

**INFLUENCE OF DISASTER RISK REDUCTION PROJECTS ON ADAPTIVE  
CAPACITY TO CLIMATE VARIABILITY IN KITUI COUNTY, KENYA**

**BY**

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## DECLARATION

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

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## **DEDICATION**

This thesis is dedicated to my parents Mr. and Mrs. Mambo for their unfailing care and support and my siblings for their constant encouragement and inspiration they instilled in me during the entire Masters program from 2014-2018.

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**LIST OF ABBREVIATIONS AND ACRONYMS**

AFIDEP	African Institute for Development Policy
ARP	Arid and Semi Arid Land Resilience Project
ASAL	Arid and Semi-Arid Lands
DFID	Department for International Development
DRR	Disaster Risk Reduction
ENSO	El Nino Southern Oscillation
FAO	Food and Agriculture Organisation
GOK	Government of Kenya
HHH	Household Head
IPCC	Intergovernmental Panel on Climate Change
KLSP	Kenya Livelihoods Support Project
KMD	Kenya Meteorological Department
MNRE	Ministry of Natural Resources and Environment
OCHA	Office for the Coordination of Humanitarian Affairs
PAI	Population Action International
UNFCCC	United Nations Framework Convention on Climate Change
UNPEI	United Nations Poverty-Environment Initiative
WMO	World Meteorological Organisation

## ABSTRACT

Disaster risk reduction projects are some of the initiatives undertaken with an aim of addressing climate variability associated disasters such as droughts and floods and loss of agricultural production. The projects are normally aimed at reducing vulnerability and increasing resilience among rural communities towards climate variability and change. Results of adaptation measures undertaken by such projects to increase adaptive capacity of the communities remain largely under researched. By use of a descriptive survey design, this study focused on the influence of Caritas disaster risk reduction projects on the adaptive capacity to climate variability in Kitui County. Specifically, the study sought to analyze rainfall and temperature data (1979-2014) for climate variability in the study area. It also evaluated the effectiveness of adaptation measures to climate variability among project beneficiaries as well as examining the influence of socio-economic factors on the uptake of the adaptation measures. During the study, two sampling techniques were used; purposive sampling that was used to select The Kenya Livelihood Support Project and Arid and Semi-Arid Lands Resilience Project implemented by Caritas-Kitui and also select key informants. Random sampling aided in selection of 106 project beneficiary households who were administered with questionnaires. Data obtained was analyzed through Statistical Package of Social Sciences and Excel in relation to the set objectives. The study employed descriptive statistics such as frequencies, mean and standard deviation as well as inferential statistics of ANOVA to test any significant differences on decadal means of rainfall and temperature while Chi-Square was used to test for any significant difference in rating used in Likert scale responses. Data was displayed in tables and graphs. Analyzed rainfall and temperature data obtained from Katumani (9137089) Kenya Meteorological Department station indicated that there was statistically significant mean temperature variation ( $p < 0.005$ ) within 1975-2014 while no statistically significant difference in rainfall variation within the same period. There was statistically significant correlation between mean annual temperature and rainfall ( $p < 0.005$ ) at 2-tailed significance level. In terms of perception of significant weather changes observed, 39% and 27% of respondents in ARP and KLSP projects asserted that there has been prolonged droughts experienced in the area. Likert scale was used to rank project adaptation measures and based on Total Weighted Mean (T.W.M) used to compute the ranking, it was observed that on-farm water harvesting (T.W.M=337.08), soil conservation (T.W.M=262.91) and income diversification (T.W.M=232.23) ranked first, second and third respectively in ARP applied adaptation measure while KLSP applied adaptation measures, soil conservation was ranked first at T.W.M=387.80 and on-farm water harvesting second at T.W.M=346.36. Chi-square test performed to determine if there was any statistically significant difference in Likert scale rating of effectiveness of project adaptation measures indicated a significant difference ( $p < 0.005$ ) in ratings under on-farm water harvesting and soil conservation in both projects. Socio-economic factors that influence uptake of project adaptation measures, it was observed that finance was ranked first T.W.M=314.52 and 341.46 in ARP and KLSP project respectively. The study therefore concludes that disaster risk management projects have an influence on the adaptive capacity to climate variability. In addition socio economic factors that would influence uptake of adaptation measures should be put into consideration during project planning and implementation.

## CHAPTER ONE: INTRODUCTION

### 1.1 Background of the Study

Global occurrence of climate change which is manifested through but not limited to warming of the atmosphere and oceans, decrease in ice and snow levels, increase in sea levels and also changes in weather patterns has been evident in the recent past (Kaushik and Sharma, 2015). Global climate changes have been mainly linked to human activities that result in the accumulation of greenhouse gases in the atmosphere. Changes to the nature and frequency of extreme events, threats to water resources and food security has also been observed (Mimura *et al.*, 2007). In a country like Bangladesh for example, people are vulnerable to natural disasters caused by climate change due to the position of the country and also dependence on the natural resources to earn a livelihood (Saadat and Islam, 2011). In addition, in the Pacific Island countries economic and human losses have been experienced due to natural hazard occurrence such as tropical cyclones and storms, earthquakes, tsunami and volcanic activities (Office for the Coordination of Humanitarian Affairs (OCHA), 2009; Ministry of Natural Resources and Environment (MNRE), 2005).

According to Intergovernmental Panel on Climate Change (IPCC) (2014), Africa has been identified as one area in the world that is most susceptible to the impacts of climate change as approximately 70% of people depend on rain-fed agriculture as a source of livelihood. More than 60% of Arid and Semi-Arid Lands (ASALs) inhabitants live in conditions of extreme poverty due to environmental degradation and climatic shocks caused by aridity (Kirimi *et al.*, 2013). Climate change in sub-Saharan Africa has also been identified as a major contributor to the negative impacts on food security and livelihoods within the region (Connolly-Boutin and Smit, 2016). In addition to climate change, political, socio-economic and biophysical stressors have increased the region's susceptibility to climate change negatively compromising the region's adaptive capacity.

In the 21<sup>st</sup> century, average temperature in the Africa region are projected to increase by 1.5-3°C while rainfall variation in terms of spatial and temporal distribution will increase adversely affecting crop productivity (James and Washington, 2015). According to Boko

*et al.*, (2007) increases in temperature and rainfall reduction has resulted to water scarcity hence leading to over extraction of water resources in Africa. This in return has resulted to water stress and it is projected that by 2055, people living in the northern and southern parts of Africa will be water stressed. These will lead to threatened economic developments made in the developing world as the mitigation measures will inadequately prevent devastating climate change impacts (Bruckner, 2012). It is therefore necessary for policy makers, communities and individuals to adapt to changes in climate to increase resilience against future climate change, much of which remains highly uncertain (Bryan and Behrman, 2013).

Adaptation to climate change must be viewed as more than a simple response to environmental emergencies or disasters as many adverse climate impacts will take decades or more to come into effect thus cannot be reduced to emergency-response scenarios (Simoões *et al.*, 2010). Disaster Risk Reduction (DRR) initiatives undertaken from the grassroots level for example awareness creation through education or infrastructure development can significantly contribute to reducing vulnerability to climate variability among beneficiaries (Mercer, 2010). It is essential that societies, organisations and governments establish and strengthen issues pertaining climate change so that projects undertaken at community level can increase the adaptive capacity of locals.

Two (DRR) projects will be considered for the research study and the projects include:- The Kenya Livelihood Support Project (KLSP) which was a one year project that was completed in May 2014 and targeted Yatta and Ikutha wards in Kitui County. The project's goal was to improve resilience of drought affected communities in the diocese of Kitui with specific objectives of increasing farm yields through on farm water harvesting and soil conservation for increased crop production, food and income security of vulnerable households frequently affected by drought. The second project named Arid and Semi Arid Land Resilience Project (ARP) was also a one year project that was completed in March 2014 that targeted Nguni, Ngomeni and Mwitika wards of Kitui County. The goal of the project was to promote resilience and pastoral and agro-pastoral livelihoods in Kitui County. The project promoted resilience by ensuring that the project

beneficiaries were able to cope with the disasters especially drought that occurred in the area. These was done through addressing the specific objectives which were to improve sustainable livelihood security of vulnerable households through increased income, food and diversified livelihood strategies; to promote sustainable access to and management of natural resources through community based natural resource management and advocacy; to mitigate risk, reduce vulnerability and enable communities to better prepare for and respond to humanitarian crisis and shocks.

Monitoring and evaluation carried out by the project implementers indicate that the objectives of the projects were met where the number of people that now have a diversified source of income increased by 70% and the management of natural resources have also increased by 80% especially water resource. This resulted to increased ownership of the resources thus management of the resource is done sustainably with selected members to act as the leaders in the various groups formed. It was also noted that some people are yet to embrace other sources of income which are not climate sensitive thus intense sensitization is needed as these were mainly the old people from the age of 65 years and above.

## **1.2 Problem Statement**

Arid and Semi-Arid Land areas which are vulnerable to climate change and variability in Kenya occupy about 80% (455,309.6 Km<sup>2</sup>) of the total land area in Kenya (Opiyo, 2014). Approximately one third of Kenya's population which amounts to about 8 million people live in ASALs areas and their livelihoods are dependent on natural resources (Bobadoye *et al.*, 2016). Scientists have also warned that climate change and variability will exacerbate rainfall and temperature variations in the ASAL areas (IPCC, 2001). These therefore leads to people living in the ASALs areas come up with adaptation measures applied at community and household levels to enhance their survival (Silvestri *et al.*, 2012; Osano *et al.*, 2013).

In the past two decades, adaptation to climate variability has become a concern in the scientific and political fields (Niang, et al., 2014). This can be attributed to the link between climate variability, food security and farm productivity (Wheeler and von Braun,

2013). Occurrence of disasters linked to climate variability such as drought have led to unforeseen risks and uncertainties thus the need for incorporating new technologies and adjusting farming systems based on new information gathered (Steenwerth, et al., 2014). On the other hand, taking no adaptation action may result to increased vulnerability among people exposed to associated climate stressors hence efforts of the past decades aimed at resilience becoming futile (Niang, et al., 2014; Wheeler & von Braun, 2013).

Projects for example DRR have been established with an aim of reducing vulnerability of communities to the negative impacts of climate variability as it poses significant challenges to development initiatives within a community (Gero *et al.*, 2011). These project initiatives may have a positive impact on the adaptive capacity to climate variability or result to negative impacts by increasing their vulnerability and reducing resilience to climate variability (Bryan and Behrman, 2013). Despite the fact that wide research has been undertaken on adaptation measures applied by projects including DRR to help address vulnerability, the influence of these adaptation measures to adaptive capacity of beneficiaries remains low. In view of these, the study sought to evaluate the influence of KLSP and ARP disaster risk reduction projects on adaptive capacity to climate variability.

### **1.3 Research Questions**

1. How has climate (rainfall and temperature) varied between 1979 and 2014 in Kitui County?
2. How effective were the applied project adaptation measures among beneficiary households between 2013 and 2014?
3. How did socio-economic factors influence the uptake of adaptation measures to climate variability by beneficiary households between 2013 and 2014?

### **1.4 Research Objectives**

The overall objective of the study was to investigate the influence of disaster risk reduction projects on adaptive capacity to climate variability in Kitui County.

### **1.4.1 Specific Objectives of the study**

The study was guided by the following specific objectives:

1. To assess climate variability (rainfall and temperature) between 1979 and 2014 in Kitui County.
2. To evaluate the effectiveness of applied adaptation measures to climate variability among beneficiary households between 2013 and 2014.
3. To ascertain the influence of socio-economic factors on the uptake of adaptation measures to climate variability by beneficiary households between 2013 and 2014.

### **1.5 Hypotheses**

The study was guided by the following hypotheses:-

H<sub>1</sub> Climate (rainfall and temperature) has varied significantly within 1979 and 2014 in Kitui County.

H<sub>0</sub> Climate (rainfall and temperature) has not varied significantly within 1979-2014 in Kitui County

### **1.6 Significance of the Study**

Undertaking the research study was essential in that it will provide insight on how DRR projects influence adaptive capacity to climate variability among beneficiaries thus assist DRR project planners identify initiatives that enhance resilience to climate variability minimizing beneficiaries maladaptation. In addition, scholars interested in further research on DRR projects and climate variability will find invaluable source of information.

### **1.7 Conceptual Framework**

Ability to adapt to climate variability depends on the several factors that among them socio-economic factors, project adaptation measures undertaken and also the manner in which climate variability manifests itself that is the climatic hazard that will occur for

example drought, extreme temperatures floods among others. Adaptive capacity will either lead to resilience or vulnerability to climate variability as illustrated in Figure 1.

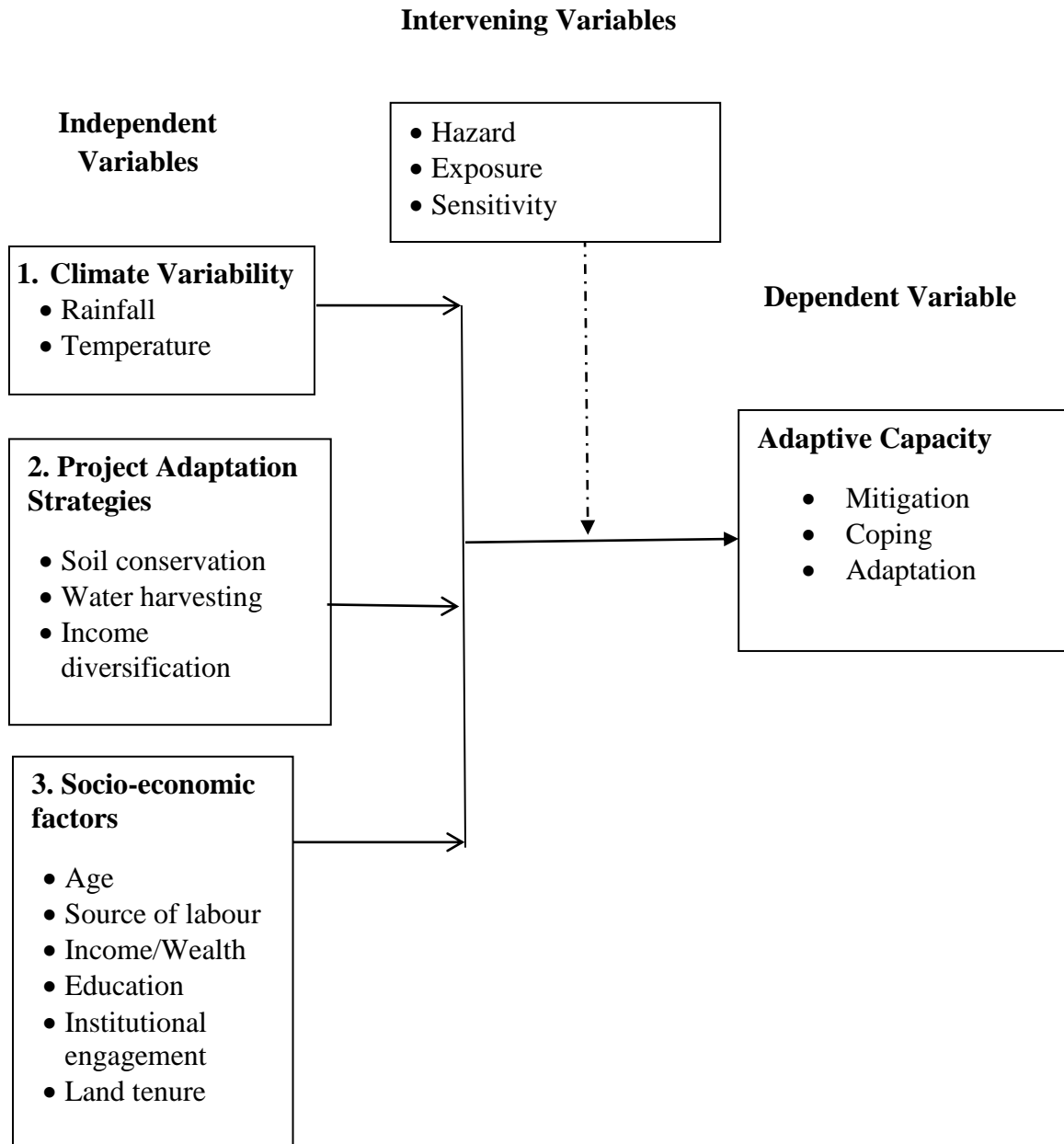


Figure 1: Conceptual framework adapted from (Frankenberger and Nelson, 2013; DFID, 2011)

## 1.8 Definition of Significant Terms

**Climate Variability:** These can be described as changes in weather elements such as rainfall, temperature, ocean currents, and wind flow patterns over time due to internal (natural processes within the climate system) or external variability (natural or man-made external forcing).

**Adaptive Capacity:** This is the ability of a system to adjust itself to the prevailing climatic changes and variability including extremes minimizing the potential damages while taking advantage of opportunities that arise.

**Vulnerability:** A set of conditions and processes resulting from physical, social, economic and environmental factors, which increase the susceptibility of a community to the impact of hazards.

**Hazards:** These are man-made or natural occurrences that can potentially impact the lives and livelihoods of communities' adversely for example drought, floods, and cyclones among others.

**Resilience:** This is the ability of a system (social or ecological) to withstand and absorb disturbances or shocks as it retains its basic functioning properties.

**Disaster Risk Reduction (DRR):** It is any activity undertaken by a community, aid agency or government in form of policies, strategies and practices that aim to prepare, mitigate or adapt and increase resilience towards hazards resulting to sustainable development.

**Project beneficiaries:** These refer to individuals, households or communities that are involved in project activities to produce outputs.

## CHAPTER TWO: LITERATURE REVIEW

### 2.1 Preview of Literature

According to FAO (2010), climate change is viewed as one of the most complex and challenging environmental problem facing the world today. Key issues of concern are the weather uncertainties, persistent climatic abnormalities, rampant environmental degradation and imminent food insecurity. These are further aggravated by increased population growth and increased agricultural production for food production which leads to environmental degradation due to vegetation clearing. These factors among others lead to environmental degradation, climate change, droughts, floods and also food insecurity.

### 2.2 Occurrence of Climate Variability

Climate variability occurrence has been observed in many parts of the world resulting to increase in frequency and intensity of floods, droughts and cyclones (Kiprotich *et al.*, 2015). Ribot *et al.*, 2009 defined climate variability as the inter-annual differences in observed climatic parameters within an average period of at least 30 years. Among individuals and communities, climate variability has been identified as one of the stresses that they have to cope with in their day to day activities (Ziervogel and Calder, 2003). In the ASAL areas, the rate of desertification is on the rise due to human factors and climate variability hence Kenya's land which consist of 75% ASAL is also subjected to these changes (GoK, 2010). These therefore makes the valuable biodiversity and other natural resources of the country become threatened to extinction (Khisa *et al.*, 2014; World Bank, 2009). In addition, climate variability in the ASALs leads to increased food insecurity, poverty among others due to a major drought that tends to occur once in every five years (Omoyo *et al.*, 2015).

Global temperatures have been on the rise with some of the warmest years recorded to occur since 1990, on a decadal time scale, 2000-2009 was recorded to be the warmest worldwide (WMO, 2010). In addition, Hulme *et al.*, (2001) stated that slight increase in the mean temperatures and annual precipitation in Eastern Africa has been observed between 1900 and 2000. According to The Fourth Assessment Report of the IPCC,

increase in global temperatures are likely to be attributed to human-induced causes through emission of greenhouse gases into the atmosphere (IPCC, 2007). The changes in temperature have led to fluctuations in yield and quality of food due to drastic changes in the cropping season (Kiprotich *et al.*, 2015) and more so a decrease in economic activities practiced has been experienced (Khisia *et al.*, 2014).

Rainfall variability in Sub-Saharan Africa regions has led to drought occurrence leading to decline in agriculture production thus increased instances of food insecurity as many rural-livelihoods rely on rain-fed agriculture (Ifejika *et al.*, 2008; Ongoma, 2013; AFIDEP and PAI, 2012). On the other hand, occasional high rainfall experienced that is of high intensity leads to occasional floods (Gachathi and Eriksen, 2011). Kitui County is classified under the Arid and Semi-Arid Lands (ASALs) areas that make 89% of the country with rainfall between 550 mm and 850 mm per year (GoK, 2014). Cases of erratic and unreliable rainfall occurrence has been on the rise in ASALs (Kiprotich *et al.*, 2015) resulting to increased rates of evapotranspiration making the areas experience hot and dry weather condition. This consequently leads to reduction of food production hence the residents are highly vulnerable to the impacts of climate variability (Khisia *et al.*, 2014). In addition to this, (Mertz *et al.*, 2009; Mortimore and Adams, 2001) observed that variability in rainfall and temperature at inter and intra-seasonal and annual scales has been experienced for many generations as indicated by farmers in arid and semi-arid environments which made the farmers come up with their own ways of coping with the climate variations. The rainfall variations are associated with the El Nino Southern Oscillation (ENSO) where El Nino results to heavy rainfall while La Nina events leads to absence of rainfall (Goddard and Graham, 1999; Wolff *et al.*, 2011).

The general understanding of climate variability and its effects is essential for comprehensive management in an integrated approach and in addressing the overall development goals and well-being of the people living in prone areas, and involving the different sectors and stakeholders affected (Kihupi *et al.*, 2002). In this context, the study sought to access the occurrence of climate variability in Kitui County that will give insights on climatic hazards experienced and anticipated.

## **2.3 Effectiveness of Climate Variability Adaptation Strategies**

Our climate is changing and will continue to change despite the efforts undertaken to curb emissions due to the presence of greenhouse gases in the atmosphere (IPCC, 2007). It is therefore necessary to be on guard regarding changes that are likely to occur as a result of climate change and variability especially to vulnerable populations likely to be negatively affected by the changes.

### **2.3.1 Concept of Adaptation**

Eriksen *et al.* (2011), defined adaptation as “a wide range of behavioural adjustments that households and institutions make (including practices, processes, legislation, regulations and incentives) to mandate or facilitate changes in socio-economic systems, aimed at reducing vulnerability to climatic variability and change.” This is similar to Adger *et al.*, (2003) who defined adaptation as “the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities or to cope with the consequences”. These definitions have similarities where adaptation to climate variability is viewed as measures that are undertaken to reduce vulnerability to human population through embracing variations and changes in climate and making appropriate adjustments so as to cope with the changes.

Adaptation as a response strategy identified by the United Nations Framework Convention on Climate Change (UNFCCC) has been used in addressing climate change and variability mainly through focusing on alleviation of adverse climate impacts through system-specific actions of a wide variety (Fussel and Klein, 2002). According to Schipper (2009), adaptation requires longer-term adjustments that focus on addressing the effects of climate change and variability while mitigation aims at addressing the sources of climate change. In order to develop adaptation strategies that will help in reducing the vulnerability of communities, it is essential to have an understanding of the process that might influence the uptake of the adaptation (Adger and Vincent, 2005).

Integration of Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) initiatives will result in effective reduction of vulnerabilities to disasters and climate

change (Bettencourt, *et al.*, 2006; AusAID, 2009). Climate change adaptation refers to “an adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits benefit opportunities” (IPCC, 2007) while DRR is “the systematic development and application of policies, strategies and practices to minimise vulnerabilities, hazards and the unfolding of disaster impacts throughout a society, in the broad context of sustainable development” (UNIDSR, 2004). Some benefits that have been identified through integration of CCA and DRR initiatives include but not limited to; increased efficiency of resources in terms of human, financial, natural; sustainability of initiatives and also reduction of climate related losses mainly through DRR initiatives (Venton and La Trobe, 2008).

Adaptation to climate variability results to adjustments in socio-economic arrangements with an aim of reducing vulnerability of societies, households, communities and countries among others (Smit and Wandel, 2006). According to (Kelman *et al.*, 2009; Nunn, 2009), local communities have developed local coping mechanisms to changes that have occurred in their environments as a result of climate change and variability. These mechanisms can be built upon in future adaptation strategies to be implemented and can also serve as a platform from which lessons can be borrowed.

### **2.3.2 Community Based Adaptation Approach**

Community based adaptation strategies have been on the rise as communities have realized the importance of valuing their local culture, prevailing conditions and also the development issues they are facing (Uitto and Shaw, 2006). Through local initiatives, communities are able to work with DRR partners to build resilience to disasters caused by climate change and variability as communities themselves identify the risks using local knowledge (van Aalst *et al.*, 2008; Mercer *et al.*, 2009). Projects implemented with involvement of local participation are likely to address the needs and concerns of the beneficiaries as communities own the projects resulting to long-term benefits especially when project implementation period elapses (Charlton, 1995; Gibson *et al.*, 2005). Moreover, local participation may be a hinderance to project implementation due to power relations which determine who is to be represented and whose needs are to be addressed

and should be considered especially when dealing with vulnerability and adaptation to climate change and variability (Kothari and Cooke, 2001).

Projects may positively or negatively influence beneficiary community hence it is important to factor in the local conditions, ensure participation from marginalised groups and ownership for purposes of sustainability. For DRR projects to enhance adaptive capacity of project beneficiaries, participation of all stakeholders and transparency must be adhered to (Barnett, 2008).

The most commonly used adaptation measures include; use of new crop and animal varieties suited for ASALs, crop diversification, change of planting dates, irrigation, soil conservation measures, and practice of agroforestry among others (Onyeneke and Madukwe, 2010). In the context of the study, the research aimed at evaluating the effectiveness of the adaptation measures to climate variability employed by disaster risk management projects that include; on-farm water harvesting, soil conservation measures and diversification of livelihoods.

#### **2.4 Influence of Socio-Economic Factors on Adaptation to Climate Variability**

According to Deressa *et al.* (2009) some socio-economic factors that influence the level of adaptation to climate variability include; gender, age, access to extension services and credit, information on changes in climate, level of education and income status of the household head among others. Bryan *et al.* (2009) in a study carried out in Ethiopia and South Africa, it was established that finance, access to extension services, credit and fertile land influenced level of adaptation to climate variability. These factors helped in the facilitation of adaptation especially among the less well-off farmers. In Sri-Lanka and parts of South Asia, age, gender, level of education of household head, size of the farm, employment type were some of the factors that influenced the decision of adaptation to climate variability (Weerahewa *et al.*, 2012).

According to Adebisi and Oyesola (2013), gender influenced adaptation levels in that households headed by women are likely to have low adaptation to climate variability as women barely have land ownership rights due to cultural practices that discriminate

women. This is despite them having land user rights. In addition, Anyoha *et al.*, (2013) asserted that gender has a significant degree of influence in the level of adaptation to climate variability. On the other hand, Nhemachena and Hassan (2007) stated that there is a high likelihood of female households to uptake adaptation strategies due to high involvement and experience in agricultural activities thus tend to acquire more information on the available coping strategies.

Education also influences level of adaptation to climate variability (Anyoha *et al.*, 2013) in that individuals with high level of education tend to be aware of climate variability thus high tendency of adaptation. In addition, level of education influences the level of knowledge acquisition about the environment, the uptake of improved technologies and adaptation to climate variability (Norris and Battie, 1987; Adebisi and Oyesola, 2013). In contrast to these findings, Daulagala *et al.*, (2012) argued that level of education did not have any significant influence on level of adaptation.

Age is also a factor that influences the level of adaptation to climate variability and it can have a positive or negative impact especially when it relates to adoption of new technologies (Gbegeh and Akubuilu, 2013). In the case of farming for example, the older farmers who are more experienced in farming will evaluate new modern technologies on offer based on their experience and are highly likely to adopt to the new technologies unlike the young farmers who are less experienced. However, older farmers tend to be more risk averse compared to young farmers hence a likelihood that they will not adopt to new technologies as they are less flexible and not ready to try out new technologies (Adesina and Forson, 1995; Mwangi and Kariuki, 2015). On the other hand, older farmers have high costs to incur when switching to new technologies due to the many years of investment unlike young farmers whose investment are much less thus will incur low cost in switching to new technologies (Marenja and Barrett, 2007). This may hinder older farmers from adopting new technologies as compared to young farmers.

The size of a household influences the level of adaptation to climate variability in that households that are large tend to have high uptake chances of climate variability adaptation measures as the family members act as a source of labour for agricultural

activities some of which are coping strategies to climate variability (Marenya and Barrett, 2007; Anley *et al.*, 2007). In instances where family members are inadequate to supply the labour required for farm operations, it may pose as a challenge to uptake of adaptation measures (Nkonya, *et al.*, 2008). However, large household would lead to some members indulging into off-farm activities so as to earn an extra income to sustain the needs of the family (Tizale, 2007).

Farm sizes influence decisions on uptake of climate variability adaptation measures in that people with large farms tend to seek more information on how they can make their lands productive with an aim of increasing their income through increased yields. Through information gathering, they are able to employ new adaptation technologies unlike people with small farms who rarely seek for information on how to increase productivity in their farms (Daberkow and McBride, 2003; Marenya and Barrett, 2007).

Institutional engagement influences adaptation to climate variability in terms of access to information, credit among others. Accessibility to formal and informal institutions increases the likelihood of uptake of adaptation measures for example, access to meteorological information increases the likelihood of households practicing adaptation measures related to variation in climate (Yesuf *et al.*, 2008; Mariara and Karanja, 2007; Smit and Pilifosova, 2001). In addition, farmers with access to extension services are more likely to acquire information on climate variation and changes that are occurring or likely to occur thus high likelihood of uptake of adaptation measures (Gbetibouo, 2009). Despite the effectiveness of extension services in increasing uptake of adaptation measures especially those that are technical, it has been observed that extension-farmer linkages are weak in some parts of Sub-Saharan Africa and information tends to flow from farmer to farmer (Adesina and Forson, 1995; Kinyangi, 2014). It is therefore necessary that farmer networks be strengthened for purposes of information and technology transfer. Farmer cooperatives as a form of social networking has also shown to increase the level of adaptation uptake among farmers (Pannell, 1999; Maddison, 2006) thus the need to engage them in research processes, on-farm demonstrations and trials. This increases the spread of information as farmers tend to learn from one another.

Land tenure influences uptake of adaptation measures as it relates to land property rights (Shiferaw *et al.*, 2009; Gbetibouo, 2009). Insecure land tenure systems limits households to invest in adaptation measures especially those are capital intensive for example investing in irrigation equipment. These land tenure systems may include but not limited to communally owned land, rented land among others.

Wealth is also a factor that influences the level of adaptation in that inadequate finance hinders the acquisition of technologies and required resources for purposes of adaptation (Onyeneke and Madukwe, 2010). Since adaptation to climate change and variability is costly additional costs of labour in cases of insufficient family labour may influence levels of adaptation (Deressa *et al.*, 2008). In addition, people who are financially well-off are likely to adopt technologies that require high financial input to adopt to climate variability (Knowler and Bradshaw, 2007). In the context of the study, the research aimed at finding the socio-economic activities that have an influence on the uptake of adaptation measures to climate variability by project beneficiaries.

## **2.5 Research Gaps**

Based on the literature review various adaptation measures by projects are available that are aimed at reducing vulnerability to climate variability impacts such as drought occurrence. Most of these adaptation measures are assumed to increase adaptive capacity of beneficiaries (Wood *et al.*, 2014) therefore the study sought to assess the influence of DRR projects on adaptive capacity of beneficiaries in the study area.

Socio-economic factors have varying influence on adaptive capacity as per the literature review undertaken and it is in this view that the study sought to establish socio-economic factors that influenced uptake of DRR adaptation measured applied among project beneficiaries in the two project areas.

## CHAPTER THREE: METHODOLOGY

### 3.1 Study Area

The research was carried out in Kitui County and comprised of Kitui South, Mwingi Central and Mwingi North sub-counties. According to GoK (2014), Kitui County covers an area of 30,496.4 km<sup>2</sup> stretching from latitudes 0°10' South to 3°0' South and longitudes 37°50' East to 39°0' East. The County has a population of 1,012,709 people as per the population and household census report 2009 (GoK, 2009a).

The climate is hot and dry with erratic and unreliable rainfall (GoK, 2009b) and falls under arid and semi-arid climatic zones receiving temperatures throughout the year that range from 22°C to 34°C. The rainfall pattern is bi-modal with annual rainfall ranging between 250 mm-1050 mm (long rains around May and June, and short rains around September and October). The County's major livelihood activity is agriculture where the major food crops grown are cereals, legumes and root crops (GoK, 2014).

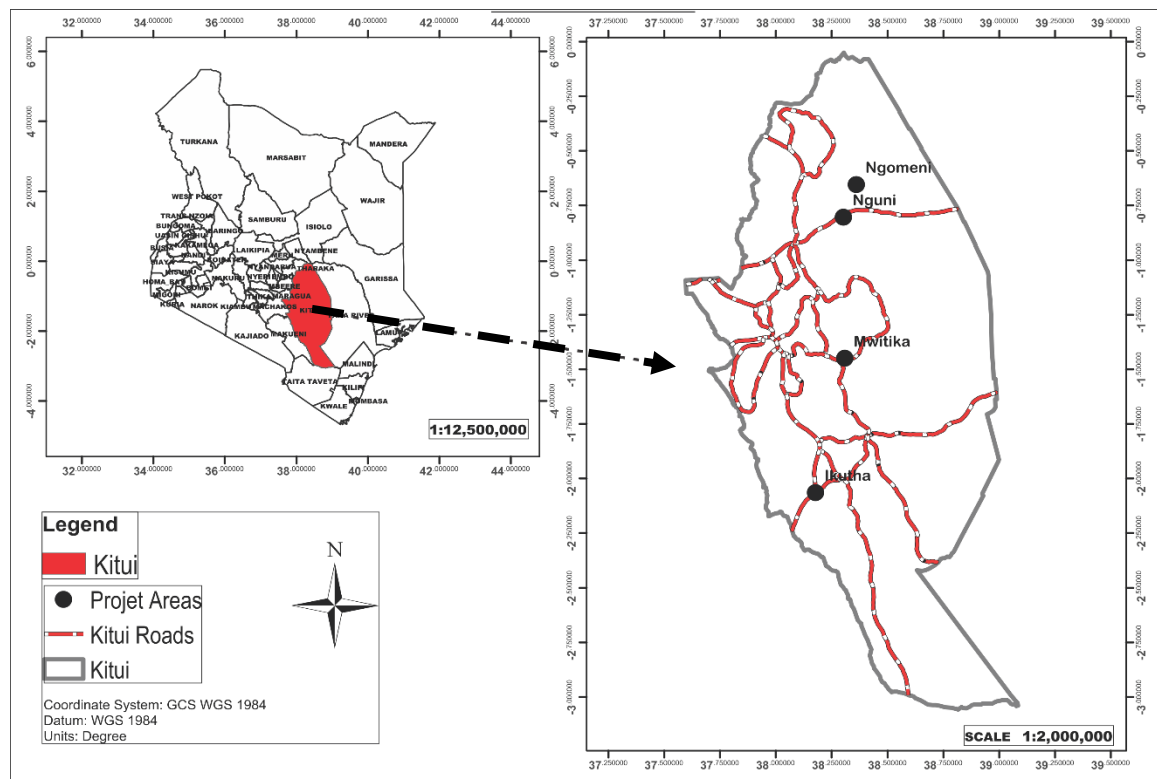


Figure 3.1: Map of the study area (Kitui County)

### 3.2 Research Design

A descriptive survey design was used in collecting both qualitative and quantitative data. Orodho (2003), defined descriptive survey design as a method of collecting information through use of interviews or administering questionnaires to a sample of individuals. It is essential in collection people's opinions or social economic issues.

### 3.3 Target Population

The target population was 2,500 households that benefited from projects' interventions and comprise of 1,000 and 1,500 of KLSP and ARP respectively.

Table 3.1: Target population

<b>Project Name</b>	<b>Area Implemented (Wards)</b>	<b>No. of beneficiary households</b>
The Kenya Livelihood Support Project (KLSP)	Yatta and Ikutha	1,000
Arid and Semi-Arid Lands Resilience Project (ARP)	Nguni, Ngomeni and Mwitika	1,500
<b>TOTAL</b>		<b>2,500</b>

### 3.4 Sample Size

According to Nassiuma (2000), a coefficient of variation between 21% to 30% and a standard error ranging between 2% to 5% is usually acceptable in surveys therefore a coefficient variation of 21% and a standard error of 2% was used so as to determine the sample size of the number of respondents. The lower limit for coefficient of variation and standard error was chosen so as to ensure low variability in the sample and minimize the degree of error.

$$n = \frac{NCv^2}{(Cv^2 + (N - 1)e^2)}$$

Where:  $n$  is the sample size,  $N$  is the target population,  $Cv$  is the coefficient of variation and  $e$  is the standard error.

Therefore;

$$n = \frac{2,500 \times 0.21^2}{(0.21^2 + (2,500 - 1)0.02^2)}$$

$n=106$  households

Table 3.2: Sample size

<b>Project Name</b>	<b>No. of beneficiary households</b>	<b>Sample size</b>
The Kenya Livelihood Support Project	1,000	42
Arid and Semi-Arid Lands Resilience Project (ARP)	1,500	64
<b>TOTAL</b>	<b>2,500</b>	<b>106</b>

### 3.5 Sampling Procedure

Purposive sampling was used to select key informants who refer to persons with specific knowledge required (Mugenda and Mugenda, 2003). They comprised of twelve (12) elderly men and women (60 years and above) who have lived in Kitui County throughout their lives hence are conversant with the past climate (rainfall and temperature) of the area. The twelve were selected purposively as getting people in the age group may be difficult as it forms 5.2% of the entire population (GoK, 2009a). For project implementers' the two (2) project managers were selected from the two projects implemented.

To obtain the households for survey, stratification based on the two projects undertaken was first carried out. This was followed by simple random sampling to select the 106 project beneficiary households. The survey was to assist in getting information on socio-economic characteristics of households and how it influences level of uptake of adaptation measures to climate variability.

### **3.6 Data Collection Instruments**

For better understanding of the subject matter, a survey (household survey and key informant interviews) were conducted so as to obtain both quantitative and qualitative data (Newing, 2011). A structured questionnaire was administered among 106 individual household beneficiaries to obtain information on different aspects of the study which were:- demographic information of household beneficiaries; socio-economic characteristics of beneficiary households; influence of socio-economic factors on the uptake of adaptation measures to climate variability; perception on occurrence of climate variability and its impact on their livelihoods; adaptation and coping strategies employed and effectiveness of climate variability adaptation measures employed by projects among project beneficiaries (Appendix 1).

An interview schedule was administered to key informants who were the project implementers. This aimed at generating general information on the impact that the implemented projects have had on project beneficiary households in regard to adapting to climate variability (Appendix 2).

Rainfall and temperature data from 1975 to 2014 was obtained from Kenya Meteorological Department (KMD) and used to generate variation trends of rainfall and temperature over time. The temperature and rainfall data collected was from 1975-2014 so as to obtain data for four decades hence variation in study period. The data was also used to verify responses from households' perception on the variation of climate that had been experienced. In addition, document analysis was conducted for any secondary data source availed during the course of the study.

#### **3.6.1 Pre-testing**

A sample of 10 household questionnaires were administered to randomly selected household beneficiaries, 5 in each project who were not considered during the actual survey. The key informant schedule was administered to the overall project coordinator who was not also considered in the actual survey. The responses acquired helped in filling in gaps, restructuring the questions where necessary for purposes of clarity and help

generate the required information. The pre-test helped to ensure validity and reliability of the data collection instruments.

### **3.6.2 Validity of Instruments**

Validity is the degree to which an instrument measures what it is supposed to measure. It also ensures that data collected is accurate and address the variables under investigation. Validity of the instruments was ensured through undertaking a pilot study to determine if the instruments yielded the required information. Wide consultation was done between the researcher and the University supervisors to ensure that the instruments were well structured, focused, accurate and consistent. Data obtained from the pre-test was used to revise the questionnaire to ensure it was comprehensive and ready for administration in the actual field survey.

### **3.6.3 Reliability**

Reliability refers to the degree of consistency yielded by an instrument when replicated systematically. It is meant to ensure an instrument is precise. Reliability of the research tools was done and enhanced through the researcher self-administering household survey questionnaire to different project beneficiaries at different times and comparing the responses attained. Those selected for the pre-test were not be considered in the actual data collection. The inconsistencies that were experienced were addressed by restructuring and rephrasing of questions in the final tool to be used. Katumani weather station was selected as it had consistent weather recordings for over 35 years (1975-2014) thus sufficient data for the study period was available and were also within the study area.

### **3.7 Data Collection Procedure**

A research permit was obtained from National Commission for Science, Technology and Innovation (NACOSTI). This was followed by pre-testing of the research instruments that aimed at ensuring validity and reliability of the tools. Issues arising from the pre-test were addressed and necessary amendments done on the tools. Primary data collection was then undertaken which lasted for approximately one month.

Data collection was conducted in two phases that are desktop literature which involved sourcing of documented secondary data and information on climate variability and adaptation measures employed to enhance resilience. The second phase involved data collection in the field through the use of questionnaires, key respondents interview schedules to obtain firsthand information on the topic of focus. Questionnaires administered to project beneficiary households' were self-administered by the researcher as this provided a leeway for probing and seeking clarity in areas that added value to the research. The method also helped in saving time and ensuring that the questionnaires were completely filled. Climatic data (rainfall and temperature) for the period 1979-2014 were obtained from the Kenya Meteorological Department Katumani weather station (number 9137089) for analysis to establish whether there has been any variation in temperature and rainfall for the last 35 years. For decadal analysis, temperature and rainfall data was considered from 1975-2014 to cater for four complete decades. This station was chosen because it had regular weather records for more than 35 years.

### **3.8 Data Analysis**

Data collected was both qualitative and quantitative. The data obtained was stored in SPSS software version 20 with assigned variable names. The quantitative data obtained from household survey was subjected to measures of central tendency and dispersion where relevant statistical softwares (SPSS and Excel) were used for purposes of displaying the data. For example, measures of dispersion were used to make generalization on the effectiveness of each project adaption measure to climate variability among project beneficiaries' households while measures of central tendency were relied upon to compare household responses on climate variability and actual climate (rainfall and temperature) data recorded by the KMD. On the other hand, qualitative data was analyzed based on themes emerging from each objective.

Data obtained from key informants guided by the key informant schedule was summarized in key themes. Analysis of the data was essential in providing more information and verifying responses obtained from household surveys on the impact of

implemented project adaptation measures in assisting beneficiaries cope with variations in climate and also provide insight on climate variation occurrences within the area.

Choice of Katumani Station as a KMD station to obtain rainfall and temperature data was based on consistency of recorded data for four decades (1975-2014) that was used in decadal analysis. Percentage of missing data was also put into consideration to ensure that data obtained was reliable. The data was analyzed using excel and displayed in graphs and charts. Annual rainfall and temperature trends were computed and also anomalies in both rainfall and temperature over the same period of time were displayed. ANOVA analysis was conducted for objective one to find out if there was any statistically significant decadal variation of both rainfall and temperature within 1975-2014. This was followed by a post hoc analysis to find out if there was any statistically significant differences within the decades. Correlation analysis was also carried out to find out if there was any correlation between mean annual temperature and rainfall. The time period of decadal analysis differed from the study period (1979-2014) to cater for four complete decades.

Total Weighted Means were calculated to assist in ranking likert scale responses after which Chi-square analysis was carried out to test for any significant difference on the different rating used in the likert scales and were used for objective two and three.

## **CHAPTER FOUR: RESULTS AND DISCUSSIONS**

### **4.1 Response Rate**

One hundred and six questionnaires were administered to respondents in the two projects, 103 questionnaires were found valid after data cleaning. The response rate achieved was 97% for both ARP and KLSP projects. According to Idrus and Newman (2002), a response rate of 50% is considered good enough in social studies.

### **4.2 Background Information of Respondents**

#### **4.2.1 Gender**

In the ARP project, out of 62 project beneficiary respondents, 76% and 24% were female and male respondents respectively while in KLSP project, out of the total 41 project beneficiary respondents, 78% were female and 22% were male as shown in Table 4.1. This could be attributed to the fact that women are highly engaged in farming activities and are more likely to be impacted by climate variation hence will tend to take up adaptation strategies to climate variation (Nhemachena and Hassan, 2007).

#### **4.2.2 Marital Status**

Majority of the respondents in both projects as indicated in Table 4.1 were married with 87.1% (n=54) and 85.37% (n=35) for ARP and KLSP respectively. Widowed and widowers accounted for 4.84% (n=3) and 2.44% (n=1) in ARP and KLSP project respectively while singles accounted for 12.2% (n=5) in KLSP and divorced/separated category accounted for 8.06% (n=5) in ARP project. According to Smith, (2014) women in a married relationship tend to get support from their spouses in terms of start-up capital. Aelst and Holvoet, (2016) noted that marital status may influence the uptake of climate variability adaptation measures especially among women in marriage as they have entitlement to certain socio-economic benefits such as land ownership rights.

Table 4.1: Background information of respondents

Parameters	ARP Project		KLSP Project	
	(n=62)		(n=41)	
Gender of household beneficiary				
Male	15 (24.19)		9 (22.95)	
Female	47 (75.8)		32 (78.05)	
Marital Status				
Married	54 (87.10)		35 (85.37)	
Widowed/Widower	3 (4.84)		1 (2.44)	
Single	0 (0)		5 (12.20)	
Divorced/Separated	5 (8.06)		0 (0)	
Level of education				
No formal education	7 (11.29)		5 (12.20)	
Primary school level	42 (67.74)		25 (60.98)	
Secondary school level	12 (19.35)		9 (21.95)	
Diploma/Degree level	1 (1.61)		2 (4.88)	
Size of land owned (acres)				
Less than one acre	2 (3.23)		4 (9.76)	
1 to 3 acres	22 (35.48)		25 (60.98)	
4 to 6 acres	24 (38.71)		9 (21.95)	
Above 7acres	14 (22.58)		3 (7.32)	
	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>
Age	47.8	12.69	48.2	10.92
No. of household members	6	2.5	5	2.1

*NB: Figures in parenthesis ( ) indicate percentage (%)*

### 4.2.3 Education

It was noted as illustrated in Table 4.1 that majority of respondents had some level of education many of whom had primary level education 60.98% and 67.74% in KLSP and ARP projects respectively. Those with secondary level education accounted for 21.95% and 19.35% while those who had attained diploma/degree level accounted 4.88% and

1.61% in KLSP and ARP projects respectively. It was also noted there were those with no formal education who accounted for 12.20% and 11.29% in KLSP and ARP projects respectively. This therefore indicates a population that can be regarded as educated thus are able to acquire knowledge on the changes occurring in their environment and also take up adaptation strategies to climate variability (Norris and Battie, 1987; Adebisi and Oyesola, 2013). This supports Anyoha *et al.* (2013) who stated that education has an influence on the level of adaptation to climate variability as educated individuals tend to be aware of climate variability hence high tendency of adaptation.

#### **4.2.4 Size of Land**

Distribution of land in terms of acreage among respondents in the two projects is illustrated Table 4.1. Distribution of land varied in the two projects in that majority of respondents 60.98% (n=25) in KLSP project had land sizes between one and three acres while in ARP project majority of respondents 38.71% (n=24) owned land sizes between four and six acres. The average size of land was 2 acres (KLSP) and 3 acres (ARP) can be considered as moderately large farms hence tend to influence the uptake of climate variability adaptation measures through seeking of information on adaptation technologies to improve land productivity, increase their yield and consequently lead to increase in income among respondents (Daberkow and McBride, 2003; Marenya and Barrett, 2007).

#### **4.2.5 Age**

The average age of respondents interviewed was 47.8 and 48.2 years in ARP and KLSP projects respectively (Table 4.1). In terms of uptake of adaptation strategies to climate variability, such a population will be willing to take up new strategies since they have experienced climate variations over time (Ndambiri *et al.*, 2012). This age group are likely to take up adaptation strategies that may require intense labour and also seek more information regarding climate variability adaptation measures unlike a more elderly population (Onu, 2005). In addition, this age of farmers is more risk averse compared to more older farmers hence are flexible and ready to take try out new technologies (Adesina and Forson, 1995; Mwangi and Kariuki, 2015).

#### 4.2.6 Average Household Members

The average number of household members for each project was 5 and 6 for KLSP and ARP projects respectively. Large number of household members act as a cheap source of labour hence many households tend to use it as a main source of labour. This corresponds with Marenya and Barrett, (2007); Anley *et al.* (2007) who asserted that large family size tend to increase the uptake level of climate variability adaptation measures as family members are used as the main source of labour.

#### 4.2.7 Income

In both projects, majority of the respondents 80.49% (KLSP) and 77.42% (ARP) earn their livelihood from farming, 7.32% (KLSP) and 16.13% (ARP) source their income from business and 7.32% and 4.84% of the respondents in KLSP and ARP project respectively earn their livelihood from salary and 4.88% and 1.61% of respondents in KLSP and ARP project respectively earn their livelihood from remittance (Table 4.2).

Table 4.2: Average income and sources

<b>Main source of income of beneficiary</b>	<b>ARP Project (n=62)</b>	<b>KLSP Project (n=41)</b>
Business	10 (16.13)	3 (7.32)
Crop/Animal farming	48 (77.42)	33 (80.49)
Salary/wage	3 (4.84)	3 (7.32)
Remittance	1 (1.61)	2 (4.88)
<b>Average monthly income</b>		
Below 10,000	40 (64.52)	34 (82.93)
10,001-20,000	19 (30.65)	5 (12.20)
20,001-30,000	2 (3.23)	1 (2.44)
30,001 and above	1 (1.61)	1 (2.44)

*NB: Figures in parenthesis ( ) indicate percentage (%)*

This therefore indicates that majority of respondents rely heavily on sources of income that are climate sensitive thus where slight variations in climate would adversely affect their means of livelihood and their ability to withstand the effects of climate variation. According to Aelst and Holvoet (2016), well-off households either engage in salaried employment or small businesses while the less well-off households are engaged in casual labour which is mainly agricultural based hence are more vulnerable to climate variation. In addition, income from casual labour is not sufficient for households to apply adaptive measures that require high investments in terms of cash.

In addition, majority of the respondents in both projects as illustrated in Table 4.2, 82.93% (KLSP) and 64.52% (ARP) earn an average monthly income of below Kshs. 10,000. 12.20% (KLSP) and 30.65% (ARP) earn an average monthly income ranging from Kshs. 10,001 to 20,000, 2.44% (KLSP) and 3.23% (ARP) earn an average monthly income range of Kshs. 20,001 to 30,000 while only 2.44% and 1.61% in KLSP and ARP projects respectively earn an average income of Kshs. 30,001 and above. As illustrated in Table 4.2, crop/animal farming is the main source of income which are rainfall dependent. This in turn influences the amount of monthly income accrued which can be attributed to reliance on rain fed agriculture and in the event that income diversification from on-farm to off-farm activities has not been embraced, monthly income will be impacted on (Berman *et al.*, 2015).

#### **4.2.8 Land Tenure**

Land tenure relates to land property rights and ownership. Majority of the respondents 70.73% (KLSP) and 90.32% (ARP) have acquired their land through inheritance while others own land through buying 21.95% (KLSP) and 8.06% (ARP) and obtaining a title deed to show legal ownership (Table 4.3). In the two project areas, land ownership is viewed as secure as only 1.61% of respondents in ARP project zone own land communally and no leasehold type of land ownership in both project zones. Secure land ownership tends to influence uptake of climate variability adaptation measures as households invests in the various adaptation measures without having land insecurity issues (Shiferaw *et al.*, 2009; Gbetibouo, 2009).

Table 4.3: Type of land ownership

<b>Type of land ownership</b>	<b>ARP Project (n=62)</b>	<b>KLSP Project (n=41)</b>
Inheritance/Ancestral land	56 (90.32)	29 (70.73)
Communal land	1 (1.61)	0 (0)
Private land	5 (8.06)	9 (21.95)
Inheritance and Private	0 (0)	3 (7.32)

*NB: Figures in parenthesis ( ) indicate percentage (%)*

### **4.3 Institutional Engagement of Project Beneficiaries**

Project beneficiaries in the two projects were affiliated to different institutions for different purposes that they felt was beneficial to them.

#### **4.3.1 Membership of Social Groups**

Respondents of the two projects were members of various social groups as illustrated in Table 4.4. In the two projects, it was observed that most of the respondents 75.61% and 43.55% for KLSP and ARP projects respectively belonged to social welfare groups. Respondents in KLSP and ARP projects constituted of 19.51% and 32.26% respectively belonged to more than one social group as different groups have different benefits to them. In addition, neither of the respondents in the two groups belonged to church or family group solely as the benefits gained are minimal.

Table 4.4: Membership of social groups

<b>Membership of Social Groups</b>	<b>ARP Project (n=62)</b>	<b>KLSP Project (n=41)</b>
Social welfare group	27 (43.55)	31 (75.61)
Community Based Organization	15 (24.19)	2 (4.88)
Combination	20 (32.26)	8 (19.51)

*NB: Figures in parenthesis ( ) indicate percentage (%)*

#### 4.3.1.1 Benefits of Social Groups

Respondents in the two projects had varying reasons as to why they belonged to various social groups. The respondents joined various social groups for different purposes with majority of respondents 39.02% in KLSP and 30.65% in ARP joining for development purposes. It was observed that 21.95% and 38.71% of respondents in the two projects belonged to a more than one social group for multiple benefits. This aimed at addressing most of their needs that include finances, improving livelihoods, obtaining trainings for livelihood improvement among others. Few of them 12.20% (KLSP) and 6.45% (ARP) joined social groups for social networking as it was considered less beneficial. According to Yesuf *et al.*, 2008; Mariara and Karanja, 2007; Smit and Pilifosova, 2001, these engagements to formal and informal institutions can be attributed to ease of access to information on climate variability and credit facilities hence increasing the likelihood of uptake of adaptation measures.

#### 4.3.2 Extension Services

Engagement of private extension services was the least in both projects and 2.44% in KLSP and none in ARP as they offer their services for a fee hence majority of the respondents refrained from engaging their services. In both projects, majority of respondents 51.22% and 41.94% in KLSP and ARP projects respectively obtained their extension services from NGOs like Caritas which carry out development projects in ASAL areas (Table 4.5).

Table 4.5: Extension services

<b>Source of Extension Services</b>	<b>ARP Project (n=62)</b>	<b>KLSP Project (n=41)</b>
None	8 (12.90)	3 (7.32)
Government	10 (16.13)	12 (29.27)
Private	0 (0)	1 (2.44)
NGOs	26 (41.94)	21 (51.22)
Government and NGO's	18 (29.03)	4 (9.76)

*NB: Figures in parenthesis ( ) indicate percentage (%)*

The Government also offers extension services through the Ministry of Agriculture and this can be illustrated by people who have benefited from their services at 29.27% and 16.13% in KLSP and ARP projects respectively. It was also noted that some farmers obtained extension services from both the government and also NGOs. According to (Gbetibouo, 2009), farmers with exposure to extension services are more likely to take up climate variability adaptation measures as they can easily access information on variation and change in climate. Lack of access to extension services by some farmers 7.32% and 12.90% in KLSP and ARP projects respectively may be attributed to weak extension-farmer linkages resulting to inadequate information flow from farmer to farmer (Adesina and Forson, 1995). In such instances farmer cooperatives as a form of networking can be enhanced as it increases the level of adaptation uptake among farmers (Pannell, 1999; Maddison, 2006).

#### **4.4 Assessment of Climate Variability**

##### **4.4.1 Rainfall Trends**

Illustration of the trends of rainfall and temperature data (1979 to 2014) obtained from KMD (Katumani station) showed variations over time as shown in Figure 4.1. From Figure 4.1, variations in rainfall were observed in the study between 1979 and 2014. From the data analyzed, it was observed that rainfall variation was experienced within the 35 years of the study period. The highest precipitation was recorded in the years 1982, 1989, 1998 and 2006 which recorded 937.5 mm, 985.8 mm, 990.6 mm and 873.6 mm respectively. The year 1998 and 1989 which recorded extremely high rainfall respectively would have been attributed to occurrence of El-Nino where high rainfall amounts were recorded countrywide. These recording were similar to Camberlin *et al.*, 2001 who noted that the extremely high rainfall received during the El-Nino period led to destruction of crops in most parts of the country. Several occurrences of El-Nino in Kenya have been recorded in the past with events having similar characteristics of wetter than normal episodes being experienced but with variation being observed in terms of magnitude, duration and global climatic impacts (Karanja and Mutua, 2000). In Mt. Kenya and Western areas for example, rainfall received during the 1998/1997 El-Nino occurrence

was three to ten times the expected means and the areas were hard hit by flooding (GOK/UNDP, 1998).

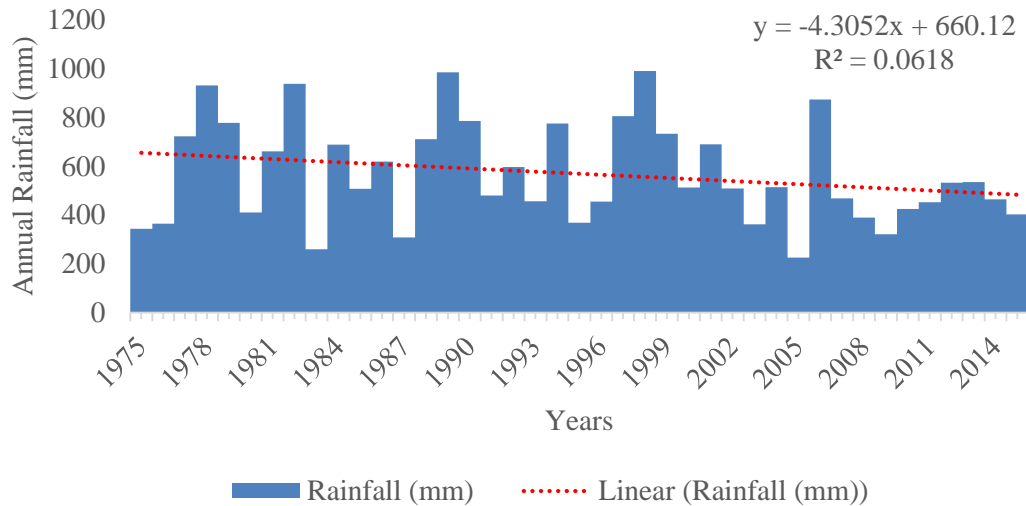


Figure 4. 1: Annual rainfall distribution and linear trends from 1979 to 2014

On the other hand, the lowest level of precipitation was recorded in the years 1983, 1987, 1995, 2003, 2005 and 2007 with rainfall amounts of 259.4mm, 308.2mm, 368.8mm, 361.7mm, 226.0mm and 321.1mm respectively. It is noted that 1998 recorded the highest amount of precipitation while in 2005 was the year with the least amount of rainfall recorded within 1979 to 2014. The annual precipitation range was 774.6mm within the period of study.

Various variations in precipitation was observed where there was a sharp increase in rainfall recorded in 2005 (226.0 mm) and 2006 (873.6 mm) followed by a declining trend in rainfall received in the subsequent years. In 1983 a sharp decline of annual rainfall received was observed from 1982 recorded annual rainfall with variation of 678.1 mm. The inter-annual rainfall variations observed were similar to those observed by Hulme *et al.*, 2001. According to Karanja and Mutua (2000), these variation in rainfall received can also be associated to influence of ENSO phenomenon which has a strong influence on the rainfall pattern in Kenya where ENSO oscillates between El-Nino and La Nina events.

The linear rainfall trend indicates as the years progress, the rainfall experienced tend to decline as indicated by the declining trend line. It is therefore necessary to brace and be prepared for less rainfall as the years progress.

#### 4.4.1.1 Decadal Rainfall Distribution

In terms of decadal rainfall records Table 4.6, it was observed that 1985 to 1994 recorded the highest amount of precipitation at 6227.8 mm which was an average of 622.8 mm each year while the least decadal rainfall recorded was between 2005 and 2014 at 4689 mm which was an average of 468.9 mm each year. It was also noted that there was an increase in decadal precipitation between 1975 to 1984 and 1985 to 1994 as indicated in Table 4.6 after which the rest of the decades a declining trend in precipitation was observed. The rainfall variations observed could be attributed to variations in climate resulting to decline in precipitation received. This findings are supported by Christensen *et al.*, 2007 who projected that there would be an increase in rainfall variability in Kenya.

Table 4.6: Decadal rainfall distribution from 1975-2014

<b>Decade</b>	<b>Number (n)</b>	<b>Total Decadal Rainfall (mm)</b>	<b>Average Decadal Rainfall (mm)</b>	<b>Std. Deviation</b>
1975-1984	10	6097.8	609.8	248.2115
1985-1994	10	6227.8	622.8	197.3034
1995-2004	10	5940.9	594.1	204.0170
2005-2014	10	4689.0	468.9	170.4173

Table 4.7 shows the output of the ANOVA analysis that aims at finding out if there is any statistically significant difference between ten-year group means on precipitation. The results show that the significance value ( $P = 0.332$ ) is above 0.05 therefore there is no statistically significant difference in the rainfall distribution among the 10 year periods from 1975-2014.

Table 4.7: ANOVA test on annual decadal rainfall distribution from 1975-2014

<b>Rainfall</b>	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>P-Value</b>
Between Groups	151113.6	3	50371.21	1.17688	0.332097
Within Groups	1540823	36	42800.64		
<b>Total</b>	<b>1691936.6</b>	<b>39</b>			

A Tukey Post Hoc test on 10-year period for rainfall variations was carried out to determine if there was any statistically significant difference in rainfall variation between the four decades within 1975-2014.

Table 4.8: Post Hoc analysis on 10-year period for rainfall variations from 1975-2014

Tukey HSD						
<b>(I)</b>	<b>(J)</b>	<b>Mean</b>	<b>Std.</b>	<b>Sig.</b>	<b>95% Confidence Interval</b>	
<b>Decade</b>	<b>Decade</b>	<b>Difference (I-J)</b>	<b>Error</b>		<b>Lower Bound</b>	<b>Upper Bound</b>
1975-1984	1985-1994	-13.0000	92.5210	.999	-262.180	236.180
	1995-2004	15.6900	92.5210	.998	-233.490	264.870
	2005-2014	140.8900	92.5210	.435	-108.290	390.070
1985-1994	1975-1984	13.0000	92.5210	.999	-236.180	262.180
	1995-2004	28.6900	92.5210	.989	-220.490	277.870
	2005-2014	153.8900	92.5210	.357	-95.290	403.070
1995-2004	1975-1984	-15.6900	92.5210	.998	-264.870	233.490
	1985-1994	-28.6900	92.5210	.989	-277.870	220.490
	2005-2014	125.2000	92.5210	.536	-123.980	374.380
2005-2014	1975-1984	-140.8900	92.5210	.435	-390.070	108.290
	1985-1994	-153.8900	92.5210	.357	-403.070	95.290
	1995-2004	-125.2000	92.5210	.536	-374.380	123.980

It was observed from the test that there was no statistically significant differences within 1975-2014 decadal periods as all the p values were greater than 0.05 as illustrated in Table 4.8.

#### 4.4.1.2 Annual Average Rainfall Anomalies

Rainfall anomalies (Figure 4.2) were observed in 1989/1990 and 1997/1998 where the study area experienced extreme high rainfalls above normal. On the other hand extremely low rains were experienced in 1983, 1987 and 2005. Variations in rainfall has been a major contributor to decline of crop production in ASALs where rainfall has varied and become unpredictable in space and time (Nicholson, S N, 2001).

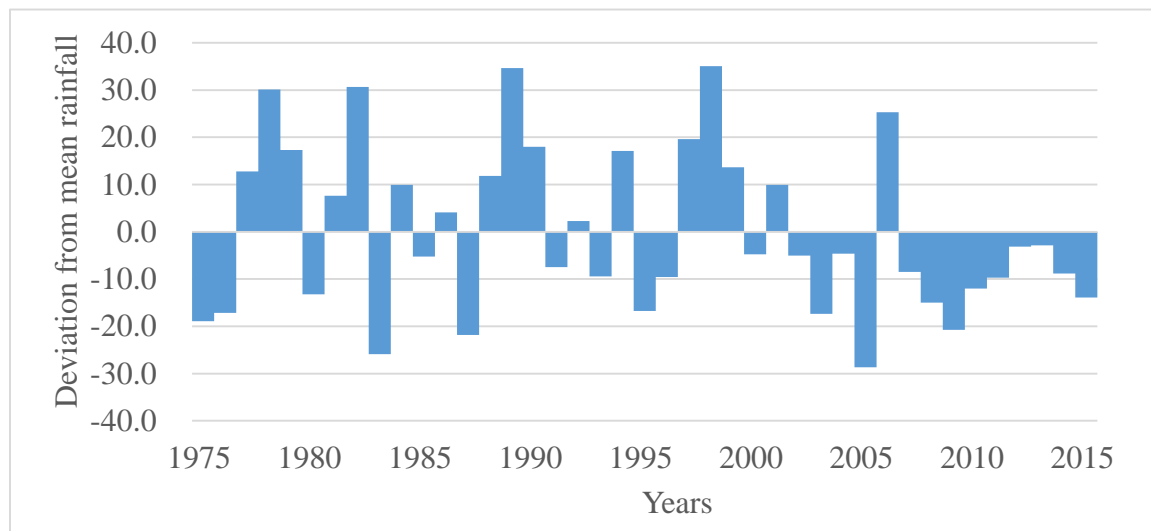


Figure 4.2: Annual average rainfall anomalies for Kitui County from 1979 to 2014

From 2007 to 2015, we see that there has been a negative deviation from the mean indicating that the recent amount of rainfall received within those years have been less than the average rainfall normally received.

#### 4.4.2 Temperature Trends

##### 4.4.2.1 Mean Maximum and Minimum Monthly Temperatures

Mean maximum and minimum temperature data analyzed as indicated in Figure 4.3 shows the trend of temperature in different months of the year within 1979-2014 that is

the study period. It was observed that maximum mean temperatures were recorded in the months of January to March where a record high of 33.1°C was observed in the month of March within the 35 year period of study. August to October also experienced high temperatures where October recorded the highest temperatures at 31.2°C. From the analysis it was observed that temperatures would start rising steadily from January to March followed by a decline of temperatures between March and July. Temperatures would then gradually rise from July to October and gradually decline up to December. It was also noted that July recorded the lowest mean maximum temperatures within the study period at 29.0°C.

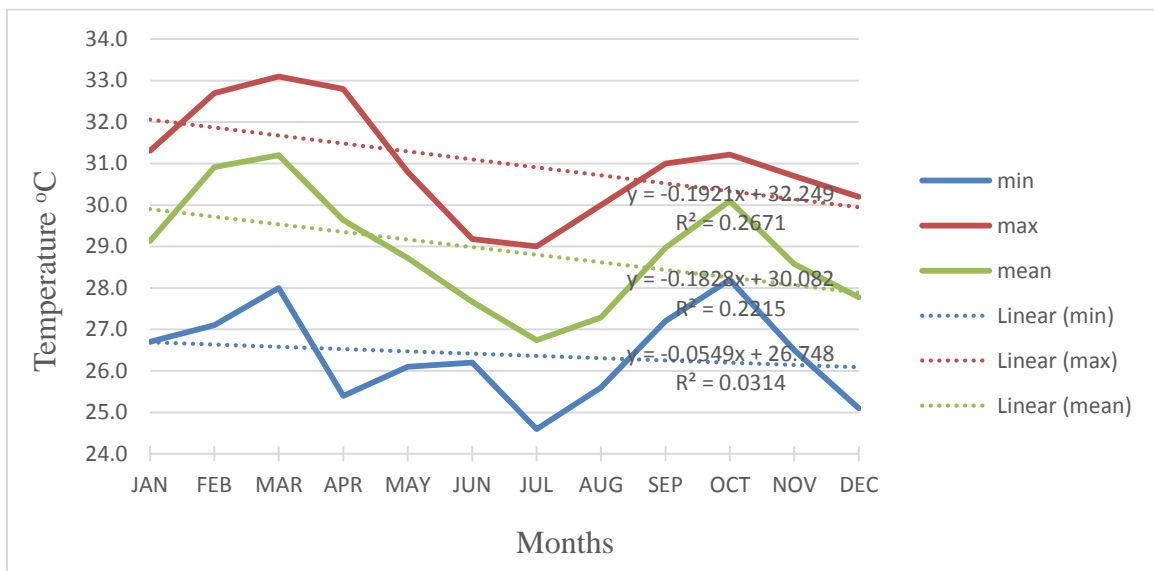


Figure 4.3: Mean maximum and minimum monthly temperatures 1979-2014

On the other hand, mean minimum temperatures were also computed and it was observed that the month of October recorded the highest minimum temperatures at 28.2°C while the lowest recorded mean minimum temperatures within the study period was in July at 24.6°C. Slight temperature increase was observed from April to May which was 25.4°C to 26.1°C stabilizing in June at 26.2°C which was followed by a sudden drop of temperatures in July which recorded 24.6°C.

Variations in mean maximum and minimum temperatures were also observed as shown in the Figure 4.3 where the highest variation recorded was in the month of April at 7.4°C

within 1979-2014. Lowest variation was recorded in the months of June and October at 3.0°C each.

#### 4.4.2.2 Annual Maximum and Minimum Temperatures

Figure 4.4 illustrates highest annual maximum temperatures recorded within 1979-2014 were recorded in 1987 at 33.1°C, 1992 at 33.0°C, 2009 at 32.9°C and 1997 at 32.7°C while least annual maximum temperatures were recorded in 1998 at 29.6°C and 2012 at 30.0°C. On the other hand, highest annual minimum temperatures recorded within the study period were in 2011 at 28.1°C, 2014 at 28.0°C and 2007 at 27.8°C. Lowest annual minimum temperatures recorded were in 1993 at 24.6°C and 1981 at 25.2°C. The highest variation between the annual maximum and minimum temperatures recorded within the study period was in 1992 at 8°C. The annual minimum temperatures have been on the rise as indicated by the rising trend line with an approximate of 1°C increase. The annual maximum temperature have a slight fall indicated by the slight decline of the linear trend line.

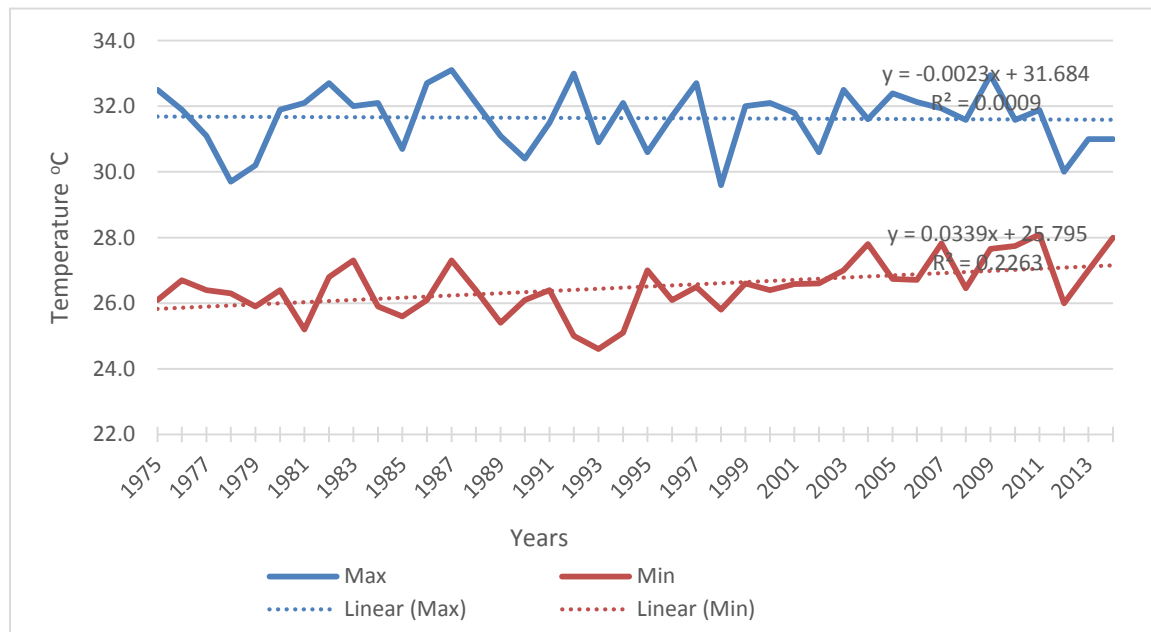


Figure 4.4: Annual maximum and minimum temperature 1979-2014

#### 4.4.2.3 Mean Annual Temperature

Based on analysis of temperature data obtained from the Katumani Kenya Meteorological Department (KMD) stations from 1979-2014 for Kitui County, it was observed that in the recent years, temperatures have been on the rise as illustrated in Figure 4.5.

Annual variations of temperature is evident from the fluctuations in temperatures throughout the reference period especially between 1980 and 1990 indicated by the sharp drop and rise of the temperature series. Highest mean annual temperatures recorded were in 2011 at 30.1°C and 2009 at 30.0°C while the lowest mean annual temperatures recorded were in 1989 at 27.4°C, 1993 and 1998 both at 28.1°C. Temperatures have been on the rise in the recent decade as indicated by the dotted trend line.

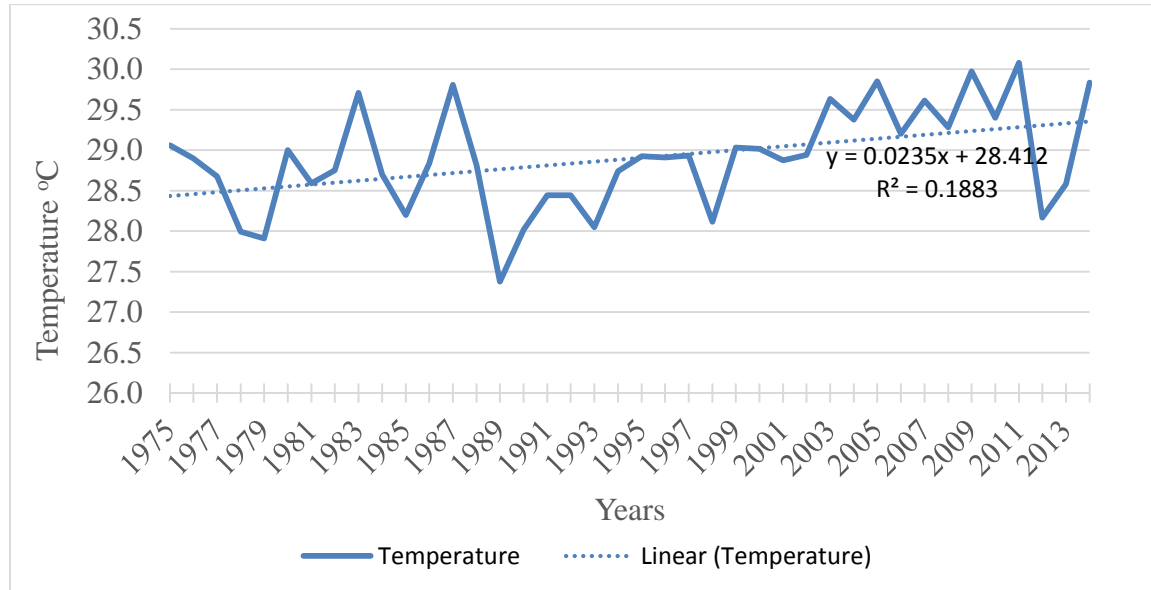


Figure 4.5: Mean annual temperature series and linear trend from 1979 to 2014

On the other hand, Figure 4.6 shows temperature anomalies where both negative and positive anomalies were observed with the highest negative being -1.5°C observed in 1989 and the highest positive variation recorded in 2011 at 1.2°C. In the recent past 2003-2014 positive anomalies were observed which indicate an increase in temperatures. This therefore indicates there is a variation of temperature and also an increase in temperatures in the recent decade. The observed increase in temperature are likely to be attributed to

human-induced cases through emission of greenhouse gases into the atmosphere based on The Fourth Assessment Report of the IPCC (IPCC, 2007).

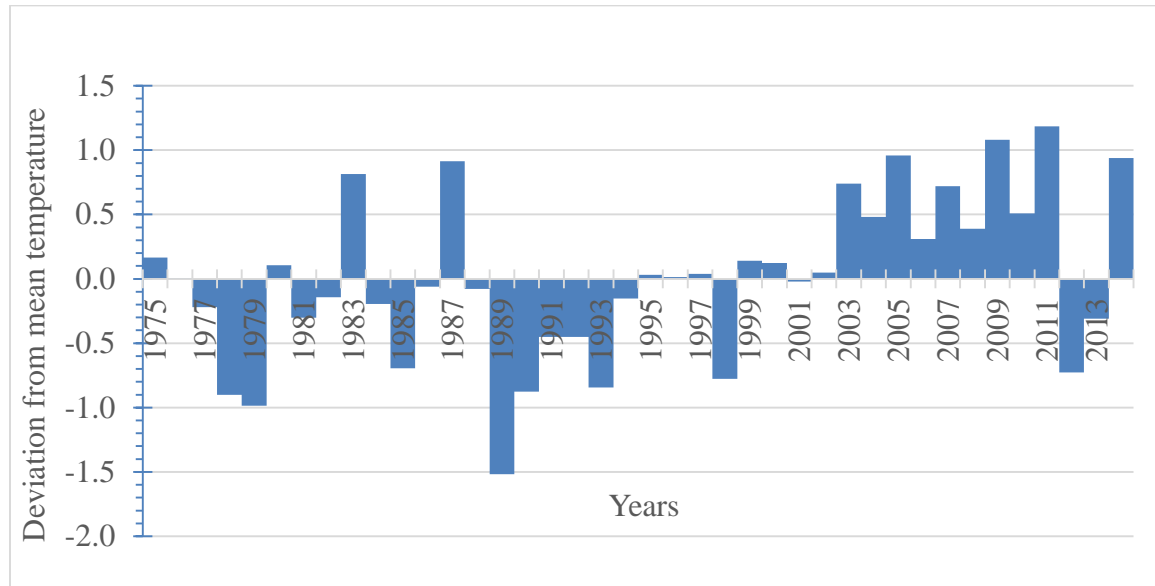


Figure 4.6: Mean annual temperature anomalies for Kitui County from 1979 to 2014

Rainfall and temperature data of the study area traced back from 1979 to 2014 from KMD, variations of both rainfall and temperature was observed with some years having above normal occurrences in regard to temperature and rainfall. This supported the perception that the study area experiences climate variations. From the analysis of both rainfall and temperature trends, it can be concluded that from 1979-2014, Kitui County has experienced variations in climate indicated by positive and negative anomalies, sharp increase and decrease in both rainfall and temperature.

#### 4.3.2.4 Decadal temperature variations from 1975-2014

Table 4.9 shows the output of the ANOVA analysis and whether there is a statistically significant difference between ten-year group means. The results show that the significance value  $p=0.004$  is less than 0.05 therefore there is a statistically significant difference in the decadal temperature variations within 1975-2014. This shows that the temperature in Kitui County varied over the years under consideration. This supports the findings from the responses given by the respondents who participated in the study.

Table 4.9: ANOVA decadal temperature analysis from 1975-2014

	<b>Sum of</b>		<b>Mean</b>		
<b>Temperature</b>	<b>Squares</b>	<b>df</b>	<b>Square</b>	<b>F</b>	<b>P-value</b>
Between					
Groups	4.67019	3	1.55673	5.090893	0.004857
Within					
Groups	11.00834	36	0.305787		
<b>Total</b>	<b>15.67853</b>	<b>39</b>			

Decadal Tukey Post Hoc test was carried out on temperature variations obtained to determine if there was any statistically significant difference in temperature variation between the four decades within 1975-2014.

Table 4.10: Post hoc decadal (1975-2014) temperature analysis

Tukey HSD

<b>(I)</b>	<b>(J)</b>	<b>Mean</b>	<b>Std.</b>	<b>Sig.</b>	<b>95% Confidence Interval</b>	
<b>Decade</b>	<b>Decade</b>	<b>Difference</b>	<b>Error</b>		<b>Lower</b>	<b>Upper</b>
		<b>(I-J)</b>			<b>Bound</b>	<b>Bound</b>
1975- 1984	1985-1994	.2800	.2454	.667	-.381	.941
	1995-2004	-.2200	.2454	.807	-.881	.441
	2005-2014	-.6700*	.2454	.046	-1.331	-.009
1985- 1994	1975-1984	-.2800	.2454	.667	-.941	.381
	1995-2004	-.5000	.2454	.193	-1.161	.161
	2005-2014	-.9500*	.2454	.002	-1.611	-.289
1995- 2004	1975-1984	.2200	.2454	.807	-.441	.881
	1985-1994	.5000	.2454	.193	-.161	1.161
	2005-2014	-.4500	.2454	.275	-1.111	.211
2005- 2014	1975-1984	.6700*	.2454	.046	.009	1.331
	1985-1994	.9500*	.2454	.002	.289	1.611
	1995-2004	.4500	.2454	.275	-.211	1.111

\*. The mean difference is significant at the 0.05 level.

It was observed from the test that temperature variation was only statistically significant within 1975-1984 and 2005 and 2014 decadal periods as indicated by the p value (0.046) which is less than 0.05 as indicated in Table 4.10. This therefore indicated that temperature has significantly varied within the two decades where temperatures have had an increasing trend and this coincides with The Fourth Assessment Report of the IPCC that global temperatures have increased and could be attributed to human induced causes (IPCC, 2007).

#### 4.4.3 Comparison of Mean Annual Rainfall and Temperature (1979-2014)

Figure 4.7 illustrates a comparison of mean annual rainfall and temperature data from 1979-2014 for Kitui County. From the illustration, it is observed that rainfall trend has been declining while temperature trend have been on the rise as indicated by the trend lines. Rainfall and temperature trend lines indicate that in the 1975-1984 decade, temperatures were low and rainfall was high while in the subsequent decades, the rainfall has been declining while the temperatures have been increasing. This is also observed in the 1995 to 2004 and 2005 to 2014 decades where the temperature and rainfall trend lines gap has increased as illustrated in Figure 4.7.

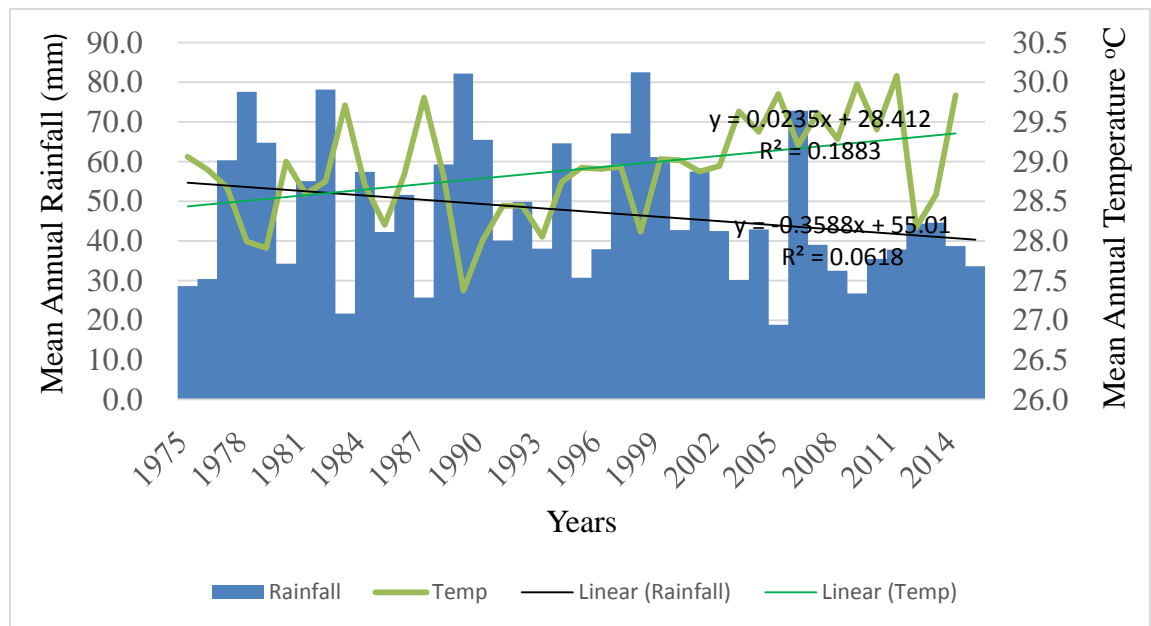


Figure 4.7: Comparison of mean annual rainfall and temperature data from 1979-2014

It was also observed that in years that experienced high rainfall, the temperatures were low for example in 2009 and 1983 mean annual temperature recorded was 30.0°C and 29.7°C respectively while the mean annual rainfall received was 26.8 mm and 21.6 mm respectively. On the other hand, 1989 recorded the highest mean annual rainfall at 82.2 mm while the temperatures recorded were the lowest recorded within the study period at 27.4°C. A correlation analysis of mean annual temperature and rainfall was done to find out if there was any significant relationship between the two variables and is as illustrated in Table 4.11

Table 4.11: Correlation between mean annual rainfall and temperature (1975-2014)

		<b>Correlations</b>	
		<b>Temp</b>	<b>Rainfall</b>
Temp	Correlation Coefficient	1.000	-.667**
	Sig. (2-tailed)	.	.000
	N	40	40
	Spearman's rho		
Rainfall	Correlation Coefficient	-.667**	1.000
	Sig. (2-tailed)	.000	.
	N	40	40

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The results on Table 4.11 show that the strength of association of mean annual temperature and rainfall is very low ( $r=-0.667$ ) which indicates that there is a negative correlation between the variables. The p-value for the correlation between the two variables is less than the significance level of 0.05, which indicates that the correlation coefficients are significant.

#### **4.4.4 Significant Weather Changes Observed From 1979 To 2014**

Table 4.12 shows project beneficiary responses on some significant weather changes that have been observed within the study period. Very dry seasons and prolonged droughts in the two projects were the significant changes that majority of the respondents identified to have occurred within the study period. In ARP project 39% (n=24) stated that prolonged droughts have been observed while 24% (n=15) stated that very dry seasons was a significant change they observed. In the KLSP project, 30% (n=12) stated that very

dry seasons had been observed while 27% (n=11) stated that occurrence of prolonged droughts was a significant change they had observed within the study period.

In line with these findings, Slegers (2008) also asserted that drought is a climate variability associated hazard and affects agricultural productivity in areas that it is experienced.

Occurrence of unpredictable rains was also a significant change that was experienced in both project areas where 9% (n=6) and 22% (n=9) in ARP and KLSP projects respectively. This would be as a result of climate variations resulting into the changes in the rainfall pattern of the area. Similarly, Gissila *et al.*, 2004 observed that there has been variation in rainfall experienced in that the rains are torrential and are not systematic in their occurrence i.e. at times they start earlier or later than expected. This consequently interferes with the cropping pattern among project beneficiaries.

Table 4.12: Significant weather changes that have been observed within 1979-2014

Weather Attribute	ARP Project		KLSP Project	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Unpredictable rains	6	9	9	22
Very wet seasons	0	0	1	2
Very dry seasons	15	24	12	30
Prolonged droughts	24	39	11	27
Unpredictable rains and very dry seasons	2	3	1	2
Very dry seasons and Prolonged droughts	11	18	6	15
Unpredictable rains, Very dry seasons and Prolonged droughts	4	7	1	2
<b>Grand Total</b>	<b>62</b>	<b>100</b>	<b>41</b>	<b>100</b>

During the analysis, it was noted that some respondents in both projects had observed multiple changes in the weather pattern i.e. unpredictable rains and prolonged droughts, very dry seasons and prolonged droughts within the study period as indicated in Table 4.12. For example, in ARP project, 18% (n=11) while in KLSP project 15% (n=6) stated that they had experienced the occurrence of both prolonged droughts and very dry seasons within the study period.

Based on the project beneficiaries' responses on the significant weather changes experienced, it supports the findings of Dillon *et al.*, (2016) who asserted that climate variability has contributed to changes in regional seasons in terms of changes in temperature and rainfall trends experienced.

#### 4.4.5 Impacts of Weather Variability Within 1979 To 2014

Weather changes experienced within the study period has caused various impacts that have impacted the project beneficiaries differently Table 4.13.

Table 4.13 : Impact of weather changes within 1979 to 2014

Attribute	ARP Project		KLSP Project	
	Frequency	Percentage	Frequency	Percentage
	(n)	(%)	(n)	(%)
Crop failure	34	55	26	63
Increased temperature	7	11	4	10
Soil erosion	1	2	1	2
Crop failure and Increased temperature	19	30	9	23
Crop failure and Soil erosion	1	2	1	2
<b>Grand Total</b>	<b>62</b>	<b>100</b>	<b>41</b>	<b>100</b>

Crop failure and high temperatures were the major weather impacts that were experienced by respondents in both projects accounting for 97% (n=60) and 95% (n=39) in ARP and KLSP projects respectively. Crop failure at 55% (n=34) and 63% (n=26) in ARP and KLSP projects respectively. This can be attributed to decline in rainfall received in the area which supports CEEPA (2006) who asserted that rainfall has become less reliable. Increase in temperatures was also a change that respondents noted in both projects where 11% (n=7) and 10% (n=4) in ARP and KLSP projects respectively. Similar results were highlighted by (Komba and Muchapondwa, 2012) who asserted that temperature increase had been experienced that caused heat stress on plants, reduces water availability and prevalence of new pests and diseases. Increased temperatures would be a contributing factor to decline in food production coupled with factors such as prolonged droughts and very dry seasons as illustrated in Table 4.12 as Ubisi et al., (2017) asserted that prolonged droughts, increased dry seasons, reduced rainfall and heat waves have led to crop failure, livestock death and disease outbreaks.

Soil erosion was also experienced in the two project areas at 2% each and this would be attributed to torrential rains that fall carrying away the top fertile soil. It is therefore evident that climate variability weather changes have led to occurrence of impacts such as crop failure, increase in temperatures and soil erosion which increases vulnerability among respondents to climate variations.

#### **4.5 Perception of Climate Variability among Project Beneficiaries**

Household survey results on the perception of climate variability (rainfall and temperature) occurrence indicated that variations have been noticed in both rainfall and temperature between 1979 to 2014 study period. Rainfall aspects that were focused on were rainfall amount, intensity, duration and occurrence as illustrated in Figure 4.8. It was observed that there has been a decrease in the rainfall amount, intensity, duration and occurrence in areas where the two projects were implemented. This supports findings by Maddison, 2006 and Mertz *et al.*, 2009 who asserted that rainfall decline has been observed in the recent past.

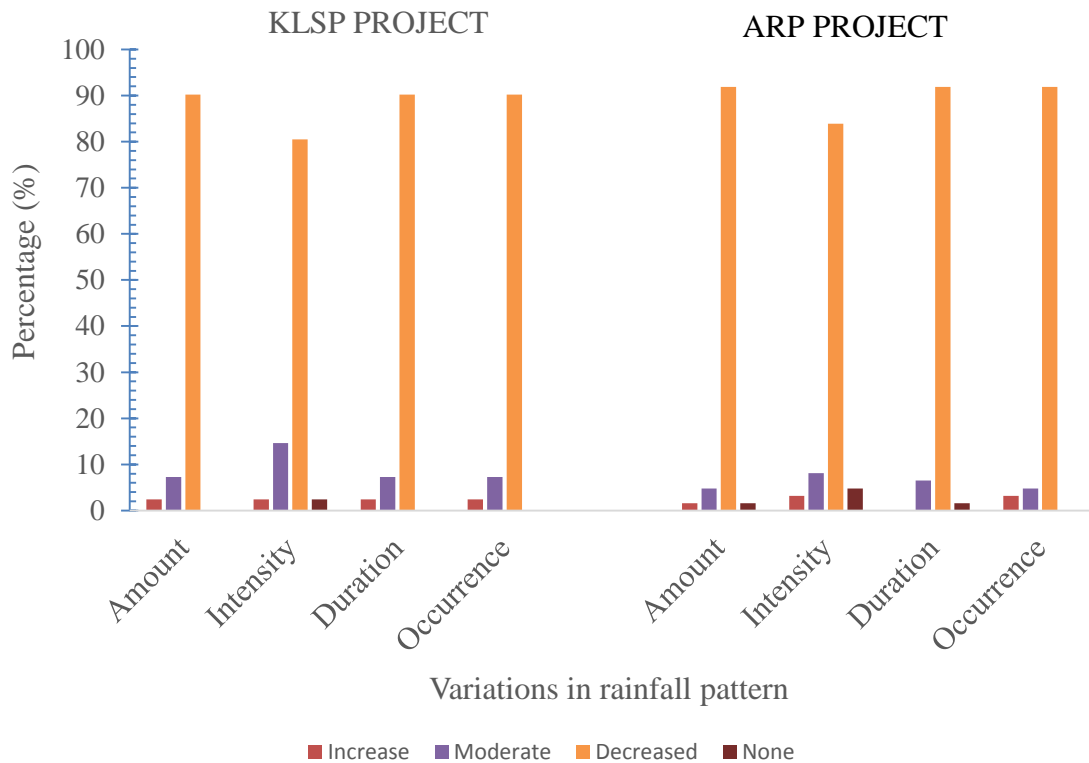


Figure 4.8: Variations in rainfall as perceived by project beneficiaries

#### 4.6 Climate Variability Adaptation Measures

Table 4.14 shows a descriptive analysis of project beneficiaries' responses on whether they have taken any initiative in applying climate variability adaptation measures on their own initiative either consciously or unconsciously. It was noted that a majority of households 75.6% (n=31) and 75.8% (n=47) in KLSP and ARP projects respectively agreed to have undertaken climate variability adaptation measures while 24.3% (n=10) and 21% (n=13) for KLSP and ARP projects respectively strongly agree to have undertaken their own initiative in employing adaptation measures that will assist them increase their adaptive capacity to climate variability. It is therefore evident that despite project interventions, the project beneficiaries had in their own capacity consciously employed adaptation measures. On the other hand, 3.2% (n=2) of respondents in ARP project have employed adaptation measures without knowingly doing that hence the neutral response.

Table 4.14: Application of self-initiated climate variability adaptation measures

<b>Attribute/Project</b>	<b>KLSP</b>	<b>ARP</b>
Neutral	0 (0)	2 (3.2)
Agree	31 (75.6)	47 (75.8)
Strongly Agree	10 (24.3)	13 (21)
<b>Total</b>	<b>41 (100)</b>	<b>62 (100)</b>

*Figures in parenthesis ( ) indicate percentage (%)*

#### **4.5.1 Ranking of Application of Adaptation Measures**

In terms of ranking of climate variability adaptation measures applied by farmers in KLSP project (Table 4.15) and ARP project (Table 4.16), change in crop variety was ranked the highest in both projects at a Total Weighted mean of 468.3 and 451.3 respectively followed by change in planting dates at 439.1 (KLSP) and 432.4 (ARP), implementation of water conservation measures at 388 (KLSP) and 403.2 (ARP), diversification of crop and animal variety at 358.5 (KLSP) and 381.8 (ARP), diversification of income generation from on-farm to none farming activities at 329.3 (KLSP) and 366.5 (ARP) and lastly ranked was change in size of land under cultivation at 329.3 (KLSP) and 366.5 (ARP). These rankings based on total weighted mean indicate the application of adaptation measures by project beneficiaries in both projects.

Ranking of change in crop varieties was ranked the first in both projects with majority of people n=28 and n=41 in KLSP and ARP project respectively strongly agreeing to have taken up the measure. The high uptake of the adaptation measure by majority of the respondents could be attributed to intensive education measures by various organizations, NGOs and projects within the area on crop varieties that are drought resistant e.g. millet, sorghum and cowpea which are suitable for the agro-ecological zone as explained by project implementers in both projects. The production of these crops help in reducing food shortage as well as act as a source of income for households since they are high yielding. In addition, some organization such as Farm Africa have supported households by supplying improved seed varieties with an aim of ensuring that the area is food secure amidst the variation in climate.

Table 4.15: Ranking of applied adaptation measures in KLSP Project

Statement	Response					
	S.D	D	N	A	S.A	T.W.M
Change in crop variety	0 (0)	0 (0)	0 (0)	13(31.7)	28 (68.3)	[468.3]
Implement water conservation measures	1(2.4)	6 (14.6)	2 (4.9)	20 (48.8)	12 (29.3)	[388]
Diversification of crop and animal variety	0 (0)	10 (24.4)	5 (12.2)	18(43.9)	8 (19.5)	[358.5]
Change in planting dates	0 (0)	1 (2.4)	2 (4.9)	18 (43.9)	20 (48.8)	[439.1]
Change in size of land under cultivation	9 (22.0)	13 (31.7)	0 (0)	9 (22.0)	10 (24.4)	[295.4]
Diversification of income generation from on-farm to none farming activities	6 (14.6)	10 (24.4)	2 (4.9)	12 (29.3)	11 (26.8)	[329.3]

*Figures in parenthesis ( ) indicate percentage (%), SD (Strongly Disagree) =1, D (Disagree) =2, N (Neutral) =3, A (Agree) =4, S.A (Strongly Agree) =5 and T.W.M (Total Weighted Mean)*

Change in planting dates as an embraced adaptation was ranked second in both projects with majority of respondents (n=38) and (n=58) in KLSP and ARP projects respectively agreeing to have adopted the measure. The high uptake of the adaption measure can be attributed to households understanding the changes in rainfall pattern hence aim at maximizing on utilization of rains that fall irrespective of their time of occurrence. These validates (Recha *et al.*, 2011) findings who asserted that farmers had adopted to changes

in planting dates as an adaptation to rainfall variation patterns with an aim of utilizing the available rainfall to increase crop productivity.

Table 4.16: Ranking of applied adaptation measures in ARP Project

Statement	Response					
	S.D	D	N	A	S.A	T.W.M
Change in crop variety	2 (3.2)	1 (1.6)	1 (1.6)	17 (27.4)	41 (66.1)	[451.3]
Implement water conservation measures	5 (8.0)	5 (8.0)	1 (1.6)	23 (37.1)	28 (45.2)	[403.2]
Diversification of crop and animal variety	5 (8.0)	5 (8.0)	3 (4.8)	32 (51.6)	17 (27.4)	[381.8]
Change in planting dates	2 (3.2)	1 (1.6)	1 (1.6)	29 (46.8)	29 (46.8)	[432.4]
Change in size of land under cultivation	9 (14.5)	10 (16.1)	4 (6.5)	24 (38.7)	15 (24.2)	[342]
Diversification of income generation from on-farm to none farming activities	6 (9.7)	10 (16.1)	4 (6.5)	21 (33.9)	21 (33.9)	[366.5]

*Figures in parenthesis ( ) indicate percentage (%), SD (Strongly Disagree) =1, D (Disagree) =2, N (Neutral) =3, A (Agree) =4, S.A (Strongly Agree) =5 and T.W.M (Total Weighted Mean)*

Implementation of water conservation measure as an adaption measure was ranked third in both projects with majority of respondents (n=51) and (n=32) attesting to have adopted the measure. High uptake of the adaptation measure as explained by both project

implementers was as a result of increased number of projects being implemented in the area which focus on the establishment of cut-off drains, retention ditches, terracing, run-off harvesting, and agroforestry as the area is considered an ASAL. Many projects have also intensified construction of water pans and dams to ensure water availability as piped water is not available in the area. These would also ensure that water is available for crop production which is an indispensable requirement for plant growth from planting to maturity (Khuram and Rasul, 2011).

Diversification of crop and animal variety was ranked fourth in both projects with majority of people (n=26) and (n=49) in KLSP and ARP projects agreeing to have taken up the measure. The likelihood of adopting diversification of crop and animal variety as an adaptation measure is mainly driven by persistent climate shocks experienced by project beneficiaries within the project areas (Martina *et al.*, 2016). Diversification also help in ensuring that family revenues are consistent especially in a market system that is characterized by failures, resulting to weak insurance and risk coping mechanisms (Kurosaki and Fafchamps, 2002).

Ability to diversify income generation from on-farm to none farming activities was ranked fifth with majority of the respondents (n=24) and (n=42) in KLSP and ARP projects respectively attesting to have adopted the measure. Failure of uptake of the adaptation measure could be attributed to the fact that in the remote rural areas, there are limited options of none farming activities (Martina *et al.*, 2016). Inadequate alternative income generating none farming activities has consequently resulted to land degradation due to intensified cultivation on available land (Atinkut and Mebrat, 2016). The limited options available makes farmers opt to diversify crop and animal variety and well as intensify change in crop variety as an alternative measure.

Change in land size was ranked last at position six as an adaptation measure practiced in both project areas. Despite majority of people (n=39) in ARP project having taken up the measure, a substantial number of people (n=22) and (n=19) in KLSP and ARP projects respectively have not embraced the adaptation measure. Uptake of the adaptation measure can be attributed to land degradation through accelerated soil erosion and run-off

due to intensified food production to feed the increasing population with diminishing land sizes a trend observed in Sub-Saharan Africa (Ahmed *et al.*, 2000). This causes farmers to abandon part of their farms especially those that are badly degraded (Baaru, 2011). In addition, farmers perceive restoration of soil fertility to degraded soil as a slow process (Okoba and De Graff, 2005) hence opt to abandon degraded land. Economic factors such as high labour and capital requirements is also a concern among farmers in deciding whether to invest in soil conservation measures (Gathaara *et al.*, 2010; Hatibu *et al.*, 2000) and this would be a contributing factor in change of land size among project beneficiaries.

The application of various adaptation measures at individual household level indicates that adaptation to climate variability has become a necessity to increase resilience and also ensure survival from climate variability adverse effects (Bradshaw *et al.*, 2004; Kurukulasuriya and Mendelsohn, 2008; Maddison, 2006). These also helps in promoting food security and improved socio-economic wellbeing within households.

#### **4.6.1 Chi-Square Test for Ranking of Self initiated Climate Variability Adaptation Measures**

Chi-square test was performed on respondents responses on ranking for the various self-initiated climate variability adaptation measures to determine if there was any statistical significance in the different rates based on the likert scale provided.

It was observed that in ARP project (Table 4.17), there was a statistically significant difference ( $p < 0.05$ ) among the various likert scale ratings used in all the self initiated climate variability adaptation measures. This could be attributed to majority of people opting for one response rank hence causing the difference. This also influenced the sequence of ranking on the preferred self-initiated adaptation measures that project beneficiaries had taken up. Based on the different means obtained, the self-initiated adaptation measures ranking is similar to that of the Total Weighted Mean illustrated in Table 4.16.

Table 4.17: ARP Project Chi-Square Test for self initiated applied adaptation measures

<b>Adaptation Measures</b>	<b>Response Rank</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig.</b>	<b>Mean of ranking</b>
Change in crop variety	Disagree	3	20.7	0.000	2.89
	Neutral	1	20.7		
	Agree	58	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Implement water conservation measures	Disagree	10	20.7	0.000	2.66
	Neutral	1	20.7		
	Agree	51	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Diversification of crop and animal variety	Disagree	10	20.7	0.000	2.63
	Neutral	3	20.7		
	Agree	49	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Change in planting dates	Disagree	3	20.7	0.000	2.89
	Neutral	1	20.7		
	Agree	58	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Change in size of land under cultivation	Disagree	19	20.7	0.000	2.32
	Neutral	4	20.7		
	Agree	39	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Diversification of income generation from on-farm to none farming activities	Disagree	16	20.7	0.000	2.42
	Neutral	4	20.7		
	Agree	42	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		

*Disagree=1, Neutral=2, Agree=3*

It was observed that in KLSP project (Table 4.18), there was a statistically significant difference ( $p < 0.05$ ) in the various likert scale responses used in rating implementing of water conservation measures; diversification of crop and animal variety; change in planting dates and diversification of income generation from on-farm to none farming activities as self initiated climate variability adaptation measures.

Table 4.18: KLSP Project Chi-Square Test for self initiated applied adaptation measures

<b>Adaptation Measures</b>	<b>Response Rank</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig.</b>	<b>Mean of ranking</b>
Implement water conservation measures	Disagree	7	13.7	0.000	2.61
	Neutral	2	13.7		
	Agree	32	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Diversification of crop and animal variety	Disagree	10	13.7	0.000	2.39
	Neutral	5	13.7		
	Agree	26	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Change in planting dates	Disagree	1	13.7	0.000	2.9
	Neutral	2	13.7		
	Agree	38	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Change in size of land under cultivation	Disagree	22	20.5	0.639	1.93
	Agree	19	20.5		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Diversification of income generation from on-farm to none farming activities	Disagree	16	13.7	0.000	2.17
	Neutral	2	13.7		
	Agree	23	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		

*Disagree=1, Neutral=2, Agree=3*

However, there was no statistically significant difference ( $p>0.05$ ) in the response rating under change in size of land under cultivation which could be attribute to the almost equal number of responses in the ranking. Based on the different means obtained, the self-initiated adaptation measures ranking is similat to that of the Total Weighted Mean illustrated in Table 4.15.

## 4.7 Project Adaptation Measures

### 4.7.1 Project adaptation measures applied in the study area and their effectiveness

Various adaptation measures were employed by the two projects ARP and KLSP as illustrated in Tables 4.19 and 4.20 respectively. On-farm water harvesting, soil conservation as adaption measures employed by both projects while income diversification was applied by ARP project only. On- farm water harvesting in both projects was highly effective at 69.35% and 73.17% in ARP and KLSP projects respectively as indicated in Tables 4.16 and 4.17. In terms of ranking based on the total weighted mean, on-farm water harvesting in ARP project was ranked first at 337.08 while in KLSP project it was ranked second at 346.36. Uptake and effectiveness of this adaptation measure would be attributed to unreliable rainfall caused by climate variability (Parry *et al.*, 2004) hence the need to increase adaptive capacity to ensure water availability within households.

Table 4.19: Effectiveness rating of ARP project adaptation measures applied

<b>Statement</b>	<b>N.E</b>	<b>L.E</b>	<b>M.E</b>	<b>H.E</b>	<b>T.W.M</b>
On-farm water harvesting	9(14.52)	2(3.23)	8(12.90)	43(69.35)	337.08
Soil conservation	14(22.58)	1(1.61)	41(66.13)	6(9.68)	262.91
Income diversification	20(32.26)	16(25.80)	12(19.35)	14(22.58)	232.23

*Figures in parenthesis ( ) indicate percentage (%), N.E (Not Effective) =1, L.E (Least Effective) =2, M.E (Moderately Effective) =3, H.E (Highly Effective) =4, and T.W (Total Weighted Mean*

Table 4.20: Effectiveness rating of KLSP project adaptation measures applied

<b>Statement</b>	<b>N.E</b>	<b>L.E</b>	<b>M.E</b>	<b>H.E</b>	<b>T.W.M</b>
On-farm water harvesting	5(12.20)	1(2.44)	5(12.20)	30(73.17)	346.36
Soil conservation	0(0)	0(0)	5(12.20)	36(87.80)	387.80

*Figures in parenthesis ( ) indicate percentage (%), N.E (Not Effective) =1, L.E (Least Effective) =2, M.E (Moderately Effective) =3, H.E (Highly Effective) =4, and T.W (Total Weighted Mean)*

Soil conservation as an adaptation measure employed by both projects was moderately effective at 66.13% in ARP project and highly effective at 87.80% in KLSP project as illustrated in Tables 4.19 and 4.20 respectively. In terms of the total weighted mean, soil conservation was ranked second in ARP project at 262.91 while in KLSP project it was ranked first with a total weighted mean of 387.8. Based on discussions with key informants who were project implementers, they asserted that soil conservation was highly effective in KLSP project as there was a budget set aside for undertaking the activity while under ARP, the adaptation measure was enshrined in reduction of vulnerability to better prepare and respond to adversities associated with climate variability. This approach required a greater contribution in terms of labour from the community to implement the activity which was a challenge to most households due to high cost and also availability of skilled labour was a challenge.

On the other hand, income diversification as an adaptation measure applied was least effective at 32.26% (n=20) with a total weighted mean of 232.23 hence was ranked third in the adopted project adaptation measures. In ARP project, it was observed that 77.42% of people rely on crop/ animal farming which is climate reliant while only 16.13%, 4.84% and 1.61% of people rely on business, salary and remittances respectively as a source of income (Table 4.2). This indicates that majority of people have not totally embraced other income generating activities that are not affected by variations in climate. However, it was observed that some people are embracing other income generating activities that are not climate reliant which include brick making, motorcycle operation

commonly known as “bodaboda”, sand harvesting, charcoal burning and bee keeping. It is therefore essential that initiatives that encourage uptake of income generating activities that are not affected by variation of climate changes be encouraged so as to increase resilience of people against the effects of climate variation.

#### 4.7.2 Chi-Square Test on Effectiveness Rating of Project Adaptation Measures

A chi-square test was carried out to determine if there was any significant difference on the ratings of effectiveness of project adaptation measures applied by ARP and KLSP project among the project beneficiaries which consequently influenced overall effectiveness of project adaptation measures.

Table 4.21: Chi-Square test on effectiveness rating of ARP project adaptation measures

<b>Adaptation Measure</b>	<b>Rate of Effectiveness</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig.</b>	<b>Mean of Effectiveness</b>
On-farm water harvesting	Not effective	9	15.5	0.000	3.37
	Least effective	2	15.5		
	Moderately effective	8	15.5		
	Highly effective	43	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Soil Conservation	Not effective	14	15.5	0.000	2.63
	Least effective	1	15.5		
	Moderately effective	41	15.5		
	Highly effective	6	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Income diversification	Not effective	20	15.5	0.521	2.32
	Least effective	16	15.5		
	Moderately effective	12	15.5		
	Highly effective	14	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		

In ARP project (Table 4.21), there was significant differences in the rate of effectiveness ( $p < 0.05$ ) in on-farm water harvesting and soil conservation measure and could be

attributed to majority of people (n=43) ranking on-farm water harvesting as highly effective while majority of people (n=41) ranking soil conservation as moderately effective. From the obtained means on-farm water harvesting (mean=3.37) was ranked first followed by soil water harvesting (mean=2.63) and lastly income diversification (mean=2.32) which support the Total Weighted Mean obtained in Table 4.19

In KLSP project (Table 4.22), there was significant differences in the rate of effectiveness ( $p < 0.05$ ) in on-farm water harvesting and soil conservation measure and could be attributed to majority of people (n=30) and (n=36) ranking on-farm water harvesting and soil conservation as highly effective respectively. From the obtained means soil conservation (mean=3.88) was ranked first followed by on-farm water harvesting (mean=2.63) which support the Total Weighted Mean obtained in Table 4.20.

Table 4.22: Chi-Square test on effectiveness rating of KLSP project adaptation measures

<b>Adaptation Measure</b>	<b>Rate of effectiveness</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig,</b>	<b>Mean of effectiveness</b>
On-farm water harvesting	Not effective	5	10.3	0.000	3.46
	Least effective	1	10.3		
	Moderately effective	5	10.3		
	Highly effective	30	10.3		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Soil conservation	Moderately effective	5	20.5	0.000	3.88
	Highly effective	36	20.5		
	<b>Total</b>	<b>41</b>	<b>41</b>		

*NB: Expected values are different in KLSP as some rate of effectiveness (n=0) were omitted*

### **4.7.3 Rating of Factors Influencing the Uptake and Implementation of Project Adaptation Measures**

The research sought to find out some of the factors that influenced the uptake and implementation of project adaptation measures as indicated in Tables 4.20 and 4.21. In both projects, finances was a key factor of influence on the uptake and implementation of

project adaptation measures basing on the total weighted mean where in ARP project, the total weighted mean was 314.52 while in KLSP project the total weighted mean was 341.46. In ARP project it was noted that it moderately influenced uptake and implementation at 56.45% (n=35) while in KLSP project it was of high influence at 51.22% (n=21). This would be attributed to the fact that income earned by 95% of people in ARP project was below Ksh. 20,000 while in KLSP project 97% of people earned below Kshs. 20,000 (Table 4.2). Based on this earnings people shied away from adaptation measures that had some cost implications.

Labour availability came in second based on the total weighted mean as a factor that influenced uptake and implementation of project adaptation measures.

Table 4.23: Rating of factors influencing uptake of ARP project adaptation measures

Statement	Responses				
	N.I	L.I	M.I	H.I	T.W.M
Finances	4(6.45)	3(4.84)	35(56.45)	20(32.26)	314.52
Size of land	22(35.48)	23(37.10)	14(22.58)	3(4.84)	196.78
Access to information	16(25.81)	13(20.97)	18(29.03)	15(24.19)	251.6
Labour availability	3(4.84)	8(12.90)	39(62.90)	12(19.35)	296.74
Technical assistance	10(16.13)	16(25.81)	18(29.03)	18(29.03)	270.96
Project conditions	16(25.81)	18(29.03)	22(35.48)	6(9.68)	229.03

*The figures in parenthesis ( ) indicate percentage (%), N.I (No Influence) =1, L.I (Least Influence) =2, M.I (Moderate Influence) =3, H.I (High Influence) =4, and T.W.M (Total Weighted Mean)*

Total weighted mean for ARP project was 296.74 while that of KLSP project was 302.44. In terms of influence labour availability had moderate influence in both ARP and KLSP project. Project adaptation measures applied (on-farm water harvesting and soil conservation measures) in both project required labour input which was mainly sourced from family members. This was therefore a challenge especially to families who had inadequate family labour and were required to hire hence it was an issue that the project

beneficiaries felt that had an influence in the uptake and implementation of the project adaptation measures.

Table 4.24: Rating of factors influencing uptake of KLSP project adaptation measures

Statement	Responses				
	N.I	L.I	M.I	H.I	T.W
Finances	0(0)	4(9.76)	16(39.02)	21(51.22)	341.46
Size of land	14(34.15)	9(21.95)	14(34.15)	4(9.76)	219.54
Access to information	14(34.15)	15(36.59)	7(17.07)	5(12.20)	207.34
Labour availability	1(2.44)	10(24.39)	17(41.46)	13(31.71)	302.44
Technical assistance	11(26.83)	16(39.02)	8(19.51)	6(14.63)	221.92
Project conditions	18(43.90)	18(43.90)	5(12.20)	0(0)	168.3

*The figures in parenthesis ( ) indicate percentage (%), N.I (No Influence) =1, L.I (Least Influence) =2, M.I (Moderate Influence) =3, H.I (High Influence) =4, and T.W.M (Total Weighted Mean*

Technical assistance was ranked third as a factor that influenced uptake and implementation of project adaptation measures where the total weighted mean in ARP project was 270.96 while that of KLSP project was 221.92. In terms of influence it had moderate/high influence in ARP project while in KSLP project it had no influence. Technical assistance had an influence in both projects in that adaptation measures applied required skillful people to guide in their implementation to ensure success. This therefore would require project beneficiaries that do not have skillful labour among family members hire labour which would be an extra cost to them and would have hindered their ability to take up a particular adaptation measure.

In ARP project, access to information, project conditions and size of land were ranked fourth, fifth and sixth respectively while in KLSP project, size of land, access to information and project conditions were ranked fourth, fifth and sixth respectively based on the total weighted mean.

Project conditions in ARP project had moderate influence 34.58% (n=22) especially in implementation of soil conservation measures where the project beneficiaries had to contribute in terms of acquiring resources to implement the adaptation measure. This was due to the fact that the project had not set a side finances for this but could only provide technical assistance. In KLSP project this had the no influence/least influence 43.90% (n=18) as a budget had been set aside for acquiring resources needed to implement the adaptation measure hence making it affordable to all beneficiaries to adopt and implement.

On the other hand, access to information in both projects had moderate influence in ARP project 29.03% (n=18) while in KLSP project it had least influence 36.59% (n=15) in uptake and implementation of project adaptation measures. This was because project beneficiaries' had adequate information on project activities which had been acquired through trainings and workshops organized by the projects. In terms of size of land it had no influence in both projects as the projects were not particular in the acreage one had but all people were eligible to benefit from the adaptation measures employed.

#### **4.7.4 Chi-Square Test on Rating of Factors Influencing Uptake of Project Adaptation Measures**

A chi-square test was carried out to test for any significance on rate of influence of socio-economic factors on the uptake of project adaptation measures

In ARP project (Table 4.25) we find out that there was significant difference ( $p < 0.05$ ) in the different rating of influence in finances, size of land, labour availability and project conditions while no significant difference was found on the different rates of influence in access to information and technical assistance. In terms of the means of rate of influence, finances had the highest mean at 3.15 followed by labour availability (2.97), technical assistance (2.71), access to information (2.52), project conditions (2.29) and lastly size of land (1.97). These means support ranking of influence of socio-economic factors based on the Total Weighted Means obtained in Table 4.23.

Table 4.25: ARP Project Chi-Square test on rating of factors influencing uptake of project adaptation measures

<b>Socio-economic factor</b>	<b>Rate of Influence</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig.</b>	<b>Mean (Rate of influence)</b>
Finances	No Influence	4	15.5	0.000	3.15
	Least Influence	3	15.5		
	Moderate Influence	35	15.5		
	High Influence	20	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Size of land	No Influence	22	15.5	0.001	1.97
	Least Influence	23	15.5		
	Moderate Influence	14	15.5		
	High Influence	3	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Access of information	No Influence	16	15.5	0.840	2.52
	Least Influence	13	15.5		
	Moderate Influence	18	15.5		
	High Influence	15	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Labour availability	No Influence	3	15.5	0.000	2.97
	Least Influence	8	15.5		
	Moderate Influence	39	15.5		
	High Influence	12	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Technical assistance	No Influence	10	15.5	0.428	2.71
	Least Influence	16	15.5		
	Moderate Influence	18	15.5		
	High Influence	18	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		
Project conditions	No Influence	16	15.5	0.030	2.29
	Least Influence	18	15.5		
	Moderate Influence	22	15.5		
	High Influence	6	15.5		
	<b>Total</b>	<b>62</b>	<b>62</b>		

In KLSP project (Table 4.26) we find out that there was significant difference ( $p < 0.05$ ) in the different rate of influence in finances, labour availability and project conditions while

no significant difference was found on the different rates of influence in size of land, access to information and technical assistance.

Table 4.26: KLSP Project Chi-Square test on rating of factors influencing uptake of project adaptation measures

<b>Socio-economic factor</b>	<b>Rate of influence</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig.</b>	<b>Mean (Rate of influence)</b>
Finances	Least Influence	4	13.7	0.004	3.41
	Moderate Influence	16	13.7		
	High Influence	21	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Size of land	No Influence	14	10.3	0.082	2.20
	Least Influence	9	10.3		
	Moderate Influence	14	10.3		
	High Influence	4	10.3		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Access to information	No Influence	14	10.3	0.063	2.07
	Least Influence	15	10.3		
	Moderate Influence	7	10.3		
	High Influence	5	10.3		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Labour availability	No Influence	1	10.3	0.004	3.02
	Least Influence	10	10.3		
	Moderate Influence	17	10.3		
	High Influence	13	10.3		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Technical assistance	No Influence	11	10.3	0.136	2.22
	Least Influence	16	10.3		
	Moderate Influence	8	10.3		
	High Influence	6	10.3		
	<b>Total</b>	<b>41</b>	<b>41</b>		
Project conditions	No Influence	18	13.7	0.016	1.68
	Least Influence	18	13.7		
	Moderate Influence	5	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		

In terms of the means of rate of influence, finances had the highest mean at 3.41 followed by labour availability (3.02), technical assistance (2.22), size of land (2.20), access to information (2.07) and lastly project conditions (1.68). These means support ranking of

influence of socio-economic factors based on the Total Weighted Means obtained in Table 4.24.

These shows that while implementing climate variability adaptation measures, socio-economic factors have varying degrees of influence on the uptake of adaptation measures among project beneficiaries as illustrated in Table 4.23 and Table 4.24 of ARP and KLSP projects respectively. From the two projects, it was noted that finances, labour availability and project conditions were factors that influence uptake of project adaptation measures while access to information and technical assistance had less influence in both projects. It is therefore necessary to put into consideration these factors when rolling out projects to ensure success of the project adaptation measures is not hindered.

#### 4.7.5 Success of the Projects

Project beneficiaries were asked to rate the success of projects they benefited from and this is illustrated in Table 4.27. KLSP project was rated as highly successful by majority of the beneficiaries at 68% while ARP project was rated moderately successful at 56% by majority of the beneficiaries. The success of KLSP project would be attributed to the fact that the adaptation measures employed increased resilience of project beneficiaries from the impact of climate variability and also due to the fact that each activity had a budget line hence assisted beneficiaries in the uptake of the employed measures.

Table 4.27: Success rating of projects

Project/Statement	Highly Successful		Moderately Successful		Least Successful		Total	
	No.	%	No.	%	No.	%	No	%
The Kenya Livelihood Support Project (KLSP)	28	68	10	24	3	8	<b>41</b>	<b>100</b>
Arid and Semi-Arid Land Resilience Project (ARP)	23	37	35	56	4	7	<b>62</b>	<b>100</b>

On the other hand ARP project was rated moderately successful as project beneficiaries asserted that some adaptation measures e.g. soil conservation required project beneficiaries to contribute almost 80% as the project only assisted them in the technical

aspect. In addition, income diversification as an adaptation measure required capital for startup which the project did not address hence beneficiaries felt the project would have designed mechanisms for example giving loans to assist project beneficiaries get startup capital. The project implementers' also felt that income diversification as a means of reducing impacts of climate variation among project beneficiaries needs to be intensified in terms of creating more sensitization and undertaking it a continuous initiative rather than a one off activity.

From the observations made, it can be concluded that soil conservation and water harvesting were highly embraced as adaptation measures that aided project beneficiary households adopt to the impacts of climate variability. On the other hand income diversification needs to be continuously advocated for and mechanisms derived on how to assist project beneficiary households in adopting and embracing the adaptation measure.

#### **4.7.6 Chi-Square Test for success ratings**

A chi-square test (Table 4.28) was carried out to find out if there was any significant difference in the success ratings used to rate the success of the ARP and KLSP projects. It was observed that in both projects, there was a significant difference  $p < 0.05$  in the success ratings. This could be attributed to majority of people ( $n=35$ ) in ARP project rating the project as moderately successful while majority of people ( $n=28$ ) in KLSP rated the project highly successful. These consequently influenced the success rates of the project where ARP was rated as moderately successful while KLSP project was rated highly successful.

Based on the means of success ratings, it was observed that ARP project had a mean of 2.31 while KLSP had a mean of 2.61 which support the project success rating (Table 4.27)

Table 4.28: ARP and KLSP Chi-Square test on success rating of project

<b>Project</b>	<b>Success Rating</b>	<b>Observed N</b>	<b>Expected N</b>	<b>Sig.</b>	<b>Mean (Success Rating)</b>
ARP	Least successful	4	20.7	0.000	2.31
Project	Moderately successful	35	20.7		
	Highly successful	23	20.7		
	<b>Total</b>	<b>62</b>	<b>62</b>		
KLSP	Least successful	3	13.7	0.000	2.61
Project	Moderately successful	10	13.7		
	Highly successful	28	13.7		
	<b>Total</b>	<b>41</b>	<b>41</b>		

## **CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Summary of Findings**

This section discusses findings of the study based on the three objectives, that is, To assess climate variability (rainfall and temperature) between 1979 and 2014 in Kitui County; To evaluate the effectiveness of adaptation measures (soil conservation, water harvesting and income diversification) to climate variability among beneficiary households and To ascertain the influence of socio-economic factors on the uptake of adaptation measures to climate variability by beneficiary households.

The first objective of the study was to assess climate variability (rainfall and temperature) between 1979 and 2014 in Kitui County. According to KMD statistics, there were changes in temperature and rainfall in the study area over the past 35 years. There was statistically significant difference in decadal mean annual temperatures within 1979-2014. An increase in temperatures over the years was noted with some years experiencing extremely high temperatures. Changes were also noted in rainfall where there was a decline in the amount, intensity, occurrence and duration of the rains. It was also noted that the rains have become unpredictable over time unlike years before where occurrence of rainfall was consistent. These statistics were supported by respondents who asserted there was a declining trend in rainfall and increase in temperature. This was related to decline in food production within the county and in most of people resulted in buying food or depending on government aid as they mainly rely on rain fed agriculture for food production.

The second objective was to evaluate the effectiveness of adaptation measures (soil conservation, water harvesting and income diversification) to climate variability among beneficiary households. From the findings, it was noted that on-farm water harvesting was highly effective and ranked first and second in ARP and KLSP projects respectively. It was practiced intensively by all project beneficiaries. Soil conservation was also effective in the two projects ranking second and first in ARP and KLSP projects respectively. The beneficiaries asserted that it helped in the conservation of soil preventing it erosion from occurring hence conserving the top fertile soil that is essential

for plant growth. Income diversification was ranked third in terms of effectiveness in that many beneficiaries were reluctant on embracing new initiatives of earning income hence was not effective in empowering people become resilient to the impacts of climate variation. Others embraced the adaption measure but later on went back to farming hence lacking consistency.

The third objective was to ascertain the influence of socio-economic factors on the uptake of adaptation measures to climate variability by beneficiary households with regard to the three adaptation measures employed by the two projects. The projects adaptation measures were soil conservation, water harvesting and income diversification. Results showed that in regard to the extent of uptake of the three adaptation measures, income, labour availability and technical knowhow had varying degrees of influence on their uptake and implementation.

## **5.2 Conclusion**

The results therefore imply that DRR projects have an influence on the adaptive capacity to climate variability hence their implementation should aim at increasing the resilience of beneficiaries through selection of measures that are able to directly address vulnerability. It was established that the most preferred adaptation measure was soil conservation and water harvesting as a coping strategy to the variation of climate experienced in the study area. Information regarding climate variability was also identified as a vital tool that will assist in designing of future adaptation measures especially when projects are being rolled out. In addition, socio-economic factors should be put into consideration as from the findings, it was evident that they play a role in the uptake of the varying adaptation measures introduced. Knowledge and understanding of these socio-economic factors can be vital in policy making and also strengthening of adaptive capacity to climate variability.

## **5.3 Recommendations**

Based on the findings of this study, in order to ensure enhanced adaptive capacity to climate variability in the study area;

1. Analyzing and dissemination of rainfall and temperature information to area residents by relevant ministries would also assist in enhancing their resilience against the impact of climate variability. This would also assist in application of disaster prevention mechanisms rather than addressing a disaster once it has occurred
2. Enhance opportunities for undertaking irrigation in small scale and increase water harvesting with guaranteed high water use efficiency during irrigation by building high farm level managerial capacity.
3. The household socio-economic factors (income, source of labour and technical assistance) which highly influenced the level of adaptation should be taken into consideration in any effort to promote adaptation to climate variability among project beneficiaries.

#### **5.4 Further Research**

Further studies are recommended in:

1. Characteristics of seasonal variations of rainfall patterns so as to identify inter/intra rainfall variability and how it impacts on climate sensitive livelihoods.
2. How socio-economic factors that influence the uptake of adaptation measures to climate variability would be addressed and factored in during planning and implementation of projects or initiatives aimed at enhancing climate variability resilience.

## REFERENCES

- Adebisi, A. O., & Oyesola, O. B. (2013). Socio-economic Factors Affecting Adaptation Strategies of Selected Horticultural Farmers to Climate Change in Osun State, Nigeria. *ARPN Journal of Agricultural and Biological Science*, 8(4), 344-350.
- Adesina, A. A., & Forson, J. B. (1995). Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. *Agricultural Economics*(13), 1–9.
- Adger, W. N., & Vincent, K. (2005). Uncertainty in adaptive capacity. *C. R. Geoscience*(337), 399–410.
- Adger, W. N., Huq, S., Brown, K., Conway, D., & Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies*, 3(3), 179-195.
- Aelst, K. V., & Holvoet, N. (2016). Intersections of Gender and Marital Status in Accessing Climate Change Adaptation: Evidence from Rural Tanzania. *Elsevier*, 79, 40–50.
- AFIDEP and PAI. (2012). *Population Dynamics, Climate Change, and Sustainable Development in Kenya*. Nairobi and Washington, D.C: African Institute for Development Policy (AFIDEP) and Population Action International (PAI).
- Ahmed, B., Longtau, S. R., & Odunze, A. C. (2000). *Soil and water conservation in Northern Nigeria: Case study report prepared by Eco Systems Development Organisation (EDO)*. Jos, Nigeria: Overseas Development Institute.
- Anley, Y., Bogale, A., & Haile-Gabriel, A. (2007). Adoption decision and use intensity of soil and water conservation measures by small-holder farmers in Dedo district, Western Ethiopia. *Land degradation and Development*(18), 239-302.
- Anyoha, N. O., Nnadi, F. N., Chikaire, J., Echetama, J. A., Utazi, C. A., & Ihenacho, R. A. (2013). Socio-economic factors influencing climate change adaptation among crop farmers in Umuahia South Area of Abia State, Nigeria. *Net Journal of Agricultural Science*, 1(2), 42-47.
- Atinkut, B., & Mebrat, A. (2016). Determinants of farmers choice of adaptation to climate variability in Dera woreda, south Gondar zone, Ethiopia. *Environmental Systems Research*, 5(6), 1-8. doi:10.1186/s40068-015-0046-x
- AusAID. (2009). *Investing in a Safer Future A Disaster Risk Reduction policy for the Australian aid program*. Canberra: AusAID.

- Baaru, M W;. (2011). *Improving samllholder land productivity through promotion of sustainable soil and water conservation technologies in Machakos District: A case of vegetative macro contour lines*. Nairobi: University of Nairobi.
- Barnett, J. (2008). The Effect of Aid on Capacity to Adapt to Climate Change: Insights from Niue. *Political Science*, 1(60), 31-45.
- Berman, R. J., Quinn, C. H., & Paavola, J. (2015). Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: Implications for adapting to future climate change. *Climate Change and Development*(7), 71-84.
- Bettencourt, S., Croad , R., Freeman, P., Hay, J., Jones, R., King, P., Van Aalst, M. (2006). *Not if but when: Adapting to natural hazards in the Pacific Islands Region*.
- Bobadoye, A. O., Ogara, W. O., Ouma, G. O., & Onono, J. O. (2016). Assessing Climate Change Adaptation Strategies among Rural Maasai pastoralist in Kenya. *American Journal of Rural Development*, 4(6), 120-128. doi:10.12691/ajrd-4-6-1
- Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Yanda, P. (2007). *Africa Climate Change;Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge UK: Cambridge University Press.
- Bradshaw, B., Dolan, H., & Smit, B. (2004). Farm-level adaptation to climatic variability and change: Crop diversification in the Canadian prairies. *Climatic Change*, 67, 119-141.
- Bruckner, M. (2012). *Climate change vulnerability and the identification of least developed countries (LDCs)*. Economic and Social Affairs. The United Nations Development Policy and Analysis Division.
- Bryan, E., & Behrman, J. (2013). *Community- based adaptation to climate change: A theoretical framework, overview of key issues and discussion of gender differentiated priorities and participation*. International Food Policy Research Institute. Washington, D.C: CAPRI Working Paper No.109.
- Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa:options and constraints. *Environment Science Policy*, 12, 413-426.
- Camberlin, P., Janicot, S., & Pocard, I. (2001). Seasonality and atmospheric dynamics of the teleconnection between African rainfall and tropical sea-surface

temperature: Atlantic vs. ENSO. *International Journal of Climatology*(23), 973–1005.

CEEPA. (2006). *Climate Change and African Agriculture Policy Note No. 10*. University of Pretoria. South Africa: Centre for Environmental Economics and Policy in Africa (CEEPA).

Charlton, R. (1995). NGOs, Politics, Projects and Probity - A Policy Implementation Perspective. *Third World Quarterly, II*(16), 237-255.

Christensen, J. H., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, I., Whetton, P. (2007). "Regional Climate Projections". In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt, . . . H. Miller (Ed.), *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report Contribution of Working Group I to the Fourth Assessment Report.

Connolly-Boutin, L., & Smit, B. (2016). Climate Change, Food Security, and Livelihoods in Sub-Saharan. *Regional Environmental Change, 16*, 385-399.

Cooper, P. J., Dimes, J., Rao, K., Shapiro, B., Shiferaw, B., & Twomlow, S. (2008). Coping better with current variability in the rain-fed farming systems of Sub-Saharan Africa: An essential first step in adapting to future climate change. *Agriculture Ecosystems and Environment*(126), 24-35.

Daberkow, S. G., & McBride, W. D. (2003). Information and Adoption of Precision Farming. *Journal of Agribusiness, 1*(21), 21-38.

Daulagala, C., Weerahewa, J., Marambe, B., Pushpakumara, G., Silva, P., Punyawardena, R., Jana, S. (2012). Socio-economic characteristics of farmers influencing adaptation to climate change: Empirical results from selected homegardens in South Asia with emphasis on commercial orientation. *Sri Lanka Journal of Advanced Social Studies, 2*(2), 71-90.

Department for International Development (DFID). (2011). *Defining disaster resilience: A DFID approach paper*. London: DFID.

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yusuf, M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Journal of Global Environmental Change, 1*-8.

Deressa, T., Hassan, R. M., Alemu, T., Yesuf, M., & Ringler, C. (2008). *Analyzing the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of*

- Climate Change in the Nile Basin of Ethiopia*. Environment and Production Technology Division. International Food Policy Research Institute (IFPRI).
- Dillon, M. E., Woods, H. A., Wang, G., Fey, S. B., Vasseur, D. A., Telemeco, R. S., & Pincebourde, S. (2016). Life in the frequency domain: The biological impacts of changes in climate variability in multiple time scales. *Integr Comp Biol this issue*.
- Eriksen, S., Aldunce, P., Bahinipati, C. S., Martins, R. D., Molefe, J. I., Nhemachena, C., Sygna, L. (2011). When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development*, 1(3), 7-20.
- FAO. (2010). Analysis of Climate Change and Variability Risks in the Smallholder Sector; Case studies of the Laikipia and Narok Districts representing major agro-ecological zones in Kenya. *Environment and Natural Resource Management*.
- Few, R., Osbahr, H., Bouwer, L. M., Viner, D., & Sperling, F. (2006). *Linking climate change adaptation and disaster risk management for sustainable poverty reduction: synthesis report*. Brussel, Belgium: European Commission and Vulnerability and Adaptation Resource Group.
- Frankenberger, T. R., & Nelson, S. (2013). *Summary of the Expert Consultation on Resilience Measurement for Food Security*. Rome, Italy: Food and Agricultural Organization and World Food Program.
- Fussel, H. M., & Klein, R. J. (2002). Assessing the Vulnerability and Adaptation to Climate Change: An Evolution of Conceptual Thinking. *UNDP Expert Group Meeting on Integrating Disaster Reduction and Adaptation to Climate Change*. Havana, Cuba.
- Gachathi, F. N., & Eriksen, S. (2011). Gums and resins: The potential for supporting sustainable adaptation in Kenya's drylands. *Climate and Development*, 3(1), 59-70.
- Gathaara, V. N., Gachene, C. K., & Ngugi, J. N. (2010). Adoption and opportunities for improving soil and water conservation measures in Kathekaikai Settlement Scheme, Machakos District. *12th KARI Biannual Scientific Conference*. KARI.
- Gbegeh, B. D., & Akubuilu, C. J. (2013). Socioeconomic determinants of adoption of yam miniset by farmers in Rivers state, Nigeria. *Wudpecker Journal of Agricultural Research*, 2(1), 33 - 38.
- Gbetibouo, G. A. (2009). *Understanding farmers' perceptions and adaptations to climate change and variability. The case of the Limpopo basin, South Africa*. IFPRI.

- Gero, A., Meheux, K., & Dominey-Howes, D. (2011). Integrating community based disaster risk reduction and climate change adaptation: examples from the Pacific. *Natural Hazards and Earth System Sciences, 11*, 103-113.
- Gibson, C. C., Andersson, K., Ostrom, E., & Shivakumar, S. (2005). *The Samaritan's Dilemma: The Political Economy of Development Aid*. Oxford: Oxford University Press.
- Gissila, T., Black, E., Grimes, D., & Slingo, J. (2004). Seasonal forecasting of the Ethiopian summer rains. *Int. J. Climatol*(24), 1345-1358.
- Goddard, L., & Graham, N. E. (1999). Importance of the Indian Ocean for simulating rainfall anomalies over Eastern and Southern Africa. *Journal of Geophysical Research: Atmospheres, 104*(16), 19099-19116.
- GoK. (2009a). *National Population and Housing Census Report*. Nairobi: Kenya National Bureau of Statistics.
- GoK. (2009b). *Food Security Analysis: Kenya Agricultural Sector Development Strategy*. Nairobi: Ministry of Agriculture.
- GoK. (2010). *National Climate Change Response Strategy (NCCRS)*. Nairobi, Kenya: Government of Kenya.
- GoK. (2014). *Kitui County Integrated Development Plan*. County Government of Kitui.
- GOK/UNDP. (1998). *Food Emergency Assessment Report*. Government of Kenya/United Nations Development Programme.
- Hatibu, N., Mahoo, H. F., & Lazaro, E. (2000). *The contribution of soil and water conservation to sustainable livelihoods in semi-arid areas of Sub-Saharan Africa*. AGREN.
- Hulme, M., Doherty, R., Ngara, T., New, M., & Lister, D. (2001). African climate change: 1900 – 2100. *Climate Research, 17*, 145-168.
- Idrus, A. B., & Newman, J. B. (2002). Construction related factors influencing the Choice of Concrete floor Systems. *Journal Construction Management and Economics, 20*, 13-19.
- Ifejika, S., Kiteme, B., & Wiesmann, U. (2008). Droughts and famines: The underlying factors and the causal links among agro-pastoral households in semi-arid Makueni district, Kenya. *Global Environmental Change, 18*(1), 220-233.

- IPCC. (2001). *Climate Change 2001: Impacts, Adaptations and Vulnerability*. Report of working group II. Cambridge: Cambridge University Press.
- IPCC. (2007). Summary for Policymakers. In S. Solomon, D. Qin, M. Manning, Z. Cheng, M. Marquis, K. B. Averyt, H. L. Miller (Ed.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1-18). Cambridge United Kingdom and New York, NY, USA: Cambridge University Press.
- IPCC. (2014). Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach , M. D. Mastrandrea, T. E. Bilir, L. L. White (Ed.), *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1-32). Cambridge, UK and New York, USA: Cambridge University Press.
- James, R., & Washington, R. (2015). Changes in African temperature and precipitation associated with degrees of global warming. *Climate Change*, 117(4), 859-872.
- Karanja, F. K., & Mutua, F. M. (2000). *Reducing the Impcat of Environmental Emergencies through Early Warning and Preparedness- The Case of El-Nino Southern Oscillations (ENSO)*. UNFIP, UNEP, NCAR, WMO, IDNDR, UNU, Nairobi, Kenya.
- Kaushik, G., & Sharma, K. C. (2015). Climate Change and Rural Livelihoods - Adaptation and Vulnerability in Rajasthan. *Global NEST Journal*, 17(1), 41-49.
- Kelman, I., Mercer, J., & West, J. (2009). Combining different knowledges: community-based climate change adaptation in small islands developing states. *Participatory Learning and Action*(60), 41-53.
- Khisa, G. V., Oteng'i, S. B., & Mikalitsa, S. M. (2014). Effect of Climate Change on Small Scale Agricultural Production and Food Security in Kitui District, Kenya. *The Journal of Agriculture and Natural Resources Sciences*, 1(1), 34-44.
- Khuram, R., & Rasul, G. (2011). Rainfall variability and maize production over the Potohar plateau of Pakistan. *Pakistan Journal of Meteorology*, 8(15), 63-70.
- Kihupi, N. I., Kingamkono, R., Rwamugira, W., Kingamkono, M., Mhita, M., & Brien, K. O. (2002). *Promotion and Integration of Indigenous Knowledge in Seasonal Climate Forecasts. Consultancy Report Submitted to Drought Monitoring Center*. Harare, Zimbabwe.

- Kinyangi, A A;. (2014). *Factors Influencing the Adoption of Agricultural Technology Among SmallHolder Farmers in Kakamega North Sub-County, Kenya*. Masters Thesis, University of Nairobi, Nairobi.
- Kiprotich, M. J., Mamati, E., & Bikketi, E. (2015). Effect of climate change on cowpea production in Mwanja watershed: A case of Machakos County. *International Journal of Education and Research*, III(2), 287-298.
- Kirimi, J. N., Mwangi, J. G., & Nkurumwa, A. O. (2013). Climate Change Challenges and Adaptation Strategies Among the Pastoralists in Laikipia County Kenya. *International Journal of Agricultural Extension*, 20-30.
- Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, 32, 25-48.
- Komba, C., & Muchapondwa, E. (2012). Adaptation to climate change by smallholder farmers in Tanzania. *Economic Research*.
- Kothari, U., & Cooke, B. (2001). *Participation: the new tyranny?* London: Zed Books.
- Kurosaki, T., & Fafchamps, M. (2002). "Insurance market efficiency and crop choices in Pakistan". *Journal of Development Economics*(67), 419-453.
- Kurukulasuriya and Mendelsohn. (2008). A Ricardian analysis of the impact of climate change on African cropland. *African Journal of Agricultural and Resource Economics*, 2, 1-23.
- Maddison, D. (2006). *The perception of and adaptation to climate change in Africa*. University of Pretoria, South Africa: Centre for Environmental Economics and Policy in Africa.
- Marenja, P. P., & Barrett, C. B. (2007). Household-level Determinants of Adoption of Improved Natural Resources Management Practices among Smallholder Farmers in Western Kenya. *Food Policy*(32), 515 – 536.
- Mariara, J. K., & Karanja, F. K. (2007). The Economic Impact of Climate Change on Kenyan Crop Agriculture: A Ricardian Approach. *Global and Planetary Change*(57), 319-330.
- Martina, B., Salvatore , D., Smale, M., & Swanson, T. (2016). *Climate, Shocks, Weather and Maize Intensification Decisions in Rural Kenya*. Boston, Massachusetts : Agricultural and Applied Economics Association.
- Mercer, J. (2010). Disaster Risk Reduction or Climate Change Adaptation: Are we reinventing the wheel? *J. Int. Dev*(22), 247–264.

- Mercer, J., Kelman, I., Suchet-Pearson, S., & Lloyd, K. (2009). Integrating indigenous and scientific knowledge bases for disaster risk reduction in Papua New Guinea. *Geographical Analysis B*(91), 157–183.
- Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel. *Environmental Management*(43), 804–816.
- Mimura, N., McLean, R., Nurse, L., Agard, J., Brigulio, L., Lefale, P., Sem, G. (2007). *Small islands, in: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- Ministry of Natural Resources and Environment (MNRE). (2005). *National Adaptation Programme of Action*. Apia, Samoa: MNRE.
- Mortimore, M. J., & Adams, W. M. (2001). Farmer adaptation, change and 'crisis' in the Sahel. *Global Environmental Change-Human and Policy Dimensions*(11), 49–57.
- Mugenda, O. M., & Mugenda, A. G. (2003). *Research Methods: Quantitative and Qualitative Approach*. Nairobi: African Centre for Technology Studies (ACTS).
- Mwangi, M., & Kariuki, S. (2015). Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries. *Journal of Economics and Sustainable Development*, 6(5), 208-213.
- Nassiuma, D. K. (2000). *Survey Sampling: Theory and Methods*. Nairobi University Press.
- Ndambiri, H., Ritho, C., Mbogoh, S., Ng'ang'a, S., & Muiruri, E. (2012). Assessment of farmers' adaptation to effects of climate change in Kenya. *Journal of Economics and Sustainable Development* .
- Newing, H. (2011). *Conducting Research in Conservation: A Social Science Perspective*. London: Routledge.
- Nhemachena, C., & Hassan, R. (2007). *Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI discussion paper, 174*. Washington, DC: International Food Policy Research Institute (IFPRI).
- Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). *Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects*. . Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

- Nicholson, S N. (2001). Climate and Environmental Change in Africa during the Last Two Centuries. *Climate Research*, 14, 123-144.
- Nkonya, E., Pender, J., Kaizzi, C., Kato, E., Mugarura, S., Ssali, H., & Muwonge, J. (2008). *Linkages Between Land Management, Land Degradation, and Poverty in Sub-Saharan Africa: The Case of Uganda*. Washington D.C: International Food Policy Research Institute.
- Norris, E., & Battie, S. (1987). Virginia farmers' soil conservation decisions: An application of tobit analysis. *Southern Journal of Agricultural Economics*, 19(1), 89-97.
- Nunn, P. (2009). Responding to the Challenges of Climate Change in the Pacific Islands: Management and Technological Imperatives. *Clim. Res.*(10), 211-231.
- Office for the Coordination of Humanitarian Affairs (OCHA). (2009). *Samoa/Tonga Tsunami Situation Report 6*. Office for the Coordination of Humanitarian Affairs (OCHA). Suva, Fiji Islands: United Nations.
- Okoba, B. O., & De Graff, J. (2005). Farmers knowledge and perceptions of soil erosion and conservation measures in the Central Highlands, Kenya. *Land Degradation and Development*, 16(5), 465-487.
- Omoyo, N. N., Wakhungu, J., & Oteng'i, S. (2015). Effects of climate variability on maize yield in the arid and semi arid lands of lower eastern Kenya. *BioMed Central Journals*, 1-13.
- Ongoma, V. (2013). A review of the effects of climate change on occurrence of aflatoxin and its impacts on food security in semi-arid areas of Kenya. *International Journal of Agricultural Science Research*, 2(11), 307-311.
- Onu, D. O. (2005). Analysis of factors influencing farmers' adoption of alley farming technology under intensified agriculture in Imo State, Nigeria, using a qualitative choice model. *Agro Forestry Systems International*(29), 76-187.
- Onyeneke, R. U., & Madukwe, D. K. (2010). Adartation measures by crop farmers in the Southeast Rainforest zone of Nigeria to climate change. *Science World Journal*, 5(1), 32-34.
- Opiyo, O E. (2014). *Climate Variability and Change on Vulnerability and Adaptation among Turukana Pastoralist in North-Western Kenya*. PhD Thesis, University of Nairobi, Department of Rangeland Management, Nairobi.
- Orodho, J. A. (2003). *Essential of Education ans Social Sciences Research Method*. Nairobi: Masola Publishers.

- Osano, P. M., Mohammed, Y. S., De Leeuw, J., Stephen, S. M., Ole Kaelo, D., Schomers, S., Ogutu, J. O. (2013). Pastoralism and ecosystem-based adaptation in Kenyan Masailand. *International Journal of Climate Change Strategies and Management*, 5, 198-214.
- Pannell, D. (1999). Economics, extension and the adoption of land conservation innovations in agriculture. *International Journal of Social Economics*(26), 999–1012.
- Parry, M. L., Rosenzweig, C., Iglesias, A., Livermore, M., & Fischer, G. (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change*, 14, 53-67.
- Recha, C., Makokha, G., Traore, P. S., Shisanya, C., & Sako, A. (2011). Determination of seasonal rainfall variability, onset and cessation in semi-arid Tharaka district, Kenya. *Theoretical and Applied Climatology*, 3, 1-16.
- Ribot, J. C., Najam, A., & Watson, G. (2009). Climate Variation, Vulnerability and Sustainable Development in the Semi-Arid Tropics. (E. L. Schipper, & I. Burton, Eds.) *The Earthscan Reader on: Adaptation to Climate Change*, 117-160.
- Saadat, M. A., & Islam, S. A. (2011). *Impact of Climate Change on Rural Livelihood: A Case Study*. Bangladesh: 3rd International Conference on Water & Flood Management (ICWFM-2011).
- Schipper, E. L. (2009). Conceptual History of Adaptation in the UNFCCC Process. (E. L. Schipper, & I. Burton, Eds.) *The Earthscan Reader on Adaptation to Climate Change*, 359-376.
- Shiferaw, B., Okello, J., & Reddy, R. (2009). Adoption and Adaptation of Natural Resource Management Innovations in Smallholder Agriculture: Reflections on Key Lessons and Best Practices. *Environ Dev Sustain*(11), 601–619.
- Silvestri, S., Bryan, E., Ringler, C., Herrero, M., & Okoba, B. (2012). Climate Change Perception and Adaptation of Agro-pastoral Communities in Kenya. *Regional Climate Change*, 12(4), 791-802.
- Simões, A. F., Kligerman, D. C., Rovere, E. L., Maroun, M. R., Barata, M., & Obermaier, M. (2010, October 8). Enhancing adaptive capacity to climate change: The case of smallholder farmers in the Brazilian semi-arid region. (Elsevier, Ed.) *Environmental Science and Policy*, 801-808.
- Slegers, M F. (2008). "If only it could rain": Farmers' perceptions of rainfall and drought in semi-arid central Tanzania. *Journal of Arid Environments*(72), 2106-2123.

- Smit, B., & Pilifosova, O. (2001). Adaptation to climate change in the context of sustainable development and equity. *Climate Change 2001: Impacts, Adaptation, and Vulnerability; Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16, 282-292.
- Smith, N M;. (2014). Gender and livelihood diversification: Maasai women's market activities in Northern Tanzania. *Journal of Development Studies*(51), 305–318.
- Steenwerth, K. L., Hodson, A. K., Bloom, A. J., Carter, M. R., Cattaneo, A., Chartres, C. J., Horwath, W. R. (2014). Climate-smart agriculture global research agenda: scientific basis for action. *Agriculture & Food Security*., 3(11).
- Tizale, C. Y. (2007). *The dynamics of soil degradation and incentives for optimal management in the Central Highlands of Ethiopia*. University of Pretoria. Pretoria, South Africa: Faculty of Natural and Agricultural Sciences.
- Ubisi, N. R., Mafongoya, P. L., Kolanisi, U., & Jiri, O. (2017). Smallholder farmer's perceived effects of climate change on crop production and household livelihoods in rural Limpopo province, South Africa. *Change Adaptation Socioecology Systems*(3), 27–38.
- Uitto, J. I., & Shaw, R. (2006). Adaptation to climate change: Promoting Community-based approaches in the developing countries. *Sansai*(1), 93-108.
- United Nations Development Programme–United Nations Environment Programme Poverty-Environment Initiative (UNPEI). (2011). *Mainstreaming Climate Change Adaptation into Development Planning: A Guide for Practitioners*. Nairobi: UNDP-UNEP.
- United Nations International Strategy for Disaster Reduction (UNISDR). (2004). *Terminology: Basic Terms of Disaster Risk Reduction*. Geneva: UNISDR.
- van Aalst, M. K., Cannon, T., & Burton, I. (2008). Community level adaptation to climate change: the potential role of participatory community risk assessment. *Global Environmental Change*(18), 165–179.
- Venton, P., & La Trobe, S. (2008). *Linking climate change adaptation and disaster risk reduction*. United Kingdom: Tearfund.
- Weerahewa, J., Pushpakumara, G., Silva, P., Daulagala, C., Punyawardena, R., Premalal, S., Roy, J. (2012). Are homegarden ecosystems resilient to climate change? An

analysis of the adaptation strategies of homegardens in Sri-Lanka. *APN Science Bulletin*, 2, 22-27.

Wheeler, T., & von Braun, J. (2013). Climate Change Impacts on Global Food Security. *Science*, 508-513.

Wolff, C., Haug, G. H., Timmermann, A., Damste, J. S., Brauer, A., Sigman, D. M., . . . Verschuren, D. (2011). Reduced Interannual Rainfall Variability in East Africa During the Last Ice Age. *Science*, 333, 743-747.

Wood, S. A., Jina, A. S., Jain, M., Kristjanson, P., & DeFries, R. S. (2014). Smallholder farmer cropping decisions related to climate variability across multiple regions. *Global Environmental Change*(25), 163–172.

World Bank. (2009). *Making Development Climate Resilient: A World Bank Strategy for Sub-Saharan Africa*. Sustainable Development Department. World Bank.

World Meteorological Organisation (WMO). (2010). *WMO statement on the status of the global climate in 2009*. Geneva, Switzerland: World Meteorological Organization.

Yesuf, M., Falco, S., Deressa, T., Ringler, C., & Kohlin, G. (2008). *The Impact of Climate Change and Adaptation on Food Production in Low income countries*. Washington DC: IFPRI.

Ziervogel, G., & Calder, R. (2003). Climate Variability and Rural Livelihoods: Assessing the Impact of Seasonal Climate Forecasts in Lesotho. *Royal Geographical Society*, 35(4), 403–417.

## APPENDICES

### Appendix 1: Household Survey Interview Schedule

I am a student at Kenyatta University pursuing Master of Environmental Studies (Climate Change and Sustainability) with major focus on aspects of climate variability. The information you provide will be treated with utmost **confidentiality**. **Your assistance in answering the questions will be highly appreciated.**

Name: \_\_\_\_\_ Date of interview: \_\_\_\_\_

Sub-County: \_\_\_\_\_ Ward: \_\_\_\_\_

Location: \_\_\_\_\_ Household No. \_\_\_\_\_

Time when the interview started: \_\_\_\_\_

### HOUSEHOLD DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

1. Gender of household head
  - 1= Male
  - 2= Female
2. Year of birth \_\_\_\_\_
3. Highest level of education
  1. None
  2. Primary school level
  3. Secondary School Level
  4. Diploma/Degree level
4. Marital Status
  1. Married
  2. Widowed/Widower
  3. Single
  4. Divorced/Separated
5. What is your **main** source of income?
  1. Business
  2. Crop/Animal farming

3. Salary/wage
  4. Remittance
  6. What is your average monthly income?
    1. Below 10,000
    2. 10,001-20,000
    3. 20,001-30,000
    4. 30,001 and above
  7. How many members are in your household?
- 
8. What is the size of your land (in acres)?
    1. Less than one acre
    2. 1 to 3 acres
    3. 4 to 6 acres
    4. Above 7 acres
  9. What is the type of land ownership?
    1. Inheritance/Ancestral land
    2. Communal land
    3. Private land (has title deed)
    4. Leasehold
  10. For how long have you lived on this place?
    1. 0-5 years
    2. 6-10 years
    3. 11-15 years
    4. Above 16 years
  11. What is the main source of labour on your farm?
    1. Family members
    2. Casual labour
  12. How long have you been practicing farming?
    1. 0-5 years
    2. 6-10 years
    3. 11-15 years

4. Above 16 years
13. What are the sources of extension services you receive?
1. None
  2. Government
  3. Private
  4. NGOs
14. Which social group do you belong to?
1. Church group
  2. Social Welfare group
  3. Family group
  4. Community Based Organisation
15. What is the importance of being in a social group?
1. Financial support
  2. Development purposes
  3. Agricultural support
  4. Social networking

#### **CLIMATE CHANGE AND VARIABILITY**

16. What significant changes in weather have you observed in the past years?
1. Unpredictable rains
  2. Very wet seasons
  3. Very dry seasons
  4. Prolonged droughts
17. What impact have the above changes caused?
1. Crop failure
  2. Flooding
  3. Increased temperatures
  4. Soil erosion
18. How many months do you experience food shortages within the household?
1. None
  2. 1-3 months
  3. 4-6 months

4. Above 6 months

19. What are the causes of food shortages?

1. Drought
2. Floods
3. Inadequate land
4. Lack of farm inputs

20. How do you cope with food shortages?

1. Buy food
2. Obtain relief food from Government/NGOs/Private Organisations
3. Get assistance from friends/relatives

21. Are there changes that have been observed in rainfall in terms of:

<b>Attribute</b>	<b>Increased</b>	<b>Moderate</b>	<b>Decreased</b>	<b>None</b>
Amount				
Intensity				
Duration				
Occurrence				

22. In the past years, have you observed any changes in temperatures?

1. Increase
2. Decrease
3. Moderate
4. None

23. What have the changes in rainfall and temperatures affected you?

1. Crop failure
2. Flooding
3. Droughts
4. Increase in crop variety
5. Soil erosion

24. Have you taken any measures to help in adjustment to climate variability experienced?

1. Strongly Disagree

2. Disagree

3. Neutral

4. Agree

5. Strongly agree

25. How would you rank the application of the following adaptation measures?

<b>Statement</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly Agree</b>
Change in crop variety					
Implement water conservation measures					
Diversification of crop and animal variety					
Change in planting dates					
Change size of land under cultivation					
Diversification of income generation from on-farm to none farming activities					

### **PROJECT ADAPTATION MEASURES**

26. Caritas has implemented projects in a bid to assist communities in adaptation to climate variability. Which project are you a beneficiary?

1. The Kenya Livelihood Support Project (KLSP)
2. Arid and Semi-arid Land Resilience Project (ALP)

27. Which adaptation measures have you employed by the project have you embraced?

1. On-farm water harvesting
2. Soil conservation
3. Income diversification

28. How would rate the effectiveness of these adaptation measures practiced?

<b>Statement</b>	<b>Not effective</b>	<b>Least effective</b>	<b>Moderately effective</b>	<b>Highly effective</b>
On-farm water harvesting				

Soil conservation measures				
Income diversification				

29. To what extent did the following factors influence uptake and implementation of the project adaptation measures?

<b>Statement</b>	<b>Highly influenced</b>	<b>Moderately influenced</b>	<b>Least influenced</b>	<b>No influence</b>
Finances				
Size of land				
Access to information				
Labour availability				
Technical assistance				
Project conditions				

30. How would you rate the success of the project you benefited from?

<b>Statement</b>	<b>Highly successful</b>	<b>Moderately successful</b>	<b>Least successful</b>	<b>No impact</b>
The Kenya Livelihood Support Project (KLSP)				
Arid and Semi-arid Land Resilience Project (ALP)				

Time the interview ended: \_\_\_\_\_

**THANK YOU FOR YOUR COOPERATION**





**NATIONAL COMMISSION FOR SCIENCE,  
TECHNOLOGY AND INNOVATION**

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Ref. No.

Date:

**NACOSTI/P/16/82699/9856**

**22<sup>nd</sup> June, 2016**

Patricia Wanjiku Mambo  
Kenyatta University  
P.O. Box 43844-00100  
**NAIROBI.**

**RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on *“Influence of disaster risk reduction projects on adaptive capacity to climate variability in Kitui County, Kenya,”* I am pleased to inform you that you have been authorized to undertake research in **Kitui County** for the period ending **21<sup>st</sup> June, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Kitui 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  
Kitui County.

The County Director of Education  
Kitui County.