *et al.*, 2005; Audsley *et al.*, 2006). Water is vital to plant growth therefore varying precipitation patterns have a significant impact on agriculture.

Over 80% of total agriculture globally is rain-fed therefore, it is projected that future precipitation changes would reveal the magnitude and direction of climate impacts on crop production (Olesen & Bindi, 2002; Tubiello, Rosenzweig, Goldberg, Jagtap, & Jones, 2002). Drought impacts vary from region to region (Parmeshwar, 2014). For instance in India, climate models generally project a decrease in dry season precipitation and an increase during the rest of the year including the monsoon season, but still with a large inter-model spread (Christensen, 2007). In the decade from 2002-2012 India had three major droughts (2002, 2009 and 2012) with the 2012 drought causing 0.5% reduction in India's gross domestic product (GDP) (Manipadma, 2013). The cumulative damage arising from drought in Thailand between 1989 and 2003 was estimated to be 4474.4 million THB or US \$112 million (Pavelic *et al.*, 2012). In 2010, Thailand faced its worst drought in 20 years resulting in the water level of the Mekong River falling to its lowest level in 50 years (Danny, 2011).

African countries are among the most vulnerable to impacts of climate variability and drought. The drought impacts adversely affect the wellbeing of the population. Drought impacts in Africa are compounded by numerous factors such as poverty, high population density and human diseases. This is expected to multiply the demand for water, food and forage for livestock within the continent in the next thirty years (Okoro, Uzoukwu, & Chiomezie, 2014). Drought is one of the critical natural disasters that adversely affect people, river basins, water resource systems and ecosystems (Jahangir, Sayedur, & Saadat, 2013). Assessment of drought conditions is critical for planning water supplies, irrigation systems, crop and food security program, hydropower generation, water quality management and waste disposal systems (Abad, Zade, Rohina, Delbalkish & Mohagher, 2013).

Africa is affected more severely by drought than any other regions (Yanda and Mubaya, 2011). Increasing rainfall variability and frequent extreme climatic events especially droughts and floods disrupt agricultural production leading to famine and severe loss of livelihoods. Prolonged dry years have reduced the ability of African societies to cope with droughts (Muthui, 2007). Between the early 1970s and the mid 1990s the African Sahel experienced one of the most dramatic long-term changes in climate observed anywhere in the world in the twentieth century, with rainfall declining on average by more than twenty per cent (Hulme, Doherty, Ngara, New & Lister, 2001).

The above period of climatic desiccation was associated with a number of very severe droughts, most notably in the early 1970s and 1980s, during which hundreds of thousands of people and millions of animals died (Glantz, 1976 & 1996). Niger witnessed severe food insecurity in 2001, 2005, 2010, and 2012 that resulted in appeal for international humanitarian assistance and food relief due to drought. Drought was the principle trigger for spikes in food prices and conflicts over pasture and water; it was highly correlated with some crop pests and diseases, and it aggravates mortality and morbidity due to livestock diseases (World Bank, 2013). Drying trends have also been observed in the northern Congo basin and may continue resulting in a transition to savannah in the region (Warren, 2006). In East Africa, it has been projected that water availability will decline due to drought. In addition, there is a likelihood of increased desertification due to decline in precipitation especially during the dry months (Wilby, Orr, Hedger, Forrow & Blakmore, 2006). These climate changes in East Africa will have serious implications for water resources, food security, the spread of disease, the productivity of natural resources, sea-level rise, and desertification. The

people at high risk in times of climatic variability are those living on flood plains, coastal areas, mountains as well as those having no means of adapting to changes (Holmgren & Oberg 2006). Disaster risk management, adjustments in technologies and infrastructure, ecosystem-based approaches, basic public health measures and livelihood diversification are reducing vulnerability, although efforts to date tend to be isolated (IPCC, 2014). According to Kenya National Water Development Report (2006), Kenya has a long history of floods and droughts. Both climatological records and oral knowledge show that the droughts with severe occurrence resulting to both human and ecological impact occurred in the following years: 1928, 1933, 1934, 1942, 1944, 1952, 1955, 1960 and 1965. Over the past 50 years, Kenya has experienced at least one main drought per decade (FAO, 2010). Droughts in Kenya have impacted adversely on rain fed agriculture, water resources, hydropower generation and ecosystems. The agricultural sector alone which contributes to more than 51% of the gross domestic product (GDP) in Kenya (Mwangi, Watterhall, Dutra, Giuseppe & Pappenbenger, 2013) has been critically affected by frequent droughts.

In the recent past, there has emerged a need for perception studies on drought because different people perceive drought differently and derive local adaptation measures based on their individual perception. According to Jones *et al.* (1999) planned adaptation to future climate will be based on current individual, community and institutional behavior. Previous research has shown that individual risk perceptions may deviate considerably from expert risk assessments and that risk perceptions are to a large degree shaped by personal experiences with the hazard (Slovic, 2000). Knowledge about individual perceptions of risk is relevant information for the formation of an effective climate variability adaptation policy for policy makers (Botzen, Aerts and van den Bergh, 2009). Perceptions to climate variability in Kenya differ from one region to the other as reflected in such studies as Byg and Salick (2009), Petheram, Zander, Campbell, High, and Stacey (2010) and Shisanya and Khayesi (2007).

Over 80% of the Kenyan population earns their living through farming and employment in the agriculture sector (Mose, 1999). According to Jaetzold and Schmidt (2011) the main agro ecological zones (AEZs) in Kenya are based on their probability of meeting the temperature and water requirements of the leading crops. The main agro ecological zones refer to potentially leading crops; maize zones, wheat zones, un-irrigated rice zones, irrigated rice zones, sorghum zones, finger millet zones and Cotton in zones while livestock is possible in all zones (Jaetzold, Schmidt, Hornetz, & Shisanya, 2011). Over 80%

of Kenya land mass fall under arid and semi arid lands (ASAL), which are prone to frequent drought. About one third of Kenya's population lives in ASAL and largely depends on rain-fed agriculture as their source of livelihoods. However, most of the agricultural activities are constrained by recurrent droughts (Huhó, Ngaira & Ogindo, 2010). FAO (2010) established that between 1996 and 2010, Kenya had a total of 9 natural disasters and 3 combined natural and human-induced disasters. Over 70% of the natural disasters in Kenya are associated with droughts and extreme weather conditions. The severity and frequency of droughts in the country have been increasing over the years (Wilby *et al.*, 2006).

The human sufferings that accompany prolonged drought provide an indication of the vulnerability of the country to climate variability (Nyongesa, Saumtally & Bindi, 2008). The most recent severe drought by the time of data collection in the study was recorded in 2009. The 2009 drought caused devastation in Kenya's dry lands including loss of beef cattle camels and sheep (KFSSG, 2011). The situation in Kenya is made worse by the presence of over 450,000 refugees who are victims of civil unrest (KCCAP, 2013) who depends on the government support during drought. As an adaptation measure to increasing drought severity in Kenya, subsistence farmers' turn to non-agricultural activities such as burning charcoal and sand harvesting that degrades the immediate environment (Huhó *et al.*, 2010).

There are different individual drought perceptions which consequently lead to different household and community drought adaptation strategies. Such strategies may include: livelihood diversification, selling of livestock, weather predictions, forecasts and warnings, land use planning; water storage among others. Laikipia west sub-County faces frequent drought and occasional flash floods which results in negative socio-economic and environmental effects (Huhó *et al.*, 2010). Economic, social, environmental and health effects of drought and household drought adaptation strategies in Laikipia West sub-County is not well understood. The existing studies on assessment of perception in Kenya have focused on climate variability. There is need for studies that focus specifically on drought perception since perception have an influence on household drought adaption strategies. Understanding the physical nature of drought hazards and the corresponding impacts and underlying vulnerability and communicating these dangers in an effective manner forms the basis for developing informed drought adaptation and preparedness measures to reduce the effects of drought while contributing to drought resilient societies (UN, 2009).

## **1.2 Statement of the Problem**

Frequent droughts have occurred in Kenya in the last 30 years resulting to food insecurity, scarce pasture, loss of livelihoods and human lives. Laikipia West sub-County is more vulnerable to drought because of over reliance on rain-fed agriculture and natural pasture just like most arid and semi-arid parts of Kenya. The major sources of livelihoods in Laikipia West sub-County are maize farming and livestock keeping, sectors that are vulnerable to drought. The proximity of the region to Mount Kenya National Park results to invasion of farms by elephants during drought which lead to crop loses. In addition, frequent land use conflicts between pastoralists and crop farmers in Laikipia West sub-County, usually triggered by drought, motivated the study.

There are national level efforts to mitigate effects of drought in Kenya. These include National Agriculture and Livestock Extension Program (NALEP), food relief, generation and dissemination of climate forecasts, as well as ministerial and institutional (for example National Drought Management Authority) intervention programs such as: *Njaa Marufuku*, ASAL based and rural livelihoods support program, Laikipia Community development assistance among others. Despite these national-level efforts, severity of droughts on household livelihoods such as crop and livestock remain unclear in Laikipia West Sub-County. There is need for an integrative approach that is cognizant of the physical and socio-economic effects of drought in Laikipia West sub-County. Against this background, this study sought to quantify and assess the effects of drought on livelihoods in Laikipia West sub-County. The study also sought to find out the effects of 2009 drought in Laikipia West sub-County and the household and community drought adaptation strategies in place.

## **1.3 Objectives of the Study**

### **1.3.1 Broad Objective**

The broad objective of the study was to make contribution to the understanding of the effects of drought on household livelihoods and adaptation strategies in Laikipia West sub-County, Kenya.

### **1.3.2 Specific Objectives**

- i. To analyze temporal drought trends in Laikipia West sub-County from 1984 to 2014.
- ii. To determine the effect of drought events on household livelihoods in Laikipia West sub-County.



- iii. To establish household perceptions to drought disasters in Laikipia West sub-County.
- iv. To identify the most preferred drought adaptation strategy and adaptation determinants in Laikipia West sub-County.
- v. To evaluate the role of institutions in managing local level drought adaptations in Laikipia West sub-County.

#### **1.4 Research Questions**

The study was guided by the following research questions;

- i. How are the temporal drought trends in Laikipia West sub-County from 1984 to 2014?
- ii. What are the effects of drought on household livelihoods in Laikipia West sub-County?
- iii. How do households in Laikipia West sub-County perceive drought disasters?
- iv. What are the most preferred drought adaptation strategies and adaptation determinants in Laikipia West sub-County?
- v. What is the role of institutions in managing local level drought adaptations in Laikipia West sub-County?

#### **1.5 Justification of the Study**

Drought is the most important agricultural risk with high probability and severity affecting both crop and livestock production (World Bank, 2013). Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability (IPCC, 2014). There is need to quantify drought according to severity, frequency, magnitude and spatial distribution and its effects on agriculture and livestock (Recha, 2013). Analysis of drought characteristics in Laikipia West sub-County is meant to identify, classify and quantify seasonal and annual drought years in the sub-County between 1984 and 2014. The study also assessed household perceptions and factors influencing their perception to drought which is important in understanding household drought adaptation strategies. Research shows that any attempts to elicit adaptive behaviour patterns should come after understanding how climate variability is perceived by stakeholders and what shapes their perceptions (Diggs, 1991; Shisanya & Khayesi, 2007; Slegers, 2008; Weber, 2010).

The Ministry of Special Programs drafted a National Disaster Management Policy that established the guiding principles and institutional framework for disaster management in Kenya (MOSSP, 2010). The policy stipulates that communities will be involved in designing, management, implementation, monitoring and evaluation of disaster management programs (TIK, 2012). Evaluation of drought adaptation determinants and drought adaptation strategies in Laikipia West sub-County provides an understanding of household and community drought adaptation strategies during drought. The study provides understanding of the factors influencing adaptation strategies across the households. The result on adaptation strategies and determinant is expected to inform the Ministry of Environment and Natural Resources on existing drought adaptation strategies in Laikipia West sub-County that can be used as a bench mark when assessing the implementation of the National Climate Change Response Strategies in Kenya (2010) and National Climate Change Act 2016. The study further contributes to the nation food security goal on the improvement of research and extension services and improving their linkages.

Evaluation of the role of institutions is expected to improve the understanding of the role played by various institutions in managing local level drought adaptation in Laikipia West sub-County. While drought adaptation efforts frequently focus on the technical and managerial aspects of drought planning and response, there are frequent acknowledgements of the need for additional research to improve understanding of how the broader system of institutional frameworks, social networks, and stakeholder values and beliefs affect society's capacity to manage drought (Lackstrom, 2015).

## **1.6 Scope and Limitation**

Climate variability variables include drought, within season dry spells, onset, cessation, rainfall amount and intensity among others that negatively affects livelihoods. In this study, drought was chosen because it has been a major threat to households' livelihoods in Kenya in the last 30 years (Huho *et al.*, 2010). The study assessed the effects of drought on household livelihoods. The effects of drought were divided into two categories. The first category was on the direct effects of drought on household livelihood which was limited to the effects on crops and livestock. The second category was on indirect effects of drought on household wellbeing which was limited to environment, social and health effects. For instance, drying of rivers increases the distance to the water points which consume

households' time in accessing the resource. The time spent on getting water could have been utilized on generation of income. The effects of drought and adaptation strategies were limited to 2009 as it was the most recent severe drought at the time of conceptualizing the study, and therefore respondents were more likely to recall. Literature showed that it is easier for farmers to recall more recent and/or extreme events than older or moderate ones (Taylor, 1988).

Data on the number of households was based on the records kept by the Kenya National Bureau of Statistics. The administration of questionnaires targeted the household heads. In the study the household head was the senior most persons present in the household during the time of data collection. The household was selected as the main unit of analysis because major effects of drought are more severe at household level and decisions about adaptation to climate-induced stresses and livelihood processes are taken at that level (Thomas, 2008). The study also focused on the community level because the Hyogo framework for Action (2005-2015) emphasizes the need for the study on effects of drought and adaptation strategies at the community level. From the earlier study it was noted that disaster effects ratios increase as the unit of analysis moves from the national to the regional, community and household levels (CDRSS, 2006).

Rainfall data was collected from WRMA rainfall stations for 30 years (1984-2014). The 31 year was chosen because it is the minimum recommended period for climatological analysis (WMO, 2012). There were Rumuruti, Nyahururu, Mokogondo forest, Thomson falls and Ndaragwa rainfall stations within the study area. However, only data from Rumuruti and Ndaragwa stations were used. Rainfall data from Mokogondo, Thomson falls and Nyahururu stations were found to be inadequate to support a climatological analysis given the gaps found. Laikipia West sub-County was chosen as the study area due to the variation in livelihood options from humid mixed livelihood zones and sub-humid agro-pastoralism livelihood zone. The choice of Laikipia West sub-County was informed by the fact that, drought effects on household livelihood and adaptations strategies vary with the households source of livelihoods. Although Ndaragwa station is not within the study area it was used due to its proximity to Mutara a location within the study area and could have significant effect on the livelihood activities in the location.

Analysis of effects of drought on crops and livestock was limited to household survey data. This was in part attributed to lack of livestock data from Laikipia West Sub County

Livestock department. Notwithstanding, households information on effects was deemed sufficient for a perception study as it gives the direction on the most affected livelihoods. There are different methods of analyzing and quantifying drought based on type of drought (WMO 2006). In this study, the focus was on meteorological drought because it has a direct effect on crops and pasture in the study area. The level of education among household was a challenge during data collection exercise. This caused delays during data collection process. The delays were occasioned by difficulties in reading the questions among households and required explanations at every stage.

### **1.7 Assumptions of the Study**

The study made the following assumption

- I. Rainfall is the most significant climate element (relative to other climate elements) that affects livelihoods; notably maize and livestock in Laikipia West sub-County
- II. The people of Laikipia West sub-County are engaged in adaptation practices to cushion themselves from the effects of drought
- III. Information collected from the respondent was accurate and relevant to the study

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1 Introduction

This chapter interrogates relevant studies on global drought characteristics and trend, effects of drought on resources and livelihoods, perception of climate variability and associated effects, household adaptations to drought, drought disasters and preparedness, institutional components of drought adaptations, theoretical framework and conceptual framework.

#### 2.2 Global Drought Characteristics and Trend

Drought occurs in every part of the globe and adversely affects the lives of a large number of people, causing considerable damage to economies, the environment, and property (Ominijo and Okogbue, 2014). Globally, drought has become more frequent and severe (Wambua, Mutua and Raude, 2014). Drought characteristics and impacts vary significantly from region to region (Wilhite, 1997). The magnitude of drought is indicated by extend with which it falls below a threshold level over an extended period of time (Morid, Smakhtin and Bagherzadeh, 2007). The magnitude and location of drought events in Jordan varies by the season and months and tends somehow to increase with time (Al-Qinna *et al.*, 2010). Droughts tend to be more severe in some areas than in others (Ominijo and Okogbue, 2014). The severity and frequency of droughts in Kenya have been increasing over the years. Some of the recognizable droughts events include 1952-1955, 1973-1974, 1983-1984, 1992-1993, 1999-2000 and 2009-2011 droughts (Wilby, Hedger, Forrow and lakmore, 2006). The severity of drought is gauged by the degree of moisture deficiency, its duration, and the size of the area affected. If the drought is brief, it is known as a dry spell, or partial drought. A drought spell is usually defined as more than 14 days without appreciable precipitation. Near normal dry or mild drought was predominant in the 100 years of study.

Mild drought has the highest number of occurrence in the northern Nigeria (Ominijo and Okogbue, 2014). Droughts events in Jordan were observed in 1970, 1973, 1977, 1978, 1979, 1982, 1984, 1986, 1993, 1996, 1999, 2000, 2001 and 2004 (Al-Qinna *et al.*, 2010). Iran experienced recurring drought events leaving an estimated 37 million (over half the country's population) vulnerable to food and water shortage. Twenty provinces experienced precipitation shortfalls during winter and spring (Agrawala *et al.*, 2001). Extreme drought

events were documented in 1964, 1983, 1997, 2005 and 2010 in Amazon basin, with great impacts on the population and ecosystems (Tomasella *et al.*, 2013). In addition, severe flooding episodes have been documented in 1954, 1989, 1999, 2009, 2011 and 2012 in the Amazon (Marengo, Tomasella, Soares, Alves and Nobre, 2011). Droughts in many parts of the world are part of normally occurring inter-annual climate variations, and although El Niño events may cause or intensify drought conditions, many droughts are independent of the El Niño phenomena. This variable as a cause of drought is exemplified in Southern Africa, where there is a strong correlation between the ENSO and rainfall patterns (Wright 1977), but not all droughts are correlated to ENSO events and conversely not all ENSO events result in drought conditions. According to Muga (2010) inter-annual climate variability (ENSO) has huge impacts on the African climate. Warm ENSO events also referred to as El Niño events produce abnormally high amounts of precipitation in parts of equatorial Africa.

According to IPCC (2007) East Africa has been faced by large variability in rainfall with occurrence of extreme events in terms of droughts and floods. The region has experienced droughts in the last 20 years -1983/84, 1991/92, 1995/96, 1999/2001, 2004/2005. El-Niño related floods of 1997/98 were a very severe event enhanced by unusual pattern of SST in the Indian Ocean. The El Niño in 1997/98 and La Niña in 1999/2000 were the most severe in 50 years. A frequency distribution analysis of seasonal or annual rainfall amounts is of great value giving estimates of probabilities of having more (or less) rainfall than certain specified amounts (Tilahun, 2006). According to Williams and Funk (2011) global temperature have grown more positive and convection and rainfall have increased over the Indian Ocean in recent decades, precipitation totals during the long-rains season in eastern Africa have declined. In Ethiopia and Kenya, which are reasonably well instrumented with meteorological stations, precipitation declines have been most severe in the central and eastern regions.

It has been documented that in sub-Saharan Africa, eight major droughts have occurred in the last four decades: 1965/66, 1972/74, 1981/84, 1986/87, 1991/92, 1994/95, 1999/2001 and 2005/06 (Nikola, 2006). According to the National Environmental Management Authority's, Kenya (NEMA, 2010) serious droughts have occurred at least 12 times in the past 50 years in Kenya. Drought occurs as the result of large inter-annual and seasonal variability in precipitation (Boochabun, *et al.*, 2004). Drought occurs mainly due to uneven distribution of rainfall over an area within a year or within a rainy season

(Limpinuntana, 2001).

Assessment using SPI and NDVI in Jordan showed that the country, during the past 35 years, faced frequent non-uniform cycles of drought/wet periods in an irregular repetitive manner. Drought seasons appear in a random fashion of either short or long life span from one to three consecutive years. Obviously, the severity of the observed drought incidences increases in both magnitudes and life span by time from normal to moderately severe level and one exceptional extreme drought level during 1999–2000. Drought in Jordan act intensively during January, February and March and shift its position with time by alternative migrations from the southern desert parts to northern desert parts and from the eastern desert parts to highlands and JRV at the west (Al-Qinna *et al.*, 2010). In the Sahel region dry conditions occur during periods in which the southern hemisphere oceans and northern Indian Ocean are warmer than the remaining northern hemisphere oceans, and it is a shift to such a pattern of global temperature distributions that is now widely accepted as being responsible for the turn towards aridity in the Sahel from the late 1960s (Giannini, Saravanan & Chang, 2003).

### **2.3 Global Effects of Drought on Resources and Livelihoods**

Drought is a form of environmental stress that originates from a deficiency in precipitation over an extended period of time long enough to cause moisture deficiency, biotic loss, crop failure, loss of lives both human and bovine and general hardships (Ngaira, 2004). Drought is a deficiency in precipitation or a departure from expected or normal rainfall conditions and a naturally part of climate variability (Lackstrom, 2015) that affects a greater part of Laikipia West sub-County. Drought can be said to occur when rain falls below half the long-term average or when rainfall in two or more successive years falls 75% below average (Pratt, Le Gall & De Haan, 1997). Droughts have direct and indirect effects on livelihoods especially where they are weather dependent. Prolonged droughts in the food-insecure regions may cause famine, epidemics, and deaths, generate water crisis due to drying up of perennial streams, food security and overall economic development (Karim & Rahman, 2014). Drought is one of the major threat among natural hazards to peoples livelihood and social economic development (UN, 2009) it affects grasslands causing massive livestock and wildlife deaths and an increase in human to human and wildlife to human conflicts (GOK, 2010). Despite the growing understanding and acceptance of the importance of disaster risk reduction and increased disaster response capacities, disasters and in particular the

management and reduction of risk continue to pose a global challenge (HFA, 2005). Disasters triggered by prolonged drought in developing countries can severely harm countries to malnutrition, famine, loss of life and livelihoods, emigration and conflict situation; whereas drought in developing countries primarily results in economic losses (UN, 2009).

Disasters induced by drought account for about 90% of all disasters in the horn of Africa (UNISDR, 2012). In the Asian region, in particular India and China drought disasters recorded the largest number of human death from 1980 to 2006 (UN, 2009). The East African region is prone to natural disasters such as floods, drought, landslides, strong winds, lightening and their secondary impacts such as diseases and epidemics. Drought and floods are the most common in the East African region (UNISDR, 2012). In West Africa, disasters triggered by natural hazard event have increased in occurrence and severity over the last decades. Impacts of disasters have resulted into high vulnerability of West African people and slow down the process of sustainable development to achieve the millennium development goals in the sub region (UNISDR, 2012). Drought has been a severe challenge faced by many crop and livestock producers in the United States in 2011 and 2012. Nearly 80% of United States agricultural land experienced drought conditions during the summer of 2012, the effects of which exacerbated the initial drought impacts of 2011 and are expected to be felt for years to come (Wallander, Aillery, Hellerstein, and Hand, 2013).

Drought is one of the major scourges of humanity with its devastations manifested in form of negative economic effects, massive malnutrition, human miserly and death to both livestock and people. While drought effects are often measured in terms of economic losses such as crop failure and livestock losses, drought conditions are also associated with decreased levels of employment, income, nutrition, and health (Chagnon, 2000; Glantz, 1994; Vogel, 1995). The extension of agriculture push pastoralist to historically marginal areas in the Sahel region. These led in massive loss of livestock, the destruction of communities and livelihood systems, and massive societal disruption on a regional scale in the Sahel (Keita, 1998). According to a study by Marshall and Hildebrand (2002) in North Africa, pastoralism was the most sensible and viable option in the unpredictable northern African environment, where reliable supplies of large quantities of permanent water simply did not exist. Far from being a poor substitute for agriculture or urban living, or the result of a backwardness that prevented the peoples of the time from advancing, pastoralism was a superior system for ensuring food security in the African environment.



Pastoralism is widely practiced today and remains a dominant feature of rural East Africa in which most households sustain their means of livelihood from keeping livestock (Anderson & Mowjee, 2008). However, it is practiced under marginal circumstances and high production risk because of different natural and man-made factors (Bekele & Amsalu, 2012). Since much of the pastoral household's consumption requirements are derived from livestock or exchange with livestock products, loss of livestock due to drought is a serious risk for the livelihoods and socio-cultural fabrics of the pastoral households (Aklilu & Alebachew, 2009). Household herd size has extremely declined from time to time because of the related effects of the drought such as lack of pasture and water, emaciated body condition, susceptibility to disease, death, low production, productivity and reproduction rate, and reduced pastoralists' terms of trade. In addition, increased severity and frequency of drought has affected pasture seed bank, reduced germination, growth, sprouting and regeneration capacity of nutritious grasses, bushes and herbaceous pasture in an alarming rate (Bekele & Amsalu, 2012). Globally, El Niño-related droughts, when coupled with high temperatures and abnormal rainfall distribution, produce lower than average yields of rice, maize, wheat and other agricultural products (Allen, 1996). The severity of drought has posed serious pasture and water scarcity (Bekele & Amsalu, 2012). Water is the most fundamental physical capital that has shaped pastoral society (Helland, 1997; Cossins & Upton, 1987).

According to Alcamo *et al.* (2007) decreased crop production in some Russian regions could be compensated by increased production in others, resulting in relatively small average changes. However, their results indicate that the frequency of food production shortfalls could double in many crop growing areas in the 2020s, and triple in the 2070s. Although water availability in Russia is increasing on average, the water resources model predicted more frequent low run-off events in the already dry crop growing regions in the south, and a significantly increased frequency of high run-off events in much of central Russia (Alcamo, Dronin, Endejan, Golubev & Kirilenkoc, 2007).

According to Li, Wang and Yan (2009) 60–75% of observed yield reduction rates can be explained by a linear relationship between yield reduction rate and a drought risk index based on the present day severity index. Present-day mean yield reduction rate values are diagnosed as ranging from 5.82% (rice) to 11.98% (maize). By assuming the linear relationship between the drought risk index and yield reduction rate holds into the future. Li *et al.* (2009) estimated that drought related yield reductions would increase by more than

50% by 2050 for the major crops. According to Tilahun (2006) it is essential to take into account the unique rainfall characteristics of arid and semi-arid lands so as to be able to optimally utilize the low rainfall areas for agricultural purposes. Drought sets a vicious cycle of socio economic effects beginning with crop failure, unemployment, erosion of assets, decrease in income, worsening of living conditions, poor nutrition, and subsequently, decreased coping capacity, and thus increasing vulnerability of the poor to another drought and other shocks as well as the risk of political instability (UNISDR, 2012). The situation is made worse by the ever increasing world population. The impact of rapid population growth on food security has received considerable attention over the past decades (Pinstrup-Anderson, 1995). Population growth continues to out-strip food availability in many countries and evidence from many developing countries indicates that countries with high population growth are the same countries suffering from acute food insecurity (FAO, 2009). Droughts of the 1980s and 1990s resulted in reduced livestock production and maize yields (Harsch, 1992; Laing, 1992), including a 50% crop failure in one region of South Africa (Vogel, 1995).

According to IPCC (2014) climate variability and extremes have long been important in many decision-making contexts. Climate-related risks are now evolving over time due to both climate variability and development. According to Sokona and Denton (2001) climate variability is already exerting control over development progress, including efforts to address food security and poverty alleviation in sub-Saharan Africa. On many occasions extreme climate variability events leave vulnerable people in Africa and indeed in other regions of the world totally unprepared and unable to cope. Climate change accentuates the gaps between the worlds rich and poor. An estimated 17.5 million people are food insecure in Kenya, Ethiopia, and Somalia, the US government has spent over \$1.1 billion on food aid in these countries since 2009. Food balance modeling suggests that this insecurity stems (in part) from stagnating agricultural development, population growth, and recent drought (Funk, *et al.*, 2008; Funk & Brown, 2009).

In many societies vulnerability differs between men and women. Women are vulnerable to environmental changes because of their responsibilities in the family, which are exacerbated by the impacts of climate variability. Since access to basic needs and natural resources, such as food, water and fuel, becomes hampered, women's workload has increased (Dankelman *et al.*, 2008). As drought hits, women's role become harder. They have to walk

further to find water and other resources and at the same time there is less food and they miss out a meal in order that children feed (REGLAP, 2011). There is accepted view in the developing world that women are amongst the poorest and most disadvantaged group in the society and 70% of the 1.3 billion people in the developing world living below the poverty threshold are women (Sokona & Denton, 2001) making them the most vulnerable group. The climate of East Africa is characterized by a great spatial variability, ranging from arid and semi-arid to sub humid and humid conditions. Rainfall is highly variable yet it supports farming and environmental system in the region (UNISDR, 2012). According to Kettlewell, Sothern & Koukkari (1999) the proportion of total rain falling in heavy rainfall events appears to be increasing, and this trend is expected to continue as the climate continues to warm. Soil moisture management in semi-arid and arid areas of the tropics is faced with limited and unreliable rainfall and high variability in rainfall pattern.

According to Mpandeli and Maponya (2014) Sekhukhune District in Limpopo Province South Africa, low rainfall results in decreases in agricultural activities including shortage of drinking water, loss of both livestock and crops and also lack of grazing capacity. According to Pachauri (2004) a decline in agriculture production would have serious implications on the rural populations and this would lead to food insecurity, reduced income and livelihoods of the poor. In recent years, food production has lagged far behind population growth in nearly two thirds of developing countries (FAO, 2007). The Sub-Saharan region was hard hit as food production fell in 31 of the 46 African countries (FAO, 2005).

#### **2.4 Effects of Drought on Livelihoods in Kenya**

Kenya has a landmass of about 582,350 km<sup>2</sup> with only 17% of arable land while 83% consists of arid and semi-arid land (NCCRS, 2010). Climate-driven changes affect resources critical for economic development of Kenya. An example is the 1999/2000 La Niña droughts, which left approximately 4.7 million Kenyans facing starvation (NCCRS, 2010). Drought has become a perennial problem in Kenya with chronic vulnerability being concentrated in ASALs. With decreasing rainfall reliability, famine cycles have reduced from 20 years (1964-1984) to 12 years (1984-1996), to two years (2004-2006) and to yearly (2007/2008/2009/2010/ 2011) (GoK, 2010). During the 1971-1974 droughts the Kenya nomads suffered heavy losses, and the subsequent famines were compounded by an outbreak of cholera and high incidence of malnutrition (Wisner 1977). The 2008-2009 droughts in Kenya left 3.8 million pastoralists and agro-pastoralists in dire need of food relief and 1.5

million primary school children required feeding in the schools (KFSSG, 2009). Many children and women starved in dry lands and others continued to suffer malnutrition due to lack of balanced diet, especially milk and meat which is their main diet, as men left with their herds to look for pasture and water. The poor households in urban areas suffer the effects of drought due to escalation of food prices (KFSSG, 2009).

According to PFE (2007) pastoralism is a livelihood system and way of life practiced by people dwelling in arid and semi-arid environments, using mainly traditional knowledge to optimize the interaction between humans, the environment and livestock. Pastoralists are people who primarily derive their living from the management of livestock (sheep, goat, camel and cattle) on rangelands. According to Opiyo, Wasonga and Nyangito (2014) drought was one of the most frequent hazards among pastoralist in Turkana, in addition to other hazards such as conflicts, disease outbreaks and flooding. The people who are already poor in this remote part of the Kenya are struggling to cope with the added burden of increasingly unpredictable weather, which is triggered by climate variability. Drought affects grasslands causing massive livestock and wildlife deaths and an increase in human-human and wildlife-human conflicts. Cases of conflict have been reported in areas around the Lower Tana Delta, Laikipia, and Lagdera. In Lagdera in 2005 warthogs attacked and killed goats and sheep to drink their intestinal fluids after the warthog's natural watering points dried up (NCCRS, 2010).

Satellite assessment on Kenya forests indicate that, between 2000 and 2007, Kenya lost 72% of its indigenous forests (GoK, 2009). It is therefore possible that the severity of drought in Kenya in 2009 and 2011 may have been, to some extent, attributed to the effects of devastating forest losses in the 2000-2007 period when the Country lost 72% of its forest cover. The projected rise in temperature and long periods of drought will lead to more frequent and intense forest fires. Major rivers flowing from the major water towers in Kenya including the Tana, Athi, Sondu Miriu, Ewaso Ngi'ro and Mara experience severe reduced volumes during drought and many seasonal ones completely dry up. The parts of the country mostly affected are the Eastern, North Eastern and parts of the Rift Valley region (NEMA, 2010). According to Karanja (2013) there is significant relationship between rainfall characteristics and potato production in Oljoro-orok division, Nyandarua County. It is important to understand the nature of variability of rainfall so as to be able to optimally utilize the low rainfall areas for agricultural purposes. According to Kipkorir (2002) rainfall

is the most important environmental factor limiting agricultural activities in arid and semi-arid regions of the tropics. Although irrigation is believed to be an important strategy in alleviating the current food crisis, rain-fed agriculture is still the dominant practice in most developing countries.

According to Gullet, Asha, Ahmed and Mwangi (2006) prolonged periods of high temperatures and increasingly poor rainfall in Kyuso district, Kitui County were primarily responsible for the surge in crop and livestock diseases, total crop failure, livestock deaths, increased food insecurity as well as rising poverty levels. In addition, there has been a notable increase of drought in terms of frequency, duration and intensity. Any damage caused by drought on agriculture and water resources leads to famine, humanitarian crisis, rationing of water supply and decline in hydropower generation. Effective drought forecast allows water resource decision makers to develop drought preparedness plans. Such plans are critical for advance formulation of programs to mitigate drought-related environmental, social and economic effects. Therefore, accurate drought assessment and forecasting with an adequate lead time is paramount for formulation of mitigation measures in river basins (Sharda, Srivasta, Kalin, Ingram & Chelliah, 2012).

## **2.5 Perception of Climate Variability and Associated Effects**

Drought adaptations depend on how it is perceived at household level. The way local communities perceive drought influence their adaptation strategies. Different people perceive drought differently and derive local adaptation measures based on their individual level perception. Research shows that any attempts to elicit adaptive behavior patterns should come after understanding how climate variability is perceived by stakeholders and what shapes their perceptions (Diggs, 1991; Shisanya & Khayesi, 2007; Slegers, 2008; Weber, 2010). Lack of understanding or poor perception of climate variability risk relative to other risks among a large part of the population may lead to mal-adaptation (Leiserowitz, 2005; Weber, 2006; Reynolds, Bostrom, Read & Morgan (2010). Tschakert (2007) characterized the understanding of climate variability and change in the context of multiple livelihood risks. Research findings underline the importance of tackling both climatic and non-climatic conditions in enhancing adaptation.

According to Shisanya and Khayesi (2007) residents of Nairobi do not perceive climate change as being a significant problem when compared to other socio-economic

problems such as corruption, unemployment, crime, garbage and poverty. Understanding individuals' perceptions of, or concern about, extreme weather events is very important for designing and implementing climate adaptation policies. Individual judgments of climate change-related risks can determine the perceived legitimacy as well as compliance with adaptation policies (Peacock, Brody & Highfield, 2005). Climate variability is a complex problem for individuals (Swim, Clayton, Doherty, Gifford, Howard, Reser, Stern and Weber (2011), which implies that understanding the cognitive dimension and perceptions is very important for climate variability adaptation. The absence of perceived importance to the public and lack of public awareness or demand to take action are the main hurdles to implementation of adaptation projects (Archie, Dilling, Milford, & Pampel, 2012).

Individual perceptions of natural hazards are important factors influencing decision-making mitigating these risks (Burn, 1999; Flynn, Slovic, Mertz, & Carlisle., 1999). For example, high flood-risk perceptions of individuals are related to a high demand for flood insurance (Botzen & van den Bergh, 2012). Similarly to the household level, perceptions of extreme weather risks at the organizational level can be expected to be an important factor influencing the resources that an organization is willing to devote to drought adaptation. According to Vasileiadou and Botzen (2014) individuals who have experienced an intense, life threatening event have a significantly higher level of concern than those without such an experience. This suggests limited intervention possibilities for communication of adaptation, as well as for raising support for adaptation measures. Framing adaptation measures in relation to personal circumstances and emotions during extreme events could help raise concern about extreme weather events, as well as societal support for adaptation measures.

According to Recha (2013) the term climate change was very familiar with the participants in Tharaka as they had heard it from the radio and agricultural officers. There was unanimous agreement that there was climate change in Tharaka and this was attributed to cutting of trees which had a cooling effect on the environment. According to Ndambiri, *et al.* (2012) majority of the farmers were well aware that climate was changing and it was the cause of the recurrent droughts that were ravaging the district. Majority of the farmers noted that there was an increase in temperature, extended periods of temperature, a decrease in precipitation, changes in the timing of rains and an increase in the frequency of droughts. According to Hudson (2002) farmers' perceptions of drought effects on livestock prices vary widely. Although about 33% of the commercial and 20% of the communal farmers report that

drought has no effect on livestock prices, most farmers think that livestock prices fall from 10% to 50% during drought. On the average, commercial farmers report that cattle prices decrease about 15% during drought conditions, and communal farmers report an average decrease of 27%. Due to the lower market prices of livestock, many commercial farmers do not sell animals in drought conditions unless they can receive the normal price for their animals.

## **2.6 Household Adaptations to Drought**

Drought is a serious global concern and a threat to food security for the rising global population. While change in mean climate will have significance for global food production and may require ongoing adaptation, greater risks to food security may be posed by changes in year-to-year variability and extreme weather events. According to FAO (2008) the current farming systems in the world today are adapted to local climate due to climate variability. While coping strategies usually refer to short-term activities, they can be expanded for use in the longer term. Adaptation strategies refer to all those responses to climatic conditions that may be used to reduce vulnerability (IPCC, 2001; Adger, Kelly, Winkels, Huy & Locke, 2002). Adger *et al.* (2002), argue that adaptation will allow a system to reduce risks associated with hazards by reducing its social vulnerability. What constitutes extreme weather depends on geographical location. For example, temperatures considered extreme in a region would be considered normal in other regions. Adaptation is critical in protecting livelihoods and food security in many developing countries. It involves all actions aimed at adaptations to drought that cannot be avoided and at reducing their negative effects.

In many regions, farmers may adapt to increase in extreme temperature events by moving to practices already used in warmer climate. Even though uncertainties around these projections are considerable, adaptation to extreme events is considered a priority, given the potentially high costs of damages from extreme weather and climate variability (van Dorland *et al.*, 2011). An important issue is how to raise an adequate level of concern among individuals, policy makers, and broader decision makers in companies and organizations so that adaptation to extreme events becomes mainstream practice. Although some decision makers are proactive about adaptation to extreme events, it seems to be a low urgency and low priority policy option for many others (Bulkeley, 2010). The primary coping strategies for drought occurrence as reported by farmers in the North West province, South Africa

include selling animals, buying fodder, obtaining grazing rights in additional pastureland, feeding crops to animals which would otherwise be sold for cash, and combinations of these strategies. Most commercial farmers who have a drought strategy report that they will sell livestock to decrease their herd size thereby conserving their resources, and most communal farmers report they will buy fodder or only sell enough animals to buy fodder (Hudson, 2002).

According to IPCC (2014) adaptation is becoming embedded in some planning processes, with more limited implementation of responses. Engineered and technological options are commonly implemented adaptive responses, often integrated within existing programs such as disaster risk management and water management. There is increasing recognition of the value of social, institutional, and ecosystem-based measures and of the extent of constraints to adaptation. Adaptation options adapted continue to emphasize incremental adjustments and co-benefits and are starting to emphasize flexibility and learning. Most assessments of adaptation have been restricted to impacts, vulnerability, and adaptation planning, with very few assessing the processes of implementation or the effects of adaptation actions.

According to Aerts, Botzen, Bowman, Ward, and Dircke (2011) several climate variability adaptation plans are currently being designed and implemented by national and local governments. Individual citizens and decision makers in the private sector play a key role in such plans for the support and implementation of climate variability adaptation measures. Drought adaptation strategies may vary from one household to the next, from one community to the other and from one social class to the other. According to Mpandeli (2006), commercial farmers most of the time have wide choices during drought than subsistence and small-scale farmers. Due to the fact that majority of the commercial farmers have strong financial backups, they also have good infrastructure especially irrigation systems such as Centre Pivot and drip irrigation system. According to Aerts and Botzen (2011) on increasing resilience of New York City to flooding and climate variability stricter flood-resistant building codes and inclusion of climate variability risks in urban planning should be considered.

According to IPCC (2014) due to frequency of shocks in the dry land communities, adaptive or coping capacity and mechanisms adopted by vulnerable households could well have equal or larger ranges to that of exposure and sensitivity. Some smallholder farmers in



Zimbabwe, for example, have been known to sell their livestock to compensate for lack of income because of insufficient harvest (Phillips *et al.*, 1999; Adger *et al.*, 2002; Patt and Gwata, 2002). In South Africa one of the coping strategies frequently used by farmers is to shift to crops that require less water such as sorghum (Annandale, Jovanovic, Mpandeli, Lobit, & Sautoy, 2002). The problem with such a strategy is that majority of farmers in South Africa have very limited access to technology, market access and farm inputs (Vogel, 2000; Ziervogel and Downing, 2004).

According to Oba (2001) on how seven major pastoral groups in the northern part of Kenya adapt to drought difficulties, nomads begin to move herds to dry season pastures earlier than usual and the livestock remain there as long as the drought lasts. This involves selective access to cross sub-sections and cross border rangelands. In the second phase, family herds are divided into smaller but specialized units. Those with long watering intervals are moved further away from the wells than those requiring more frequent watering. Young men scatter in every direction with these small units in search of fresh pastures and water. Thus, mobility is intensified. Young herders go to kinsmen and friends to beg for access to grazing land.

According to Gulliver (1951) during 'drought stress' threat period a herd owner may have to reduce the number of people dependent on the livestock for food. The women, children and the elderly are moved out of their homesteads and sent away to live with kinsmen and allies in towns and farming villages. This enables herders to migrate further away from home in search of forage and water. It also helps to reduce the number of people dependent on pastoral production, and thus saves milk for calves. This helped to improve the survival rate of calves. Systematic culling and sale of livestock also helped keep livestock numbers down as well as generating a cash income they could use to buy food (Gulliver, 1951). Apart from relying on kinsmen for food, the nomads would trade, farm and take up wage employment temporarily as they waited for rains to restore pastures and allow them to return to full-time pastoralism. These strategic responses have also been documented in recent research carried out by Barton *et al.* (2001).

There was evidence that during and after the 2005-2006 drought and famine, herders joined together in corporate groups and pooled their surviving stock in order to exploit economies of scale. The respondents said that once the livestock had been pooled, they were left in the hands of few selected men or families in the pasturelands as the rest moved in

search of food. Migrants had similarly left their families and livestock with kinsmen and neighbors or friends as they went out in search of employment and other income generating activities (Juma, 2009).

## **2.7 The Institutional Components of Drought Adaptations**

The term “institution” refers to the systems of rules that shape individual and collective decisions and actions. In addition to the formal aspects of institutions (e.g., policies, regulatory frameworks, legislation, organizational arrangements), institutions also entail social practices and relationships, underlying values and norms that shape behaviors and routinized activities that emerge and are reproduced as actors follow rules (March & Olsen, 1989; O’Riordan & Jordan, 1999; Scott, 2008; Young, 2002). As institutions mediate how societies govern climate risks and manage responses to environmental and social change, understanding how institutions can contribute to more proactive management strategies is a particularly salient topic for the drought planning community (Wilhite, 2005). Institutions are both important component of adaptive capacity and can act as barriers to climate adaptation efforts. Having other components of adaptive capacity (for example material assets, technology infrastructure, or economic resources) does not necessarily translate into action if institutional capacity does not exist (Eakin *et al.*, 2014; Gupta *et al.*, 2010; McNeeley, 2014; Moser & Ekstrom 2010).

Laikipia West sub-County is a multiethnic society, making it unique due to culture, social and economic dynamics. Understanding the role of institutions in managing local level drought adaptation is important due to different beliefs and traditions of the people that shape their day to day decision making. The high rate of population growth in Laikipia West sub-County has implications for pressure on scarce pasture and land resources (Mkutu, 2001). The dry conditions in Laikipia West sub-County accelerated fights and theft which further led to conflicts (Mwangi, 2012). According to Mkutu (2001) violent conflict in the pastoral areas can be caused and aggravated by a number of factors including the existence of intensified cattle rustling; small arms proliferation; inadequate state security policies; weakening, undermining of, or inadequate engagement with, traditional governance systems; inappropriate government development policies; inadequate land tenure policies; political and socio-economic marginalization of pastoralists; and inadequate arrangements to cope with drought. In Laikipia West sub-County occurrences of such conflicts have been largely connected with competition resources and drought (Maina, 2000). This has resulted into

human deaths, lack of peace, injustice, displacement of persons, and loss of property, underdevelopment and general disorientation of people's living patterns (Kinoti, 1994). The conflict in Laikipia West sub-County has often pitted the farmers against pastoralists and private ranch owners (Mwangi, 2012). Drought in Laikipia West sub-County leads to conflicts and therefore understanding of drought adaptations strategies offers avenue for alternative dispute resolution mechanism.

According to Akerlund (2001) the church and Church- Based Organizations (CBOs) such as Caritas, Diakonia, Inter-life, Church of Sweden, Swedish Mission, Covenant Church, Swedish Ecumenical Women Council and Swedish Mission Council have been involved in peace building processes in areas affected by conflicts in Africa. According to Mwangi (2012) the Catholic Church has set up an elaborate network of more than 700 Small Christians Communities (SCCs) in Laikipia West sub-County. These SCCs have representatives of the Catholic Justice and Peace Commission (CJPC) which is an arm of the Catholic Church that promotes civic education, conflict resolution and democracy. The CJPC representatives gather all the information regarding conflicts and other issue such as drought and relay them to the national office who responds by giving out food, shelter and clothing (Mwangi, 2012). Presbyterian Church of East Africa (PCEA) in Laikipia West sub-County has similarly set up a network of *districts*. The districts are group of families who meet once a week for prayers and sharing on any emergency issues. These *districts* channel their problems to the congregation. The congregation may help the victims directly if they have the resources or may contact the parish and presbytery for assistance. There are more than 500 *districts* in Laikipia West sub-County and have been used in offering food and shelter to the victims of conflicts and droughts (Mwangi, 2012).

The current study assessed the implementation of Hyogo Framework for Action which was domesticated into NCCRS (2010) on the community and household participation in drought risk reduction and preparedness to drought in Laikipia West sub-County. The indicators that guide the assessment of the implementation at the community level were;

- i. How the communities in Laikipia West have been trained on disaster awareness,
- ii. How communities are mobilized either as self-help groups, religious organizations or the youth or women groups during disasters.

The purpose of National Climate Change Response Strategy (NCCRS) is to put in

place robust measures needed to address challenges posed by climate variability and change (NCCRS, 2010). The integration of climate information into Government policies is important because climate is a major driving factor for most of the economic activities in Kenya. The National Climate Change Response Strategies (2010) analyzed in Laikipia West sub-County are: promotion of irrigated agriculture by developing irrigation schemes along river basins, construction of water basins and pans, set up measures to institutionalize early warning systems on drought, flood and disease outbreaks, investing in programmes to harvest and store fodder for use during dry seasons, source livestock fodder from other regions, promotion of economic diversification among pastoral communities and awareness campaigns among the pastoralist communities on the importance of balancing stocking rates with available land resources as a way of ensuring sustainable pastoralism.

## **2.8 Summary of Literature and Gaps Identified**

In conclusion the chapter has made effort to review literature on drought characteristics and trends, effects of drought on resources and livelihoods, perception of climate variability, household adaptations to drought and institutional components of drought adaptations. In this study the focus is on classification and quantification of drought-information useful in planning for drought adaptation. The reviewed studies assessed the global and regional impacts of drought while this study did not only assess the effects of drought in an arid and semi arid region of Laikipia West sub-County but also the community drought adaptation strategies in place to reduce the effects of drought. The studies on Kenya reviewed above discussed the effects of drought on resource and livelihoods in Kenya while the current study did not only analyze the effects of drought, but also the effects of 2009 drought episode on household income, health, environment and social effects. The study also assessed the most impacted livelihood in Laikipia West sub-County. The reviewed studies also assessed the perception of climate variability in both rural and urban area while the current study looked at perception to drought among households. The current study also analyzed the social economic characteristics of the households that influence perception to drought. The aforementioned studies assessed adaptations to climate variability in different regions of the world while the current study analyzed drought adaptation strategies among households in a semi-arid part in Kenya. The study also assessed the community drought adaptation strategies.

The studies discussed also looked at general drought disasters preparedness and

policy framework. The practice part of the institutions and implementation of these policies at local level remain wanting. The current study assessed the effects of drought on crop and livestock production and analyses the implementation of six activities of the National Climate Change Response Strategies (2010). These activities are: formation of youth, women's and men's groups, CBOs, as forums for outreach, documenting effects of drought and linking them to community livelihoods, drought management training among households and community members, using graphical images to pass climate change information, encouraging individual voluntarism in raising awareness, and setting aside emergency funds to caution vulnerable households during drought. The study also analyzed the role of institutions in managing local level drought adaptations

## **2.9 Theoretical Framework**

This study adopted social learning theory by Albert Bandura (1962) in understanding households' adaptation to drought events and Hyogo Framework for Action in understanding drought preparedness at household and community level. Human behaviour is regulated to a large extent by anticipated consequences of perspective actions (Bandura, 1969). During the course of learning, people not only perform responses, but they also observe the differential consequences accompanying their various actions. Learning cannot take place without awareness of what is being reinforced (Dulany, 1962). In social learning theory, psychological functions involve a continuous reciprocal interaction between behaviour and its controlling conditions. The theory assumes that whether or not people choose to perform what they have learned observationally is influenced by the consequences of such actions. Social learning theory also assumes that modeling influences produce learning principally through their informative functions and observers acquire mainly symbolic representations of modeled activities rather than specific stimulus-response associations (Bandura & Barab, 1971).

The tenets of social learning theory are attention process, retention process, motoric reproduction process and reinforcement and motivational process. In attention process, a person cannot learn much by observation if he/she does not attend to or recognize the essential features of the model behaviour. In conceptualization of social learning theory to the study, response and adaptation to drought is the reinforcement and motivation. Attention process was conceptualized to drought events which has significant effects on livelihoods and

captures the attention of the households. Retention processes explain that past influence achieves some degree of permanence and that observational learning involves two representational systems: imaginal and verbal. In motoric reproduction process, the learner puts together a given set of responses according to the modeled patterns. In the study the retention process was conceptualized to explain the past experiences the household and community members have observed as a result of drought events.

Reinforcement and motivation process is conceptualized to strategies that produce positive results during drought are enhanced while those that produce negative results are ignored in future. The symbolic coding is informed by the effects on drought on households while cognitive organization informs their perceptions to drought. Whether household drought perception is severe or moderate is informed by the retention processes. The retention process is a factor of social economic characteristics of the household. The judgment of whether drought is severe influenced by experience, source of income, age, gender, education among other variables.

In the study, understanding drought preparedness was guided by the Hyogo Framework for Action 2005-2015. Adopted by 162 member states of the United Nations, the Hyogo Framework for Action is the key instrument and global blue print for implementation of disaster risk reduction. Its overarching goal is to build the resilience of nations and communities to disaster by achieving substantive reduction of disaster losses by 2015 (UNISDR, 2012). In their approach to disaster risk reduction, states, regional and international organizations and other actors concerned should take into consideration the key activities listed under each of the five priorities for action which are: ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation; identify, assess and monitor disaster risks and enhance early warning; use knowledge, innovation and education to build a culture of safety and resilience at all levels; reduce the underlying risk factors and strengthen disaster preparedness for effective response at all levels.

The current study considered the second, fourth and five priorities which are: Identify, assess and monitor disaster risks and enhance early warning, reduce the underlying risk factors and strengthen disaster preparedness for effective response at all levels. The activities under these priorities are; develop early warning systems that are people centered, in particular systems whose warnings are timely and understandable to those at risk, promote

the integration of risk reduction associated with existing climate variability and future, prepare and periodically update disaster preparedness and contingency plans and policies at all levels, promote regular disaster preparedness exercises, including evacuation drills, with a view to ensuring rapid and effective disaster response and access to essential food and non-food relief supplies, as appropriate, to local needs, promote the establishment of emergency funds, where and as appropriate, to support response, recovery and preparedness measures (HFA, 2005).

The study also assessed the existence of emergency funds reserved by communities' self-help groups in Laikipia West sub-County to counter the effect of drought. The communities' volunteerism opportunities during drought disasters such as sharing of information, community awareness programs and supporting the most vulnerable were examined. The community information exchange channels were also evaluated. At the household level the study examined how the early warning information is received and exchanged among households. The household food and non-food relief supplies in reserve stores for use during disaster were also assessed. The study established the existence of emergency funds reserved by individual households in Laikipia West sub-County to counter effect of drought.

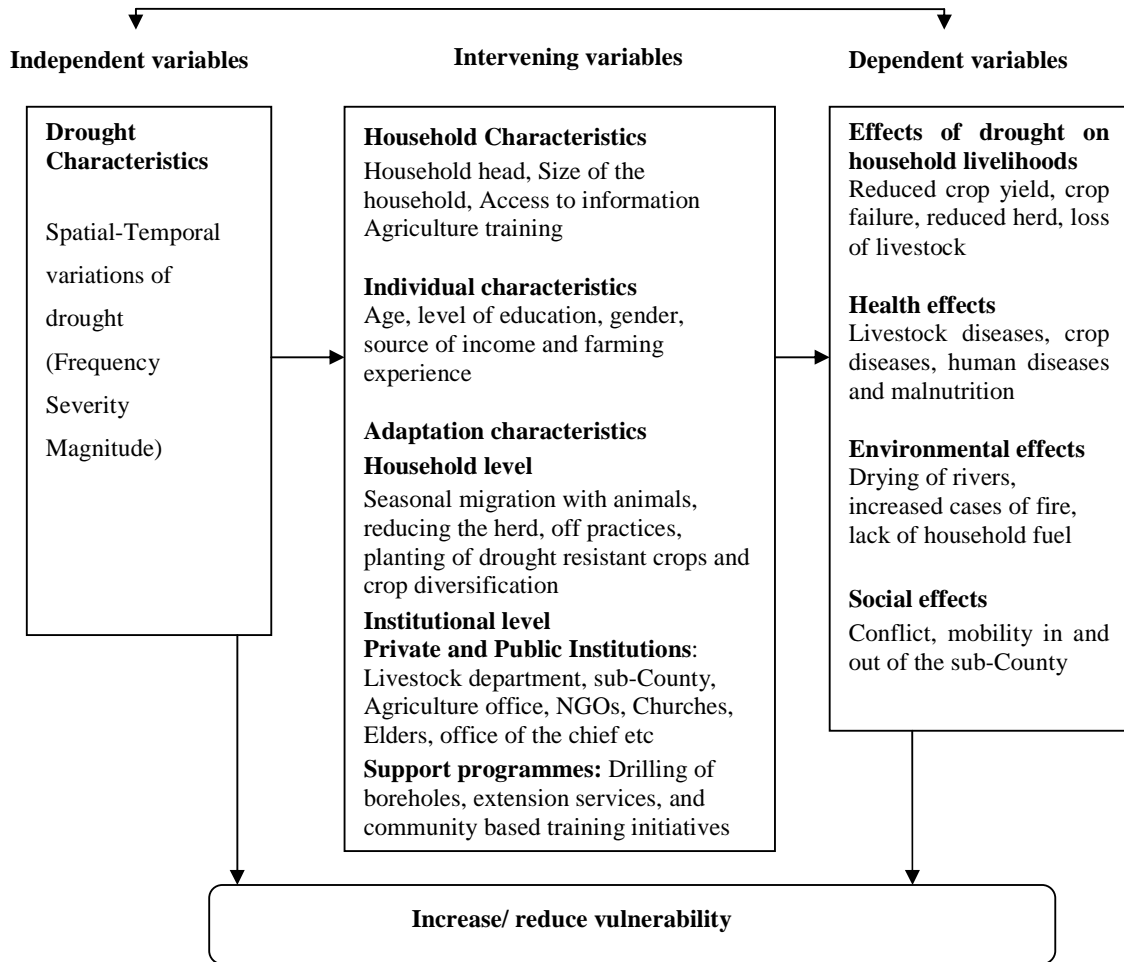
## **2.10 Conceptual Framework**

Figure 2.1 presents a conceptual framework of the study. It illustrates the interaction between droughts and household characteristics, economic effects, preparedness and drought adaptation strategies. In this study, drought characteristics affect maize and livestock in Laikipia West sub-County. Drought characteristics such as frequency, severity and magnitude result to economic effects such as decreased maize yields, crop failure, reduced herd size, decreased milk yield, loss of livestock. There are also health effects such as: crop and livestock diseases while the social effects are mobility in and outside the sub-County. The drought characteristics determine the adaptation strategies such as: early warning, exchange of information, food and non-food relief supplies, and emergency funds reserved, destocking, migration with their livestock, off-farming practice, crop diversification and planting of drought resistant seeds.

Drought adaptation strategies at the community level are training on disaster awareness, community mobilization, emergency funds, volunteerism and exchange of

information. Household characteristics such as age and gender, level of education, type of household, and access to information, experience, household head, agricultural training and perceptions to drought inform farmers on the response and adaptation strategies to drought. Preparedness and adaptations is likely to be influenced by household characteristics such as the education of the household head, age, gender, type of household, experience, agriculture, and household head (Opiyo *et al.*, 2014). Drought characteristics linked to, household characteristics, preparedness and adaptation lead to increased or reduced vulnerability to drought. The independent variables are drought perceptions as either severe or moderate and drought preparedness. The dependent variables are the social economic characteristics of the population.





**Figure 2.1:** Conceptual Framework for analyzing effects of drought on livelihoods and adaptation strategies. (*Source:* Synthesis of literature by Author, 2015)

## CHAPTER THREE

### 3.0 RESEARCH METHODOLOGY

#### 3.1 Introduction

This section deals with procedures and methods used in the study. The chapter entails the description of the study area, research design, sampling procedures and sample size, data collection, validity and reliability of data, data analysis and tools and ethical considerations.

#### 3.2 Study Area

##### 3.2.1 Location and Size

The study area is Laikipia West sub-County in Laikipia County, Kenya. Laikipia means *treeless plain* in Maasai language (CDIDP, 2013). Laikipia West sub-County is located to the north west of Mount Kenya. The sub-County lies between Latitude  $0^{\circ} 05'$  and  $0^{\circ} 43'$  North and between longitudes  $36^{\circ} 10'$  and  $36^{\circ} 50'$  East and an area of 3,188.8 Km<sup>2</sup> as shown in Figure 3.1. The altitude of the sub-County varies between 1,000m above sea level and 2,600 m (Thenya *et al.*, 2011). Laikipia West sub-County has four administrative wards namely; Rumuruti, Muhotetu, Sipili and Olmoran (KNBS, 2010). This study however was carried out in Rumuruti ward.

##### 3.2.2 Climate and Agro- ecological Zones

Agro-ecological zones are strongly related to distribution of rainfall and are therefore a proxy for food insecurity and climate vulnerability, which are both important to indicate the areas' close representativeness of the country's natural regions and show the general climate of the area (Mubaya & Mafongoya, 2017). The study area is located in the rain shadow of Mount Kenya making the area dry. The sub-County has humid, semi humid and semi-arid agro-ecological zones. The agro ecological zone of the sampled ward (Rumuruti ward) is maize and mixed and pastoral livelihood zones (Jaetzold *et al.*, 2011). Laikipia West sub-County is classified as 50 - 85% ASAL with annual rainfall varying between 500 and 800 mm (Jaetzold *et al.*, 2011). Daily temperatures vary with altitude and season; mean temperatures range within 22-26°C and temperature Minimum and Maximum are 6-14°C and 35°C respectively. Due to the sub-County leeward position North West of Mount Kenya, it is comparatively dry despite its location on the Equator. The spatial distribution and the temporal viability of rainfall are strongly influenced by Mount Kenya and Aberdare Ranges.

Precipitations also vary greatly in terms of time and amount along the same gradient. Rainfall follows the seasonal movements of the Inter Tropical Convergence Zone (ITCZ) resulting in two rainfall seasons (Huho *et al.*, 2010). The rains primarily fall in two seasons; first is the wet season that occurs during March-April-May and often accounting for 80% of total annual rainfall. Second is the wet season that occurs in October-November-December (Huho *et al.*, 2010).

Map of the study Area

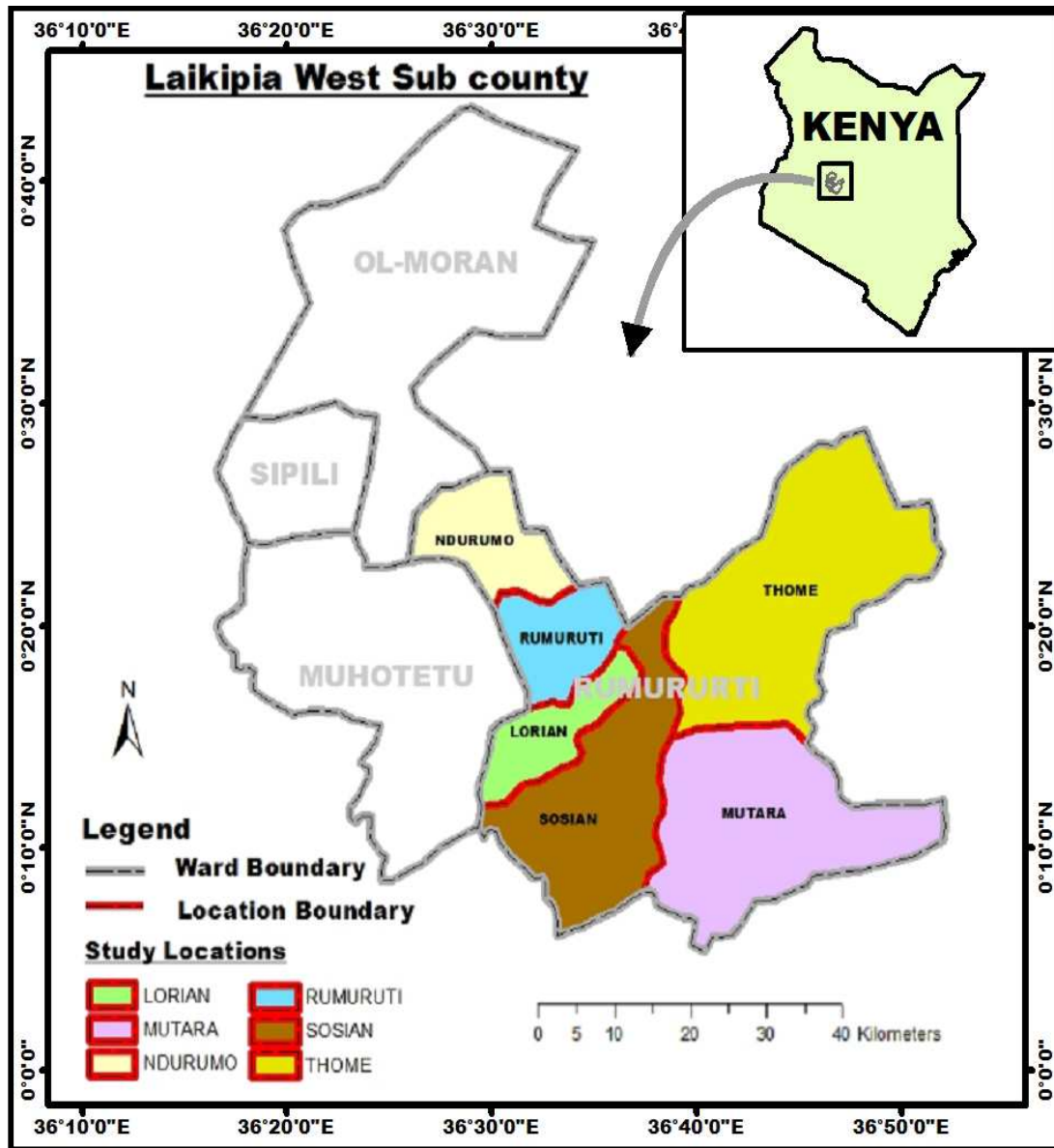


Figure 3.1: A map of Laikipia West sub-County showing the sampled sites.  
Source: IEBC (2012)

### 3.2.3 Soil and Vegetation

There are four categories of soils in Laikipia west sub-County namely: well drained to moderately well drained, deep, very dark greyish brown, firm, cracking clay, with (thick) humic topsoil: verto-luvic phaeozems. Well drained, shallow to moderately deep, reddish brown, firm clay loam, with humic topsoil: chromo-luvic phaeozems, partly lithic phase. Imperfectly drained deep, dark greyish brown, firm, cracking clay. Imperfectly drained, deep, dark greyish brown, firm clay (hardpan), abruptly underlying a topsoil of sandy clay loam: eutric Planosols (Jaetzold *et al.*, 2011).

According to (Jaetzold *et al.*, 2011), phaeozems are well drained, less weathered clay soils (the clays consist mainly of montmorillonites) with high contents of organic/humic substances in the topsoil and plant-available soil water; thus possessing a high fertility. Vertisols (Black Cotton Soils) are dark montmorillonite-rich, poorly drained cracking clays of the bottomlands with peloturbation processes. Planosols are soils with an albic E horizon, hydromorphic properties and a slowly permeable B horizon, developing on different parent materials of the bottomlands.

### 3.2.4 Population Characteristics

The sub-County has a population of 89,925 who are 44,176 male and 45,749 female. There are 39,966 households in the sub-County (KNBS, 2010). According to the KNBS (2009) the Laikipia West sub-County population density was at 42 persons per square kilometer. This was projected to increase to 51 persons per km<sup>2</sup> by the year 2017 as a result of in-migration and natural population growth (CDIDP, 2013).

The sub-County has multiple ethnic communities with Kikuyus, Maasai and Samburu communities forming the largest portion of its residents. Minority communities in Laikipia West sub-County are: Kalenjin, Meru, Pokots, Somali, Turkana, European and Asian settlers (CDIDP, 2013). Ethnic communities influence the land use systems in Laikipia West sub-County. In the upper region (Sosian, Lorian and Ndurumo Locations) intensive maize, wheat and beans farming is practiced as well as rearing of dairy animals is done by the Kikuyus, Kalenjin and Meru. In the lower regions (Rumuruti, Thome and Mutara Locations) agro pastoralism and pastoralism is practiced by the Samburu, Maasai, Turkana and the Pokot. Irrigation farming has also been practiced in the lower region where tomatoes and onions are grown. European and Asian settlers also own ranches in the lower region. Over 48% of the population is classified as poor while 59.3% depend on relief aid from the Government of

Kenya and the World Food Program (WFP) (GOK, 2010).

### **3.2.5 Agriculture and other Economic Activities**

According to the first Laikipia County Development Integration Plan (2013) over 60% of households in the sub-County derive their livelihood from agricultural activities. Majority of the farming households are small scale holders whose average farm land size is 2 acres mainly for food production. The farm size for large scale holder on average is 20 acres mainly for wheat and maize production. The ranching community holds an average of 10,000 acres. Average land holding in the group ranches per household is 23 acres. Sixty five percent of land owners have title deeds. There are 6 distinct land use patterns heavily influenced by the climatic conditions and the ecological zones. These include among others; pastoralism, mixed farming, ranching, agro pastoral, marginal mixed farming and formal employment/trade/business. In 2012, crop farming and livestock keeping sub-sector employed 141,383 persons comprising 47% of the employed population. Agriculture contributes 75% of the household incomes. The main crops grown are maize, beans, wheat, Irish potatoes, cabbages and tomatoes. The main types of livestock raised are cattle, sheep, goats, camels, donkeys, poultry and pigs.

In Laikipia County, agriculture employs over 80% of its population (Kairu, 2002). Flower farming is a new agricultural practice in the area and has also employed a good number of young people. Laikipia West sub-County is known for its big open ranches which provide a significant source of beef for local consumption and export (CDIDP, 2013).

### **3.3 Research Design**

The study adopted mixed research design that combined qualitative and quantitative approaches to achieve the objectives. Cross sectional household survey, in-depth interview and documentary review were used. Documentary review was used to analyze temporal drought using SPI drought index based on rainfall data in Laikipia West sub-County from 1984 to 2014. The study utilized qualitative data from cross-sectional household survey and key informant interviews. Quantitative data utilized in the study is rainfall data from Ndaragwa and Rumuruti rainfall stations. Cross sectional household survey assessed the effects of 2009 drought on household livelihoods; establish the household perceptions to drought disasters and evaluated the household and community drought adaptation strategies and drought adaptation determinants in Laikipia West sub-County. In-depth interview design

was used to evaluate the role of institutions in managing local level drought adaptations in Laikipia West sub-County.

### **3.4 Sampling Procedure and Sample Size**

#### **3.4.1 Rainfall Stations**

Rainfall data was collected from Rumuruti and Ndaragwa WRMA stations. The selection of the rainfall stations was informed by the fact that they are the only reliable stations in the study area. Although there are other weather stations such Mukogondo forest, Thomson falls forest and Nyahururu rainfall stations in Laikipia West sub-County, the data from these stations was unreliable and could not qualify for a climatological analysis.

#### **3.4.2 Household Respondents**

The study used Slovin's formula (Galero, 2011) to determine the number of household respondents. Slovin's formula allows a researcher to sample the population with a desired degree of accuracy. Slovin's formula is written as

$$n = N / (1 + Ne^2) \tag{I}$$

Where:

n – Sample size,

N -Total population

e - Error of tolerance=0.05

Laikipia West sub-County had 39,966 households (KNBS, 2010) translating to 196 calculated households. Multistage cluster sampling technique was used to select respondents and study site. In stage one, administrative wards were clustered based on their different economic activities. There are four wards in Laikipia West sub-County (Figure 3.1). The wards are: mixed livelihood zones which comprise of Muhotetu and Sipili and sub- humid agro-pastoralism livelihood zone comprising of Rumuruti and Olmoran. In stage two, purposive sampling was used to select the study ward. The selected ward was Rumuruti whose choice was based on variation in livelihood options. The selection of Rumuruti ward a sub-humid agro-pastoralism was informed by the fact that, effects of drought on household livelihood and adaptations strategies are determined by economic activities of the households. Stage three involved proportionate random sampling to select household respondents from all the six locations in Rumuruti ward as shown in Table 3.1 using the following formula.

$$n = p/\mu \times 300 \quad (2)$$

Where;

n is the sample population of the Location.

P is the population of the household in the location.

$\mu$  is the total households in the ward.

Rumuruti Ward has six locations namely: Rumuruti, Lorian, Ndurumo, Mutara, Thome and Sosian. The Ward has eleven sub-locations namely: Rumuruti Township, Mutamaiyo, Lorian, Ndurumo, Kagaa, Mutara, Kiamariga, Thome, Mathira, Sosian and Maundu Miiri.

**Table 3.1 Households Sample Population in Rumuruti Ward**

<b>Location</b>	<b>Total Population</b>	<b>Sample Population</b>
Rumuruti	16,094	67
Thome	6,612	28
Ndurumo	6,030	25
Mutara	6,226	26
Sosian	6,422	27
Lorian	5536	23
<b>Total</b>	<b>46,920</b>	<b>196</b>

### 3.4.3 Key Informants Interviews

Key informants were selected as shown in Table 3.2. Two key informants in three categories (Chiefs, elders and NGOs) in the sampled ward were purposively selected. One informant in each of the two categories (sub-County agriculture officer and sub-County livestock officer) in the sampled ward was purposively selected.

**Table 3.2: Sample Population for Key Informants**

<b>Key Informants</b>	<b>Number per Ward</b>	<b>Total Sampled</b>
Chiefs	2	2
Elders	2	2
Sub-County agriculture officers	1	1
Sub-County livestock officer	1	1
NGO officials	2	2
<b>Total</b>		<b>8</b>



### **3.5 Data Collection**

The description of the data collection process is objectives based

#### **3.5.1 Rainfall Data**

Daily rainfall amount data from Rumuruti and Ndaragwa Water Resource Management Authority (WRMA) stations for the 31 years period (1984-2014) was collected. Thirty one year's period was chosen because it is within the minimum period which data can be analyzed using SPI. Data of less than 30 years shortens the sample size and weakens the confidence (WMO, 2012).

#### **3.5.2 Household Survey Data**

Cross-sectional household survey was used to collect household data on the household perceptions to drought, effects of drought on household livelihoods, adaptation strategies during the 2009 drought. Household surveys are carried out to gather statistical information about the attributes and actions of a population by administering standardized questionnaires to some of its members (Buckingham & Saunders, 2004). The necessity of using surveys for this research came from the research questions, particularly research questions ii, iii and iv which sought to investigate the effects of drought, perceptions adaptation and to drought. Household data was collected from proportionately random selected household in all administrative locations of the sampled ward using structured questionnaires. A questionnaire (Appendix A<sub>1</sub>) containing structured questions was administered. The information sought from household include: socio-economic characteristics of the households, their perceptions and drought adaptation strategies in place.

#### **3.5.3 Key Informants Interview Data**

Key informant interviews (KIIs) are qualitative interviews with people who are aware of what is going on in the community (Denzin & Lincoln, 2005). Key informants are people perceived to have particular insight or opinions about the topic under study. They may be ordinary people and not necessarily the specialists, the better educated, those in power or the officials (Mikkelsen, 2005). In the study, the main criteria for selecting the key informants were their profession, position in leadership, ages, and those assumed to have extensive knowledge on effects of drought and adaptation strategies in Laikipia West sub-County. By conducting in-depth informant interviews, it was possible to analyze not only respondents' attitudes and behavior, particularly in relation to drought, but also the long term experiences

and expectations concerning drought adaptations.

Key informant interviews complemented the survey research and targeted, chiefs, elders, sub-County agriculture and livestock officers and non governmental organization officials. The key informant interviews are used to supplement, validate, explain, illuminate and reinterpret quantitative data (Miles & Huberman, 1994). The key informant interviews consisted of guiding questions (Appendix A<sub>2</sub>) for uniformity during interviews with different categories of informants and were used to answer question v.

### **3.6 Validity and Reliability of the Data**

Instruments used to collect data must be both reliable and valid for the study to be credible (Gail, 2011). Validity in research refers to how accurately a study answers the study question or the strength of the study conclusions. It refers to accuracy of measurement. Reliability refers to whether an assessment instrument gives the same results each time it is used in the same setting with the same type of subjects. Reliability is part of the assessment of validity (Gail, 2011). In the current study a pilot study was conducted in the neighboring Ndaragwa Ward to test for validity of the research instruments. The pilot study ensured that the questionnaires were as clear as possible before the collection of primary data in the study area. The questionnaire was revised after the pilot study and the unclear questions modified.

Rainfall data was collected from Water Resources Management Authority for Rumuruti, Nyahururu and Ndaragwa stations for a period of 31 years. The data was scrutinized to check the missing data. Missing data percentages was calculated to determine its reliability. The Rumuruti and Ndaragwa station data was considered for climatological analysis because the missing values were less than 10% for any year as per the requirements of the world meteorological organization. The Nyahururu station data was not considered for the analysis because more than 34% of the data was missing and failed the reliability of climatological test.

### **3.7 Data Analysis and Tools**

The description of data analysis was objectives based.

#### **3.7.1 Temporal Drought Trends in Laikipia West sub-County (1984-2014)**

The selected drought index was Standardized Precipitation Index (SPI). Standard precipitation index was selected because it has been used to analyze drought severity in other regions of the world. The Standardized Precipitation Index expresses the actual rainfall as a

standardized departure with respect to rainfall probability distribution function and hence the index has gained importance in recent years as a potential drought indicator permitting comparisons across space and time (Kumar, Murthy, Sessa & Roy 2010). The computation of SPI requires long term data on precipitation to determine the probability distribution function which is then transformed to a normal distribution with mean zero and standard deviation of one. Thus, the values of SPI are expressed in standard deviations, positive SPI indicating greater than median precipitation and negative values indicating less than median precipitation (Edwards and McKee, 1997). Drought characteristics analyzed were; frequency, severity and magnitude of drought. In the study SPI was used in the analysis temporal drought in Laikipia West Sub County from 1984 to 2014.

As suggested by McKee, Doesken and Kleist (1993) SPI represents wetter and drier climates in a similar way. The SPI is calculated as follows:

$$SPI = \frac{X - \bar{X}}{\sigma} \tag{3}$$

Where:  $\sigma$  - Standard deviation  
 $X$  - Precipitation  
 $\bar{X}$  - Mean precipitation.

Positive SPI values indicate greater than median precipitation and negative value indicate less than median precipitation because the SPI is normalized, wetter and drier climates are represented in the same way; thus wet and dry periods are monitored using SPI as in Table 3.3. The SPI values ranges from -2 to +2, with values of 2 or greater denoting extremely wet spells and values of 2 or less indicating extremely dry spells. The condition is said to be near normal for SPI values between -0.99 to + 0.99 (Boubacar, 2012).

**Table 3.3 Standard Precipitation Index (SPI) values**

<b>SPI values</b>	<b>Drought characteristics</b>
2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderate dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

Source: WMO (2012)

### **3.7.2 Effects of Drought events on Household Livelihoods**

Data collected using questionnaire was processed to ensure that all responses were categorized in order to make comparisons and analysis possible. The processing involved editing, coding, classification and tabulation. Editing helped to detect errors and omissions, and the appropriateness of the data to the study objectives. Editing also involved scrutiny of all completed questionnaires to ensure that there was accuracy; consistence, uniformity and that they were completely filled in order to facilitate coding, classification and tabulation. This helped to put data into manageable categories that were consistent with the research problem. The percentages of the household responses on the effects of 2009 drought were computed using descriptive statistics and the various effects categories identified. The effects of drought identified were direct effects on household income such as crop failure, reduced herds, livestock losses, reduced crop yields among others. The indirect effects of drought were also identified and they include effects on health, environment and social well being of the households.

### **3.7.3 Household Perception to Drought Disasters**

The household perceptions were analyzed using percentages and the results cross tabulated with socio-economic characteristics. Logistic regression model was used to analyze drought perception and factors influencing household perceptions to drought in Laikipia West sub-County. The strength of logistic regression model is that it can take coded values. Logistic regression technique has no assumptions on the linear relationship between independent variables and can be used in any mix of dichotomous, discrete and continuous predictor (independent) variables (Tabachnick & Fidell, 2001). The logistic regression readily allows each variable in the analysis to be described in terms of its strength of contribution to the outcome (Hair, Black, Babin, Anderson & Tatham, 2006). Logistic models are the most appropriate econometric models to apply to the evaluation of qualitative dependent variables that have dichotomous groups ( ‘adapted’ and ‘not adapted’) while the independent variables are categorical, continuous and dummy (Long and Freese, 2006).

The perception of drought as either severe or moderate in this study was informed by the choice of logistic regression model which accommodate binary variables. The two discrete and mutually exclusive variables were regressed on explanatory factors whose choice was based on theory and literature. These variables are: age, gender, education level, length

of stay in the study area, farming experience, household income, land ownership and previous agriculture training

The logistic regression model is specified as:

$$\begin{aligned}
 z_1 &= \frac{e^{\beta X}}{1 + e^{\beta X}} \\
 z_0 &= \frac{1}{1 + e^{\beta X}} \\
 z_i &= \ln \left( \frac{z_1}{z_0} \right) = e^{\beta X}
 \end{aligned}
 \tag{4}$$

Where: X is the vector - independent variables in question,  $\beta$  is the vector of variables to be estimated. Application of this type of model is a challenge since the dependent variable is dichotomous in nature and has a probability of 0 or 1 and most of the predicted values by the independent variable may fail to fall under the predesigned areas of zero and one. The empirical model is as follows:-

$$z_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \varepsilon \tag{5}$$

Where:

$Z_i$ = the perception by the  $i^{\text{th}}$  household on drought.

$x_i$  = the vector of explanatory variables of probability of perceiving drought by the  $i^{\text{th}}$  household.

$\beta$ = the vector of the parameter estimates of the regressor's hypothesized to influence the probability of households

$i$  = is perception about drought.

$e_i$ =is called the error term, disturbance term. This variable captures all other factors which influence the dependent variable  $Z_i$  other than the regressors'  $x_i$ .

In the analysis of factors influencing household perception to drought using logistic regression model, various categories of responses within socio-economic characteristics of the households were regressed against dependent variable. The data was cross tabulated and reference categories identified before regression. The dependent variable was the household

responses on the description of the 2009 drought where they were to identify whether the drought was severe or moderate. The independent variables were the socio-economic characteristics which were gender, age, education, time the respondent had been farming, income, size of the land, type of land ownership and training on farming. The logistical regression variables were coded as shown on Table 3.4. During the regression analysis one category was left out in each variable to act as a reference category. The reference categories in each of the socio-economic variables are; male, below 30 years, informal education, below one year, less than two acres, and ownership of land and confirmation of attendance of training on farming. Wald test at 5% level of significance was used to determine the factors affecting perception to drought. Wald test can be able to detect the smaller significant changes than chi-square.

**Table 3.4 Descriptions of variables in logistic regression**

Variable Name	Variable codes and description
Perception to drought	Drought characteristics were categorized as 0= moderate and 1= severe
Drought determinants	They were coded as 0=adaptation strategy in question and 1=for others
<b>Socio economic variables</b>	
Gender	0= males and 1= female
Age	0= below 30 years, 1= 31-40 years, 2= 41-50 years, 3=51-60 years and 4= 61 and above
Education	0= informal education, 1= primary education, 2= secondary education and 3= tertiary education
Length of engagement in farming	0= 0-5 years, 1= 6-10 years, 2= 11-15 years, 3= 16-20 years, 4= 21-25 years, 5= 26-30 years, and 6= above 30 years
Household source of income	0= government employment, 1= business person, 2= maize farming, 3= dairy farming, 4= pastoralism, 5= wheat farming
Annual income	0= below 120000, 1= 120000-500000 and 2= 500000 and above
Household land size	0=less than 2 acres, 1= 2-5 acres, 2= 5-10 acres and 3= over 10 acres
Land ownership	0= Owned land, 1= Leased land and 2= communal land ownership
Training on farming Course	0= no and 1= yes

### 3.7.4 Household Drought Adaptation Strategies and Drought Adaptation Determinants

Chi-square test was used to analyze the association between drought adaptation strategies and socio-economic characteristic of the households in Laikipia West sub-County. The independent variables were the drought adaptation strategies during drought by individual households while the dependent variables were the socio-economic characteristics of the households. The significant threshold was measure at 5% level of significance. The chi square formula is as follows:

$$\chi^2 = \sum \frac{(O - E)^2}{E} \quad (6)$$

Where,

$\sum$ - Sum of

O- Observed value,

E- Expected value

Kendall's rank correlation was used to rank the most preferred drought adaptation strategies by the household heads. The following scales were used, 1-Regularly, 2- Sometimes and 3-never used. Kendall's rank correlation provides a distribution free test of independence and consider two samples, x and y each of size n. The total number of possible pairings of x with y observations is  $n(n-1)/2$ . Now consider ordering the pairs by the x-values and then by the y-values. If  $x^3 > y^3$  when ordered on both x and y then the third pair is concordant, otherwise the third pair is discordant. S is the difference between the number of concordant (ordered in the same way,  $n_c$ ) and discordant (ordered differently,  $n_d$ ) pairs. Tau (t) is related to S by:

$$\tau = \frac{n_c - n_d}{n(n-1)/2} \quad (7)$$

If there are tied (same value) observations then  $t_b$  is used:

$$t_b = \frac{S}{\sqrt{\left[ n(n-1)/2 - \sum_{i=1}^t t_i(t_i-1)/2 \right] \left[ n(n-1)/2 - \sum_{i=1}^u u_i(u_i-1)/2 \right]}} \quad (8)$$

Where;  $t_i$  is the number of observations ties data particular rank of x and  $u_i$  is the number tie data rank of y. In the presence of ties the statistic  $t_b$  is given as a variant of t adjusted forties. When there are no ties  $t_b=t$ . An approximate confidence interval is given for  $t_b$  or t. The confidence interval does not correspond exactly to the p-values of the tests because slightly different assumptions are made (Samra and Randles, 1988). In the interpretation of the research findings in the current study the adaptation strategy with the lowest mean is the most frequently preferred strategy during drought.

### **3.7.5 Role of Institutions in Managing Drought Adaptations**

Individual informant narratives were captured in the analysis of the role of institutions in managing local level drought adaptation in Laikipia West sub-County. The informant's views were supplemented with existing data from literature on the role of institutions on drought adaptation strategies.

### **3.8 Ethical Considerations**

Research ethics were upheld at all stages of the study period. Honesty and objectivity prevailed when collecting, analyzing, interpreting and presenting data. Participants in the interviews were informed about the purpose and nature of the study, including its time period, expected outcome and confirmation that all information would be confidential. A research permit (Appendices 7 and 8) was obtained from National Commission for Science, Technology and Innovations before the study was conducted.



## CHAPTER FOUR

### 4.0 THE SOCIO-ECONOMIC CHARACTERISTICS OF THE STUDY POPULATION.

#### 4.1 Introduction

This chapter presents results and discussion on households' socio-economic characteristics. Understanding the household socio economic characteristics forms the foundation in understanding drought effects on household livelihoods, drought adaptation strategies among individual households and the community. According to the IPCC (2007) the factors affecting agriculture include: temperatures, rainfall, humidity, carbon dioxide, wind, seed availability and quality, access to information, education, gender, transport, and market. The household decision making and judgment of events is influenced by their socio-economic characteristics thus the variations in decisions, responses and adaptation strategies among households living in the same geographical boundaries with uniform physical characteristics.

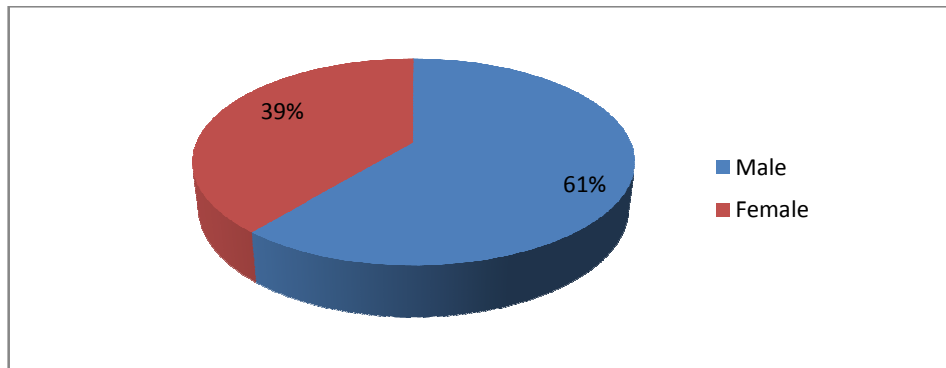
#### 4.2 Response Rate of the Household Survey

For the household survey, 196 questionnaires were administered to the selected household respondents. Out of 196 questionnaires administered, 195 were filled and returned, however 15 questionnaires were incomplete and could not be considered during analysis. One hundred and eighty (180) questionnaires were considered during data analysis representing 92% response rate, which is considered satisfactory to make conclusions for the study. According to Mugenda and Mugenda (2003) a 50% response rate is adequate, 60% good and above 70% response rate very good.

#### 4.3 Gender of the Household Heads in Laikipia West sub-County

Household heads are the pillars on the day to day decisions and solutions adopted at the house hold levels. In order to understand the responses and adaptation strategies to the 2009 drought event in Laikipia West sub-County the study sort to know the gender of the household heads. Results in Figure 4.1 shows that 61% were men while 39% were women. In Laikipia West sub-County the different economic activities which are crop farming, pastoralism and agro pastoralism attract members of either gender though the number of men

is higher than women. The high number of male headed households could be attributed to patriarchal social order in the African culture. This finding contradicts the earlier argument by Peacock, Jowett, Dorward, Poulton and Urey (2004) that smallholder agriculture in sub-Saharan Africa is becoming a female dominated sector as a consequence of faster male out-migration.



**Figure 4.1: Household head by gender in Laikipia West sub-County**

#### **4.4 Age of the Household Head in Laikipia West sub-County**

Efficient and sustainable drought adaptation practices made by individual households vary according to several factors such as age. Human responsibilities increase with age and therefore the study sort to know the age bracket of the household heads. Age of the household head is an important consideration not only on the decisions made by an individual household but by other sectors such as financial institutions who offer credit facilities to households. Results in Table 4.1 show that, 33 % of the respondents were below the age of 30 years, 32% between 30 to 40 years and 19% between 41 to 50 years. The high number of youth is a reflection of the general age-structure of the population in Kenya. Those above 61 years (7%) represent the senior most group and are assumed to be the most experienced in terms of farming practices, drought prediction and drought adaptation strategies. Those below 30 years are assumed to have greater responsibilities of bringing up young families and therefore drought becomes unnecessary burden. Though those below 30 years could lack the necessary experience on drought adaptations they are energetic and therefore disseminated with the right information they are in a position to implement the required drought adaptation strategies.

**Table 4.1: Age of the household head in Laikipia West sub-County (N=180)**

Years	Number of respondents	Number of respondents (%)
Below 30 years	59	33
30-40 Years	58	32
41-50 Years	34	19
51-60 Years	17	9
61 And Above	12	7
Total	180	100.0

*Source:* Field data (2016)

#### 4.5 Household Heads Education Level in Laikipia West sub-County

Education background of the household head is an important resource that makes a difference in the agriculture sector. Results in Table 4.2 show that, 31% of the household head had attained primary education while 8% had attained tertiary education. The high number of respondents who have no formal education (29%) could have missed the opportunity to learn the importance of weather forecasting and seasonal climate forecast which is important to farmers in determining the time of planting. Laikipia West sub-County being a rural area in a developing country the high number of respondent without formal education could be a limitation in adopting new technology and drought adaptation strategies.

**Table 4.2: Households education level in Laikipia West sub-County (N=180)**

Education	Number of respondents	Number of respondents (%)
No formal education	53	29
Primary education	55	31
Secondary education	58	32
Tertiary education	14	8
Total	180	100.0

*Source:* Field data (2016)

In order to assess the disparities in education among the members of either gender, the variable on education was cross tabulated with gender. The results presented in Table 4.3 show that 61% men and 54% of women have primary education and below. The number of men who have informal education is higher than that of female while tertiary education, though attained by few people, has equal number of either gender. The high number of male with no formal education could be reflected by the higher number of male respondents and not necessarily that women are more educated in Laikipia West sub-County than men.

The high number of households who have primary education and below from either gender could have a negative significance on the day to day decisions made on drought response and adaptation strategies by members of either gender. The high number of

respondents with informal education may be an indication of the crucial role played by indigenous knowledge in drought adaptation strategies in Laikipia West sub-County. There are many forums that offer learning opportunities to households such as; churches and mosques, interaction with agriculture extension officers, chief *barazas*, and interaction among themselves. The finding supports the earlier works of Bishnu (2010) in Nepal that the level of education still remains very low in rural areas. According to Uphoff (1996) formal education broadens the outlook and knowledge of the farmers and thus educated farmers are more receptive to innovations and more likely to adapt to rainfall variability. According to Karanja (2013) on the analysis of effects of rainfall variability on potato production in Oljoro-orok Nyandarua County, educated farmers are fast in decision making which is an indication that supplied with the right information they have the potential of increasing yields.

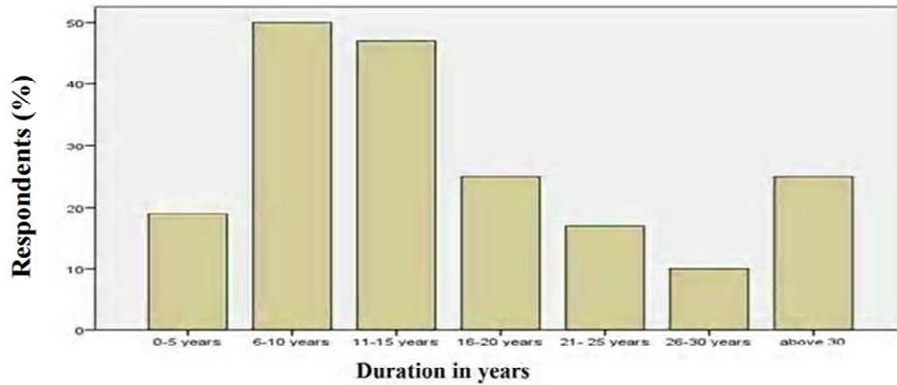
**Table 4.3 Cross tabulation of education and gender in Laikipia West sub-County (N=180)**

Gender	Education (%)			
	Informal	Primary	Secondary	Tertiary level
Male	27	34	30	9
Female	31	23	33	13

*Source:* Field data (2016)

#### **4.6 Duration Household head had stayed in Laikipia West sub-County**

The number of years a household has lived in an area could translate to the accumulated experience gathered on the physical, social and economic dynamics of that region over the years. The findings in Figure 4.2 shows that 26% of respondents had lived in the study area for a period of 6-10 years while 10% of the respondents had lived in Laikipia West sub-County for less than five years. With the high number of household heads having stayed in Laikipia West sub-County for a period of 6-10 years, they were in the study area during 2009 drought which was the reference drought event for the study.



**Figure 4.2 Duration of stay by the household head in Laikipia West sub-County**

*Source:* Field data (2016)

The study sought to understand the number of years the respondents had been engaged in farming in the area. This could indicate the experience gained over the years that would enable them adapt to a variable climate. The findings in Table 4.4 show that 31% of the respondents have farmed in Laikipia West sub-County for between 6 and 10 years, while 7% have farmed for less than one year. The variation in the number of years the respondents have farmed could be an indicator of the variations in drought adaptation strategies in the sub-County.

Experience in farming gained after a cumulative number of years an individual has been involved in any particular undertaking cannot be ignored. People learn from previous success or mistake and relate present events with the similar ones in the past. Decisions and actions that were successful in the past are likely to be embraced in the future while decisions and actions that failed in the past are likely to be ignored in the present and in future. These finding is supported by earlier work of Karanja (2013) in Oljoro-orok, Nyandarua County which revealed that experience enable farmer to learn new trends of weather patterns, pest and diseases and the best time of planting to realize profit because of the market forces.

**Table 4.4: Length of household heads engagement in farming in Laikipia West sub-County (N=180)**

Years	Number of respondents	Number of respondents (%)
Below 1 year	12	7
1-5 years	45	25
6-10 years	56	31
11-15 years	18	10
16-20 years	16	9
Above 20 years	33	18
Total	180	100.0

*Source:* Field data (2016)

The years of experience a household has gained were further operationalized into the following categories: less experience (0-5 years), experienced (6-10 years) and more experienced (11- and above). Further analyses of Table 4.6 reveal that 30.8 % of the respondents have less experience, 32.5 % are experienced and 36.7 % has more experienced. The high number of those with no and low experience could be a limitation in the drought adaptation strategies adopted by the respondents.

The findings in Table 4.6 show that members of either gender have lived in the sub-County for less than 20 years. Among the households who have lived in the study area for more than 20 years 33% are male while 70% of female have lived in the sub-County for less than 15 years. This shows that based on the experience with the weather patterns in the sub-County men are likely to adopt better drought adaptation strategies to drought than women.

**Table 4.5 Cross Tabulation of the duration the household head had stayed in the area and gender (N= 180)**

Gender	Years lived in the Location (%)						
	0-5	6-10	11-15	16-20	21-25	26-30	Above 30
Male	13	19	23	12	10	5	18
Female	4	38	28	15	6	6	3

*Source:* Field data (2016)

#### **4.7 Household's Source of Income in Laikipia West sub-County**

The study analyzed the source of households' income in order to evaluate their vulnerability to droughts. Source of income was broadly categorized into six categories' namely: government employment, business person, maize farming, dairy farming, pastoralism and wheat farming. Source of income was considered since vulnerability to

drought varies from one source to the other. Rain fed agriculture for example is more vulnerable to drought events than government employment. Results presented in Table 4.6 reveal that major source of income for the households in the study area are maize farming (34%) and pastoralism (34%). While 17% of the households observed that business is their major source of income. Since farming and pastoralism rely heavily on rainfall, such households are likely to be affected adversely in the situation of adverse weather. Laikipia West sub-County which lies within the leeward side of Mount Kenya may not be favourable for rain fed maize farming making respondents choose pastoralism as a complementary income source.

**Table 4.6: Households Source of Income in Laikipia West sub-County (N=180)**

<b>Source of income</b>	<b>Number of respondents</b>	<b>Number of respondents (%)</b>
Government Employment	6	3
Business Person	30	17
Maize Farming	62	34
Dairy Farming	9	5
Pastoralism	62	34
Wheat Farming	1	1
Other	10	6
<b>Total</b>	<b>180</b>	<b>100.0</b>

*Source:* Field data (2016)

In order to assess gender disparity in sources of income among households, the findings on gender were cross tabulated with the source of income. Results in Table 4.7 shows that, the number of men is more than women in various income categories in the sub-County. The higher number of men involved in pastoralism is an indication that it is a male dominated activity. Maize farming and pastoralism are the dominant sources of income while wheat farming and government employment are the least source of income among the households. These findings show that agriculture and pastoralism are the major source of livelihood in Laikipia West sub-County. Any threat to these sectors such as drought in the sub-County is a threat to the lives of the households therefore the need for drought adaptation strategies.

**Table 4.7 Cross Tabulation of Gender and Source of Income in Laikipia West sub-County (N=180)**

Gender	Source of Income						
	Government Employment	Business Person	Maize Farming	Dairy Farming	Pastoralism	Wheat Farming	Other
Male	3	13	34	7	35	1	7
Female	3	24	31	6	30	0	6

*Source:* Field data (2016)

In order to assess levels of income, respondents were further asked to indicate their annual income bracket. The respondent's income could limit or support drought adaptation. The results in Table 4.8 show that 71% of the respondents had an income of below Ksh. 120,000 (1176 USD) per year which translates to below Ksh. 10,000 (98 USD) per month. The high number of respondents earning below Ksh 10,000 (98 USD) per month is an indication of difficulties they potentially face during drought. The household income was further operationalized to low income (Ksh. 120,000/1176 USD), middle income (Ksh. 120,000/1176 USD -500,000/4902 USD) and upper income (above Ksh. 500,000/4902 USD). According to Jaetzold *et al.* (2009) a rural family of five persons required Ksh. 172,500 (1691 USD) per year (using 2009 prices) to be food secure and meet other household needs. According to the Kenya economic survey (2017) lower income group comprises households with monthly expenditure below Ksh 23, 670 (232 USD). The middle income group comprises of households with monthly expenditure between Ksh 23,671(232 USD) and Ksh 119,999 (1176 USD). The upper income group comprises households with monthly expenditure above Ksh 120,000 (1176 USD).

Low incomes among households in Laikipia West sub-County mean that they may not be in a position to meet their daily needs such as food, medical care and school fees and save fund for emergencies. During drought the cost of basic commodities such food is normally high which increases the burden on already strained budget among the households in Laikipia West sub-County. According to Parmeshwar (2014) reduction in agricultural production due to drought in Maharashtra state in India subsequently causes increase in food prices. Drought reduces the household income leaving them with little to spend and making basic needs such as education a luxury when compared to food.



**Table 4.8 Household annual income in Laikipia West sub-County (N=180)**

<b>Household annual income (Ksh.)</b>	<b>Number of respondents</b>	<b>Number of respondents (%)</b>
Below 120,000(1,176 USD)	128	71
120,000-500,000(1,176-4,902 USD)	38	21
Over 500,000 (4,902 USD)	14	8
Total	180	100.0

*Source:* Field data (2016)

#### **4.8 Household Farm Size in Laikipia West sub-County**

In order to assess how farm size influences drought effects, respondents were asked to provide information on their farm size. The data on land should be handled with care because most of the households had no documentation as proof of ownership. However, the researcher sought to know the size of the land owned by the respondents. Results in Table 4.9 show that 10% of the respondents own 2 to 5 acres of land, 10% own over 10 acres of land. With 38% of the households having less than 2 acres of land, intensive farming is the only viable option for the households in Laikipia West sub-County. Crop farming is among the main economic activities in the area and with such small land sizes, maximum returns per acre remain the only guarantee to increased production among households.

This finding supports the earlier study by Ogola, Milton, Ayieko, Orawa and Kimani (2011) in Nakuru which revealed that small land size is an indication that intensive farming is the only option to enhance production. The small land sizes among the households leave them more vulnerable to weather-related disasters such as drought since when they happen the respondents have limited options. Small-scale farmers have limited options since their sources of income are limited, leading to little savings in form of food or cash in the financial sectors such as banks and little to spend on daily needs such as food, clothing, and school fees. The small land size in an agro-pastoralist region could also be a source of conflict due to decreased grazing fields during drought. This was observed by Ahmed (2001) who mentions the case of Sudan and indicates that “the shrinking of land resources used by pastoralists and agro-pastoralists has been accentuated further by instability created by conflicts and civil wars which are becoming a major feature in the region.”

**Table 4.9: Size of the Land Owned by Households in Laikipia West sub-County (N=180)**

Years	Number of respondents	Number of respondents (%)
Less than 2 acres	68	38
2-5 acres	18	10
5-10 acres	76	42
Over 10 acres	18	10
Total	180	100.0

*Source:* Field data (2016)

In order to assess whether the size of land owned by households determines the choice of economic activity among households, the source of income was cross tabulated with the size of the land. The findings on Table 4.10 show that 54% of household heads with less than 2 acres of land are involved in maize farming compared to 29% who are pastoralist. Twenty two percent (22%) of the household heads who have over 10 acres of land are pastoralist as compared to 4% who are maize farmers. All households practicing wheat farming have over ten acres of land. This finding shows that the choice of the economic activities among households in Laikipia sub-County depends on the size of the land holding.

Economies of scale in wheat farming make it unfavorable for those with small portions of land but the best bet for those with large portions of land. Pastoralism requires large portions of land since small portions will be limited in the availability of pasture. Maize farming is flexible since it depends on the category of farmers and the reasons for farming among various households. Those with small portions of land may practice subsistence maize farming while those with large portions of land will practice commercial maize farming. For respondents involved in business the size of the land may have less significance. This is explained by the low variations in the number of respondents involved in business and the size of land they own.

**Table 4.10 Cross Tabulation of the size of the land and source of income in Laikipia West sub-County (N=180)**

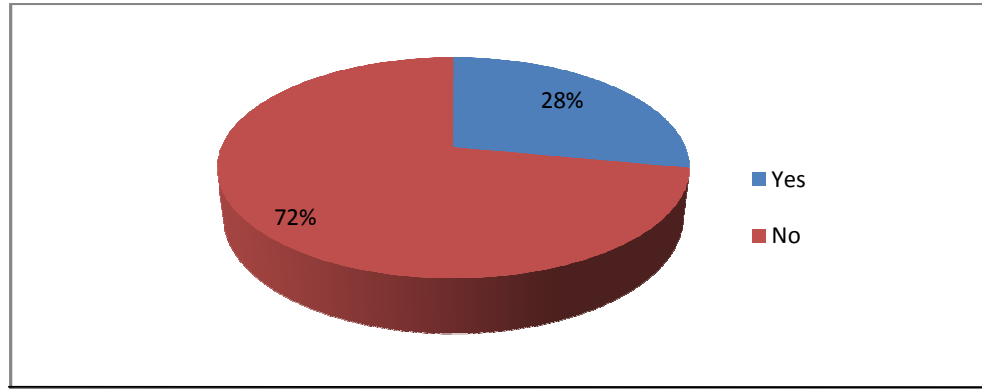
Source of income	Size of the Land (Acres) (%)			
	Less than 2	2-5	5-10	Over 10
Government Employment	16	34	50	0
Business Person	33	39	24	4
Maize Farming	54	2	40	4
Dairy Farming	25	0	67	8
Pastoralism	29	6	43	22
Wheat Farming	0	0	0	100
Other	23	15	54	8

Source: Field data (2016)

#### 4.9 Trainings in Agriculture among Household Heads in Laikipia West sub-County

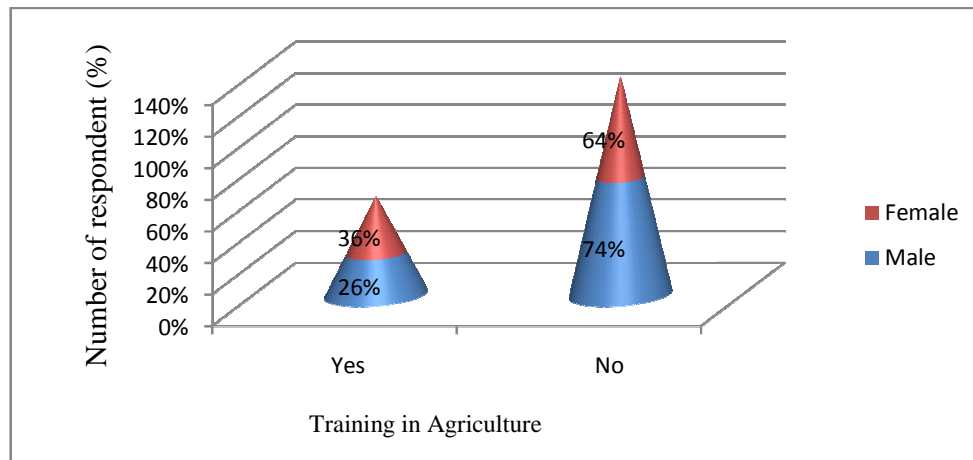
In order to assess the households' opportunities for improvements on farming skills, the respondents were asked to state whether they have attended some training on farming or not. Results in Figure 4.3 show that 72% of the respondents have not attended any training on farming while 28% have attended. Training in agriculture was categorized to capacity building workshops, seminars, extension officer, formal training by resource persons during chief's *barazas* or any other forms of gathering. The high number of households (72%), who have not attended farming training, is an indicator that they could have missed opportunities to learn the existence of new seed varieties in the market, better strategies to deal with weather disasters and learn sustainable management practices. Capacity building through trainings updates household farming skills and enables them learn new farming trends.

The importance of agriculture extension officers cannot be underestimated; farming trainings offer a platform for dissemination of emerging issues in the agriculture sector, information of new seed varieties and availability of subsidized fertilizers and channels of accessing credit facilities. The high numbers of respondents who have not attended training means the households have missed the benefits associated with these trainings and that they have missed the value for their taxes which is spent on paying the agriculture extension officers.



**Figure 4.3: Trainings in Agriculture among household heads**

The findings in Figure 4.4 show that 74 % of males have not attended any training in farming compared to 26 % who have attended. In Laikipia West sub-County where the high number of men compared to women are pastoralists. This explains why they have not attended training perhaps due to the nature of pastoralism as a source of livelihoods where pastoralist migrates from one place to another in search of water and pasture. Though majority of men have not attended training, generally very few households from either gender have attended these trainings and could have a negative effects on drought adaptations in Laikipia West sub-County.



**Figure 4.4: Trainings in Agriculture among household heads by gender**

## CHAPTER FIVE

### 5.0 DROUGHT CHARACTERISTICS, TRENDS AND ITS EFFECT ON HOUSEHOLD LIVELIHOODS.

#### 5.1 Introduction

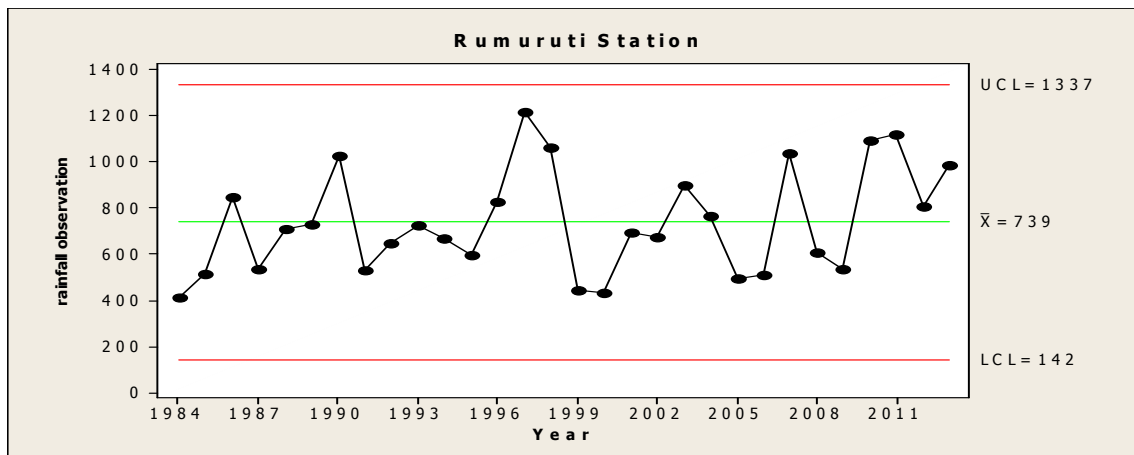
This chapter presents results on rainfall trends, drought characteristics and effects of 2009 drought on household livelihoods, perceptions of drought disasters and factors influencing drought perception in Laikipia West sub-County. Drought characteristic was operationalized as severe and moderate. Drought events were analyzed at both seasonal and annual categories. Households' perceptions to drought were regressed against socio-economic characteristics of the households.

#### 5.2 Rainfall Trend in Laikipia West sub-County 1984- 2014

Rainfall data collected during the study period are shown on appendix 3. Rainfall trend is the graphical representation of the observed drought years from 1984 to 2014 in Laikipia West sub-County. Results in Figure 5.1a and Figure 5.1b show the trend of annual rainfall amounts in Ndaragwa and Rumuruti stations. The highest rainfall amount was experienced in 1997 and 1998 in Rumuruti and Ndaragwa respectively. This coincides with the 1997/1998 El Niño phenomena in Kenya where the country received rainfall above normal. Other periods when the region experienced high rainfalls are 1990 and 2012. The lowest average rainfall was experienced in 1984, 1999, 2000 and 2009. When compared to the mean rainfall, 53% of the study period in Rumuruti station received below mean rainfall while 40 % received rainfall above the mean. This shows that during the study period more years recorded below normal rainfall.

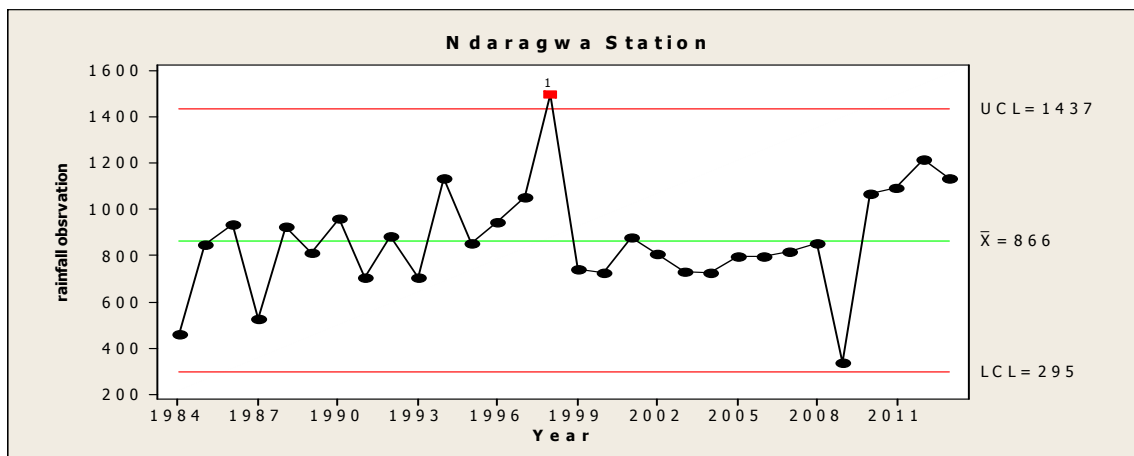
The lowest average rainfall experienced in 1999 and 2000 coincides with La Niña phenomena that followed the El Niño rains of 1997 and 1998. In a related study, it was established that in South Africa drought disasters tend to occur in the year following the onset of El Niño and are less frequent at other times (Dilley & Heyman 1995). The lowest rainfall amount was recorded in 1984 in Rumuruti and in 2009 in Ndaragwa stations. Ndaragwa had a higher precipitation compared to Rumuruti and this could be due to its proximity to the Aberdare Ranges. When compared to the mean rainfall, 47% of the study period in Ndaragwa station received below the mean rainfall while 37 % received rainfall above the mean. This shows that during the study period more years recorded below normal rainfall as compared to

the years that received above normal rainfall. During the study period only 16% of the years received normal rainfall in Ndaragwa. The mean rainfall in Ndaragwa station is higher compared to Rumuruti station and this could mean that Mutara location which is in proximity to Ndaragwa could have favourable conditions to support maize (other crop) farming or growth of pasture than the other Locations in Rumuruti Ward.



**Figure 5.1 a: Annual rainfall trend (1984-2014) for Rumuruti station**

Source: Field data (2016)



**Figure 5.1 b: Annual rainfall trend (1984-2014) for Ndaragwa station**

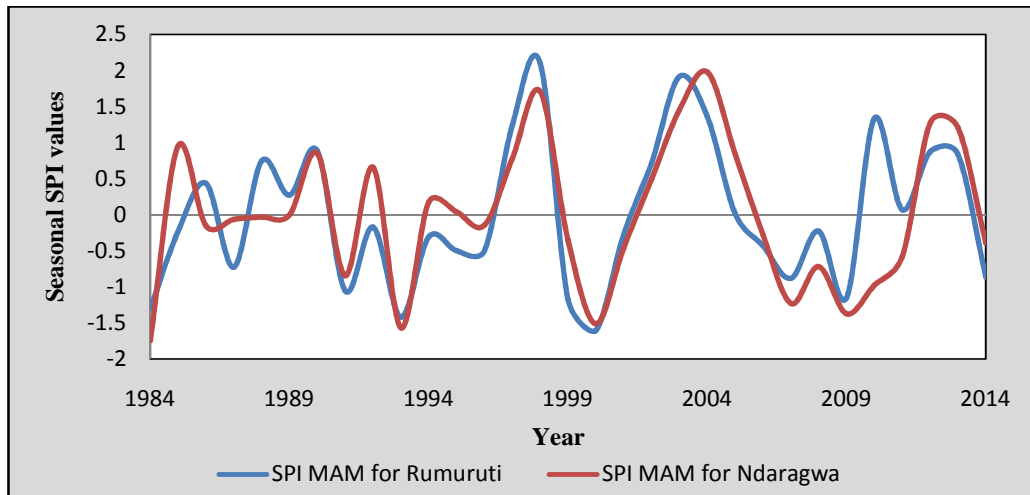
Source: Field data (2016)

### **5.3 Drought Characteristics in Laikipia West sub-County (1984- 2014)**

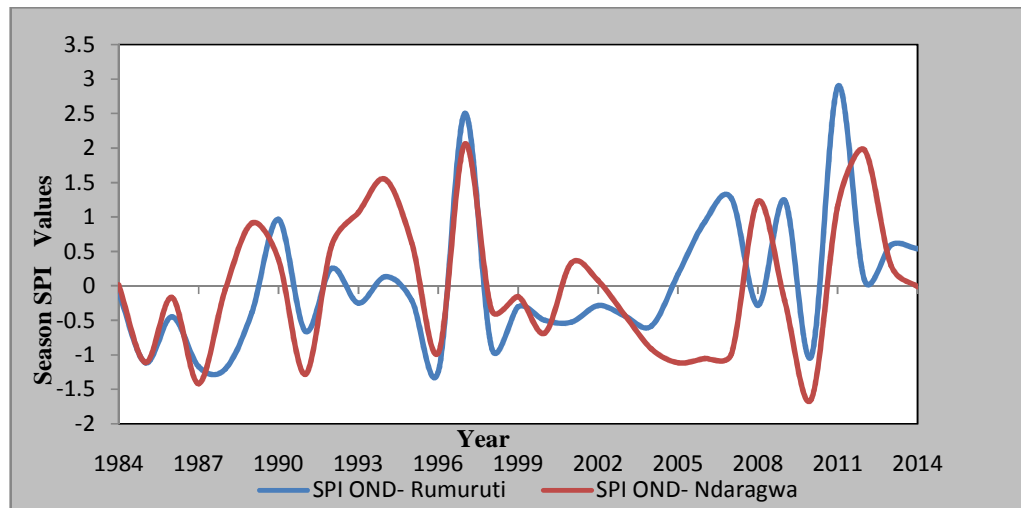
Rainfall data has been used to identify, quantify and classify seasonal drought years, both long and short rain seasons in Laikipia West sub-County from 1984 to 2014. Drought characteristics have been analyzed on seasonal and annual bases. Drought analysis for the growing seasons has been necessitated by their importance to crop growers and pastoralist who entirely depends on rain-fed agriculture. The crop growing season and livestock pasture in Laikipia West sub-County are March, April and May (MAM) which is a long rain season and October, November and December (OND) which is a short rain season. The dry months are January, February, June, July, August and September. In this study, drought was categorized as moderate and severe. Moderate drought refers to the drought with the SPI value of -1.0 to -1.49 and severe drought refers to drought with SPI value of -1.5 to -1.99.

Results in Figure 5.2 show that for the period under study during the long rain season, about 19% and 16% of the years received below normal rainfall at Rumuruti and Ndaragwa stations respectively. It is notable that; 1993 and 2000 were the driest years during the MAM at both Rumuruti and Ndaragwa; while 1998 was the wettest year in both stations during the same season. The recent severe drought during MAM was in 2009 in Ndaragwa and Rumuruti stations. The SPI results in Figure 5.3 show that for the period under study, about 16% and 29% of the years received below normal rainfall during the OND at Rumuruti and Ndaragwa stations respectively. It is notable that; 1985, 1987, 1996 and 2010 were the driest years at both Rumuruti and Ndaragwa; while 1997 was the wettest year in both stations during the same seasons. The recent drought during OND was in 2010 in Ndaragwa and Rumuruti stations.

Seasonal drought events show that for the period under study, Laikipia West sub-County has not experienced drought during the MAM and OND seasons in the same year. This shows that in case there is drought in one season the following season is a non-drought season. This explains the importance of seasonal climate forecast to crop farmers on placing the best bet in maximizing production in favourable seasons and to caution them during unfavorable seasons either by planting drought resistant seeds or opting not to cultivate crops.



**Figure 5.2: Long rain season SPI results for Rumuruti and Ndaragwa station**  
*Source: Field data (2016)*



**Figure 5.3: Short rain SPI results for Rumuruti and Ndaragwa station**  
*Source: Field data (2016)*

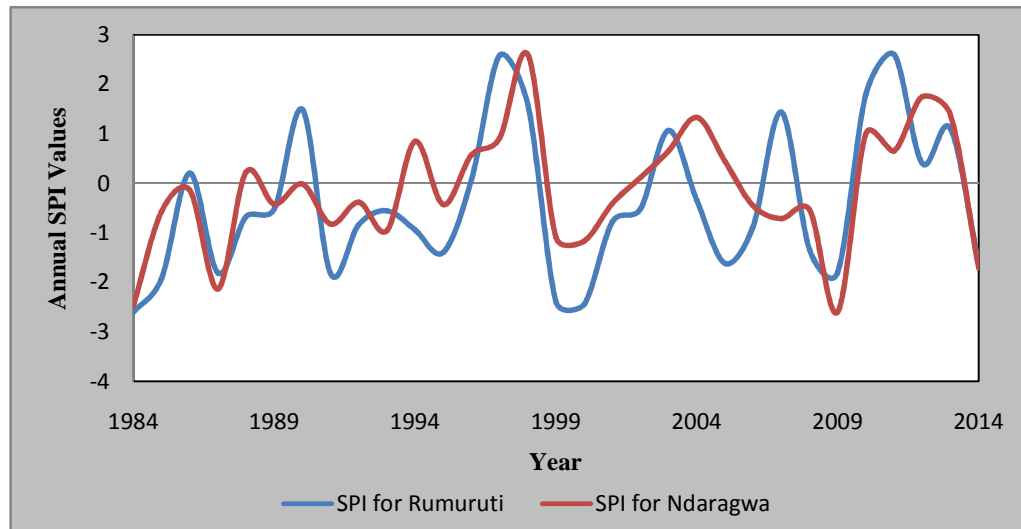
Annual drought analysis is important because of livestock farmers who depend entirely on natural pasture for their livestock. The standard precipitation index annual results in Figure 5.4 show that for the period under study, about 36% and 17% of the years received below normal annual rainfall at Rumuruti and Ndaragwa stations respectively. Also 40% and 67% of the total number of years under study received normal rainfall at Rumuruti and Ndaragwa stations respectively. It is notable that; 1984, 1987 and 2009 were the driest years at both Rumuruti and Ndaragwa; while 1998 was the wettest year in both stations. It is instructive to note that in 1990, Rumuruti received above normal rainfall while Ndaragwa received below normal rainfall. The results highlight the significance of localized factors



such vegetation cover and topography in influencing rainfall amount. Notable too is establishment that Rumuruti ward has experienced more droughts in the past than Ndaragwa ward.

The results presented in Figure 5.4 reveal that, moderate drought was experienced in 1995 and 2008 in Rumuruti and 1999 and 2000 in Ndaragwa; severe drought in 1985, 1987, 1991, 2005, 2009 at Rumuruti station and 2014 in Ndaragwa; while extreme drought was experienced in 1984, 1999 and 2000 in Rumuruti and 1984, 1987 and 2009 in Ndaragwa. The 1984 drought is on record as the most severe drought in Kenya that was triggered by La Niña event of 1982-1984 (Shisanya, 1990). The wet years are also classified as moderately wet, very wet and extremely wet years. These are quantified as 1.0 to 1.49, 1.5 to 1.99, and 2.0 and above respectively. The moderately wet (1.0 to 1.49) years were: 1990, 2003, 2007 and 2013 in Rumuruti and 2004, 2010 and 2013 in Ndaragwa. These results concur with earlier studies that the drought cycle has changed in the recent time and become more frequent, 2-3 years, giving no time to recover from the effects (Akliliu & Alebachew, 2009; Coppock, 1994; Anderson & Mowjee, 2008).

The wet years (1.5 to 1.99) were 1998 and 2010 in Rumuruti and 2012 in Ndaragwa. The extreme wet years (2.0 and above) were 1997 and 2011 in Rumuruti and 1998 in Ndaragwa. The identified drought years in Rumuruti and Ndaragwa were also drought years in Kenya as described by earlier studies that Kenya has experienced drought for the last 30 years in, 1983/84, 1987/1988, 1991/92, 1995/96, 1999/2000, 2004/2005, 2008/2009 and 2011 (Huho *et al.*, 2010). The 1984, 1991-92, 1994 droughts were declared as national disasters by the government of Kenya (Huho & Kosonei, 2013). Other regions of the world that experienced drought during the same period include Thailand (Prapertchob, Bhandari & Pandy, 2007) and South Africa (Tyson & Dyer, 1978; Vogel, 2000; Adger, 2001; Kihupi, Kingamkono, Dihenga, & Rwamugira, 2003).



**Figure 5.4: Annual SPI results for Rumuruti and Ndaragwa stations**  
*Source: Field data (2016)*

#### 5.4 Effects of Drought on Household Livelihoods in Laikipia West sub-County

Individual droughts vary according to intensity, duration, and spatial extent and the types of impacts they produce (Wilhite *et al.*, 2014). Effects of drought result from the interplay of the event (i.e., precipitation deficiency) with the social characteristics of an area, drought risks and perceptions also vary across regions and locales (Wilhite *et al.*, 2007). The effects of 2009 drought on household livelihood in Laikipia West sub-County was analyzed at five categories. These are crops, livestock, and health, social and environmental effects. The data on the effects of 2009 drought was obtained from the household survey. The effects of drought were limited to 2009 drought to enable respondents recall accurately.

##### 5.4.1 Effects of Drought on Crops in Laikipia West sub-County

Household survey results in Table 5.1 show that 2009 droughts led to reduced crop yields (57%) and crop failure (26%). According to Wilhite, Svoboda, and Hayes (2007) the effects of drought are as a result of the interplay between natural event (precipitation deficiency) and social response. The findings supports the earlier argument by Boubacar (2012) that revealed that in United State of America poor temporal spread of rainfall is harmful to crop. The findings also supports the earlier argument by Olaoye (1999) that regular occurrence of drought as a result of erratic rainfall distribution and cessation of rain during the growing season reduced Nigeria’s capability for increased crop production.

In 2014/2015 MAM season an agriculture officer observed that;

*‘Land was prepared during the March/April rains but there was no germination. Eighty percent of the farms experienced total crop failure.’*

**Table 5.1: Effects of drought on household livelihoods in Laikipia West sub-County (N=180)**

	Number of respondents	Number of respondents (%)
Reduced crop yield	103	57
Crop failure	47	26
High cost of goods	30	17
Total	180	100.0

Source: Field data (2016)

On the effects of 2009 drought on crops, an extension officer observed that:

*‘Laikipia West sub-County experienced food shortages, lack of pasture, market supply shortages and high cost food during the 2009 drought. The high cost of food was caused by sourcing of food from the neighbouring sub-County hence increased cost. The increased cost of food increases burden to the already constraints households in Laikipia West sub-County.’*

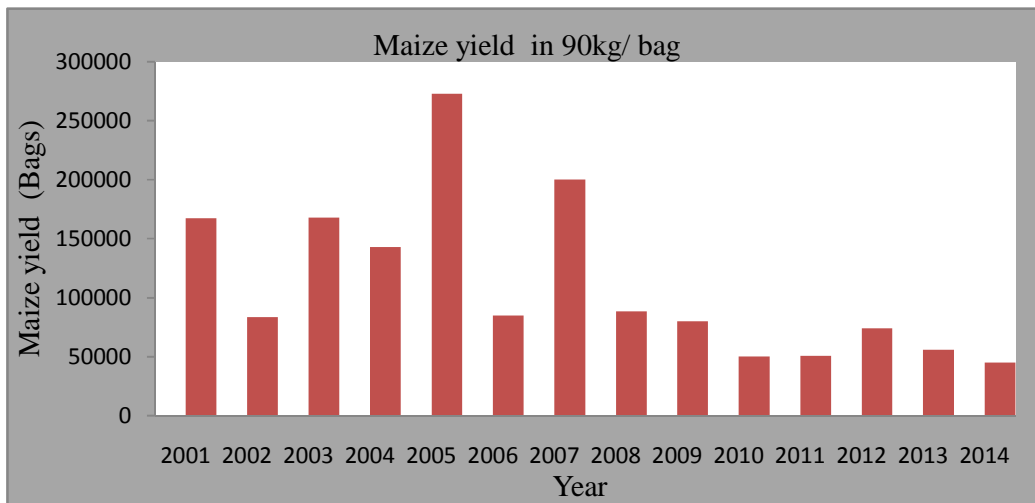
The results in Table 5.2 show that three quarter of crop area (27%) was impacted by drought while 75% of respondents reported few livestock death in Laikipia West sub-County (Table 5.3). This finding shows that crops are more vulnerable to droughts than livestock. The fact that pastoralists are able to move with their animals from one place to the other in search pasture and water increases the chances of animals’ survival. Water scarcity during drought decreases the chances of crop growth leading to decreased yields. The current study supports the earlier studies by Ortegren *et al.* (2014) and Pederson *et al.* (2012) in the Southeast USA that the severity of recent drought events has highlighted the need for a better climatological understanding of drought, particularly in order to address potential water management challenges.

**Table 5.2: Percentage of household crops impacted by drought (N=180)**

Crops area impacted	Number of respondents	Number of respondents (%)
Less than 25% crop area	37	21
Less than 50% crop area	46	25
Less than 75%	48	27
Over 75%	49	27
Total	180	100.0

Source: Field data (2016)

The secondary data on maize production from 2001 to 2014 supports the household data that shows decreased maize production in Laikipia West sub-County. Figure 5.5 shows decreased maize production from 2007 to 2014. The highest maize production during the fourteen year period was in 2005 while the lowest production was in 2014. The lowest maize production in 2014 supports the observation by the agriculture officers that 80% of the farms experienced total crop failure. The decreased production from 2007 to 2014 can be explained by the drought events on Figure 5.4 where moderate drought was experienced in 2003, 2007 and 2013 while severe drought was experienced in 2009 at Rumuruti division. The lowest production in 2010 is explained by severe drought in the same year during OND season as shown on Figure 5.3.



**Figure 5.5: Maized production in Laikipia West sub-County in bags (2001-2014)**

*Source:* Laikipia West sub-County Agriculture office (2016)

#### 5.4.2 Effects of Drought on Livestock in Laikipia West sub-County

Results in Table 5.3 show that 75% of the respondents indicated that the 2009 drought led to few livestock death while 12% indicated that 2009 drought did not cause livestock losses. The loss of animals leads to reduced livestock production. The high number of respondents indicating that few animals died shows that drought has significant effects on livestock production. Drought reduces forage production and water supplies, thus placing serious pressure on the livestock industry (UNDP, 2000; UNCDD, 1999).

According to World Bank (2013) drought makes animals more susceptible to

diseases. Grain-eating birds and grasshoppers are usually reliant on pastures to meet their food requirements. However, fodder scarcity during drought forces them to move to cultivated areas, causing severe damage to mature crops. It was not possible to estimate the exact number of the animals that died due to drought. This study supports the earlier arguments by the World Bank (2013) that considering data limitations, it is difficult to quantify the losses in the livestock sector. The economic effects of drought in Laikipia West sub-County leads to diversion of development fund by both county and national government in order to meet the basic needs of the affected households. These results are similar to an earlier by Lackstrom (2015) that drought is one of the costliest hazards faced by the United States, having caused billions of dollars in damage and affected all regions of the country over the past two decades.

**Table 5.3: Effects of drought on livestock at household level in Laikipia West sub-County (N=180)**

<b>Effects on Livestock</b>	<b>Number of respondents</b>	<b>Number of respondents (%)</b>
No livestock died	21	12
Few livestock deaths	135	75
All livestock died	24	13
<b>Total</b>	<b>180</b>	<b>100.0</b>

*Source:* Field data (2016)

#### **5.4.3 Social Effects of Drought in Laikipia West sub-County**

Besides the effects on crop and livestock production, drought was reported to have social effects in Laikipia West sub-County. As shown in Table 5.4, seasonal migration with animals (28%) and increased distance to water points (28%) were the leading social effects of drought on households. It is noteworthy that conflict over pasture (18%), job losses (11%) and children missing school (9%) were also reported as consequences of drought in Laikipia West sub-County. Drought creates fodder scarcity, thereby contributing conflict risk between herders and farmers (World Bank 2013). Drought triggers conflict as in the case of 1990 second Tuareg Rebellion in Mali (Keita, 1998). According to Thébaud and Batterby (2001) in the Sahel region, expansion of agriculture during the wet 1950s and 1960s and a shift to agro-pastoralism pushed pastoralists into more marginal regions and led to a breakdown in the networks connecting herders and farmers, further contributing to conflict between these groups.

**Table 5.4: Social Effects of drought in Laikipia West sub-County (N=180)**

	Number of respondents	Number of respondents (%)
Children missed school for lack of food and school fees	16	9
Seasonal migration with animals	51	28
Increased distance to the water point	51	28
Job losses in farms	20	11
Conflict over water and pasture	33	18
Others	9	6
Total	180	100.0

Source: Field data (2016)

The key informants' findings show that respondents who lost all their animals or suffer total crop failure during drought committed suicide. The findings supports the earlier study by Parmeshwar (2014) in Maharashtra state of India that hopelessness and mental depression due to the adverse effects of drought is one of the main causes behind the abnormally high rate of household suicide during hazards. In spite of huge expenses on measures to mitigate effects of drought, the numbers of farmer suicides continues to grow demonstrating a lack of social and community support in the existing drought relief packages (Kiem, 2013). On conflicts, a Red Cross officer stated that:

*'Increase in conflict in Laikipia West sub-County is as a result of high suspicion between the farmers and the pastoralist. The pastoralist feels that the decrease in the volume of the river downstream is as a result of the farmers using the water in the upstream for irrigation which leads to pastoralist grazing their animals on farms leading to conflict. The conflicts are not just human and human conflict but also human and wildlife conflicts. The elephants migrate upstream when the rivers dry up down streams invading people's farms and in some instances leading to heavy losses to the farmers. When the farmers complain to the Kenya Wildlife Service and the Laikipia County government, it takes a very long time for them to be compensated and this makes it difficult them to meet their daily needs and educating their children.'*

According to an informant compensation of the households when their crops are destroyed by the wild animals takes a long time however the Kenya Wildlife Service are very prompt when a wild animal is attached. With such kind of perception among the households there is need for community cooperation between the Kenya Wildlife Service and the households on sustainable solution to the human-wildlife conflicts. According to Rumuruti location Chief, alternative dispute resolution mechanisms of human conflicts are encouraged through the use of elders and religious organizations. A similar method of dispute resolution was used in Zimbabwe where the role of the traditional leader has continued to add value to

the traditional court system (Mubaya & Mafongoya, 2017). Alternative dispute resolution mechanisms promote unity among the members of the society. The churches in Laikipia West sub-County have been at the forefront in fostering peace using different methods particularly submission, confession, and peace visits (Mwangi, 2012).

Seasonal migration with the animals separate families for some time and deny parents an opportunity to raise their children together. Migration also affects school attendance among the pastoralist children leading to loss of school time which translates to poor performance in the national examinations. An informant stated that:

*'There are no government initiatives such as relief food and school feeding programmes in Laikipia West sub-County to deal with drought events like it happens in other dry lands of Kenya. The support received is from the Catholic Church relief programs under the Caritas program. The program recently supported victims of fire at Mutamaiyu village.'*

#### **5.4.4 Environmental Effects of Drought in Laikipia West sub-County**

Drought was also found to have environmental effects in Laikipia West sub-County (Table 5.5). Drying of rivers (79%), lack of wood fuel (12%) and increased fire incidences (8%) and the most reported environmental effect of droughts. Drying of rivers which was the greatest environmental effects shows that people and animals had to walk a greater distance to look for water and could also increase conflict over the few existing water sources. Animals walking over long distances increase soil erosion hence degrading soils. Laikipia West sub-County being a semi arid region suffers from decreased precipitation causing drying of rivers. This study supports the earlier findings by Ahmed *et al.* (2001) that arid and semi-arid environments are characterized by extreme variability and unreliability of rainfall both between different years and between different places in the same year. Consequently, these areas are characterized by the scarcity and seasonal variability of vegetation, and vulnerability to drought.

The increased fire incidences lead to loss of biodiversity and subsequently to negative consequences on the ecosystem. Other (1%) environmental effects mentioned by the respondents when asked to specify the category on others are soil erosion and destruction of infrastructure. Increased cases of forest fire in Laikipia have been blamed for decreased forest cover in Laikipia West sub-County. The decreased amounts of water and scarcity of pasture leads to death of animals which pollutes the environment due to the presence of unburied animal carcasses.

**Table 5.5: Environmental effects of drought in Laikipia West sub-County (N=180)**

	Number of respondents	Number of respondents (%)
Lack of household fuel	21	12
Drying of rivers	142	79
Increased cases of fire	16	8
Others	1	1
Total	180	100.0

Source: Field data (2016)

#### 5.4.5 Effects of Drought on Health in Laikipia West sub-County

Periods of droughts are often characterized by low hygiene standards; for instance it was found that during drought period, the households are forced to walk for long distances to fetch water for domestic and livestock. During such times human being and animals get the water from a common water source which increases the chances of contamination. When water quality is compromised, diseases incidences among both human and livestock increase.

In the study respondents were asked whether the 2009 drought had any health related effects. The results presented in Table 5.6 reveal that the health effects include human diseases, livestock diseases and crop diseases. Respondents observed that the 2009 drought triggered malnutrition among members of the households (40%), livestock diseases (29%) and increased crop pest (19%) among others. Reduced water volumes in rivers or lakes lead to high concentration of pollutants. Increased cases of human diseases translate to low productivity among households since more time is lost while seeking treatments as opposed to economic development. Increased cases of livestock diseases is likely to endanger human life considering the animal products such as milk and meat that people get from livestock.

An informant observed that:

*'Drought increases distance to the water points which is an additional burden to the social responsibilities of women in Laikipia West sub-County. They spend a lot of time looking for water which sometimes is dirty.'*

During drought livestock health deteriorates and greater percentage of this animals die. This study supports the earlier findings by Ahmed and Abdel (1996) in Sudan that lack of adequate forage and drinking water, coupled with long daily walks in search of feed and water, have imposed a serious strain on the animals, leading to poor health and increased mortality. The contamination of water due to decreased quantity and sharing of a common water point also exposes people to risks of water borne diseases. According to Aklilu and



Alebachew (2009) small increases in temperature can result in measurable impacts on the health of human beings and livestock as well as the availability of water, food, and feed resources. The current study contradicts the earlier study by Juma (2009) that improved animal health resulted in an increase in livestock that led to the overuse of common resources such as water.

**Table 5.6: Effects of drought on Health in Laikipia West sub-County (N=180)**

	Number of respondents	Number of respondents (%)
Increased cases of livestock disease	52	29
Increased crop pest	34	19
Human diseases	16	9
Human death	6	3
Malnutrition	72	40
Total	180	100.0

*Source:* Field data (2016)

### 5.5 Perception of Drought Disasters in Laikipia West sub-County

Assessment of drought perception is important because different people perceive drought differently and derive local adaptation measures based on their individual perception. Factor influencing drought perceptions were analyzed in order to explain why households living within the same neighborhood perceive drought differently. According to Ndambiri *et al.* (2012) in Kyuso District Kitui County, climate change is a constraint to the productive capacity of the farm households and that farmers' perceptions of the changing climate is a signal for innovative adaptation strategies to be undertaken by the farmers so as to reduce farming risks emanating from climate change.

#### 5.5.1 Drought Perception in Laikipia West sub-County

Having noted the effects of 2009 droughts on household livelihoods in Laikipia West sub-County, respondents were further asked on their perceptions to drought. The measureable indicators of perception were: severe and moderate. The assumption made in the conceptualization of drought risk in the mentioned categories was that the perceived effects of drought to an individual household could have been determined by their past effects. This is what Pennings and Smidts (2000) refer to as risk perception; the local people's own interpretation of the likelihood of being exposed to the content of risk. Assessment of local people's perceptions and attitudes informs us much more about the relevance of the adaptation strategies they are likely to adopt. Household perceptions of drought were

categorized into two classes namely: severe and moderate. The study found that 53% of the households felt that the 2009 drought was moderate and 47% drought was severe. The difference in their perception could be as results of the difference in socioeconomic characteristics of the households such as; age, gender, education, source of income, experience, agriculture training among others. The variation of respondents' responses on the drought characteristics shows that drought effects differ among households in the same neighborhood.

The households that are more vulnerable and less resilient are likely to be affected more as opposed to the households that are less vulnerable and could be more resilient. The variations of drought characteristics could also lead to adoption of different drought adaptation strategies among different household living in the same region experience common physical characteristics. Perception of drought informs households decision on short term and long term adaptation strategies that need to be put in place in Laikipia West sub-County. The study supports the earlier finding of Ndambiri *et al.* (2012) that innovations towards farm production in Kyuso District are made in response to the farmers' perceptions of variable climatic conditions.

### **5.5.2 Factors Influencing Households Perception to Drought in Laikipia West sub-County**

In order to determine the factors that influence household perception to drought the independent and dependent variables were regressed using logistic regression model and the results presented in Table 5.7. The dependent variable was the question on how households described the 2009 drought as either severe or moderate. The results show that gender of the household head was not a significant factor of perception of drought in Laikipia West sub-County. This could be because pastoralism as a source of livelihoods involves members of either gender and suffer the impacts equally. For a study in an agro-pastoralist zone it is expected that men are more likely to perceived drought more than women. This could be because of the mobility with livestock is by men. This was not the case in Laikipia. Contrary to the earlier work of Ndambiri *et al.* (2012) on perception of climate change in Kyuso, Kitui County that the probability of a male household to perceive climate change is higher than that of female household.

Contrary to the expectations results on education were not significantly related to

drought perception. It is expected that educated households have learned the different drought magnitudes and could be able to categorize drought as either severe or moderate. It is also expected that household with primary education are likely to perceive drought than those with informal education. Households with secondary education are likely to perceive drought than households with informal education while those with tertiary education are less likely to perceive drought than those with informal education. However results show that education level is not significant to drought perception. This could be because pastoralism being the major source of livelihoods in Laikipia West sub-County effects of droughts does not discriminate and all the households' livelihoods are affected irrespective of their level of education.

The number of years a household has engaged in farming is positively related to their perception to drought. Length of stay in the study area was found to be significant to perception of 2009 drought event ( $p= 0.0203$ ). It is possible that experience of the environment (study site) has contributed to a better perception of the severity of drought. Lack of a significant relationship between 26-30 years of stay perception to the 2009 drought can be attributed to their reduced interest in livelihood activities due to their advanced age. Note, persons who have stayed in the study area for more than 26 years are in their 60s and less involved in livelihood activities. This is perhaps due to their experience with weather events such as drought. According to an earlier study by Abul, Amir and Promkhambut (2013) in North East Thailand farmers who have 30 years farming experience were less likely to believe that droughts were becoming more frequent; they believed that droughts frequency remain the same. On the other hand, farmers who have less than 30 years farming experience believed that drought will become more frequent in the near future. The results support the earlier argument by Diggs (1991) on drought experience and perception of climatic change among great plains in the United State farmers, that if farmers do use the availability heuristic to form assessments of future drought, differences in the perception of drought frequency should arise from differences in individuals' experience.

According to the earlier study by Taylor, Steward and Downton (1988) on perceptions of drought in the Ogallala Aquifer region in the United State, four coherent elements shape drought perception. Previous drought experiences shape an individual's memory and are an important influence on how someone defines drought. What one remembers as a drought depends on how an individual defines it; while on the other hand, what an individual defines

as drought depends on the droughts one remembers. The way drought is defined and the way past droughts are remembered influence an individual's expectation of future droughts and one's behavior. In Laikipia West sub-County, the study on factors that influence drought perception was drawn in such way that the drought identifiable indicators were incorporated.

Pastoralism, as a source of income, was found to have significantly influenced the perception of 2009 drought event ( $p= 0.0473$ ). None of the other sources of income (Government employment, business, dairy farming, maize and farming), was found to have a significant relationship with perception of 2009 drought. Although maize, wheat and dairy farming are more sensitive to drought than pastoralism, these may not be primary sources of income. To most households, pastoralism is the lead source of income. Thus, in the event of drought, most households are severely affected-this could be due to the sensitivity nature of pastoralism on drought event. Household heads employed by the government have a regular income which does not vary with the weather events compared to pastoralist who are worst hit due to decreased pasture.

The study further established that farming on leased land significantly influenced the perception of 2009 drought event ( $p=0.0280$ ) than communal and privately owned land. This could be due to the fact that effect of drought in communal land ownership is a shared responsibility and not individual responsibility as in leased ownership. Similarly, households who own private land reserve the option not to engage in farming and therefore averting risks associated with land. It's significant to note that in Laikipia West Sub-County, most households with privately owned land are immigrants who own land and maize farmer and could opt not to cultivate crops when droughts are predicted to avoid losses unlike those on leased land that may still want to diversify the types of crops to recover money used to lease land.

Size of land was not significant to drought perception in Laikipia West sub-County. It is expected that households with large portions of land are less likely to suffer the effects of drought compared to those with small portions of land. In a pastoralism dominated area large farmers allow greater grazing fields than small land sizes. With decreased pasture because of drought large portions of land are likely to have more pasture compared to small fields. The reason why land size is not significant to drought perceptions in Laikipia could be because of the presence of large tracks of land communally owned and also existence of absentee land owners. Training on agriculture was also not significant to household drought perceptions. It

is expected that training broadens individual perceptions with the environment which is not the case in Laikipia West sub-County. This could be because of the mobile nature of the pastoralism as a source of income. The opportunities of interaction with extension officers and attending such trainings are minimal in pastoral realities.

**Table 5.7: Odd ratios for logistic regression model on the factors influencing households perception to drought**

Parameters	Coefficient Estimates	Wald	Odd ratio estimate
<b>Gender</b>			
Male (r)			1.00
Female	-0.00127	0.9975	0.999
<b>Age</b>			
<30 (r)			1.00
31-40	-0.2443	0.6204	0.783
41-50	-0.7350	0.2310	0.480
51-60	-0.6184	0.0004*	0.539
61 and above	-0.3007	0.7228	0.740
<b>Education</b>			
Informal education ( r)			1.00
Primary education	0.0841	0.8653	1.088
Secondary education	0.2095	0.7348	1.233
Tertiary education	-1.3791	0.1045	0.252
<b>Length of engt in farming</b>			
<5 ( r)			1.00
6-10	0.0784	0.9345	1.082
11-15	1.2508	0.1896	3.493
16-20	1.6412	0.1271	5.162
21-25	1.7086	0.0203*	5.521
26-30	1.3424	0.1714	3.828
<b>Source of income</b>			
Government Employee ( r)			1.00
Business persons	-1.8852	0.0814	0.152
Maize farming	-1.5997	0.1382	0.202
Dairy farming	-0.7920	0.5158	0.453
Pastoralism	-2.1796	0.0473*	0.113
Wheat farming	11.9681	0.9923	0.212
Size008_2	-0.6723	0.1607	0.511
<b>Size of land</b>			
<2 ( r)			1.00
2-5	2.0169	0.1189	7.515
5-10	0.3384	0.6477	1.403
<b>Type of landownership</b>			
Owner ( r)			1.00
Leased land	1.3224	0.0280*	3.753
Communal ownership	0.8142	0.1231	2.257
<b>Training</b>			
Yes ( r)			1.00
No	-0.8742	0.0928	0.417

\* Significant at 5% level of significance

Odds ratio <1 less likely to occur in the first group

Odds ratio > 1 more likely to occur in the first group

Odds ratio of 1 indicates event under study is equally likely to occur in both groups

( r)= Reference category

Source: Field data (2016)

## **CHAPTER SIX**

### **6.0 DROUGHT ADAPTATION STRATEGIES AND THEIR DETERMINANTS**

#### **6.1 Introduction**

This chapter presents the results and discussions on the household and community drought adaptation strategies and drought adaptation determinants. The chapter also presents results on the role of institutions in managing local level drought adaptation in Laikipia West sub-County. Summary tables to indicate percent distribution of dependent and independent variables are presented. To show how each independent variable influence the outcomes, cross tabulations were conducted and results presented. Finally chi-square of independence was conducted to identify the determinants of drought adaptation.

#### **6.2 Household Drought Adaptation Strategies in Laikipia West Sub-County**

Household adaptation strategies are the measure put in place by members of the household to respond to or recover from the effects of drought events. In order to understand some of the drought adaptation strategies adopted by the households to cope with drought, the household heads were asked to state the adaptation strategies households adopt during drought. The most common drought adaptation strategies adapted during drought in Laikipia West sub-County are: seasonal migration with animals, herd reduction, opting not to cultivate crops, planting drought resistant seeds, rural-urban migration, waiting for relief food, engaging in business, gathering wild fruits and roots and practicing charcoal burning. Studies have shown that without adaptation to climate change, farmers will become more vulnerable and agricultural production will be severely affected (Smit and Skinner, 2002).

The findings on Table 6.1 show that 25% of the respondents migrated with their animals in search of water and pasture. Household heads opted to look for employment in the construction sites or in the flower farms (15%) outside the sub-County. Cases of some of the respondents relocating to neighbouring counties such as Nakuru were reported. There are those who opted not to cultivate crops (15%) during the drought period, (14%) bought food supply as a response strategy, (14%) sold their livestock, (5%) watered their crops and a similar number of planted drought evading crops. There are those who changed their sources of income (4%) as an adaptation strategy venturing into other income generating activities, (2%) of the respondents slaughtered their animals for food while (1%) used other response strategies.

**Table 6.1: Household drought adaptation strategies in Laikipia West sub-County (N=180)**

	Number of respondents	Percentage of respondents
Sold livestock	24	14
Migrated with the animals	46	25
Search for employment	27	15
Withdraw from farming	27	15
Changed source of income	7	4
Slaughtered the animals	3	2
Bought food supply	26	14
Watered crops	9	5
Planted drought evading crops	9	5
Others	2	1
Total	180	100.0

*Source:* Field data (2016)

The results were cross tabulated with the socio-economic characteristics of the household and the results presented. The results in Table 6.2 show that households who had lived in Laikipia West sub-County for a long time were not ready to sell their belongings and migrate to other places as opposed to those who had stayed for 5 years and below. Bee keeping was not practiced by those who have lived in the area for 16-20 years, perhaps because they had tried before and faced challenges. Planting of drought resistant seed is highly preferred by those who had stayed in Laikipia West sub-County for 0-5 years. Perhaps this is because they are still open to a variety of crops to plant as opposed to those who have stayed longer and plant according to traditions and are very rigid, being used to their traditional ways of doing things.

The respondents who migrate to town in search of employment are those who have stayed in Laikipia West sub-County for 11-15 years. This could be because they have observed the drought trend longer and can be able to predict short term and long term drought periods and able to judge when looking for a short term employment is appropriate. This could be contrary to those who have stayed for a shorter period and are likely to underrate an otherwise severe drought. The respondents who gathered wild fruits and roots are those who have stayed in Laikipia West sub-County for more than 30 years. This could be because they have the knowledge on the edible fruits and roots which sometimes lead to poisoning if eaten by inexperienced people. Some plant roots are known to have medicinal value and have been exploited during drought to delay hunger. The traditional medical knowledge is passed from one generation to the other and therefore it is perfected with time, this could explain why those who have stayed longer are likely to embrace wild fruit and roots.

**Table 6.2: Cross tabulation of the duration household head had stayed in Laikipia West sub-County and adaptation strategies**

	Years lived in the location (%)						
	0-5 years	6-10 years	11-15 years	16-20 years	21- 25 years	26-30 years	above 30 years
Migrated animals in search of pasture and water	7	25	27	18	8	1	14
Sold my animals	6	22	27	18	10	4	13
Did not farm	11	25	27	8	7	9	13
Planting of drought resistant seeds	14	31	20	6	14	2	13
Bought fodder for the animals	3	22	22	21	13	3	16
Migrated to town in search of employment	9	29	40	5	5	2	10
Waited for the relief food	4	22	38	17	6	4	9
Engaged in business	9	32	32	9	8	4	6
Gathered wild fruits and roots	10	16	22	16	10	5	21
Practiced charcoal burning	3	27	35	11	5	3	14

*Source:* Field data (2016)

Results in Table 6.3 show cross-tabulation of drought adaptation strategies and socio-economic characteristics of the households. The results show that more men migrate with their livestock than women, buy fodder and sell animals during drought. Gathering of wild fruits is also common among men than women; perhaps because they are the ones herding in the bush most of the time. Waiting for relief food, opting not to farm and engaging in business are common response strategies among men and women. Selling of belongings and migrating to another area is the least preferred response among men and women. Planting of drought tolerant crops is not common among members of either gender.

The study found that despite being an arid and semi arid region that receives insufficient precipitation and faced with regular drought, planting of drought tolerant seeds is not a common practice in Laikipia West sub-County. The Households depend on maize as a source of livelihood yet the ecological conditions of the region could favor growth of drought tolerant crops and may perform better than maize. According to the World Bank (2013) widespread availability of drought-tolerant seed varieties and short-maturing varieties for cereals will help in ensuring crop production during drought years. Compared to longer maturing varieties, these short-maturing varieties will have higher yields in a drought year, but lower yields in a normal year and they might be able to resist diseases a little longer during drought years.



**Table 6.3 Cross tabulation of gender and drought adaptation strategies in Laikipia West sub-County (N=180)**

	Gender (%)	
	Male	Female
Migrated with my animals in search of pasture and water	69	31
Sold my animals	66	24
Did not farm during that period	66	34
Planting of drought resistant seeds	67	33
Bought fodder for the animals	77	23
Migrated to town in search of employment	59	31
Waited for the relief food	63	37
Engaged in business	63	37
Gathered wild fruits and roots	73	27
Practiced charcoal burning	57	23
Engaged in beekeeping	58	42

*Source:* Field data (2016)

The results in Table 6.4 show that households who migrated with their animals and embrace reduction of herd during drought were aged below 50 years. Households who were ready to sell belongings and migrate to another area were those below 30 years while none of those between 50 to 60 years were ready to migrate. It is not clear why young household heads were more willing to sell their livestock and relocate elsewhere compared to the older counter parts.

**Table 6.4: Cross tabulation of age and drought adaptation strategies in Laikipia West sub-County (N=180)**

	Age (%)				
	Below 30 Years	30-40 Years	41-50 Years	51-60 Years	61 and above
Migrated with my animals in search of pasture and water	38	27	22	8	5
Sold my animals	35	25	25	8	7
Did not farm during that period	25	33	21	15	6
Planting of drought resistant seeds	27	33	16	16	8
Bought fodder for the animals	35	33	17	10	5
Migrated to town in search of employment	26	39	29	5	1
Waited for the relief food	26	36	23	9	6
Engaged in business	39	39	15	5	2
Practiced charcoal burning	34	29	26	9	2

*Source:* Field data (2016)

The results in Table 6.5 show that households on communal land migrated with their animals unlike those who own or in leased land. This is because in communally owned land

there is less restriction on the grazing fields. The high numbers of households who sell their animals are those on communal land perhaps due to competition for the available pasture with animals from other households. The competition is evident by the fact that the high number of those who buy fodder for their animals are those on communal land ownership.

The households who opt not to cultivate crops are those on leased land as opposed to those who own land. These is perhaps due to the cost of leasing the land and the probability of returns that make those on leased land to be more cautious. The household heads who engage in business are those that are on leased land. This could be because when they decide not to farm they look for an alternative source of income and engage in business to maximize the returns and to get the money to pay the landlords.

**Table 6.5: Cross tabulation of land ownership and drought adaptation strategies (N=180)**

	Land ownership (%)		
	Owner	Leased	Communal
Migrated with my animals in search of pasture and water	45	10	45
Sold my animals	50	7	43
Did not farm during that period	63	21	16
Planting of drought resistant seeds	69	22	9
Bought fodder for the animals	46	8	46
Migrated to town in search of Employment	60	11	29
Waited for the relief food	53	12	35
Engaged in business	57	18	25
Gathered wild fruits and roots	67	13	20
Practiced charcoal burning	69	9	22

*Source:* Field data (2016)

Results in Table 6.6 show that pastoralist respond to drought by migrating with their animal (62%), selling of the animals (58%) and buying of fodder (46%). This can be explained by competition for pasture during drought which force pastoralist to migrate with their animals or even reduce their herds. Adoption of the drought adaptation strategies was least on the government employees. This is because the salary of the employees is constant and does not fluctuate with drought and are therefore least affected. Most of the maize farmers opt not to farm during drought. Maize is among the most vulnerable household activities which require evenly distributed rainfall and this explains why households will opt not to farm rather than planting crop and fail to germinate.

Households in Laikipia West sub-County have diversified their livelihoods with 35% of the maize farmers and 38% of pastoralist engaging in bee keeping. Bee keeping provides

honey that supplements the pastoralists’ regular diet during drought. In Laikipia West sub-County charcoal burning is another source of livelihood that provides income during drought among both crop farmers and pastoralist. During drought pastoralist diversify their sources of livelihoods “some of the major strategies used by pastoralists with regard to diversification of incomes include: charcoal burning, hunting, food gathering, fishing, working in urban areas, and migration to neighboring countries for labour’ (Ali, 1996).

**Table 6.6: Cross tabulation of source of income and drought adaptation strategies (N=180)**

	Source of Income (%)						
	Government Employment	Business Person	Maize Farming	Dairy Farming	Pastoralism	Wheat Farming	Other
Migrated with animals in search of pasture and water	1	8	21	7	62	1	0
sold my animals	0	8	24	8	58	1	1
Opt not to farm	3	11	45	4	24	0	13
Planting of drought resistant seeds	6	24	50	0	8	0	22
Bought fodder for the animals	2	11	22	14	46	2	3
Migrated to town in search of employment	3	17	27	5	42	0	6
Waited for the relief food	3	10	34	7	44	0	2
Engaged in business	3	30	29	6	31	0	1
Practiced charcoal burning	0	13	32	8	45	0	2
Engaged in beekeeping	4	15	35	4	38	0	7

*Source:* Field data (2016)

Results in Table 6.7 show that households with secondary education engage in business during drought. Households with tertiary education are least involved in migration with animals during drought while it is common for those with secondary education and below. Crop diversification as an adaptation strategy is practiced by households with primary education and above. Charcoal burning and bee keeping are common practices for households with primary education and below. Migration of the family to another region is the least preferred response strategy among households of all education categories. Perhaps this is an indication of how households in Laikipia West sub-County are determined to look for solutions from within rather than running away from the challenge.

Gathering of fruits and charcoal burning is the least preferred response strategy among households with secondary education and above. The strategies are preferred by those with primary and informal education perhaps because they strategies are less complex and

require low technological background to succeed in their application.

**Table 6.7: Cross tabulation of level of education and drought adaptation strategies (N=180)**

	Academic Qualification (%)				
	Informal Education	Primary Education	Secondary Education	Diploma	Degree
Sold my animals	39	33	23	5	0
Migrated with my animals in search of pasture and water	36	33	27	4	0
Opt not to farm	32	34	23	8	3
Planting of drought resistant seeds	21	33	31	13	2
Bought fodder for the animals	32	27	34	7	0
migrated with my family to another area	22	11	56	11	0
Gathered wild fruits and roots	42	11	26	21	0
Practiced charcoal burning	36	36	19	9	0
Engaged in beekeeping	38	42	15	5	0
Waited for the relief food	37	31	25	7	0
Migrated to town in search of employment	24	42	25	9	0
Engaged in business	22	28	41	9	0

*Source:* Field data (2016)

Results in Table 6.8 show that, household heads who gather wild fruits, engage in charcoal burning and beekeeping have no agriculture training. The households who gather wild fruits could still be stuck in the traditional ways of doing things. Agricultural training is expected to broaden individuals' ways of doing things. The aspect of modernity and diet diversification cannot be ignored in this modern world. Though the traditional ways of doing things is still relevant and applicable in the modern world, it should not be the only way but should complement the modern ways. Agriculture training is conducted using both theoretical and practical approaches. Agriculture training widens the individuals' drought adaptation strategies and could present various opportunities that can still be applied within a given area before searching for employment opportunities elsewhere when local solutions fail. According to one of the informant, households land is used for in-farm and out farm trials, demo plots in their farms. Conservation Agriculture is emphasized during such training. Conservation agriculture applies all technologies to utilize the available soil moisture to grow crops.

Bee keeping could be a response strategy embraced by those with no agricultural training because it is less involving. The medicinal value of honey and its use in delaying hunger could have made it a response strategy by those with no agriculture training. Migration to town in search of employment opportunity was the least preferred by those with

agriculture training.

**Table 6.8: Cross tabulation of agriculture training and drought adaptation strategies (N=180)**

	Training on farming courses (%)	
	Yes	No
Migrated with my animals in search of pasture and water	34	66
Sold my animals	45	55
Did not farm during that period	40	60
Planting of drought resistant seeds	47	53
Bought fodder for the animals	40	60
Migrated to town in search of employment	10	90
Waited for the relief food	33	67
Engaged in business	51	49
Gathered wild fruits and roots	7	93
Practiced charcoal burning	24	76
Engaged in beekeeping	10	90

*Source:* Field data (2016)

### 6.3 Use of Drought Adaptation Strategies in Laikipia West sub-County

The identified adaptation strategies in section 6.2 were ranked using Kendall rank test to established the most preferred household drought adaptation strategies in Laikipia West sub-County. The results in Table 6.9 show that engaging in business (5.93) was the most preferred adaptation strategy among crop farmers and pastoralist. Seasonal migration with the animals was the most preferred strategy among the pastoralist. Opting not to farm was the most preferred drought adaptation strategies among the crop farmers. The least preferred adaptation strategies are gathering wild fruits and selling belonging and migrating with family to other place. According to FAO (2008) adaptation is critical in protecting livelihoods and food security in many developing countries. The study supports the earlier argument that there are numerous drought adaptation options available for dry land farming, most of which focus on water conservation (Muthamilselvan *et al.* 2006).

Though seasonal migration with the animals is most preferred drought adaptation strategy among the pastoralist it is unsustainable in an area known to have deep rooted conflict over land. According to Mwangi (2012) the main causes of ethnic conflicts in Laikipia West include land, poverty, militia gangs, gun culture, political incitement, racism and ethnic animosity. Seasonal migration with the animals causes conflicts with ranchers, farmers, horticulturalists and conservation area wardens, and government authorities ([www.pragya.org](http://www.pragya.org)). Pressures on water and land resources in Laikipia West sub-County have increased greatly in recent years due to increased farming activities, rapid population growth,

and periodic drought. Conflicts involving pastoralists associated with resource competition, cattle rustling, and wide availability of small arms are widespread and of increasing concern (Mkutu, 2001). The situation in Laikipia West sub-County is made worse due to the fact that most of her neighbors from Isiolo, Baringo, Marsabit, Moyale, Samburu and Turkana communities are moving in large numbers into agricultural areas of Laikipia in search of water and pasture ([www.pragya.org](http://www.pragya.org)). On drought adaptation strategies adopted by the pastoralist a livestock officer observed that:

*'Pastoralists hire grazing land from ranchers or government holding grounds, occupying ranches and holding grounds illegally, graze and occupy abandoned sub-divided ranches illegally, encroachment and illegal grazing in private lands resulting in destruction of crops, migrating with their animals to other counties such as Nyandarua in search for pastures. Some of this strategies results to conflict especially when they graze in private land illegally. The office of the chief with the help of the elders is the key mediator during such conflicts.'*

Scarcity and insecure access to water and pasture land has led to constant friction with ranchers and other users, which has led in turn to violent conflicts ([www.pragya.org](http://www.pragya.org)). Competition over scarce grazing fields, water resources and pasture has escalated inter-ethnic animosity, often resulting in armed conflicts, which are predatory in nature and much more destructive. According to the informant conflicts between farmers and herders have mostly taken place in areas where local communities have failed to improve natural resource management, and where local conflict resolution mechanisms failed. This finding supports the earlier study by the World Bank (2013) in Niger that successful intermediation by heads of associations or traditional leaders and significant improvements in resource base appreciably reduced conflicts between farming and herding communities.

Opting not to farm being the most preferred adaptation strategy among crop farmers is also unsustainable and shows some gap in the dissemination of information by extension officers. This is because sustainable drought adaptation strategies such as planting of drought resistant seeds which is least preferred strategy could be a long lasting solution to drought situations in Laikipia. The agriculture extension officers could fill the gap by educated households on the different variety of crops that could withstand or evade drought.

Though waiting for relief food is an adaptation strategy adopted by some respondents

where they wait for the support of the well wishers, key informants revealed that the national government no longer send relief food to Laikipia West sub-County unless during very extreme events where multi-governmental agencies are requires to help. One of the informants observed that:

*Distribution of relief food is based on village on how people know each other using vehicles from partner agencies. There are famine committees in every sub-location in Laikipia West sub-County. The committee identifies the hardest hit village and the most vulnerable people.*

The results of the key informant interviews found that extension officers disseminate drought adaptation strategies to farmers in Laikipia West sub-County and they include: Training livestock farmers and pastoralists on the need to look for alternative livelihoods when drought has been predicted. The current study shows that various adaptation strategies have been adopted by households in Laikipia West sub-County. The findings supports the earlier studies that irrigation, improved crop varieties, crop diversification, farm diversification, change of planting dates and income generating activities are among the adaptation practices most frequently deployed by farmers in Bangladesh (Maddison, 2006; Uddin *et al.*, 2014).

**Table 6.9 Ranked Frequency of the use of drought adaptation strategies (N=180)**

<b>Drought Adaptation</b>	<b>Mean Rank</b>
Migrate with my animals in search of pasture and water	6.04
Sold my animals	6.26
Opt not to farm during drought period	6.26
Practiced crop diversification	6.67
Planting of drought resistant seeds	7.16
Sold my belongings and migrated with my family to another area	8.65
Buy fodder for the animals	6.43
Migrate to town in search of employment	6.91
Wait for the relief food	6.42
Engage in business	5.93
Gather wild fruits and roots	8.41
Practice charcoal burning	7.84
Engaged in beekeeping	8.04

*Source:* Field data (2016)

#### **6.4 Role of Institutional in Managing Local level Drought Adaptation Strategies in Laikipia West sub-County**

Community drought adaptations strategies are deliberate actions taken by institutions involved in spearheading community adaptation. These institutions include non- Government organizations, elders, church organizations and government of Kenya agencies. Local institutions shape impacts of climatic shocks on communities (Mubaya & Mafongoya, 2017). The success of these adaptation efforts generally hinges upon the nature of existing formal and informal rural institutions. Institutions encompass on one hand tangible governance and organizational structures (formal) and on the other hand uncodified ‘rules of the game’, cultural norms and tradition (informal or institutional arrangements) which shape behavior and the nature of human interaction (Jones *et al.*, 2010).

These institutional and political contexts are also considered to influence the adaptive capacity of a community (Smit & Wandel, 2006). Agrawala (2010) suggests four ways in which external intervention can contribute to climate change adaptation; provision of weather and climate information, technological interventions that help increase productivity (and which are not necessarily targeted towards climatic change but livelihood challenges in general), financial support to assist with implementation of these technologies and leadership efforts that promote collective action for adaptation.

The information on community drought adaptation strategies was collected from selected households through questionnaires and complemented by key informant interviews. In the questionnaire there were questions that targeted community drought adaptation strategies. The information was also obtained from the selected key informants through interviews. The result in Table 6.10 shows that there are community drought adaptation measures in place. The results show that 29.8% of households are advised to sell their livestock to reduce the herd. According to Huho and Kosonei (2013), large livestock herds among pastoralist act as insurance against loss of the entire herd to droughts. There is a livestock market at Rumuruti Township on Monday and Thursday every week which offers a platform for the members of the community to sell part of the livestock especially when drought has been predicted as captured on one of the market days (Plate 6.1). Reducing the herd among pastoralist reduces losses during drought.

Other drought adaptation measures in place at the community level are, stock pile cereals and grains (27.4%), and change of cropping patterns when drought is predicted (12.9



%). The changing of crop patterns enables the community to diversify their sources of income thus cautioning them from drought. The results support the earlier finding by Hussain and Hanjra (2004) that crop diversification, intensification and shifts from subsistence to commercial crops were likely to help poorer households by reducing food prices. It further supports the argument by Spielman and Pandy-Lorch (2009) that advancements in modern agricultural practices have increased the world’s agricultural output to feed more than five billion people, with global cereal production doubling in the last 50 years.

**Table 6.10 Community Drought Adaptation Strategies in Laikipia West sub-County (N=180)**

<b>Drought adaptation strategies</b>	<b>Number of respondents (%)</b>
Stock piling of cereals and grains for emergency aid	27.4
Rehabilitation of critical boreholes	4.8
Sale of livestock	29.8
Drilling of new boreholes	8.9
Planting trees and reforestation	4.0
Diversification of income	12.9
Recruited volunteer to offer assistance during drought	0.8
Community emergency fund	3.2
Started community-based training initiatives	7.3
Promotion of networking within the community	0.8
<b>Total</b>	<b>100.0</b>

*Source:* Field data (2016)



**Plate 6.1: Livestock Market day at Rumuruti Township**

*Source:* Author (2016)

Other drought adaptation measures are community emergency fund (3.2%), recruitment of volunteers (0.8%), and promotion of networking within the community

(0.8%). Volunteers are important because they help in identification of most vulnerable members and assist the sick and those who are weak to reach the hospital. Networking among community members is an important means through which information on early warning can reach a wider audience within a short time. According to World Bank (2013) early warning about the impending weather season coupled with ready availability of drought-tolerant varieties could help mitigate the risk of crop failure.

The results reveal that there is drilling of new boreholes by the members of the communities (8.9%) while existing boreholes are rehabilitated (4.8%). According to a WRMA official, new boreholes were drilled in 2014. Water from these boreholes and existing rivers is used for domestic consumption and irrigation during the dry periods as shown in plates 6.2 and 6.3. The leading horticulture crops grown under irrigation in this region are tomatoes and onions. On water harvesting a key informant stated the following:

*'The most popular methods of rain water harvesting for drought adaptations in Laikipia West sub-County are: earth dams, water pans, farm ponds and water tanks.'*

The finding supports the earlier work of Udmale *et al.* (2014) in Maharashtra State of India that the use of available water during drought is very important. Farmers along rivers Ewaso Ng'iro irrigate their crop during drought. Irrigation water is particularly important in agricultural areas where rainfall is irregular, scant and insufficient, in order to supplement water from rainfall and to avoid crop failures. It is argued that adequate, timely and equitable water distribution is absolutely critical for enhancing agricultural productivity and improving food security, which underpins the livelihoods of many local farmers (Hussain & Hanjra, (2004); Lipton, Litchfield, Blackman, De Zoysa, Qureshy and Waddington (2002); Hussain, Sakthivadivel and Bhattarai, 2002). It further supports the argument by Tilman, Cassman, Matson, Naylor, and Polasky (2002) that increase in crop yields have come mainly from greater inputs of fertilizers, pesticides, new crop strains and irrigation.

Other strategies are community based training initiatives (7.3%). On community based initiatives one informant stated the following:

*'The National Drought Management Authority has contingency fund which is activated as need arises through the project procedures. There are community drought initiatives such as; weekly weather updates and advisories by Agriculture Sector Development Support Programme (ASDSP) in collaboration with Laikipia County Meteorological department.'*

Other community adaptation measures aimed at conservation of the environment are: planting of trees and reforestation (5%) done formally and informally as shown on the plates 6.4, 6.5, 6.6, and 6.7 captured in drawn graphics on buildings at shopping centers' sponsored by United State Agency for International Development and Action Plan. The drawings are a public platform to create awareness on the need for environmental conservation. The message is written in Kiswahili language which is widely spoken in most rural areas in Kenya to reach a wider audience. The use of graphics as captured on plate 6.5 and 6.7 has deeper message creating awareness that, *'uharibifu wa mazingira waleta: Kiangazi, umasikini na mmomonyoko wa udongo'* (destruction of the environment results into drought, poverty and soil erosion). Community based training initiatives on drought preparedness (7.3%) aimed at creating awareness among members on dangers associated with the destruction of the environment and some of the conservation efforts that they can practice to conserve the soil. In plate 6.6 the community is encouraged to participate in training on green energy technology that reduces emissions: 'Training for better life; solar panel, biogas and community tree planting.



**Plate 6.2** Irrigation using water from River Ewaso Ngi'ro (*Source: Author, 2016*)

**Plate 6.3** Animal and human being shares a water point (*Source: Author, 2016*)

**Plate 6.4** Indiscriminate destruction of forest and charcoal burning

**Plate 6.5** Destruction of the environment through illegal logging and firewood

**Plate 6.6** Training on the importance and use of green technology

**Plate 6.7** Destruction of the environment and the warning of the consequences

*Source:* Plate 6.4 to 6.7 is graphics captured on buildings by the author a project supported by USAID (feed the future programme) and Action Plan

According to FAO (2008) adaptation is critical in protecting livelihoods and food security in many developing countries. The study findings supports the earlier argument that there are numerous drought adaptation options available for dry land farming, most of which focus on water and soil health conservation (Muthamilselvan, Manian & Kathirvel, 2006). On drought adaptation options a key informant observed that:

*‘Agriculture extension officers disseminate drought adaptation strategies to farmers through formal and informal trainings. Some of the highlights during such training are the need to look for alternative livelihoods when drought has been predicted.’*

This was evident through the observed quarrying activities as captured on plate 6.8.



**Plate 6.8: Quarrying activities in Laikipia West sub-County**

*Source: Author (2016)*



On drought adaptation strategies an informant stated the following:

*'We advise pastoralist on the need for emergency livestock off take before the onset of drought and banking the money to be used in restocking. We also teach them on the need for optimum carrying capacity, methods of fodder and pasture conservation methods, livestock management and husbandry practices such as timely breeding, housing; disease control and proper feeding of their animals. We emphasis to the livestock keepers on grazing management strategies which are aimed at conservation of pasture such as deferred grazing, rotational grazing, tethering and continuous grazing.'*

In the earlier studies in Kenya, Tanzania, Algeria, and Morocco pastoralists preserved the raised grounds or the hilly areas and the forested areas as dry season grazing areas. This allowed natural regeneration of pasture during wet years and during mild droughts. Pastoralists are forbidden from grazing in these areas for a period of time. This is a common strategy among pastoralists in other parts of Kenya and world in general such as the Sukuma of Tanzania, the Tuareg of Ahaggar in Algeria, the Il Chamus, Turkana and Rendile of northern Kenya, the Tilemsi of Mali and the Berbers of Morocco (Niamir, 1999). On drought adaptation strategies Agriculture extension officer observed that:

*'We encourage crop farmers to plant early maturing varieties, timely operations and planting of drought tolerant and drought resistant crops such as; sorghum, dolichos, cow peas, lima beans, and. We also offer continuous extension service and conservation agriculture (C.A). Conservation Agriculture applies all technologies to utilize the moisture available in the soil to raise crops. Farmers are also encouraged to use green house and work with other stallholders' such as Kenya Agriculture and Livestock Research Organization (KALRO) and seed companies.*

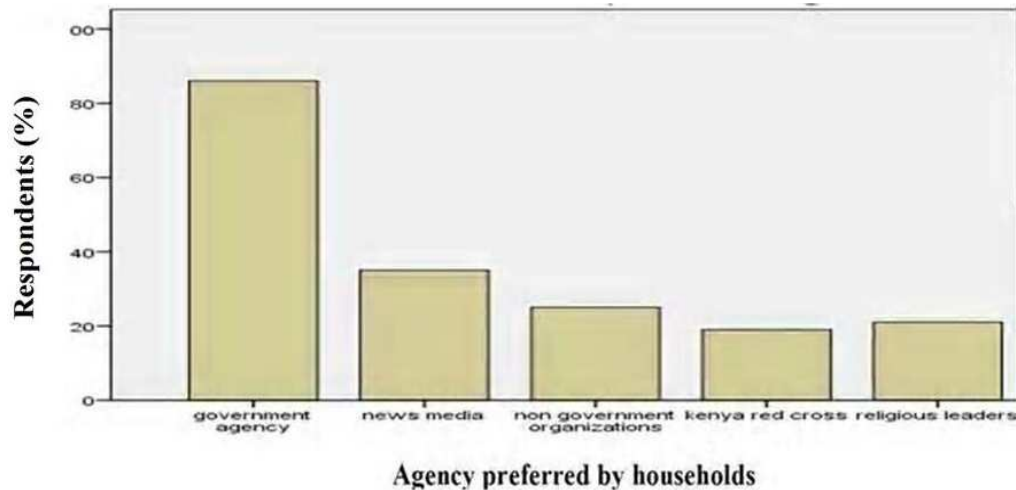
On drought adaptation strategies the sub-County livestock officer observed that:

*'We encourage farmers to practice Livestock water harvesting and adoption of conservation measures such as; camel keeping because they are environmental friendly and a good alternative to cattle, keeping sheep and goats since they can survive well in regions with deficiency of precipitation. As at the end of 2014 we had dug 22 water pans across the sub-County. We also encourage bee keeping for honey production since bees are also environmental friendly and do not compete with other livestock. From our records the following categories of bee hives were in place by the end of 2014; Log bee hives (8900), Kenya top bar hives (1250) and Langstroth (215). Other practices that we sensitize livestock keepers are the use of alternative or nonconventional feeds e.g. farm residues and farm by products. In addition, we advise farmers to sell their livestock to the Kenya Meat Commission to reduce herd before the onset of drought. We encourage Institutions and the nongovernmental organizations to purchase livestock for slaughter during drought and distribute the meat as relief food to schools.'*

On community drought adaptation strategies an extension officer observed that:

*'The common community drought adaptation strategies are: water harvesting for livelihoods such as crops, livestock and tree nurseries, water saving small scale irrigation techniques such as drip and bucket irrigation, diversification of enterprises and value chains, production of drought tolerant crop varieties and farm feed conservation, Conservation agriculture through minimum tillage, use of herbicides and cover crops, greenhouse farming, agro forestry and beekeeping.'*

The Kenya Meteorological Services (KMS) issues seasonal and annual climate information which is important to the households in Laikipia West sub-County. However KMS use various agencies to disseminate climate information to the households. In designing awareness material for the dissemination of climate information, the study sought to know the most preferred agency by the households for dissemination of climate information. The information on the agency preferred by the household heads to disseminate drought information could increase the audience and have a greater impact on the decisions made based on the disseminated information. Results in Figure 6.1 shows that 44% of the household prefer to receive drought information from the government agencies. Household response to relayed information depends on the trust that households have on the agency relaying the particular information and the reliability and accuracy of the past relayed information.



**Figure 6.1: Agency preferred by households to provide drought information**  
 Source: Field data (2016)

The study also sought opinions of an elder on the preferred agency of dissemination of drought information who observed that:

*‘The information can only come from God since lack of rainfall is as a result of people’s sin.’*

However the elder’s views ignited the debate on traditional verses scientific knowledge and to what extent should the two complement each other. The views expressed by the informant were clear testimony of the challenges faced by practioners in disseminating drought information. This perhaps requires a clear understanding on the challenges facing dissemination of drought informants in the face of religious and traditional believes among different segments of the society. Another elder stated that:

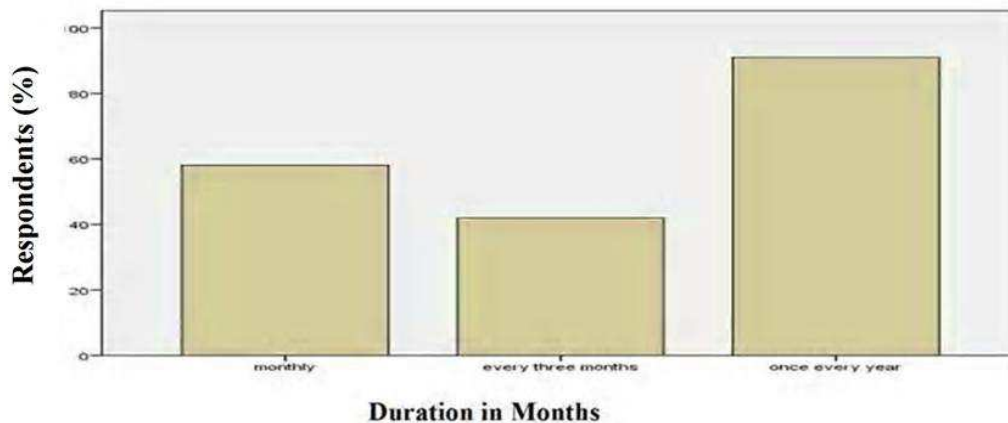
*‘There was a time we used to predict drought but today things have changed. There was a man from South Horr who was able to predict drought through observation of stars. The people said that the star wanted to eat their intestines meaning starvation due to lack of food. Unfortunately the person was killed by those people who thought he was responsible for the outcomes of the drought predictions and causes their animals to die. Since his death we have not been receiving predictions and hope one of his children will have the same wisdom when they grow up.’*

The views expressed by the elder could be an entry point for the agencies responsible for the dissemination of drought information. As a representative of the community the elders’ views are respected and therefore drought dissemination strategies could be tailor



made to fit into the current situations. The elders could be approached and informed that the ‘child’ has been born in the name of technology enabling the Kenya Meteorological Services to issue seasonal climate forecast.

To understand the frequency of dissemination of drought information, household heads were asked to state the number of times they preferred the information to be disseminated to them. The frequency of dissemination of drought information could inform the effective use of adaptation strategies. Results in Figure 6.2 shows that 48% of the respondents prefer to receive information on drought once in every year, 30% monthly bases and 22% every three months. Timely relay of drought predictions information is the initial step in drought preparedness strategies. The variation in the time households require drought predictions could be a reflection of the different livelihood activities in Laikipia West sub-County. There are those who require regular updates while other will require the information after some time. From literature the probability of adaptation rises with increased access to information. This implies that farmers with access to timely weather information and other extension services are more likely to adapt to climatic change. Similar findings have been reported in Nepal and Southern Africa (Tiwari *et al.*, 2014; Nhemachena and Hassan, 2007).



**Figure 6.2: Percentages of dissemination of drought information.**

*Source:* Field data (2016)

### **6.5 Drought Adaptation Determinants in Laikipia West sub-County**

In order to assess the factors that support or constrain drought adaptation in Laikipia West sub-County, chi-square analysis of independence was performed. Factors can have opposite effects on the probability of adoption across different adaptations (Van Dijk, Grogan

& Borisova, 2015). The independent variables were the drought adaptation strategies while the dependent variables were the socio-economic characteristics of the households. A clear understanding of the factors that influence farmers' adaptation decisions is essential to the designing of appropriate policies to promote effective adaptation in the agricultural sector (Mabe *et al.*, 2014).

The results in Table 6.11 show that migration with animals in search of pasture and water is statistically dependent on source of income ( $p=0.000$ ) and land ownership ( $p=0.000$ ). It can be observed that buying of fodder for livestock is statistically significant on the source of income ( $p=0.000$ ) and land ownership ( $p=0.001$ ). Withdrawal from farming is statistically dependent on landownership ( $p=0.007$ ). Practicing crop diversification is statistically dependent on source of income ( $p=0.000$ ), land ownership ( $p=0.038$ ) and training on agriculture ( $p=0.005$ ).

Planting of drought resistant seeds is statistically dependent on source of income ( $p=0.000$ ), land ownership ( $p=0.001$ ) and training on agriculture ( $p=0.032$ ). Migration to town in search of employment is dependent on age ( $p=0.026$ ), time they had lived in the area ( $p=0.016$ ) and agriculture training ( $p=0.010$ ). Those who are expected to migrate to town are those between 31-40 year and those below 30 year while respondents above 60 years could be limited not only due to the labour laws in Kenya but also their health status. Seasonal migration to town in search of employment could be an adaptation strategy disseminated through agriculture training and interaction among households and their application of the strategy could vary based on whether residents have attended trainings or no.

Waiting for relief food ( $p=0.035$ ) was statistically dependent on the period responded had lived in the area. Those who have lived in Laikipia West sub-County for a while have mastery of the drought patterns and are able to assess some indicators and predict the magnitude of drought for them to make a decision to look for employment as compared to those who have not stayed there for long and have not been able to study the drought patterns. Those who have lived in the sub-County for long are likely to migrate during the initial stage of drought based on predictions than those who have not stayed long and could ignore the predicted drought only to realize it was severe when it is too late. For the people who have not stayed in Laikipia West sub-County long they are likely to wait for relief food as the only option while those who have stayed long and could be aware that the government has not distributed food for a while are likely to seek other adaptation strategies rather than waiting

for food.

Engaging in business is dependent on the age ( $p=0.034$ ) of the household head and level of education ( $p=0.013$ ). Educated households are likely to access information on drought more than the uneducated household and this will inform them on the some of the business opportunities and stock their businesses. This supports the previous studies by Igodan *et al.* (1990) that there is a positive relationship between educational level of the household head and adoption of improved technologies. This implies that, farmers with higher levels of education are more likely to use improved technologies in order to adapt to climate change. This is particularly so because educated farmers are more knowledgeable due to their ability to access information pertaining to climate change and adaptation options (Ndamani and Watanabe, 2016). Access to credit facilities depends on individual age those below 18 years don't have access to credit facility. Also those who have advanced in age may qualify but with a short repayment period and therefore it would be difficult for them to access credit. The level of education though may not be a requirement by any law to start a business it could inform entrepreneurs on the better marketing strategies and the demand supply effect. Gathering wild fruits is dependent on agriculture training ( $p=0.011$ ).

Selling of belongings and migrating to other regions is dependent on source of income ( $p=0.001$ ) and agriculture training ( $p=0.000$ ). Decision by the households to sell their belonging and migrating to new areas could be inspired by education and training where the residents realize that there are other places with favourable weather patterns than. The study supports the earlier work of Hudson (2002) that drought adaptation strategies vary, depending upon factors such as culturally determined goals, the amount of resources available, and the type of resources available to farmers. These resources may be natural or social, as well as economic.

**Table 6.11 Drought adaptation determinants in Laikipia West sub-County**

Adaptation Strategies	Social Economic Characteristic (Asymp. Sig. (2-sided))						
	Gender	Age	Education	Time Lived	Source of Income	Land ownership	Training on Agriculture
Migrated with my animals in search of pasture and water	.071	.314	.103	.166	.000	.000	.156
Sold my animals	.445	.287	.100	.554	.000	.001	.545
Opt not to farm during drought	.388	.276	.375	.354	.021	.007	.471
Practiced crop diversification	.223	.887	.292	.400	.000	.038	.005
Planting of drought resistant seeds	.438	.596	.212	.200	.000	.001	.032
Bought fodder for the animals	.002	.892	.647	.108	.002	.003	.292
Migrated to town in search of employment	.459	.026	.302	.016	.634	.983	.010
Waited for the relief food	.968	.420	.730	.035	.196	.404	.271
Engaged in business	.931	.034	.013	.079	.003	.053	.309
Gathered wild fruits and roots	.257	.935	.234	.954	.837	.074	.011
Practiced charcoal burning	.278	.816	.801	.812	.856	.064	.094
Engaged in beekeeping	.268	.158	.674	.260	.981	.026	.133

*Source:* Field data (2016)

## **CHAPTER SEVEN**

### **7.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS**

#### **7.1 Introduction**

This chapter presents a summary of research findings as per the study objectives, conclusions from the findings and recommendations drawn from the study findings. The chapter also presents suggestions for further research.

#### **7.2 Summary of Findings**

The summary of findings has been discussed as per the study objectives.

##### **7.2.1 Temporal Drought Trends in Laikipia West Sub-County**

The seasonal drought characteristics results show that 1993 and 2000 were the driest years during the MAM at both Rumuruti and Ndaragwa. 1985, 1987, 1996 and 2010 were the driest years at both Rumuruti and Ndaragwa during OND seasons. The seasonal drought events show that for the period under study Laikipia sub-County has not experience drought during the MAM and OND seasons in the same year. This shows that the household of Laikipia West sub-County are able to recover during the following season after a drought season. Households in Laikipia West sub-County can be cautioned from the effects of drought through planting of drought resistant crops such as sorghum and green grams.

The years that received below normal rainfall (-0.99 to 0.99) were: 1984, 1985, 1987, 1991, 1995, 1999, 2000, 2005, 2008, 2009 and 2014. The years that experienced moderate drought (-1.0 to -1.49) are: 1995 and 2008. The years that experienced severe drought (-1.5 to -1.99) were: 1985, 1987, 1991, 2005, and 2009 while years that experience extreme drought (-2 and less) were: 1984, 1999 and 2000. The very wet years (1.5 to 1.99) were: 1998 and 2010 while extreme wet (2.0 and above) years were: 1997 and 2011. The study established that the average drought cycle in the study area is 3 years. According to SPI results the recent severe drought experienced in Laikipia West sub-County was in 2009.

##### **7.2.2 Effects of Drought Events on Household Livelihoods in Laikipia West sub-County**

The results of the household survey shows that 26% of the households observed that drought impacted over 75% of their crops, 24% of the households observed that the drought impacted less than 75% of their crops, 24% of the households observed that 2009 drought impacted less than 50% of their crops. Nineteen percent (19%) of the households observed

that the drought impacted less than 25% of their crops. The findings also show that 78% of the households lost few livestock, 11% lost many livestock while 8% did not experience livestock loss.

### **7.2.3 Household Perceptions to Drought Disasters**

On drought perception out of 180 respondents 53% of the households felt that the 2009 drought was moderate, 47% was severe. Drought perception was significantly related to source of income, land ownership and number of years a respondent has been farming. Perception to drought among different households leads to variations in drought adaptation strategies adopted by different households. The strategies adopted by individual households greatly depend on how they perceive drought. The pastoralists are likely to perceive drought as severe compared to those employed by the government. This could be explained by the fact that salary from government employment does not fluctuate with seasons while milk production and meat does.

### **7.2.4 Drought Adaptation Strategies and Drought Adaptation Determinants.**

Household drought adaptation strategies in Laikipia West sub-County are: seasonal migration with animals (25%), search for employment (15%), off-farm practices (15%) and reducing the heard (14%). Drought adaptation strategies advocated by key informants include; training livestock farmers and pastoralists on the need to look for alternative livelihoods when drought has been predicted; emergency livestock off take before the onset of drought and banking the money to be used in restocking during favourable conditions; pastoralists are also taught the need for optimum carrying capacity, stocking rate and destocking; households are taught various methods of fodder and pasture conservation methods to ensure availability of pasture throughout the year; they are also taught livestock management and husbandry practices such as timely breeding, housing; disease control and proper feeding of their animals. Other strategies advocated for are; grazing management strategies which are aimed at conservation of pasture such as deferred grazing, rotational grazing, tethering and continuous grazing.

Community drought adaptation strategies are; 30% sale of livestock to reduce the herd, 27% stock pile cereals and grains and 13% change of cropping patterns when drought is predicted. According the key informant, the common community response strategies are: Livestock keepers migrate with animals to other areas, sell their small stock such as sheep

and goats and also cull the old animals, crop farmers reduce the acreage under crops, crop farmers stop selling their grain and retain stocks for household needs, seek off- farm sources of income such as charcoal burning, casual labor.

Drought adaptations determinants are source of income, land ownership, training on agriculture, age, time households had lived in the area and level of education. These determinants support or constraint the adoption of adaptation strategies to drought in Laikipia West sub-County.

#### **7.2.5 Role of Institutions in Managing Local Level Drought Adaptations in Laikipia West sub-County**

Both formal and informal institutions play a key role in managing local level drought adaptation. These institutions plays the following roles; encouraging crop farmers to plant early maturing varieties, timely operations and planting of drought tolerant and drought resistant crops, disseminate drought adaptation strategies to farmers, pastoralist are advised on the need for emergency livestock off takes. Elders and religious organizations provide relief food to the starving households and also participate in the alternative dispute resolution.

### **7.3 Conclusions**

There has been an increase in drought years in Laikipia West sub-County from 1984 to 2014. The drought cycle has reduced from 5 years to 3 years. Drought years have been identified and the latest severe drought in Laikipia West sub-County was in 2009. Maize farming remains a major source of livelihood to many households. Most of the crop farmers in Laikipia West sub-County are immigrants who carry their tradition ways of crop production to Laikipia without taking into considerations the climatic conditions of the area. The traditional ways of life among the immigrants make them more vulnerable to drought. The 2009 negatively affected household sources of income in Laikipia West sub-County. The drought led to decreased maize yield and death of livestock. The drought also led to increased distance to the water sources and increased cases of malnutrition. Different households in Laikipia West sub-County perceive drought differently. Perception on severity of drought was influenced by source of income, land ownership and number of years a responded has been farming. There are various drought adaptation strategies adopted by households to counter the effects of drought. Engaging in business is the most preferred drought adaptation strategy among the pastoralist and maize farmers while planting of drought resistant crops is the least preferred. Formal institutions are more prevalent on drought adaptation compared to informal institutions. The formal institutions plays the following roles in managing local level drought adaptations: encouraging crop farmers to plant early maturing varieties, timely operations and planting of drought tolerant and drought resistant crops, disseminate drought adaptation strategies to households and advise pastoralist on the need for emergency livestock off takes



## 7.4 Recommendations

The study recommends the following:

- a) The high percentage of drought years in the study area is an indication that maize production is not a viable option in the area. Drought resistant crops and early maturing crop varieties should substitute maize to increase crop production
- b) The high number of crops and animals affected by 2009 drought show the need for pooling of risks. The study recommends creation of awareness on the need to insure crops and livestock against drought risks.
- c) The study recommends creation of awareness on the crop ecological requirements in Laikipia west sub-County to encourage growth of drought resistant crops such as sorghum, green grams and dolichos as an adaptation strategy to drought events.
- d) Engaging in business is the most preferred adaptation strategy among pastoralist and maize farmers. The study recommends empowerment of households through youth and women fund, *Uwezo* Fund and other financial opportunities to start small and medium enterprises which will create more job opportunities in the area.
- e) Both formal and informal institutions in Laikipia West sub-County should be engaged and their operations streamlined to establish a central command in mobilization of humanitarian assistant and any other support during drought.

## 7.5 Suggestions for Further Research

The following recommended areas of study would help enrich the understanding of the drought discourse.

- a) Research is required on the role of indigenous knowledge in drought response, preparedness and adaptation strategies in Laikipia West sub-County. Majority of the respondents have informal education hence its role cannot be underscored.
- b) Research is required on the soil conservation and management strategies in Laikipia West sub-County as an adaptation strategy to drought. Such a study can benefit from earlier studies by Bandyopadhyay (2009) and Debnath (2012) that use of organic manure in farms (for example, composting and recovery of farm yard manure and food waste, use of green mulching, etc.) can favorably modify the physical properties of soil such as bulk density, porosity, soil moisture, temperature, water retention properties and water transmission properties and soil processes like evaporation, infiltration, runoff and soil loss for better crop growth and yield. The study can also benefit from the study by Parmeshwar (2014) that in order to improve the soil moisture holding capacity, promotion of soil water conservation and use of organic manures should be promoted to combat drought.
- c) A study is recommended to find out why young household heads were more willing to sell their livestock and relocate elsewhere as compared to the older households as a way of adapting to drought.

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## APPENDICES

### Appendix 1: Household Questionnaire.

I am Amon Mwangi Karanja a PhD student at Egerton University in the Department of Geography, undertaking a research on assessment of drought effect on household livelihoods and adaptation strategies in Laikipia west sub County. This questionnaire intends to collect information that will help me complete the study. I seek your permission to gather the following information from you which will be used for the study purpose only.

**Please tick your responses in the boxes provided where applicable.**

**SERIAL NUMBER.....**



For official use only

Date..... Division..... Location.....  
 Sub location..... Village.....  
 Status of the questionnaire: Complete  not complete

#### SECTION A: Demographic Information and social economic characteristics

001. Gender?

Male  Female

002. Age?

Below 30 years  31-40 years  41-50 years   
 51-60 years  61 and above

003. Highest academic qualification?

Uneducated/informal  KCPE/ Primary  KCSE/Secondary   
 Post-Secondary/Tertiary

004. For how long have you lived in this Location?

0-5 years  6-10 years  11-15 years  16-20years  21-25 years   
 26-30years  above 30 years

005. What is your main source of income?

Government employment  Business person  Maize farming   
 Dairy farming  Pastoralism  Wheat farming   
 Others specify .....

006. What is your total annual income? Below Ksh. 120,000

Between Ksh. 120,000- 500,000

Above Ksh. 500,000

007. If your answer in 005 above is farming, how long have you been farming?

Below 1year  1-5years  6-10years   
 11-15years  16-20years  above 20years

008. What is the size of your land?

- Less than 2 acres  2- 5 acres  5- 10 acres   
 Over ten acres
009. What is your type of land ownership?
- Owner  Leased  Communal
010. Have you ever gone for training on farming courses or training?
- Yes  No

**Section B: Household perception and effects of the 2009 drought**

011. How frequent are drought episodes in this area?
- Every year   
 After every two years   
 After five years
012. What does drought mean to you?
- Lack of rainfall  Lack of food   
 Lack of pasture  Drying of rivers
013. How will you describe the 2009 drought in this area?
- Severe  Moderate
014. What was the impact of the 2009 drought in your house hold?
- (a) (i). Economic impact
- Reduced crop yield  Crop failure  Reduced milk production   
 Loss of livestock  High cost of goods   
 Others specify.....
- (ii) What percentage of your crops were impacted by drought
- No crops area impacted   
 Less than 25% crop area   
 Less than 50% crop area   
 Less than 75%   
 Over 75%
- (iii) What was the impact of drought on Livestock?
- Livestock were not impacted   
 Few deaths   
 All died
- (b) Social impact
- Children missed school for lack of food   
 Seasonal migration with animals   
 Increased distance to the water point   
 Job losses in farms   
 Conflict over water   
 Others specify.....

(c) Environmental impact

Lack of household fuel

Drying of rivers

Increased cases of fires

Others specify.....

(d) Health effects

Increase cases of livestock disease  Increased crop pest

Human diseases  Human death  Malnutrition

Others specify.....

015. How did your respond to the 2009 drought episode?

Sold livestock  Migrated with the animals  Searched for employment

Opted not farm  Changed my source of income  Slaughtered the animals

Bought food supply  watered crops  Planted drought evading crops

Others specify.....



**Section C: Adaptation and preparedness to drought strategies**

016. Did you use the following adaptation strategies during the 2009 drought?

	Yes	No
Migrated with my animals in search of pasture and water.		
Sold my animals.		
Did not farm during that period.		
Practiced crop diversification.		
Planting of drought resistant seeds.		
Sold my belongings and migrated with my family to another area.		
Bought fodder for the animals.		
Migrated to town in search of employment.		
Waited for the relief food.		
Engaged in business (Specify.....)		
Gather wild fruits and roots.		
Practiced charcoal burning.		
Engaged in Bee keeping.		

017. How are you prepared to deal with on coming drought?

- Set aside some emergency fund
- Preserve food supplies
- Mobilize my neighbors and charts the way forward
- Attend trainings on drought management
- Seek information on drought preparedness
- Wait for relief food
- Other specify.....

018. Has you put in place measures to respond to drought?

- Ye  No

019. Which of the following measures are in place?

- Stock piling of cereals and grains emergency aid
- Rehabilitation of critical boreholes
- Marketing of Livestock
- Construction of new boreholes
- Planting trees and reforestation
- Changing cropping patterns
- Recruited volunteer to offer assistance during drought
- Established community emergency fund
- Community-based training initiatives
- Promotion of networking within the community

020. Who would you prefer to provide you with information on how to make your household safe from drought?

- Government Agency.
- News Media.

Non Governmental Organizations (NGO)

Red Cross.

Religious Leaders.

Others specify.....

021. How often would you like to receive such information?

Monthly

Every three months

Once every year

## Appendix 2: Key Informant Interview Schedule

The objective of this interview is to assessment of drought effects on household livelihoods and adaptation strategies in Laikipia West sub-County. The target populations are Chiefs, Elders, Ward Agriculture and livestock officers, ward devolution officers and NGO Officials

Date.....	Starting time .....	Time ended.....
Division.....	Location.....	Sub location.....
Institution.....	Position.....	

### SCHEDULED QUESTIONS

1. What does drought mean in Laikipia West sub-County?
2. What was the effect of the 2009 drought in Laikipia West sub-County?
3. How many livestock died during the 2009 drought?
4. How did crops perform during the 2009 drought period?
5. What are the roles of your office during the 2009 drought?
6. What was the cost incurred by the government during the 2009 drought in the area.
7. How many people needed food aid during the 2009 drought in this location?
8. What criteria do you use in distribution of relief food?
9. How many people died as a result of the 2009 drought in this location
10. How did the households and Community respond during the 2009 drought?
11. What are the Community drought adaptations strategies used in the area?
12. What are the household drought preparedness and adaptation strategies in the area?
13. What are the government's drought disaster preparedness strategies?
14. Describe some of the activities undertaken to enhance drought preparedness
15. What is the adaptation challenges facing household and community in Laikipia West sub-County.
16. What do you think should be done to enhanced drought adaptation in Laikipia West sub-County.

### Appendix 3: Annual Rainfall Amount for Rumuruti and Ndaragwa Stations

YEAR	Rumuruti Station Annual Rainfall (MM)	Ndaragwa Station Annual Rainfall (MM)
1984	411	459
1985	514.8	847.5
1986	848.8	936.7
1987	533.2	527.6
1988	712.8	924.4
1989	729.3	811.5
1990	1029.2	962
1991	532	706.5
1992	648.4	887.1
1993	726.1	704
1994	667.6	1135.9
1995	598.5	853.4
1996	830.8	945.6
1997	1219.7	1053.1
1998	1065.4	1498.4
1999	441.8	740.9
2000	434.8	725.5
2001	694.2	881
2002	675.7	806
2003	902.6	731
2004	764.9	725
2005	494	795.1
2006	508.4	798.6
2007	1041	818.3
2008	608.2	854.7
2009	534.9	334
2010	1097.2	1071
2011	1122.6	1096.3
2012	809.6	1217.72
2013	986.7	1138.57
2014	604.9	

*Source:* Water Resource and Management Authority, Rumuruti (2016)

**Appendix 4: Standard Precipitation Value for Rumuruti and Ndaragwa Station**

Year	SPI for Rumuruti	SPI for Ndaragwa
1984	-2.6	-2.46777
1985	-1.92912	-0.57357
1986	0.2065	-0.13866
1987	-1.81147	-2.1333
1988	-0.67554	0.219687
1989	-0.51894	-0.42002
1990	1.488664	-0.01531
1991	-1.81914	-0.82515
1992	-0.83266	-0.3805
1993	-0.55247	-0.95465
1994	-0.94038	0.847784
1995	-1.39393	-0.42877
1996	0.076893	0.574188
1997	2.57806	0.905426
1998	1.591455	2.6
1999	-2.39588	-1.09332
2000	-2.44824	-1.16841
2001	-0.78202	-0.41024
2002	-0.5134	0.120247
2003	1.067332	0.650731
2004	-0.34332	1.330866
2005	-1.61793	0.439661
2006	-0.87455	-0.4506
2007	1.435441	-0.71594
2008	-1.34254	-0.53847
2009	-1.8006	-2.6
2010	1.794785	1.000801
2011	2.6	0.654178
2012	0.402647	1.743934
2013	1.105574	1.379045
2014	-1.61033	-1.71031

**Source: Rumuruti and Ndaragwa WRMA Stations (2016)**

## Appendix 5a. Factors Influencing Perceptions to Drought among Households

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr >Sig.
Intercept		1	1.3860	1.5466	0.8031	0.3702
GENDER001_1	2	1	-0.00127	0.4069	0.0000	0.9975
AGE002_1	2	1	-0.2443	0.4931	0.2453	0.6204
AGE002_1	3	1	-0.7350	0.6137	1.4345	0.2310
AGE002_1	4	1	-0.6184	0.7354	0.7072	0.0004
AGE002_1	5	1	-0.3007	0.8478	0.1258	0.7228
EDUCATION003_1	2	1	0.0841	0.4958	0.0288	0.8653
EDUCATION003_1	3	1	0.2095	0.6184	0.1147	0.7348
EDUCATION003_1	4	1	-1.3791	0.8495	2.6358	0.1045
iffarming007_1	2	1	0.0784	0.9536	0.0068	0.9345
iffarming007_1	3	1	1.2508	0.9537	1.7204	0.1896
iffarming007_1	4	1	1.6412	1.0758	2.3274	0.1271
iffarming007_1	5	1	1.7086	1.0997	2.4139	0.0203
iffarming007_1	6	1	1.3424	0.9815	1.8706	0.1714
INCOME005_1	2	1	-1.8852	1.0820	3.0361	0.0814
INCOME005_1	3	1	-1.5997	1.0790	2.1981	0.1382
INCOME005_1	4	1	-0.7920	1.2186	0.4224	0.5158
INCOME005_1	5	1	-2.1796	1.0989	3.9339	0.0473
size008_1	2	1	-0.6723	0.4792	1.9679	0.1607
size008_1	3	1	2.0169	1.2932	2.4323	0.1189
size008_1	4	1	0.3384	0.7406	0.2088	0.6477
ownership009_1	2	1	1.3224	0.6019	4.8280	0.0280
ownership009_1	3	1	0.8142	0.5281	2.3772	0.1231
have010_1	2	1	-0.8742	0.5202	2.8245	0.0928

Source: Field data (2016)

**Appendix 5b. Factors Influencing Perceptions to Drought among Households  
Odds Ratio Estimates**

<b>Point Effect</b>	<b>95% Wald Estimate</b>	<b>vs 1</b>	<b>Confidence Limits</b>		
GENDER001_1	2	vs 1	0.999	0.450	2.217
AGE002_1	2	vs 1	0.783	0.298	2.059
AGE002_1	3	vs 1	0.480	0.144	1.596
AGE002_1	4	vs 1	0.539	0.127	2.277
AGE002_1	5	vs 1	0.740	0.141	3.900
EDUCUCATION003_1	2	vs 1	1.088	0.412	2.875
EDUCUCATION003_1	3	vs 1	1.233	0.367	4.144
EDUCUCATION003_1	4	vs 1	0.252	0.048	1.331
iffarming007_1	2	vs 1	1.082	0.167	7.011
iffarming007_1	3	vs 1	3.493	0.539	22.646
iffarming007_1	4	vs 1	5.162	0.627	42.513
iffarming007_1	5	vs 1	5.521	0.640	47.661
iffarming007_1	6	vs 1	3.828	0.559	26.211
INCOME005_1	2	vs 1	0.152	0.018	1.265
INCOME005_1	3	vs 1	0.202	0.024	1.674
INCOME005_1	4	vs 1	0.453	0.042	4.935
INCOME005_1	5	vs 1	0.113	0.013	0.975
INCOME005_1	7	vs 1	0.212	0.019	2.334
size008_1	2	vs 1	0.511	0.200	1.306
size008_1	3	vs 1	7.515	0.596	94.774
size008_1	4	vs 1	1.403	0.329	5.989
ownership009_1	2	vs 1	3.753	1.154	12.207
ownership009_1	3	vs 1	2.257	0.802	6.355
have010_1	2	vs 1	0.417	0.151	1.156

*Source:* Field data (2016)

**Appendix 6: Maize Production per 90 Kg bags (2001-2014)**

<b>Year</b>	<b>Rainfall Amount (MM)</b>	<b>Maize yield Data (Bags)</b>
2001	694.2	167,400
2002	675.7	83,700
2003	902.6	168,000
2004	764.9	143,000
2005	494	273,000
2006	508.4	85,000
2007	1041	200,000
2008	608.2	88,400
2009	534.9	80,000
2010	1097.2	50,250
2011	1122.6	50,762
2012	809.6	74,250
2013	986.7	55,936
2014	604.9	45,000

*Source:* Laikipia West sub-County Agriculture office (2016)



## Appendix 7: NACOSTI Research Authorization



### NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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Ref: No.

Date:

**NACOSTI/P/16/29661/10673**

**4<sup>th</sup> May, 2016**

Amon Mwangi Karanja  
Egerton University  
P.O Box 536-20115  
**EGERTON.**

#### **RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on "*Assessment of drought effects on household livelihoods and adaptation strategies in Laikipia West Sub County, Kenya*," I am pleased to inform you that you have been authorized to undertake research in **Laikipia County** for the period ending **29<sup>th</sup> April, 2017**.

You are advised to report to **the County Commissioner and the County Director of Education, Laikipia County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

  
**BONIFACE WANYAMA**  
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner  
Laikipia County.

The County Director of Education  
Laikipia County.



*National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified*





## Appendix 9: Research Team in a Data Collating and Cleaning Session



*Source:* Field data (2016)

## Appendix 10: Journal Articles Published in Refereed Journals

- 1) **Karanja, A.**, Ondimu, K. and Recha, C. (2017) Analysis of Temporal Drought Characteristic Using SPI Drought Index Based on Rainfall Data in Laikipia West Sub-County, Kenya. Open Access Library Journal, 4: e3765. <https://doi.org/10.4236/oalib.1103765>
  
- 2) **Karanja, A.**, Ondimu, K. and Recha, C. (2017) Factors Influencing Household Perceptions of Drought in Laikipia West Sub County, Kenya. Open Access Library Journal, 4: e3764. <https://doi.org/10.4236/oalib.1103764>