UNIVERSITY OF NAIROBI

DEPARTMENT OF METEOROLOGY

THE INFLUENCE OF CLIMATE CHANGE PERCEPTION AND GENDER ON ADAPTATION ACTIONS IN KAJIADO AND KIAMBU COUNTIES, KENYA.

BY:

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DECLARATION

I declare that this PhD thesis is my original work and has not been submitted elsewhere for research. Where other people's work or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.

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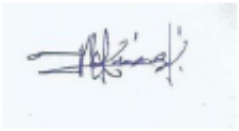
Dr. Josiah M. Kinama		15/11/2020

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DEDICATION

This work is dedicated to my family and friends

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ABSTRACT

Climate change, as a slow and gradual modification of average climate conditions, is difficult to be perceived accurately by local communities that rely on personal experience. Perceptions of climate change play a key role in shaping adaptation actions applied at the household level. Inaccurate perception of climate change could lead to the implementation of ineffective adaptation actions. These, coupled with the influence of gender roles in access, control of the resource, and decision making in climate change adaptation has the potential to derail efforts towards food security. This study, therefore, investigated perceptions of climate change and gender influence on climate change adaptation actions in Kajiado East and Central within Kajiado County in the arid part of Kenya and Kabete and Kikuyu within Kiambu County in the highland's region.

Primary data was collected using fourteen (14) key informant interviews, six (6) gendered focus group discussions, administering 312 household questionnaires, and observations. Secondary data included temperature and rainfall data for the period 1980-2017 obtained from The Modern-Era Retrospective analysis for Research and Applications, version 2 (MERRA 2) which is the latest global atmospheric reanalysis produced by the NASA Global Modeling and Assimilation Office (GMAO). Spatial and temporal characteristics of temperature and rainfall patterns in Kajiado and Kiambu counties were analyzed using time –series analysis. Chi-square test was applied in testing the statistical associations between variables ($p \leq 0.05$).

The study findings reveal high spatial and temporal variation in both temperature and rainfall patterns in Kajiado and Kiambu County, with Kajiado showing the increased minimum and maximum temperatures and rainfall variability manifesting through increased extended drought periods. There was an observed increase in minimum temperature trends in Kiambu County. The perception of the local communities on the minimum and maximum temperatures were in line with the meteorological patterns. The Chi-square test with the null hypothesis that the respondents' perception is not related to the actual observations at 0.05 significance level indicated all the p-values were below 0.05 significance which meant people's perceptions of the trends of both minimum and maximum temperature and the actual observations are similar in Kajiado and Kiambu Counties. The majority of the respondents perceived the onset for both the long rains (MAM) and short rains (OND) have gotten late.

The results further point to differentiated climate change-related effects on food security in Kajiado and Kiambu Counties. Kajiado County is more food insecure than Kiambu County leading to a dependency on food relief from donors after every drought cycle thus indicating high poverty prevalence among the majority of its population. Findings on climate change influence on gender indicated that women in Kajiado County have limited access to and control of critical resources including land and livestock, limited decision making in sell, and utilization of proceeds made from selling farm produce and livestock in comparison to women in Kiambu County.

Inaccurate perceptions of climate change by local communities, coupled with the influence of gender roles, impede achieving effective climate change adaptation actions. There is a need for extension of observational networks of weather stations to Sub-County level, improve awareness creation on climate change at the local level, adopt a new model of land sub-divisions to protect agricultural and pasture land and gender mainstreaming in climate change policies, projects, and plans at County and National level to enhance the effectiveness of adaptation actions and attain household food security.

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LIST OF ACRONYMS AND ABBREVIATIONS

(AGW)	Anthropogenic Global Warming
AEZ	Agro-Ecological Zones
AF	Adaptation Fund
AHDR	Africa Human Development Report
AR3	Assessment Report 3
AR4	Assessment Report 4
AR5	Assessment Report 5
ASAL	Arid and Semi-Arid Lands
AU	African Union
BAU	Business As Usual
CAADP	Comprehensive Africa Agriculture Development Programme
CC	Climate Change
CDF	Constituency Development Fund
CFCs	Chlorofluorocarbons
CIDPs	County Integrated Development Plans
COP	Conference of Parties
DJF	December, January, February
EAC	East African Community
EACCCP	East African Community Climate Change Policy
FAO	Food and Agriculture Organization
FGDs	Focus Group Discussion
FNSP	Food and Nutrition Security Policy
GAD	Gender and Development Theory
GBM	Green Belt Movement

GBV	Gender Based Violence
GCF	Green Climate Fund
GDI	Gender Development Index
GDP	Gross Domestic Product
GESIP	Green Economy Strategy and Implementation Plan
GHG	Green House Gases
GoK	Government of Kenya
HH	House-Hold
HOA	Horn of Africa
IGAD	Intergovernmental Authority on Development
IPCC	Inter Governmental Panel on Climate Change
JJA	June, July, August
KCRF	Kenya's Coffee Research Foundation
KII	Key Informant Interviews
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics
LATF	Local Authority Transfer Fund
MAM	March, April, May
MDG's	Millennium Development Goals
MERRA	Modern Era Retrospective-Analysis for Research and Applications
MTP III	Third Medium Term Plan
NAAIAP	National Accelerated Agricultural Input Access Program
NAP	National Adaptation Plan
NAPA	National Adaptation Plan for Actions

NASA	National Aeronautics and Space Administration
NASEP	National Agricultural Sector Extension Policy
NCCAP	National Climate Change Action Plan
NCCC	National climate change Council
NCCRS	National Climate Change Response Strategy
NCFP	National Climate Finance Policy
NDA	National Designated Authority
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Authority
NEP	National Environment Policy
NEPAD	New Partnership for Africa Development
NGAAF	National Government Affirmative Action Fund
NGO's	Non-Governmental Organizations
NIE	National Implementing Entity
NLP	National Land policy
NPGD	National Policy on Gender and Development
OND	October, November, December
QCARS	Qualitative Comparative Analysis-Based Research Synthesis
SDG's	Sustainable Development Goals
SID	Society for International Development
SON	September, October, November
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
UDHR	Universal Declaration of Human Rights

UN	United Nations
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNOCHA	United Nations Office for the coordination of Humanitarian Affairs
UNPD	United Nations Population Division
USAID	United State Agency for International Development
USDA	United States Department of Agriculture
WAD	Women in Development Theory
WCED	World Commission on Environment and Development,
WEFK	Women Enterprise Fund kitties
WFP	World Food Programme
WMO	World Meteorological Organization

OPERATIONAL DEFINITIONS OF TERMS

Adaptation refers to the process where natural or human systems adjust in response to actual or expected climate change consequences in order to reduce the likely damages while taking advantage of its opportunities (IPCC, 2007)

Climate Change refers to a permanent shift in global climatic patterns over several decades which can be assessed by use of statistical methods observing changes in the mean and/or the variability over a longer period of time usually decades. This can be attributed to natural variability or due to anthropogenic activities (IPCC, 2007)

Climate Variability refers to the short term shifting of the mean state of climate on all spatial and temporal scales beyond individual weather events (IPCC, 2014)

Meteorological drought refers to an extended period - a season, a year, or several years - of abnormal low rainfall relative to the statistical multi-year average for a region causing extensive damage to both flora and fauna (IPCC, 2014)

Agricultural drought is the interaction between climatic conditions and some other factors (e.g. increasing water consumption, variation in land use or low efficiency in the use of water) that lead to a strong decrease in agricultural production or to a worsening of product quality (Maracchi, 2000).

Food Security refers to a situation when exists when all people, at all times, have physical and economic access to sufficient safe and nutritious **food** that meets their dietary needs and **food** preferences for an active and healthy life (FAO, 1996).

Gender refers to socially constructed roles rather than biologically-determined differences. Responsibilities and opportunities associated with men and women which includes hidden power structures governing their relationship (Clancy et al., 2004).

Modern-Era Retrospective analysis for Research and Applications, version 2 (MERRA-2) is the latest global atmospheric reanalysis produced by the NASA Global Modeling and Assimilation Office (GMAO) undertaken to provide a timely replacement for MERRA and to sustain GMAO's commitment to having an ongoing near-real-time climate analysis (Gelaro et al., 2017)

Perception can be defined as the process by which humans receive information or stimuli from the natural environment and is transformed into psychological awareness. The assumption is that individual households first require to perceive change for them to decide on adapting to climate change or not (Silvestri et al., 2012).

Sustainable Development refers to development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

Vulnerability refers to the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007)

CHAPTER 1: INTRODUCTION

This chapter presents detailed background of the study, statement of the problem, objectives of the study, hypotheses of the study, justification of the study and organization of the study. The chapter introduces critical information on the linkage among perceptions of climate change, gender and adaptation actions.

1.1 Background of the Study

Human-related activities have been linked with observed warming since the 1950s (IPCC, 2007). Changing climate is considered one of the biggest 21st-century threats due to increased climate extremes including extended droughts, floods, heatwaves, and rising sea levels (IPCC, 2007; Parry *et al*., 2007; Verner, 2011). Food production at the global level has been predicted to be significantly threatened by the continuously changing climate thus undermining efforts towards food security. Increased climate change-related temperatures are predicted to contribute to increased disease-causing vectors leading to a reduction of nearly 20% in the growing seasons of critical food crops by the end of the century. For example, beans production is predicted to reduce by nearly half leading to increased food insecurity especially for beans growing regions of the world (Ortiz, 2012). The vulnerability of agriculture is very critical to global food security since the sector is dependent on people in their millions especially the poor rural populations who lack adaptation capacities thus exacerbating an already precarious food insecurity situation (IPCC, 2007; Keane *et al*., 2009).

The special report by IPCC in 2018 indicated that the anticipated impacts and costs of 1.5 degrees rise in global temperatures will be greater than the assumed previously hence the need to speed up measures of cutting back greenhouse gas emissions (de Coninck *et al*., 2018). Worst negative impacts have been predicted to affect most rural farmers in the developing world due to the high prevalence of poverty, poor infrastructure, technology and most importantly over-reliance on rain-fed agriculture which accounts for nearly 95 percent of agricultural production in the region (Ericksen *et al*., 2011; Zake and Hauser 2014; Adimassu and Kessler, 2016). Africa is expected to experience more warming than many regions in the world and faces significant challenges in achieving its development targets (Pachauri *et al*., 2014; Thornton *et al*., 2008). With changing climate, a population estimate of seventy-five million to two hundred and fifty million people are likely to experience a shortage of water and agricultural output reduced by half in Africa by the year 2020 with the application of existing production systems. Agricultural droughts continue to aggravate food insecurity situations in 34 African countries.

Also, Conflict, displacements and food supply constraints in some countries such as Niger, Central Africa Republic, Burundi and Somalia coupled with outbreaks of desert locusts especially in East Africa and the Horn of Africa has led to reduced livestock and agricultural production threatening food insecurity (FAO, 2020).

The perception of local communities on climate change is critical to the kind of adaptation options they undertake. Their knowledge and understanding of climate patterns including rainfall patterns, distributions, and the resultant effect on their livelihood vary from that of the scientific approach of establishing climate trends (Dahlberg and Blaikie 1996; Thomas *et al*., 2007; Blennow and Persson 2009; Arbuckle Jr *et al*., 2013; Simelton *et al*., 2013; Boissière *et al*., 2013). Therefore, many studies, especially in Africa, have called for a deeper climate change impact and local communities' perceived climate variabilities assessments (Nyasimi *et al*., 2013; Jarawura, 2014; Tschakert *et al*., 2014; Mubiru *et al*., 2015; Van Griensven *et al*., 2016). The perception of local communities on climate change and climate variability in several cases is generally consistent with actual climate patterns (Maddison, 2007; Eriksen and Lind 2009; Silvestri *et al*., 2012; Adimassu *et al*., 2014). However, there were other instances where inconsistencies have been recorded, for example, Bryan *et.al*., 2013, found farmer's perception of long-term changes in rainfall and temperature was not in line with observed climate data from nearby weather stations. Also, a study on farmer's perceptions of climate change and adaptation of agriculture in Pakistan found farmers perceptions of rainfall were not consistent with actual climate patterns in the country (Abid *et al*., 2019).

Climate change impact will intersect with societal variables such as gender, ethnicity, class, and race (IPCC, 2014). To sustain themselves people, utilize their physical environment, economic, political, and social-cultural resources. However, these systems have different levels of vulnerabilities depending on the status of individual gender in relation to the system. People who are already poor and marginalized in access to resources, political representations, and/or due to socially constructed roles are likely to have fewer adaptation options in comparison to individuals who are at an advantageous stage in relation to the systems in place (Mitchell *et al*., 2007). Social barriers have a bearing on the capacity of an individual to adapt, limit behavior, and contribute to maladaptation (Lindsey, 2010).

The gender equality concept can take different definitions due to differences in struggles, contexts, and political histories hence different meanings (Lombardo *et al*., 2009). Gender in the context of climate change means the different ways men and women contribute to changing climate through their normal way of earning a living and the differentiated climate change impact on gender, these include different approaches applied by both genders in creating resilience against its impacts on their livelihood sources (Ontita, 2007).

The African Union recognizes gender mainstreaming in all critical sectors as a prerequisite to attaining Sustainable Development Goals in the continent. With a changing climate, there is a need for a particular focus on women empowerment so that their input forms part of resilience-building strategies employed at the local, national, and regional levels. The promotion of gender parity is among the goals of the African Union as envisaged in article 4 (L) of the Constitutive Act.

IGAD's (Intergovernmental Authority on Development) Environment and Natural Resource Strategy considers ''adherence to gender sensitivity and equity'' as one of its critical principles in attaining Sustainable Development in the region. The East African Community Climate Change Master Plan 2011-2031 recognizes the disproportionate vulnerability of marginalized groups including women to climate change and thus recommends practical mainstreaming of gender in individual countries' local and national development policies.

Food systems determine the food security situation of any society or nation. The food system's productivity and efficiency from availability, accessibility, utilization, and nutrition status contribute significantly to addressing the shortage of food across the globe. However, climate change has become a serious challenge to the efficiency and productivity of the food systems. There is extensive literature that supports the link between climate change and agricultural production (Bergamaschi *et al*., 2010; Cherry *et al*., 2004; Hulme *et al*., 2001). Projections point to likely increased drought periods and a resultant decline in crop yields and herd sizes thus pushing more people into poverty (Bergamaschi *et al*., 2001).

In the last few decades, Kenya has experienced climate change-related increased frequency and intensity of floods and droughts leading to high crop failure and livestock deaths (GOK, 2010, 2013). The number of people categorized as food insecure during the years 2009 and 2010 was estimated to be 3.8 million with many from the ASAL part of the Country. During the 2011

long drought, the number of people facing food and nutrition insecurity increased to 10 million leading to dependence on Government and donor support (GoK, 2011; GoK, 2013).

Gender aspects of perception of climate change are important to understand because men and women may have different perceptions of climate change-related shocks due to gendered experiences. Several studies had been undertaken to shed light on the perception of women and men in relation to different stresses and how they react. Women have more concern than men on matters relating to environmental problems posing safety and health risks to their local communities. On issues of general environmental concern posing no risk to society, the gender difference has been observed to be less but still, women maintained more concern in comparison to their male counterparts (Mohai, 1992; Greenbaum, 1995; Davidson and Freudenburg 1996; Blocker and Eckberg, 1997).

According to Brody *et al*. (2008), due to differences in education level, access, and control of resources and decision-making powers, women and men experience their environmental, social, and economic realities in different ways. This will not only have an impact on the adaptation capacity of the individual but also their needs and interests. Due to gender dynamics, knowledge is less homogenous within a given population but varying according to respondents thus introducing gender-based variations in perception and knowledge on climate change among women and men farmers (Blaikie *et al*., 1997). Kung and Chen (2012) observed higher scores by female respondents on the personal impact of earthquakes in comparison to men in studying perception on the risk of earthquakes in Taiwan. Extending the gendered perceptions into the climate change realm means women perceive the threat of climate change better than men and are therefore more naturally inclined to combat it. Appreciating gender in climate change is recognizing the need to bring onboard experiences and perspectives of both genders in developing effective adaptation strategies (Kaijser and Kronsell, 2014). The need for gender mainstreaming in climate change adaptation and mitigation has been recognized (Denton, 2002; Terry, 2009; Djoudi and Brockhaus, 2011).

To address the climate change threat, Kenya has adopted several policies and frameworks which facilitated the establishment of climate change governance structures in the country. The basis of climate governance structures stems from existing international, regional, and national climate change obligations including UNFCCC, Africa Climate Change Strategy, Agenda 2063, East Africa's Climate Change Policy, The National Climate Change Act (2016), the

National Climate Change Action Plan (NCCAP) 2018-2022 among others. However, the existence of climate change policies doesn't guarantee to attain optimal adaptation strategies that enhance the resilience of individuals, farmers, pastoralists, or households. Agriculture (livestock included) being crucial for Kenya's economy, its susceptibility to climate change could cost the country US$500 million a year (2.6 percent of the country's GDP). This coupled with inaccurate perceptions of climate change and the inability of women to make decisions, biased labour divisions, and lack of access and control of critical resources including land and livestock have the potential to reduce household's capacities to effectively adapt to changing global climate.

1.2 Statement of the Problem

The perception of climate change plays a role in the choices of climate change adaptation actions applied. Local communities do not always perceive climate change accurately, leading to the application of ineffective adaptation actions negatively impacting household food security. The local's inability to perceive climate change accurately is due to dependence on traditional approaches to making sense of climate variability that varies from the scientific methods of establishing climate trends including, rainfall and temperature patterns (Arbuckle Jr *et al*., 2013; Blennow and Persson 2009; Thomas *et al.*, 2007). The community in Kajiado County is generally known to apply traditional approaches of forecasting by observing the clouds, wildlife and livestock behavior, lightning, among others. However, the increased rate of climate variability related to climate change has increasingly made it difficult to accurately perceive rainfall and temperature patterns that keep on shifting in the last few decades. Local communities are not able to spot small variations within rainfall seasons or changes in mean temperature leading to inaccurate perceptions of climate change.

Inaccurate perceptions of climate change coupled with the influence of gender roles rooted in patriarchal systems curtailing women's ability to access and control critical resources such as land, livestock, technology, credits among others undermine the success of climate change adaptations applied (Gbetibouo *et al*., 2010b; Perez *et al*., 2015). In Kenya, many communities are patriarchal in nature include the *Kikuyu* and *Maasai,* the majority of the residents in Kiambu and Kajiado Counties, respectively. Women's knowledge, skills, and unique experiences are not utilized fully in adapting to climate change due to lack of access and control of critical resources, biased labour divisions, and limited decision making. Although gender equality is enshrined in Kenya's constitution and several other gender-related policies exist, a huge gender

parity gap is still evident in many sectors including education, employment, and microfinance access (Chege, and Sifuna, 2006; Suda, 2002).

Kenya has enacted climate change policies including the climate change act 2016. However, the existence of policies does not guarantee an automatic solution to addressing climate change in the country. With climate change negatively impacting the majority of smallholder rural farmers who sometimes have difficulties perceiving climate change accurately due to lack of education, information coupled with the influence of gender roles in climate change adaptation, efforts towards sustainable development goals and vision 2030 is undermined. Therefore, it is critical to investigate the perception of climate change and gender influence on climate change adaptation actions. Such information is crucial for policymakers in planning and mitigating climate change and gender disparity threatening the achievements of vision 2030 and sustainable development goals.

1.3 Study Objectives

The overall objective of the study was to investigate perceptions of climate change and gender influence on climate change adaptation actions in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County.

1.3.1 Specific Objectives

i. Analyze the monthly rainfall and temperature patterns over Kiambu and Kajiado Counties.

ii. Examine local communities' perceptions of climate change in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County.

iii. Evaluate the effects of climate change on household food security in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County.

iv. Assess the role of gender in climate change adaptation actions in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County.

1.4 Research Questions

i. How has the temporal characteristics of rainfall and temperature over Kiambu and Kajiado Counties been changing?

ii. To what extent are local communities' perceptions of climate change over Kiambu and Kajiado Counties in line with climate patterns?

iii. How much has climate change affected food security in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County?

iv. To what extent has climate change adaptation actions been impacted by gender in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County?

1.5 Justification

Agriculture is a critical sector for Kenya's economy, directly accounting for a GDP of 26% and 27% indirectly because of linkages with other economic sectors of the Country. It contributes 65% of earnings from exports while employing nearly 68% of rural Kenya populations. Also, livestock production contributes 12% to the GDP and employs 50% of the agricultural labor force (GoK, 2013). The agricultural sector remains susceptible to temperature and rainfall variability related to climate change coupled with rapid urbanization and a high population growth rate reducing available productive lands. Kenya has experienced recurrent droughts causing severe livestock and crop losses from the years 1983, 1992, 1996, 1998, 2005, 2008-2011among others. The ASAL region covering 80% of Kenya's landmass bore much of the brunt pushing millions into poverty. The 2008-2011 drought remains the worst drought leading to estimated total losses of at USD 12.1 billion and slowed down Kenya's GDP by an average of 2.8% every year (GoK. (2016).

The inaccurate perception of climate change coupled with the influence of gender roles increases the burden on the majority of smallholder rural farmers that grapple with climate change already leading to household food insecurity. The outcome of this study will help planners and policymakers understand local communities' perceptions of climate change in relation to climate trends and the influence of gender roles on climate change adaptation actions at the County and National level by providing updates on the status of climate change awareness and the influence of gender roles in climate change adaptation. This will lead to practical mainstreaming of climate change and gender in County and National development plans and programmes so that efforts towards the achievement of vision 2030 and many

sustainable development goals including No Poverty, Zero Hunger, Gender Equality, Reduced Inequality, Sustainable Cities and Communities and Peace, Justice, and Strong Institutions are not hampered

1.6 Organization of the Study

The thesis is presented in 5 chapters. Chapter one of the study is the general background, statement of the problem, the objective of the study, research questions, the justification for undertaking the research. Chapter two contains a detailed literature review on temporal characteristics of rainfall and temperature patterns, local community perception on climate change-related rainfall and temperature patterns in Kajiado and Kiambu, and climate change policies, effects of climate change on food security in Kajiado and Kiambu Counties and food security policies, gender and climate change adaptation in Kiambu and Kajiado Counties and gender policies. Chapter three contains the research methodology. The chapter shows the process involved in the collection of data, processing, and analyses of the data. Chapter four of the research gives results and discussion of all the four objectives. Chapter five presented the study's conclusion and recommendation.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter discusses previous studies on temporal characteristics of rainfall and temperature patterns, local community perception on climate change-related rainfall and temperature patterns, climate change effects on food security, influence of gender on community climate change adaptation actions in Kajiado East and Central in Kajiado County and Kabete and Kikuyu in Kiambu County. Under each section enabling policies and regulatory frameworks were discussed for example international, regional and national climate change policies, food security policies and gender policies. The existence of polices doesn't guarantee optimal climate change adaptation, achievement of household food security or gender equity since there are other critical aspects that can impede achievement of effective climate change adaptation actions such as inaccurate perception of climate change and gender roles.

2.1 Temporal characteristics of temperature and rainfall

2.1.1 Temporal characteristics of temperature and rainfall over Kenya

Climate change-related global temperature and rainfall variations have occurred across the globe (Kakota *et al.*, 2011; IPCC, 2014). The climate of Africa, Kenya, included is highly diverse due to the influence of three drivers including, the El Nino-Southern Oscillation (ENSO), the Inter-Tropical Convergence Zone (ITCZ), and the West African Monsoon. Warm climate dominates most of the region with varying rainfall amounts from one part of the continent to another.

East Africa region faces climate change-related adverse effects devastating livelihoods with greater uncertainties in rainfall projections (Van de Steeg *et al.*, 2009). Increasing poverty levels remain one of the major threats towards achieving climate solutions. This is because the majority of these populations are dependent on the natural environment to earn a living. Forests remain a major source of water, wild fruits, firewood, medicinal plants, and spiritual homes among others. Therefore, the argument of protecting, conserving, or increasing carbon sinks doesn't remain a priority for millions of these populations living in abject poverty. This requires a recognition of the fact that stabilization of the climate cannot be achieved without critical consideration of the role of poverty in entrenching the climate crisis especially in the less developed world where the majority of the global forests are located. Poverty reduction in the less developed world and finding climate change solutions remain two of the most critical goals

under the Sustainable Development Goals although they remain major challenges (Ribot *et al.*, 1996). There have to be deliberate global, regional, and national policies that integrate the issue of poverty reduction in the climate change solution debate. Massive investments in cleaner energies and investments in adaptation and capacity building for these vulnerable communities are needed. Climate change adaptation strategies that led to poverty reduction and mitigation of changing climate include promoting agroforestry, sustainable land use management, irrigation, livelihood diversification among others (Locatelli, 2016). Importantly, more focus should be given to smallholder farmers who make up the majority of the poor that remain most susceptible to climate change shocks. Unfortunately, many times they are not prioritized by institutions for example, in Kenya, agricultural extension workers tend to focus more on large-scale coffee and tea producers than the smallholder farmers that are mostly involved in horticultural farming. Such gaps in interventions undermine efforts towards enhancing their capacities and achieve household food security. Since the region's climate is predominantly dry tropical and sub-tropical, it remains a major challenge for the agricultural sector which dominates much of the continent's livelihood base. The susceptibility of agriculture stems from its dependence on natural rainfall. This is further made worse by low adaptive capacities, poor technologies, successful diversification of food reserves, and poor disaster risk management thus exposing the vulnerability of majority smallholder farmers in the continent (Shiferaw, 2014; Osbahr, 2010; Schelling, 1992). Entire economies of many countries in Sub-Saharan Africa including East Africa remain at the mercy of shifting rainfall patterns that are only getting worse in the last few decades thus becoming a stumbling block to addressing the high prevalence of poverty (Connolly-Boutin and Smit, 2016; FAO, 1999).

Kenya is divided broadly into 7 Agro-Climate zones with differing characteristics in humidity, rainfall, vegetation cover, livelihood systems supported among, others as shown in the Table 1. Agro-climatic zones I–III receive a high level of precipitation and are considered high potential regions capable of supporting agricultural and livestock production. They account for 12% of the country's landmass. Agro-ecological/Agro-climatic zones IV-VII are considered as semi-humid to arid (marginal areas) as a result of low agricultural productivity potential and make up over 80% of the country's total landmass (Mati, 2000). Different livestock production and cropping systems are supported by different Agro-climatic zones depending on the required suitable climatic conditions.

Table 1: Agro-climate zones a in Kenya

Zone	*Moisture index (%)*	Climate classification	Average annual rainfall (mm)	Average annual potential evaporation (mm)	Vegetation	Farming system
I	>80	Humid	1100-2700	1200-2000	Moist forest	Dairy, sheep, coffee, tea, maize, sugarcane
II	65-80	Sub-humid	1000-1600	1300-2100	Moist and dry forest	Maize, pyrethrum, wheat, coffee, sugarcane
III	50-65	Semi-humid	800-1400	1450-2200	Dry forest and moist woodland	Wheat, maize, barley coffee, cotton, coconut, cassava
IV	40-50	Semi-humid to semi-arid	600-1100	1550-2200	Dry woodland and bush land	Ranching, cattle sheep, barley, sunflower, maize, cotton, cashew nuts, cassava
V	25-40	Semi-arid	450-900	1650-2300	Bush land	Ranching, livestock, sorghum, millet
VI	15-25	Arid	300-550	1900-2400	Bush land and scrubland	Ranching
VII	<15	Very arid	150-350	2100-2500	Desert scrub	Nomadism and shifting grazing

Source: Kabubo-Mariara and Karanja (2007)

In Kenya, mean temperatures are closely associated with elevation of the ground. The Northern part of the region recorded the highest temperatures during the rainy seasons, with minimum night time temperatures rising as high as 29°C. The West part of Lake Turkana and the region bordering the Somalia coast have been found to experience the recorded rises in temperatures. Mountain tops have recorded coldest regions in Kenya with frost occurring heights above

10,000 feet and ice cover occurring areas above 16,000 feet. Although Kenya has experienced temperature variations especially, since the 1960s, evidence shows this variation especially annual temperatures have remained less than 5°C. Since the 1960's average temperatures in Kenya has risen by 1 degree Celsius. Although the North-eastern part of Kenya is associated with extreme conditions, increased warming has been found to make it worse with both minimum and maximum temperatures increasing. The region has experienced a maximum day time temperature rise of between 1.3ºC–0.1 ºC and minimum night-time temperatures rise of between 1.8–0.7 ºC thus devastating already fragile livelihoods. The Coast region witnessed a rise in maximum temperatures with nights and early morning becoming more cooler and day time temperatures getting hotter (Kenya, 2010). The western part of the country has experienced a rise in maximum daytime temperatures of between 2 ºC –0.5ºC between 1960 and 2006 and minimum night-time temperatures of between 2.9– 0.8ºC. The greater Central part of Kenya has also witnessed variability in both minimum and maximum temperatures during the day and night leading to losses in crop production. According to the National Climate Change Response Strategy (NCCRS) 2010, Central Kenya has experienced a rise in maximum day time temperature of between 0.7- 0.1 ºC and minimum night temperatures of between 2.0-0.8 ºC.

Kenya's climatology is considered highly varied including precipitation distribution and intensity. Bimodal rainfall is the major type of rainfall received in the country with short rains starting between October and December while the long rains occur from March to May of every year (Kisaka *et al*., 2015). Inter-Tropical Convergence Zone (ITCZ), El Nino South Oscillation (ENSO), jet streams, Indian Ocean Dipole (IOD) influence annual and seasonal rainfall patterns in Kenya as well as monsoon winds (Ogwang *et al*., 2014; 2015; Ongoma, *et al*., 2015). Annual rainfall variability has also increased where a decline in MAM and an increase in OND has been observed (Kenya, 2010). Also, the amount of rainfall is reducing in comparison to the early 1960s where the intensity was better, although there are some regions in the country which registered increased trends of rainfall from the 1960's -2001. In the Western part of Kenya, evidence points to increased annual rainfall trends of about 2.3 mm/year since the 1960s to early 2000. In the lower Eastern part of Kenya, high variability of rainfall intensity and distribution from year to year has been experienced. This has put pressure on smallholder farmings who remain susceptible to unpredictable annual and seasonal rainfall variabilities (Omoyo *et.al* 2015).

In recent decades, Kenya has experienced frequent droughts especially in the larger Arid and Semi-Arid part of the country which makes up for more than 80% of the total land in Kenya. Although there have been other droughts such as the 2009 drought, the 2010-2011 drought has been considered to be one of the worst extended drought periods that have devasted local communities' livelihood causing severe humanitarian crises (Mosley, 2012; Lott et al., 2013). The 2010-2011 drought has been associated with failures of both the 'short rains' and 'long rains' registering precipitation with a standard deviation less than -1, which translate to a drought threshold with adverse negative impacts especially on crop and livestock production (Okoola, 1999; Orindi *et al* 2007; Koumare, 2014).

2.1.2 Temporal characteristics of rainfall and temperature over Kajiado and Kiambu Counties

Kajiado County falls under Arid and Semi-Arid Regions of Kenya with high climate variability especially rainfall patterns which are bi-modal types (Kamau *et al*., 2018). It falls under Agro-Climatic zones IV to V with annual rainfall falling between 500 mm to 800 mm. Rainfall is very critical to the livelihood system supported due to its influence on the availability of water and pasture. Rainfall in Kajiado County ranges from less than 300 mm in the Amboseli basin to higher rainfall patterns of about 1250 mm in the slopes of Mt. Kilimanjaro and Ngong hills. The long rains occur between the months of March and May while the short rain onset begins between the months of October and December. However, the patterns of both the long and short rains have been observed not to be uniform within the County with some parts receiving more rainfall than others. The eastern part of the County experiences rainfall during the October-December short rains seasons while the western part experiences rainfall mostly during March-May long rains season. (Kajiado County Integrated Development Plan 2013-2017).

The County has experienced a wide range of rainfall anomalies over the periods which can be attributed to changing climate. Observations indicate low annual rainfall in the years 1973, 1975, 1981, 1984, 1999, 2000, 2004, 2007, 2008 and 2011. The trends are consistent with what was observed by ICPAC (2007), Amwata (2013), and Opiyo (2014) in the ASALS regions of Kenya. Increased climate change-related extended drought periods have pushed the major livelihood base, pastoralism to the limit. Recurrent climate shocks coupled with land privatization, lack of effective natural resource management mechanisms continues to put both the human and livestock population in Kajiado County at a great disadvantage. Other than a

shortage of rainfall, increased land fragmentation due to activities such as illegal sand harvesting, charcoal burning, and tree felling disrupts available traditional grazing lands thus pushing the majority of the herders from the Maasai community to migrate to nearby Counties or Tanzania in search of water and pasture (Homewood *et al*., 2009).

In Kajiado County, there has been observed temperature variability with season and altitude (Bobadoye *et al*., 2016; Kamau *et al*., 2018). The lowest temperature of about 10° C has been recorded in areas around Loitoktok, eastern slopes of Mt.Kilimanjaro while the highest temperatures within the County have been recorded to be about 34° C near Lake Magadi. Although climate change-related increase in warmer temperatures has been observed recently, the period between July and August remains the coolest months with November and April recording the warmest months within the County.

Future climate projections for Kenya shows by the year 2050, temperatures will rise to 1-5 °C (Kenya, 2010). Conditions are likely to get worse with areas such as Kajiado County bearing the heaviest brunt since the county is among ASAL regions known for less rainfall and high temperatures (Downing *et al*., 2008). In 2011, ASAL regions including Kajiado were affected by the worst drought in 60 years which led to massive loss of livelihoods for nearly 40% of Kenya's population (Bobadoye *et al.,* 2016). The extended drought situation has led to increased movements of pastoralist searching pasture and water. This creates tensions between pastoralists such as Maasai, Turkana, Samburu, and also with neighboring farming communities in competition for resources. It has also led to post-harvest losses due to climate change-related increased pests and diseases in parts of the Eastern region of Kenya (Recha and Omondi, 2012).

Kiambu County experiences a bimodal type of rainfall. The short rains usually occur between the months of October to November or early December (OND). The long rains occur between the months of March to May (MAM). The period between MAM and OND is usually accompanied by frosts and small drizzles from the month of June to August. The amount of rainfall received in a given year is determined by altitude, with low lying areas receiving precipitation levels as low as 600 mm while areas of higher elevations have been found to receive precipitation levels as high as 2,000 mm. The position of a region in relation to winds bearing rainfall has been found to influence rainfall sum in different areas. For example, Nyeri County in the Central part of Kenya receives a rainfall amount of 737 mm a year while Meru

County located on the slopes of Mount Kenya receives 1320 mm of rainfall each year making it one of the very high potential agricultural zones in Counties falling under Agro-Climatic zones 1-III. Although much of Kiambu County is considered high potential due to conducive climatic conditions, areas including Ndeiya, Karai, and Thika town are have faced climate change-related drought periods thus affecting farming activities (Kiambu County Integrated Development Plan 2018-2022).

Kiambu County's mean temperature is 26°C with areas including Gatundu South, Githunguri, Gatundu North, Kabete, and upper highlands of Limuru experiencing low temperatures ranging from 7°C while areas including Kikuyu, Thika town, Kabete, and Limuru experiencing temperatures reaching as high as 34°C (Kiambu County Integrated Development Plan 2018-2022). Temperature changes have affected crop potential, an example being low temperatures leading to frost affecting the tea estates of Kiambu. In 2013, the tea sector injected $1.3 billion to the country's economy although an unreliable rainfall pattern is threatening not only foreign exchange earnings but also millions of small-scale farmers. Due to climate variability, nearly one – third of the harvested tea was lost in 2012 (Kenya Tea Research Institute, 2012). Also, the increased climate change-related temperature changes have resulted in the resurgence of malaria especially in the highlands of Kenya including Kiambu County from the 1980s onwards (Pascual *et al*., 2006).

Climate variability is making crop management a nightmare for farmers in the coffee-growing zones of Kenya. Coffee is ideal for temperatures around 19-25 degrees (Celsius) and maintaining the narrow temperature range has proven difficult for coffee producers (Jaramillo *et al.,* 2011). This leads to a significant economic loss for coffee farmers who export their products outside the countries. Increased pest and diseases associated with extreme temperatures which favor disease-causing vectors have become prevalent. Intermittent rainfall in the 2007/08 crop year resulted in disease in coffee berry thus reducing national coffee production by 23 °C to 42,000 metric tons. According to Kenya's Coffee Research Foundation (CRF), the rains caught the coffee farmers off guard leading to the losses.

2.2 Perceptions of local communities on climate change-related rainfall and temperature patterns

Climate change is viewed differently by different people. It can be presented as both a physical and social phenomenon which means they take very different meanings (Hulme,2009). The physical aspect of climate change relates to climate science where the changes are observable,

quantifiable, and measurable as well. On the other hand, the social aspect relates to human's role as active agents in reshaping the physical climatic conditions, mediated by political, social, cultural, and ethics, resulting in different interpretations of climate change phenomenon. Therefore, depending on the individual, one's priorities, and situation, the concept or idea of climate change can carry different interpretations and may mean a different course of action altogether.

There are two scientific ways of measuring weather data and they include using observations from weather stations on the ground and the use of satellite. A comparative study of data from weather stations and data from satellites has shown slightly comparable climate data from both approaches. However, the application of satellites in measuring temperatures in Brazil, the US, and India has been found to be more efficient and accurate in comparison to data from weather stations. This has been attributed to the satellite's advantage of having a perfect view of the ground or landscape in comparison to weather stations. Equally, weather stations have been found to measure rainfall patterns more accurately but can be limited in the sense that it can only cover a certain geographical scope. Also, operating ground weather stations can be very expensive in terms of demand to continuously record measurements and also the maintenance of the equipment used (Mendelsohn et al., 2007).

The majority of developing countries have a limited number of weather stations due to the aforementioned factors besides shortage incapacity to operate reliable and efficient weather stations. Therefore, satellite technology provides a great opportunity for developing countries that continuously find difficulties relying on weather station data to accurately predict climate patterns and make informed decisions. With satellite technologies, there is potential to predict droughts, famines, floods, forest fires in a cost-effective and timely manner (Reichle et al., 2017; Mendelsohn et al., 2007). This is very critical for developing countries including Kenya, where disaster risk management efforts are known to be reactionary instead of proactive leading to losses especially through forest fires and flooding.

Smallholder farmers remain most susceptible to the negative impacts of climate change and they already perceive climate change and are adapting in different ways possible depending on the availability of options determined by socio-economic and environmental factors (Maddison, 2006; Thomas *et al*., 2007; Mertz *et al*., 2009; Sampei and Aoyagi-Usui, 2009; Ishaya and Abaje, 2008; Hassan and Nhemachena, 2008). Nearly 80 percent of smallholder

farmers tend to be found in areas with erratic rainfall and infertile soils. High population growth rates, poverty, poor and inadequate technologies coupled with increased climate change-related shocks such as extended drought periods, increased pests and diseases, floods remain major threats to developing effective ways of adapting to the perceived changes (Muzari *et al*., 2012). This is a bigger challenge since smallholder farmers make the majority of those involved in agriculture across Sub-Saharan Africa contributing to National Gross Domestic Products while reducing household food insecurity and poverty.

The natural variations in climatic patterns from daily, month to month, and year to year are not straightforward to understand for many among the public leave alone human-related climate change which sometimes takes different forms such as small variations that can be visible through meteorological studies/scientific data. Studies indicate people's perceptions of climate change are mostly informed by their experience of climate change-related phenomena such as flooding events, a storm, or an extended drought period (Hansen *et al*., 2012; Rabe and Borick, 2012). Indigenous communities have historically co-existed with natural ecosystems and remain critical to enhancing the sustainability of these ecosystems. They are mainly dependent on the natural environment for livelihood and thus consider conservation and preservation of the ecosystems as part of protecting their main livelihood bases. However, climate change remains the biggest threat to the sustainability of the natural ecosystems and their livelihood due to increased climate shocks such as floods, droughts, storms, forest fires, and heatwaves among others. The interpretation of climate change and the reaction of these communities remains different from traditional approaches to understanding climate change and also adapting to it. They use traditional methods to understand climatic variations and depend on indigenous knowledge to improve their resilience which can be used together with scientific approaches to attain effective and widely accepted climate change adaptation measures. According to Doss and Morris (2001), the perspective of local communities on climate change, their adaptation approaches rooted in traditional knowledge and their general values towards nature can be useful to contribute towards getting a solution for climate change.

There has been observed consistency between meteorological data and local communities perceptions of climate variabilities (Maddison, 2007 Silvestri *et al*., 2012; Eriksen and Lind, 2009; Adimassu *et al*., 2014) for example, a study by Nhemachena and Hassan (2007), in a micro-level analysis of farmers' adaptation to climate change in Southern Africa indicated that the local communities perceived their region was getting drier and warmer with increased

drought phenomenon and reduced rainfall affecting crop production. Climate patterns of rainfall and temperature in the same location were found to support farmers' perception of climate change-related rainfall and temperature variabilities. A study by Nyanga, *et al*. (2011), on smallholder farmers' perceptions of climate change and conservation agriculture in Zambia indicated perceived shifts in the timing of seasons, climate change-related increased temperatures, extended drought periods, and also floods in their region. According to the perception of the respondents from the study, the most common causes of changing climatic conditions in their region was due to supernatural forces. The majority of the farmer's perceived climate change-related changes in the rainy seasons more than other seasons, with the observed reduction of rainfall seasons and increased variability in time, intensity, and distribution. Also, a study by Legesse *et al*. (2013) on smallholder farmers' perceptions and adaptation to climate variability and climate change in Doba district, west Hararghe, Ethiopia found that the perceptions of smallholder farmers on climate change in their region indicated unified perceived climate change and variability. One of the possible explanations is that a shift from idiosyncratic risk (also referred to as unsystematic risk is one that has no relation with overall risk in the market) to covariate risk (happens when a single event such as natural disasters affects people or households in one region) as a result of climate change might have led to unified local community' perceptions instead of the prevalence of multiple perceptions and varying insights among rural households.

On the other hand, the perception of smallholder farmers or local communities on changing climatic conditions can sometimes be in contrast with evidence provided by scientific data. Cases where the perception of local communities was reported to been inconsistent with historically recorded climate data included, Mwalusepo *et al*. (2015) observed farmers in Machakos County perceived decreasing rainfall trends which was inconsistent with historical data on rainfall in the area. Also, Bryan *et al*. (2013), found farmers' perception of long-term changes in rainfall and temperature was not in line with observed climate data from nearby weather stations. Increased temperature affects the availability of water in a region leading to the incidence of droughts which the local communities can observe due to its negative impact on their livelihoods. However, it is not easy for them to spot small variations within the seasons because they pay much attention to the productivity of their livestock and farming output. This means if productivity in either of them reduces even when there is no serious drought, they are likely to perceive the existence of drought. Previously, local communities heavily relied on

traditional methods of forecasting the climate but the increased rate of climate variability is making it difficult to depend on the traditional approaches of forecasting (Amwata, 2013).
To address the challenges of climate change, Kenya has adopted several policies and frameworks which facilitated the establishment of climate change governance structures in the country. The basis of climate governance structures stems from existing international and regional climate change obligations including UNFCCC, Africa Climate Change Strategy, Agenda 2063, and East Africa's Climate Change Policy. In line with these commitments, Kenya chose a low carbon climate-resilient development pathway as the road map to achieve its development targets. In Kenya, climate change adaptation has policy enablers, for example, The National Climate Change Act (2016) which is aimed at providing the regulatory framework for addressing climate change and foster resilience at National and County levels through mainstreaming of climate change into both plans (County and National). Through the act, a National climate change Council (NCCC) has been established which is chaired by the President. It also established a Climate Change Directorate as the lead designated National entity tasked with coordinating actions on climate change.

The National Environmental Management Authority (NEMA), is the National Implementing Entity (NIE) while the National Treasury is the National Designated Authority for the GCF. It requires all County Government's County Integrated Development Plans (CIDPs) to effectively mainstream climate change and establish climate change departments/units at County levels. The climate Change Act 2016 recognizes that addressing climate change requires a multi-disciplinary approach hence emphasizing the importance of all stakeholder involvement including public, National government, County Governments, and private sector. Also, the National Climate Change Action Plan (NCCAP) 2018-2022 is an important five-year plan which aims to further the Country's development agenda by providing mechanisms to gear the economy towards low carbon climate-resilient development pathway by focusing on adaptation and resilience enhancement of most susceptible groups including women, children, youth, the elderly, disabled persons and marginalized communities. The aforementioned five-year plan will be achieved by aligning with the government development blueprint including the big four agenda made up of food security, manufacturing, affordable housing, and affordable healthcare for all. Advocate for all stakeholder's participation including, civil society, the private sector, and all vulnerable people including women, older members of society, disabled persons, children, and youth across the Country.

However, the existence of climate change policies doesn't guarantee to attain optimal adaptation strategies that enhance the resilience of farmers because individuals, households, and community level social-cultural dynamics such as the perception of climate change and gender can become a hindrance to developing effective climate change adaptation strategies. The literature points to the fact that Climate change impact will intersect with societal variables such as gender, ethnicity, class, and race (IPCC, 2014) Gender roles affect community climate change adaptation capacities since they influence land ownership, access to climate information, credit, technology, and literacy. To sustain themselves, people utilize their physical environment, economic, political, and social-cultural resources. However, these systems have different levels of vulnerabilities depending on the status of individual gender with the system. People who are already poor and marginalized in access to resources, political representations, and/or due to socially constructed roles are likely to have fewer adaptation options in comparison to individuals who are at an advantageous stage with the systems in place (Mitchell *et al*., 2007). Social barriers have a bearing on the capacity of an individual to adapt, limit behaviour, and contribute to maladaptation (Lindsey, 2010).

Climate scientists and practitioners, therefore, consider the perception and knowledge of rural farmers on climate change and their capacity is not sufficient to develop effective adaptation strategies and achieve food security. The natural environment is already constrained by overpopulation, urbanization, and climate change has exacerbated the situation by increasing poverty levels which in turn puts more pressure on the limited environmental resources. Sustainable Development contends natural resource utilization requires consideration of sustainability as an important aspect. The present generation should meet their needs without compromising future generation's needs (World Commission on Environment and Development, 1987). Sustainable Development Goals (SGD's) acknowledge the need to sustainably utilize natural resources for benefit of all. Overexploitation of resources such as productive arable land risk leading to a reduction in agricultural production potential hence contributing to food insecurity.

Historically, communities such as the Maasai of East Africa are known to apply their traditional approaches to climate forecasting than depending on scientific climate data. They observed clouds and wind movements, lightning, and wildlife movements to predict changes in the seasons. However, over the last few decades, increased climate variability has made it difficult to rely on traditional forecasting (Amwata, 2013). The pastoralists from Kajiado County have

been found to perceive extreme droughts in the last few decades with the majority agreeing rainfall patterns have significantly changed. However, climate patterns indicated less significant differences in the average rainfall amount received in different parts of the County (Bobadoye *et al*., 2016).

Other studies have observed increased temperature in Kajiado and the greater ASAL region of Kenya with warmer days followed by warmer nights with extreme colds sometimes, especially late at night (Anwata, 2013; Opiyo, 2014). Increased temperatures have also been projected by the Inter-Governmental Panel on Climate Change fifth assessment report with severe consequences for the major livelihood base of pastoral communities in the East Africa region including in Kajiado County. The lowest monthly temperatures in Kajiado County were recorded in the months of June, July, and August. June registered 17.98°C, July 17.18°C while August registered 17.49° C. The month of March recorded the highest monthly average temperature of 21.15° C, the month of February recorded 20.77° C while April recorded 20.45°C. The perception of the local Maasai community is in line with the actual climate patterns of temperature patterns in Kajiado County. (Bobadoye *et al.,* 2016).

Kiambu County experienced minimal mean temperature variations since 1929 with increased variations being observed from the mid to the later part of the century. The changes in mean temperature in the County are attributed to anthropogenic activities leading to global warming. Also, the County has experienced massive population growth and rapid urbanization leading to the conversion of agricultural lands and forests into real estate thus reducing forest covers in the County (Jaramillo *et al.,* 2013). The perception of local farmers in Kiambu County and the larger Central region in relation to climate change is varying. A study by Asayehegn (2017), in Central Kenya on the perception of climate change found the existence of some coffee farmers who did not perceive climate change hence opted for less resilient and unsustainable adoption options in comparison to farmers who perceived climate change in their area.

A study on French beans farmers in Central Kenya found temperature increase and reduction in precipitation over the last few years are attributed to climate change. The perception of local French beans farmers was consistent with actual climate patterns thus showing an accurate understanding of climate change phenomena (Otieno *et al*., 2017). Evidence shows that when local farmers perceive climate change accurately, they tend to make effective adaptation options hence increasing resilience and household food security. In Laikipia County, Central

Kenya, local farmers perceived significant changes in rainfall patterns since the 1960s, 1970s, and 1980's when the majority of the population settled in Laikipia County. Farmers contended that the rainfall onset was known and farmers used to prepare for both the short and long rains with some degree of certainties. However, in the last few decades shifting of rainfall patterns coupled with increased temperature variations has significantly affected agricultural production. The perception of local farmers on climate change-related reduction in rainfall and temperature variation was consistent with actual climate patterns (Ogalleh, *et al.*, 2012).

Inaccurate perception of climate change coupled with the existence of patriarchal systems in Kenya where invisible social-cultural dynamics such as gendered roles exist among local communities denying women the ability to make their own decisions, access, and control of critical resources including land and livestock have the potential to reduce household's capacities to effectively adapt to changing global climate. Although Kenya has enacted enabling policies and legislative frameworks to deal with climate change, the existence of policies has not translated to a sustainable solution to climate change as evidenced by increased climate change-related extended droughts and floods leading to loss of livelihood for millions of Kenyans and pushing them into household food insecurity and poverty.

2.3. Climate change policies

The basis of climate governance structures stem from existing international and national climate change obligations.

2.3.1 International climate change policies

The foundation of international climate change policies includes the following;

1. The United Nations Framework Convention on Climate Change (UNFCCC)

Kenya ratified the United Nations Framework Convention on Climate Change (UNFCCC) two years after it was adopted during the 1992 Rio Earth Summit. The UNFCCC is aimed at stabilizing the problem of human-related greenhouse gases that were interfering with the functioning of the climate systems. It stated that the set targets should be achieved within a given timeframe so that climate change-related disasters do not become a threat to sustainable food production and also economic prosperity. The convention recognized that annex 1 countries (the US and mostly Western Europe) were mainly responsible for historic and current greenhouse gas emissions and thus should be taking lead in contributing towards climate

system stabilization more than Non-Annex I Parties who do not bear historical emissions responsibilities. Annex 1 countries were required to reduce emissions to 1990 levels by 2000.

Also, under the UNFCCC, annex 1 countries were required to assist in technology transfers and building capacities for developing countries to effectively undertake measures that can sustainably mitigate the increasing emissions while building adaptive strategies cushioning their economies against changing climate. Importantly, industrialized countries were required to report regularly on their progress and achieve the set targets. Also, both developing and least developed countries report their progress and contribute towards the goal of reducing emissions. However, their reporting was contingent on receiving funds from developed countries to ensure the reports were prepared on time especially for the case of the least developing countries (IPCC, 1992). Kenya ratified the UNFCCC due to recognition of the threat climate change posed to the achievement of its development agenda including food security and gender equity. Climate change increases the gender disparity gap by pushing more women into poverty and women make nearly half of the population.

2. The Kyoto Protocol (KP)

Kyoto Protocol was adopted during the Conference of Parties 3 (COP3) in Kyoto, Japan in the year 1997. It is an international agreement aimed to reduce greenhouse gas emissions especially carbon dioxide that threatens life on earth by increasing climate change-related. Kenya ratified the Kyoto Protocol in 2005 when it entered into force. This in recognition that KP required 37 industrialized nations to commit to reducing emissions especially these responsible for historical GHG emissions. Also, these countries were required to provide technical and financial support to developing countries such as Kenya that were not responsible for climate change yet suffered its consequences. Developing nations participated in emissions reduction projects in their specific countries and thereby sold carbon credits to developed countries that had fewer opportunities to invest in clean energy in their respective countries in comparison to developing countries.

In 2005, KP entered into force and industrialized countries made a promise to cut their annual emissions by 5.2% in 2012. By 2011, countries in Europe were able to achieve their commitment while the United States and China contributed more global emissions than the rest. In 2012 a second commitment period was entered, referred to the Doha amendment to the Kyoto protocol, where 37 countries made a binding agreement to continue their commitment

towards reducing greenhouse gases and providing technical support and finance to developing nations. Japan, Russia, and New Zealand were involved in the 1st commitment period but opted out of the Kyoto Protocol second commitment period. Also, the United States and Canada are among the countries that do not have second-round targets of the Kyoto protocol (Breidenich *et al*., 1998; Barnett, 2007; Bang *et al*., 2012)

3. The Copenhagen Accord

The UNFCCC's COP15 took place on 19th July 2009 in the Danish capital of Copenhagen. It was attended by 193 countries including Kenya to reach a fair and equitable agreement addressing the dangerous threat posed by changing climate. However, the objective was not attained due to differences in priorities between non-annex 1 and annex 1 party hence the ''Copenhagen Accord'' (CHA). Although many countries participated in COP15, only a few nations including Nicaragua, Bolivia, Sudan, Cuba, and, Venezuela agreed to support the accord. The main agenda items under the CHA included the recognition of climate change as a major threat. It called for political leadership to solve the climate crisis while considering not all parties had an equal responsibility in contributing to the problem.

It emphasized the importance of keeping global temperatures below 2 degrees level and that there was less time available to undertake the needed greenhouse gas emissions reductions due to a lack of synergy between different groups with differing priorities. It recognized that the climate change impacts were worse in developing nations including Kenya in comparison to developed nations hence the challenge of balancing poverty reduction efforts and gearing their economies towards cleaner and climate-resilient ways. Adapting to the adverse climate change impacts is a challenge for all countries especially developing and least developed countries that lack appropriate technologies and capacities to build effective resilience against changing climate. Developed countries are encouraged to support both the developing and least developed countries through the provision of adequate and sustainable financial aid, capacity building, and technological support to enhance their level of adapting to climate change. Mitigation measure shall be undertaken by Annex I parties especially these that ratified the Kyoto Protocol which is a binding agreement requiring fulfillment of the obligations agreed during the convention. However, developing countries, least developing countries, and Island nation's actions are voluntary and not binding although they contribute to cutting emissions (Ramanathan and Xu, 2010; Rogelj *et al.,* 2010).

4. The Paris Agreement.

The COP21 in Paris, 2015 was attended by all nations' party to the UNFCCC including Kenya. It was a culmination of decades of global climate change negotiations that were not always successful in bringing all parties together. It aimed at keeping global temperatures below 2 degrees Celsius above the pre-industrial levels and also reach a further goal of keeping below 1.5 degrees Celsius. It was a major milestone aimed at curbing the increasing greenhouse gas emissions and gearing the world towards low carbon development that incorporated the aspect of sustainable development. The Paris Agreement targets enhancing individual nation's abilities to contribute towards keeping global temperature below the aforementioned levels through support to developing countries in terms of financial, technical, and capacity building. Most importantly, it requires individual nations to submit their ''Nationally Determined Contributions'' which are greenhouse gases abatement potential and commitment of all countries to achieve the set targets. They are required to regularly report their progress on emissions and project implementations in line with the Paris Agreement. Also, as part of the monitoring and reporting, there is stock-taking of countries progress after every five years to make sure individual countries are achieving their commitments, address unique challenges, and take advantage of emerging opportunities that can be harnessed to ensure global temperatures remain at a level that does not threaten the functioning of the climate systems. Kenya agreed to reduce its greenhouse gas emissions by 30% by the year 2030 relative to a business as usual scenario of 143 MtCO2e. This is conditional upon receiving technical and financial support to meet this commitment.

Adaptation goal was established and recognized as an important aspect for all countries include Kenya and, the need to enhance adaptive capacities, build the resilience of most vulnerable populations especially, in the developing and least developed nations was recognized. This can be attained by national adaptation plans formulation by all countries followed by enhancements through cooperation between different countries depending on the needs, priorities, and gaps among others. Also, the provision of technical support and financial aid from developed nations to developing nations has been considered in building resilience.

Also, loss and damage from climate change caused shocks such as floods, droughts, heatwaves, and fires among others have been recognized as a critical component that required consideration. The most susceptible group of countries that could benefit from loss and damage included Island Nations such as Maldives, Tuvalu, Kiribati, and Marshal Island that are

continuously faced with floods destroying their habitats and sources of livelihoods. Also, developing countries and least developed countries especially in South America, South East Asia, and Sub-Saharan Africa grapple with extended drought seasons that wipe out millions of livestock every few years while also destroying coastal ecosystems and infrastructures through frequent floods. The increased loss of livelihood for millions of the populations in the most vulnerable parts of the world increases the global poverty index, creating a challenge in achieving sustainable development goals, for example, Kenya has been grappling with climate change-related food insecurity in the last two decades while increasing the cost of disaster risk management through increased frequencies of droughts, famine, floods, water shortage among others (Kenya, 2010)

5. Africa Climate Change Strategy

This is a 20-year strategy starting from the year 2015-2035 aimed at providing an integrated mechanism for addressing the threat of climate change in Africa. The Africa Union plays a coordinating role while regional economic bodies implement the strategy and ensure effective mainstreaming of climate change into short term and long-term development plans. The priority of the strategy is attaining sustainable development goals, reducing poverty levels with more focus on vulnerable groups such as children, women, and disabled individuals among, others. Focusing on these groups is critical because climate change intersects with societal variables and thus increases the burden on people who are marginalized in accessing resources or political representations.

According to IPCC, Africa is among the most vulnerable continent to climate change extremes such as droughts, floods, storm surges among many other hazards (IPCC, 2007). This is due to the existence of poor/weak infrastructure, high prevalence of poverty among the majority of the populations coupled with limited adaptation capacities. Most importantly, millions of populations in Africa are dependent on the agriculture sector which is very much threatened by climate variations. The agricultural sector contributes significantly to the GDPs of many African countries ranging between 5 percent to nearly 60 percent depending on the ability of these countries to diversify their economies. It employs nearly half the population directly and indirectly especially those living in rural settings. In Kenya, the agriculture and tourism sectors account for much of the GDP, yet face negative impacts of climate change. The majority of these involved in the agricultural sector are smallholder farmers who remain most dependent on rainfall agriculture hence more exposed to climate change-related variations (FAO, 2015)

Therefore, the strategy recognizes the importance of streamlining the different mechanisms aimed at addressing climate change in different regions of the continent so that there is a consolidated approach that is considerate of difference in vulnerabilities, capacities, and needs in creating sustainable solutions to the problem.

6. IGAD Regional Climate Change Strategy (IRCCS)

Kenya is a member of IGAD (Intergovernmental Authority on Development). The IGAD Regional Climate Change Strategy (IRCCS) aims to support IGAD member countries to transition to a low carbon development route so that climate change does not become a stumbling block towards attaining sustainable development in the region. The strategy also considers gender as an important component to achieving both short- and long-term regional goals including addressing climate change, poverty, food insecurity, and attaining all sustainable development goals including gender equity and equality. Women not only constitute more than half of the IGAD Member States' population but also are critical actors in the political and socio-economic transformation of the region. Achieving peace and sustainable development would remain pipe dreams without proper mainstreaming of gender at all levels. IGAD's (Intergovernmental Authority on Development) Environment and Natural Resource Strategy considers ''adherence to gender sensitivity and equity'' as one of its critical principles in attaining Sustainable Development in the region. According to Africa Human Development Report (2016), lack of gender parity in Sub-Saharan Africa contributes to a loss of $US95 billion a year (Ogallo, 2010; Meier, 2011; Kojwang and Larwanou, 2015).

7. East Africa's Climate Change Policy

The policy guides member countries include Kenya in planning and implement measures to curb the threats of climate change to the development in the region. The foundation of the policy is in three pillars, namely adaptation, mitigation, and research on climate change. Under adaptation, National Adaptation Action Plans and National Adaptation Plans which consist of improving resilience in different aspects including disaster risk management, setting early warning systems, and sustainable utilization of resources including water, land, energy, forests among others for improved livestock and agricultural productions.

Under mitigation, the policy recognizes that the East African region is not among the major sources of emissions. However, as part of the international community, there are actions taken to reduce the risk of unmitigated emissions to current and also future generations. Mitigation

measures supported include afforestation, reforestation, switching to clean energy such as wind, solar among, others, efficient transport systems, and efficient agricultural and livestock production. These are further enhanced, by building capacities related to technology transfers, climate change awareness creation, climate finance, and climate change knowledge management. The strategy recognizes the importance of a multi-disciplinary approach involving all stakeholders include governments, development partners, public, private sector, civil society among others in creating a holistic approach to dealing with the problem.

2.3.2 National Climate change policies

Other than the international climate change related policies and strategies Kenya has ratified and remains a signatory to, it has a number of enabling policies and legislative frameworks that set the foundation for addressing climate change at National level. These include the following:

1. The Constitution of Kenya (2010)

Kenya's Climate change governance is anchored on the constitution of the republic providing legislation for climate action. The constitution recognizes addressing climate change as part of the requirements in Article 42 of the Kenya constitution (2010) gives every citizen the right to a healthy and clean environment. Article 10 recognizes the importance of achieving Sustainable Development goals include addressing poverty and achieving food security, addressing gender disparity among, others which is threatened by unmitigated climate change hence advocating for action on climate change.

2. The Third Medium Term Plan (MTP III) (2018-2022)

The COP 21 Paris Agreement and United Nation's SDGs set the basis for formulating Kenya's MTP III action on climate change. It was addressed under the Environment sector as a sub-section in both Medium Term Plan I and Medium-Term Plan II however, due to climate change's significant negative impact on Kenya's economic development, it was found prudent to address it as a standalone component in the MTP III. The Climate Change thematic area target aims to "*Enhance climate actions towards a low carbon and climate resilient development."* This implies mainstreaming climate change in all targeted sectors in both National and County development plans under the MTP III to gear the Country towards a greener, prosperous, and sustainable future.

3. The Kenya Vision 2030

Kenya's Vision 2030 foundation is Political, Economic, and Social pillars. The environmental component is incorporated in the social pillar since environmental conservation is critical in achieving the targets of sustainable development which Vision 2030 aims to target. Achievement of the social pillar's objectives requires the transformation of different sectors including water, health, education, housing, gender, equity, culture, and poverty eradication. Climate change poses a significant threat to all these critical sectors of the economy thus risking becoming a stumbling block to the achievement of Vision 2030.

Equity is a key principle in Vision 2030 as it has been considered a vital part of its economic, political and social transformation agenda. The Vision 2030 programme has identified key vulnerable regions of the Country where communities need additional focus to create parity in terms of development.

4. Draft National Climate Finance Policy (NCFP) (2016)

NCFP provides a framework for mobilizing funds to address the climate change challenge in Kenya. The sources of funding include both domestic and global climate finance institutions such as the Green Climate Fund, Adaptation Fund, among others. The National climate finance policy sets the required structures for the flow of climate finance transparency and accountability in both international and domestic projects on mitigation and adaptation. NCFP recognizes multi-stakeholder participation as important to achieving effective mobilization and utilization of climate funding and most importantly to ensure climate change does not threaten to achieve vision 2030, sustainable development goals, and the big four agenda which includes food security.

5. The National Climate Change Response Strategy (NCCRS) (2010)

The NCCRS aims at establishing and strengthening institutions to undertake climate change action. As action on climate change is an expensive venture the strategy recognizes the importance of local investments/funds aimed at tackling climate change in the country rather than depending on only international sources. These will significantly help in addressing climate change-related emergencies such as frequent flooding, forest fires among, others. The Constituency Development Fund (CDF) and Local Authority Transfer Fund (LATF) are crucial domestic sources for funding climate change actions. NCCRS recommends a capacity-building

framework aimed at increasing the technical capacities of institutions in handling issues of climate funding, policies, technologies, mitigation, the adaptation among others related to climate change.

6. The National Climate Change Action Plan (NCCAP) (2013/2017)

The action plan has been formulated to implement the NCCRS. It lays the foundation for gearing Kenya to a climate resilient development road. NCCAP plan captured the ingredients for an enabling environment for climate action including aspects of policy and legislative frameworks, climate finance, technology requirements, knowledge management, capacity enhancement, monitoring, and reporting. It sets the stage for the country's NDC in line with the Paris agreement. Kenya aims to reduce emissions by 30 percent by the year 2030 subject to international support for Kenya in climate finance, technology transfers, capacity, and investments.

However, the NCCAP recognized the existence of barriers in transitioning the Country towards a lower carbon clean energy path. These barriers included gaps in policies, climate finance, technologies, capacity in understanding climate adaptation and mitigation, and monitoring and reporting. The NCCAP recommends the need to enhance capacity in all the aforementioned areas that remain a hindrance to the implementation of the action plan aimed at gearing Kenya towards achieving sustainable development goals including addressing poverty, hunger and gender disparity among others.

7. The National Adaptation Plan (NAP) (2015-2030)

NAP aims to "*Enhance Kenya's climate resilience towards the attainment of Vision 2030 and beyond*." It is anchored on Kenya's development blueprints (e.g., Vision 2030, MTEF, and MTP) and climate change policy frameworks including the NCCRS and NCCAP. The Adaptation Plan provides an M&E mechanism to ensure the NAP is fully implemented. It targets to ensure that "*adaptation interventions aimed at building Kenya's adaptive capacities and enhancing resilience are being realized and lessons learned to assist in the improvement of the Government of Kenya sector plans and programmes*." NAP recognizes the importance of gender considerations in climate change adaptation actions implemented across the board to attain optimal adaptation actions leading to food security.

8. The National Climate Change Act (2016)

The act is aimed at providing a regulatory framework for addressing climate change and foster resilience at the National and County level through mainstreaming of climate change into both plans (County and National). Through the act, a National climate change Council (NCCC) has been established which is chaired by the President. It also established a Climate Change Directorate as the lead designated National entity tasked with coordinating actions on climate change. The National Environmental Management Authority (NEMA), is the National Implementing Entity (NIE) while the National Treasury is the National Designated Authority for the GCF. It requires all County Government's County Integrated Development Plans (CIDPs) to effectively mainstream climate change and establishes climate change departments/units at County levels to ensure effective implementation of the National Climate Change Action Plan. Mainstreaming of climate change into County development plans such as the CIDPs will ensure enhanced education on climate change at the local level through support of training on climate change at the County climate change units or departments. Also, the National Climate Change Act (2016) recognizes the importance of gender consideration at both National and County levels to ensure climate change does not increase gender disparity by pushing more women into poverty when they are already marginalized in political, social, cultural, and economic opportunities.

9. Draft Climate Change Framework Policy (2014)

The policy recognizes climate change threat to the prosperity of Kenya including the economic, social, political, and environmental sphere. Therefore, it targets enhanced utilization of resources to minimize risks on the economy, most importantly vulnerable groups such as women and disable people and sectors such as agriculture. The Draft Climate Change Framework Policy considers climate finance an important source of implementing climate action at County and National levels to gear Kenya towards a greener future.

10. Green Economy Strategy and Implementation Plan (GESIP)

GESIP's overall goal is to gear Kenya towards a higher economic growth rate to achieve its Vision 2030 with the sustainable development principle as the foundation of the National growth strategy. GESIP is aimed at guiding the country to a sustainable development pathway in five themes including sustainable natural resource management; building resilience; sustainable infrastructure development, resource efficiency; and social inclusion and sustainable livelihood. These will contribute to the Paris Agreement implementation and

achievement of sustainable development goals including addressing climate change, poverty, hunger, gender disparity in Kenya.

2.4 Effects of climate change on food security in Kajiado and Kiambu Counties.

Climate change has bearing on all four food security dimensions. Climate change affects food availability due to the susceptibility of agricultural production to climate variability especially smallholder farmers across the world that make the majority of these operating below the poverty line. It changes the agro-ecological conditions suitable for farming affecting the yield and also the distribution of food products (Schmidhuber and Tubiello, 2007) from the main food production zones to different consumers in the world. Lack of food production maximization as a result of climate variability means less food available especially those from developing countries that struggle with wars, poverty coupled with changing climate.

Climate change affects the accessibility of food by its ability to impact directly and indirectly food availability. It negatively changes the agro-ecological conditions of productive lands thereby reducing yields and distribution of food, it becomes inaccessible for the majority of people around the world. This is because agricultural dependent households would have less income from selling their agricultural produce and also less subsistence food available. Decreased food supply and increased demand result in a spike in food prices locking out many populations from accessing food. The most susceptible are millions of poor small-scale farmers from third world nations (Napoli *et al.*, 2011). World Food Summit (1996) defined Utilization as "safe and nutritious food which meets their dietary needs". According to this definition for someone to be categorized as food secure, he or she must be guaranteed the safety and nutrition of the food and thus availability and accessibility of food alone are not enough. The utilization aspect also considers water and sanitation as an important aspect that contributes to the wellbeing of the individual. The concept of utilization covers the type of food one chooses, preparation, and storage mechanism of the food. Climate change reduces the ability to produce nutritious food by limiting the diversity of agricultural production and impair the quality of nutrients in the food with extreme climate variations. Also, climate change results in prolonged drought periods and flooding which both have health implications due to the negative effects on water and sanitation. According to the World Food Summit, for food security existence, food stability must be present "at all times" and this includes availability, access, and utilization. Changing climate increases the burden on most susceptible populations importantly children and women from the developing world through the destruction of main livelihood

sources and increased malnutrition. Increased poverty leads to environmental degradation, migration, and conflicts over available resources.

Projections for maize production in Africa indicate a decrease of more than 20 percent, sorghum, and millet also projected to experience mean yield reductions of 15 percent and 10 percent respectively by the year 2080. These reductions in key staple foods in some parts of the continent is projected to raise the poverty index by pushing an additional 80 million people facing the risk of hunger by 2050 (Parry *et al.,* 1999). In Kenya, maize is one of the most important staple foods providing nutritional values. However, maize production has been hampered by increased temperatures and decline of rainfall leading to increased frequency of below-average maize yield in the country since 1996 (Mumo, *et al.,* 2018).

Projections indicate East Africa will experience temperature and rainfall rise of about 5-20% from December-February and reduction of rainfall amount of about 5-10% from June-August by the year 2050 (IPCC, 2001; Hulme *et al*., 2001). Arguably the biggest threat presented by climate change in the East African region will be climate change-related changes in rainfall intensity, frequency, and predictability. This will affect the availability of water which is very critical to both agricultural production and the livestock sector. This has the potential to manifest itself into widespread failures in terms of food production leading to increased food insecurity (Case, 2006). The rainfall variations expected in the region are predicted not to be uniform throughout the year. Projections indicate that there will more precipitation during the expected wet seasons leading to the occurrence of floods and massive erosion while there will be increased drought periods in already dry regions of East Africa leading to a shortage of water. Pastoralists in the arid parts of the region such as those in Kajiado County, Kenya have adapted to the dry conditions. They practice herd mobility during the extended drought seasons in search of water and pasture. However, increased climate variability has become a big challenge to the efficiency of pastoralism.

Kenya's economy is dependent on agriculture which accounts for more than 26% of the GDP and nearly 28 percent contribution of GDP indirectly as a result of its relationship with other sectors of the economy. It employs more than 60 percent of Kenyans directly and indirectly with rural populations accounting for the majority. The livestock sector contributes 12% of GDP and is an employment source for 50% of the agricultural labor force (GoK, 2013).

However, the sector remains most susceptible to changing climate variability leading to loss of both crops and livestock after every few years (Ochieng *et al*., 2016).

Increased climate change-related water shortage has been on the rise in the region leading to losses. Drought has been experienced in Kenya from the year 1982/1983, 1991/1992/1994/1995, 1997/1998/ 2008/2009/, 2011/2012 indicating increased rainfall variability due to climate change (Kenya, 2013). The most affected region in the country in terms of water shortage in Kajiado County and the greater Arid and Semi-Arid region experiencing higher temperatures and erratic rainfall. The livelihood source of the people in the ASAL part of the Country is pastoralism and agro-pastoralism due to the favourable climatic conditions which would otherwise not support agriculture. (Orindi *et al*., 2007; Hoffmann, 2010). There are other sources of livelihood in the County, for example, small-scale farming is practiced by Maasais in Loitokitok while others are involved in livelihood diversification including ecotourism, selling honey, beards herbs among others (Munyasi *et al*., 2012). However, livestock production is the major source of livelihood practiced by the majority of the population and has been negatively impacted by climate change leading to losses. Also, the extended droughts push Maasai men to drive livestock from Kenya to Tanzania leaving their families for longer periods. The increased populations of livestock around available water points or pasture areas during drought seasons create competition and conflicts over those resources (Ellis, 2000).

This continuous increase in loss of livestock production due to climate change-related to extended drought periods or famines has led to increased food insecurity and resultant poverty among many households. The number of people categorized as food insecure has been on the rise especially in Kajiado County and the greater ASAL region, for example, a food emergency has been declared by the government on an almost yearly basis in the last decade, in 2009 more than 10 million Kenyans were declared facing starvation due to increased extended drought periods, (USDA, 2009). Also, during the extended drought of 2011, nearly 9 million Kenyans were declared food insecure and needed food emergency intervention. Over 70% of ASAL communities in Kenya survive with less than a dollar a day thus making them vulnerable to food insecurity and dependent on foreign aid (Amwata *et al*., 2015).

Malnutrition causes thousands of deaths especially during extended drought periods in Kajiado County as the main livelihood base is eroded thus pushing many households into absolute poverty. There have been reported cases of diseases such as diarrhea, malaria, and respiratory diseases, especially during Lanina induced drought. On the other hand, during periods of floods including Elnino events, there have been increased environmental diseases including cholera, typhoid, and bilharzia due to lack of or poor sanitation facilities. During the 1997 Elnino period

there were many cases of cholera outbreaks in the country including in many parts of Kenya especially Kajiado and the larger Arid and Semi-Arid region This led to the increased cost of health provision in the country during a time of crisis where the cost of reconstruction after the Elnino disaster was already high (UNICEF 2009; 2010; Kenya 2010).

Land appropriation and privatization aimed at creating ranching schemes have put nomadic pastoralism at a disadvantage and giving an advantage to wealthy landowners who do not depend on the availability of pasture land especially during the famine and extended drought seasons in Kajiado County. Maasai herders face pressure in the low-lying areas known for the availability of pasture and water from farmers growing crops such as maize and wheat thus exacerbating their precarious situation (Nyariki, *et al*., 2009). Due to its proximity to Nairobi County, Kajiado County has faced population pressure thus leading to competition for land with the main economic activity of the Maasai community which is pastoralism. There has been increased real estate in Kajiado County as a result of the business boom necessitated by the demand for affordable housing in places such as Kitengela, Isinya Ngong among others. This has contributed to less pasture land available for pastoralists during drought seasons thus leading to loss of livestock and resultant food insecurity in the County (Kinyenze and Irungu, 2017).

Also, the patriarchal nature of the Maasai community has denied women opportunities in terms of access and control of critical resources such as land and livestock, decision making abilities from household level to governance issues while also operating on biased labor divisions which favor mostly men. According to FAO 2011, women can increase the production of food by 30 percent given access to critical resources and decision making. Climate change has further exacerbated the situation by hitting hard smallholder farmers including livestock keepers where women make a significant number of the population (Harrington and Chopra, 2010; Gray and Kevane, 1999; Hovorka, 2012; Chauhan and Kumar, 2016).

Kiambu County receives adequate rainfall and is considered one of the richest Counties in Kenya. However, the County has not been immune to climate change-related rainfall and temperature variability leading to reduced agricultural potential especially for the majority of smallholder farmers in the last few years. Although much of the County receives adequate rainfall, areas such as Ndeiya and Karai wards have been found to experience climate change-related drought periods leading to food insecurity. The malnutrition rate in these two wards is higher in comparison to other parts of the County. Several groups from Ndeiya and Karai were

among the beneficiaries of the government-funded program NjaaMarufuku Kenya (NMK) in 2007 which aimed at addressing household food insecurity among vulnerable households in the country. However, the majority of these involved in the food security enhancement programme were found to be still food insecure (Wabwoba and Wakhungu, 2013).

Rapid urbanization led to many of the forested lands in Kenya turned into residential, agricultural, or recreational land for the increasing middle-class people in Kenya. For example, Kiambu County has witnessed the massive conversion of forest/agricultural land into real estate development in the last three decades. This has been largely attributed to Kiambu County's proximity to Nairobi and the demand for housing the large populations that need decent houses and yet cannot afford to live in the city. The reduction of agricultural land coupled with urbanization and most importantly climate change has contributed to the shortage of food production thus affecting food security in the country. (Lewis, 1985; Ekbom *et al*., 2001; Njiru, 2012, 2016).

Many urban areas including Kiambu County are characterized by a rapidly increasing human population, high urbanization, and socio-economic changes. These combinations are not the only recipe for potential growth in the economy and massive opportunities for people but also present potential risks as well. These include the challenge of feeding the masses at a time when climate change, land reclamation, loss of soil, and land production remain major stumbling blocks to enhance food production systems. The combined threats of climate change, pollution, urbanization, and increased growth of population in areas such as Kiambu County have resulted in increased pressure on the agroecosystems (Jaramillo *et al*., 2013). Increased poverty among the majority of the population especially in ASAL Counties such as Kajiado County led to more pressure on natural resources especially forests, water bodies, wildlife among others to provide for them directly or indirectly. Climate change has exacerbated the pressure further by reducing the potential of agriculture including livestock production while also increasing poverty-stricken populations that depend on the same natural resources through erosion of their main livelihood bases (Hertel and Rosch, 2010).

There is a need for deliberate efforts such as increased investment in agricultural research, rural infrastructure, reducing population growth and unchecked urbanization, and improving technology development in animal and plant gene banks to enhance the capacity of both smallholder and large-scale agricultural production. This will contribute to attaining many

sustainable development goals including addressing climate change, malnutrition, hunger, health issues among others.

2.4.1 International Food Security Policies and frameworks

Achievement of food security in Kenya is anchored on the following enabling international and national policies and legislative frameworks. The international frameworks include the following;

1. The Universal Declaration of Human Rights (UDHR)

UDHR affirms everyone and their families are entitled to live in a healthy quality standard of living. This right includes food, housing, clothing, medical care, and basic social services when the need arises. UDHR also guarantees security rights in case of sickness, old age becoming unemployment, and disable to ensure human lives are protected against threats that reduce their wellbeing. However, climate change poses a serious threat to the rights of billions of people across the world including in Kenya through increased rainfall and temperature variability undermining major livelihood bases such as rain-fed agriculture and livestock production

2. The Rome Declaration and Plan of Action

The declaration states that everyone shall have adequate access to safer food and remain free from hunger. The declaration emphasized the important roles of human rights, democracy, and freedom play in ensuring the accessibility of food and distribution across the world. The adequate distribution of food across the world is mainly threatened by increased environmental degradation, wars, poverty, corruption, and terrorism which hinder food production and supplies from one location to another. The declaration argues developed nations to support countries that are struggling with food insecurities by mobilizing resources to ensure adequate supplies of food resources to those in need. It advocates for policies aimed at sufficient production of food to address shortages**.**

3. The Sustainable Development Goals

SDGs aim to end poverty and attain food and nutrition security for all through the promotion of sustainable agriculture across the world to enhance production. Those are very critical especially, now that there has been increased environmental degradation, wars coupled with the variability of global climate. Although Kenya has made tremendous progress towards attaining some of the sustainable development goals, there remains the challenge of addressing poverty, hunger, and gender disparity among others.

4. The Comprehensive Africa Agriculture Development Programme (CAADP)

This has been set as a part of the New Partnership for Africa Development (NEPAD) aimed at ensuring the African continent is producing enough food for its growing population through the promotion of sustainable agriculture. CAADP aims to achieve reduced poverty and hunger in Africa by enhancing agricultural productivity through improved agricultural technologies, improved trade relations, and cooperation between countries in Africa so that there is increased export of agricultural products and wealth distribution especially in rural Africa. Through the promotion of sustainable agriculture, CAADP aims to increase the resilience of farmers and livestock keepers against climate change which threatens the achievement of household food security in African countries including Kenya.

5. The East African Community Food Security Action Plan (2011-2015)

The action plan was developed to ensure the East African region is food secure and was based on the overall objective of the East African Community Treaty concerning coordination in enhancing agricultural production and rural development. Due to dependence on agriculture by all the economies of the East African region, it promotes improved agricultural sector to create vibrant resilient economies that remain less susceptible to the vagaries of climate change.

2.4.2 National Food Security Policies and frameworks

Kenya has enacted several policies and legislative frameworks aimed at achieving food security in the country. These policies and frameworks set the foundation for increasing the resilience of the agricultural sector and the enhancement of food production threatened by climate change-related temperature and rainfall variability**.** They include the following;

1. The Vision 2030

The vision targets moving Kenya into a middle-income economy by the year 2030 with its citizens enjoy quality living standards. The vision 2030 recognizes the important role agriculture plays in achieving this target and thus mandated the Agriculture, Livestock and Fisheries Ministry in promoting and enhancing the production of food at the household level and advancing agro-industries and export of agricultural products. This requires putting into consideration sustainable utilization of land in the Country so that crop and livestock and production potentials are maximized to address food insecurity. Importantly, it recognizes climate change as a serious threat to the attainment of the goals set and thus the need for

mainstreaming it in all development plans and programmes to avoid curtailing efforts towards achieving food security in Kenya.

2. Kenya 's National Food and Nutrition Security Policy 2011

This aimed to create synergy and strengthen national strategies and sectoral policy implementations to effectively deal with food insecurities. It targets the community's vulnerabilities against extended drought periods that were addressed through the creation of synergy and coordinated efforts from National to local levels.

3. The National Agricultural Sector Extension Policy 2012 (NASEP)

NASEP set organized management of agricultural extension where public and private service providers are crucial to enhancing the productivity of agriculture in Kenya. The policy provides references on the required standards, ethics, and approaches for stakeholders in this sector including service providers on how to improve the existing collaborations or partnerships aimed at improving the productivity of the agricultural sector already faced with climate change threat undermining efforts towards enhanced food production.

4. The National Accelerated Agricultural Input Access Program (NAAIAP)

The NAAIAP is a government-led program in line with Vision 2030 and other government policy documents that are deliberately pro-poor targeting these that remain below the poverty line in the Country. The government provides subsidies to farmers that fall within this category to enhance their production potential and eventually increase their food security. Although the program witnessed some tangible success at a small scale it has faced problems included lack of adequate knowledge on issues such as crop nutrition requirements, understanding different soil characteristics, utilization of different soils for different crop production depending on the types of soils coupled with climate change.

2.5 Gender and climate change adaptation Global context

Sustainable Development Goals (SDGs) recognize the need for gender parity to alleviate poverty around the world. Women's input is invaluable and cannot be underestimated if SDGs are to be achieved. The importance of climate change and its linkages with societal variable especially genders continue to be recognized as evidenced by increased literature on the relationship (Alston, 2014; Denton, 2002; Djoudi and Brockhaus, 2011; Muthoni and Wangui, 2013; Eakin, 2005; MacGregor, 2010; Terry, 2009; Dankelman, 2010; Quisumbing *et al*.,

2008; Cohen and Young, 2007; Ray- Bennett, 2009). The more critical focus is on how these social-cultural dynamics impact how people adapt to changing climate.

According to Alston (2013), in most African communities, livelihood resources such as access to water, land, credits, political power, income, and safety nets are controlled. Approaches including participatory techniques in decision making, labor, and resource control can contribute to addressing gender inequality (Oberhauser and Johnston-Anumonwo, 2014). Deliberate government policies such as giving women more power in the land restitution process result in reduced gender inequality, a good example is Ethiopia's state policy which led to improved gender parity (Kumar and Quisumbing, 2015).

Gender and Development Theory (GAD) contends that women are an agent of change and that the existing gender concept curtailed women's abilities to contribute to the development agenda at the local and international level. GAD emerged in the mid-1970s criticizing WID (Women in Development Theory) which they argued treated women as a homogenous group and also drawn more attention to important roles societal variables. Proponents of GAD advocated for gender equity and equality where socially defined roles do not become a stumbling block to attain development. The theory focused on mainstreaming gender into national and international structures by presenting it as a development issue and not an isolated social issue This means that denying women access and control of critical resources included land, livestock, micro-finance, or technologies for enhanced livestock or agricultural production will translate to derailing their contribution to the development agenda of the household, County and the Country at large. In the field of climate change, women were found to have more concern and likely to take action than men in addressing climate change and thus availing the needed tools to them would increase resilience (McCright, 2010).

According to FAO (2011), women contribute nearly 60-80 percent of food production in developing countries. Climate change intersects with societal barriers such as gender and women being the majority of the poor, they are more susceptible in comparison to their male counterparts. Unfortunately, there's less involvement of women in planning and making decisions on matters affecting them most even when best placed to provide invaluable lessons/knowledge to disasters.

The United Nations Office for the coordination of Humanitarian Affairs' Gender Advisory Team's internal review of 39 NAPAs concluded most NAPAs are big on mentioning 'gender equality and 'mainstreaming' words but doesn't translate into clear action of implementation

(Holvoet and Inberg, 2014). Although 50% of the NAPAs acknowledge climate change impact affects women and men differently, it does not trickle down to ensuring women are involved in planning and choices of adaptation options. This ensures optimal resilience-building mechanisms are built and efforts towards food security are not hampered by lack of mainstreaming gender from grassroots to national levels.

In Kenya, the situation is no different as gender has not been considered a standalone factor under the climate change act 2016. This means that ‘’gender mainstreaming’’ is mentioned but the reality on the ground does not reflect it. Implementation is constrained by weaker property rights, illiteracy, and lack of time, low income, and unavailability of information regarding the improvement of agricultural and livestock productivity (FAO, 2009).

Sub-Saharan Africa is losing an average of $US95 billion a year due to gender inequality (Carrasco, 2016). Gender, Agrobiodiversity, and Climate Change by Bhattarai *et al*. (2015) addressing the inter-linkages between climate change and gender conclude the existence of perception in most developing nations in which climate change is seen as distant or separate from everyday realities of making decisions and the structures that interact to reinforce system-wide historical and currently social inequities.

2.5.1 Gender and climate change adaptation in Kiambu and Kajiado Counties

The communities in Kiambu and Kajiado Counties are generally patriarchal. The Kiambu County community had traditionally specified gender roles where men and women had different socially constructed roles. The patriarchal nature of this system automatically considered men to be the head of the household. In case the father died, the eldest son assumed the role (Muriuki, 1974). Girls, women, and uncircumcised boys were responsible for performing domestic/household duties. Once circumcised, boys were considered ‘men’ and qualified to be exempted from such tasks. This cemented men’s authority at household levels and was exploitatively used to gauge ‘good wife’ by the level of obedience to their husbands (Wamue-Ngare and Njoroge, 2011).

According to Kenyatta (1938), women had no ownership rights to land, livestock, and/or valuable assets. They were allowed to access and control household goods such as pans, baskets, utensils, pots, and milk. Even if women worked on the farms and generated income from selling the produce, they were still bound to send the profits to their husbands even if they worked outside the area of residence. This means it was a system of dominance where women were marginalized in resource ownership, labor divisions, and decision making.

However, the gender dynamics shifted around the 1980s when Kenya experienced economic deterioration. This was a result of external shocks especially falling oil prices of the late seventies. These led to high rates of inflation in the country resulting in deliberate government policies such as massive layoffs to keep its economy remain afloat. As men dominated the formal sector jobs, they were significantly affected in comparison to their female counterparts thereby rendering most of them jobless. As gender roles are specified in the Kikuyu household setting, it became a nightmare for men to switch smoothly to the informal sector since it was women's territory. Women including those that were laid off took care of domestic responsibilities and also slowly filled gaps left by the men who drained their slow self-esteem on illicit brews after losing prestige in the eyes of their families and general society. Importantly, this period coincided with the 1985 UN women conference held in Nairobi which discussed pushing women agenda forward all over the world. As the debate on gender equality was taking shape around the world, at the local level change was in the air too. Kiambu Women become more enterprising with the adoption of Chamas (women groups) which made access to loans easier than before. They became more independent and broke societal barriers that prevented them from owning resources, defining roles, and also curtailing their ability to make decisions that affected their families (Wamue-Ngare and Njoroge, 2011). However, because of the traditional customs which stayed for long periods, gender parity has not been attained fully in Kiambu County even though it's not as worse as in most parts of the country.

In Kajiado County, men usually belong to an age-set system which gives a platform to voice their concerns about wider issues affecting them or the community. However, women do not belong to age groups or any democratic setting recognized within the customary law. According to Talle (2007), the social age-set system is a man affair where appointments and delegations are done solely by men. This greatly hampers women's decision-making potential since the local hierarchical system doesn't provide the same platform to them as it's available to men.

According to Sen et al. (2007), gender roles hamper women from accessing proper health care when needed. Women are denied reproductive health funding support by their husbands citing family planning being culturally not accepted. Institutional factors remain a burden for women to access financial opportunities such as loans to adopt a new technology or diversify their income sources in a changing climate since lack necessary collateral such as title deeds to access micro finances. This greatly hampers efforts towards food security in Kenya since there

are millions of households headed by women and a significant majority curtailed by cultural norms in resource ownership (Deninger, 2003).

Climate change adaptation should also be viewed through the lens of the political process but not limited to the technical process since power relations affect individuals /groups/communities directly or indirectly as they struggle to adjust and sustain their unique livelihoods (Eriksen and Lind, 2009). According to the 2019 Kenya census, women made up 50.1% of the population of Kenya while men made up 49.9%, however, women remain significantly less represented at the political level. This scenario is a classical confirmation of the earlier feminist theory that, "socially constructed masculine characteristics are more valued than feminine characteristics". The absence of women from major decision-making organs such as the political process coupled with traditional customs practiced by communities such as the Maasai where they are denied ownership of resources increases their level of vulnerabilities.

Both pastoralists and farmers in Kajiado and Kiambu County are faced with the challenge of adapting to changing climatic conditions. Traditionally, the community in Kajiado County adapted to weather changes but with climate change, they continue to face increased frequencies of dry periods especially in the last few decades. Herd mobility is an important strategy to adapt to the changing climate in Kajiado County. Also, gender roles influence the choices of adaptation options and actions especially in Kajiado County. The Maasai men move their cattle to neighboring counties where water and pasture are available (Galvin *et al*., 2001) leaving women at home to take care of the family including children, elderly, the sick, and emaciated livestock. The men sometimes take many months before they return home with women left with heavy responsibilities while still not allowed to take major household decisions such as sell of the emaciated livestock or land without the consent of the man thus increasing their vulnerabilities. The recurrent droughts and flash floods that follow have led to the loss of millions of livestock in the last few years thus pushing many herders into poverty and over-dependence on donations from the Government and development partners (Campbell, 1999).

The pastoralists in Kajiado County form group ranches for effective management of water and grazing land and improve resilience against climate change. The grazing management scheme was adopted after the long drought of 1984 where significant loss of livestock was experienced due to the shortage of pasture and water. The grass protected through the management scheme

was to be utilized during drought seasons. The locals acknowledge the success and importance of the scheme however it's not devoid of local ranch politics intertwined with national politics due to the influence of the ranch officials in the eyes of the community, a clear example of the socio-political dynamics that exist within climate change adaptation space (Wangui, 2008). Equally, ownership and control of the land have majorly been influenced by the customary laws that locked out women during the land sub-division earlier leading to less control and access for women as they attempt to contribute to choices of adaptation actions and enhancement of household food security.

In Kiambu County, farmers are continuously diversifying to other sectors to increase their sources of livelihood. Besides the growing of coffee, tea, maize among other crops, they are also practicing agroforestry and keep dairy cattle, greenhouse farming, and small scale irrigation using boreholes. However, the influence of gender roles in the control of household land in Kiambu remains although slight progress has been made in recent years with increased women entrepreneurship and utilization of Chama to access credits (Wamue-Ngare and Njoroge, 2011). Much of the lucrative production of cash crops and food crops for export are still controlled by men due to land ownership rights thus undermining women as critical food producers and entrepreneurs. Also, widows from the Kikuyu community are still confronted with the challenge of their sons selling the family land without consent thus undermining women's role in enhancing household food security in the face of climate change (Musalia, 2010).

Chen *et al.* (2011) argued that denying women control and access to natural resources and opportunities hampers their choices of agricultural inputs while dealing with climate change. The inability to access loans, ownership of resources and absence from the decision-making process from household to national level means current adaptation strategies lack effective mainstreaming of gender to attain optimal climate change adaptation strategies. The Africa Human Development Report, 2016 estimates gender inequality rise of 1% results in a reduction of a human development index of a country by 0.75% (Carrasco, 2016). The invisible social-cultural dynamics such as gender coupled with inaccurate perceptions of climate change by local communities leading to the application of ineffective adaptation actions curtail efforts towards food security and sustainable development in Kiambu and Kajiado Counties and overall, in Kenya.

2.5.2 Gender Policies

There are a number of polices and legislative frameworks that set the foundation for addressing gender disparity in Kenya including both international and national frameworks. The international gender policies and frameworks include the following;

2.5.2.1 International Gender policies and Frameworks

1. **Sustainable Development Goals**

The goals recognize the threat climate change poses and advocates for the right of women including access and control of critical resources such as land, livestock and major decision making so that efforts towards enhanced adaptation actions and resultant household food security is not curtailed by gender roles rooted in traditional or customary laws. SDGs target women's and girls' empowerment by achieving gender equality for all. Sustainable Development Goals consider women empowerment as a very critical component that all other SDG goals depend on. The goal aims to eliminate all the root causes of discrimination against women by the year 2030 through advocating for the abolishment of legislation that curtails women's rights especially in regions where traditional /customary laws are important in making decisions from household to political representations.

2. **The African Union (AU).**

As climate change intersects with societal variables including gender, there is recognition of the need to ensure it does not push more women into poverty hence leading to food insecurity. The African Union (AU) considers gender mainstreaming as an important ingredient in achieving sustainable development goals. The Union acknowledges women make up a significant majority among the populations in the African continent hence the need to ensure they are part of the development agenda.

3. **IGAD's (Intergovernmental Authority on Development) Environment and Natural Resource Strategy.**

In the face of climate change, there is a need to recognize and adhere to gender sensitivity and equity in labor division, access, and control of major household resources, and most important decision making so that efforts towards addressing climate change, gender disparity, poverty, a hunger which are all sustainable development goals is not hampered. IGAD acknowledges the critical role women play in achieving the organization's specific and regional development

targets. It considers ‘’adherence to gender sensitivity and equity’’ as one of its critical principles in attaining Sustainable Development in the region.

4. **The East African Community Climate Change Master Plan 2011-2031**

This recognizes vulnerable groups including women remain most susceptible to disasters or risks. The master plan recommends gender mainstreaming into National, sectoral and local development plans so that these vulnerable groups are not locked out of economic, social, environmental management and distribution of resources for sustainable development.

2.5.2.2 National Gender policies and Frameworks

Other than the international gender policies and frameworks that anchor addressing gender disparity, Kenya has several national policies and legislative frameworks aimed at ensuring gender equity and equality is achieved especially with the threat climate change poses and increasing the disparity gap between men and women by pushing more women into poverty. The policies and legislative frameworks include the following;

1. **Constitution of Kenya**

As climate change poses a serious threat to the wellbeing of both genders, the constitution of Kenya gives everybody the right to equal opportunities and tools to effectively adapt to climate change including access and control of critical resources such as land, livestock, finance, decision making, equal labor division among others. Otherwise, climate change will continue to undermine household food security and the attainment of sustainable development goals including addressing climate change itself, poverty, hunger, gender disparity among others. The constitution of Kenya ensures everybody poses the fundamental right to enjoy equal freedom and not be discriminated against due to one's gender. Both genders have an equal chance of accessing opportunities in all spheres of life including political representation, access to economic resources, cultural and social interactions.

2. **Vision 2030**

Climate change threatens the achievement of Vision 2030 by not only undermining agricultural production which is key to Kenya’s Vision 2030 but also increasing gender disparity through pushing more women who make the majority of smallholder farmers into poverty. The Vision considers gender an important social component that is vital in achieving the set development targets. It aims at mainstreaming gender in all sectors of developments so that equity and

equality form part of the process of transforming Kenya. Vision 2030 relies so much on the constitution of the republic which guarantees both gender freedom and non-discrimination rights. These rights extend to all spheres including political, social, cultural, and economic.

3. The National Policy on Gender and Development

This policy provides the basis for ensuring gender equity and equality in Kenya. The policy is specifically geared towards improving the status of women in all spheres including political, economic, and social status. It aims to attain this target through the implementation of gender-sensitive measures that take advantage of the unique skills of women and men in building the nation. This extends to the climate change realm which requires equal opportunities for both genders to effectively adapt to climate change and attain household food security.

4. National Land policy

The National Land Policy aims to ensure there is a security of tenure in land ownership for all its citizens regardless of their economic, social, gender, or religious background. The policy lays the groundwork for land resources utilization in a sustainable way for all to benefit. These give all persons the right to occupy and utilize the land for economic benefits without any prejudices provided they have the ownership right. The policy has put in place an elaborate land resources conflicts/disputes resolution mechanism to avoid lawlessness. One of the principles of this policy is gender equity. As land is one of the most critical resources in terms of food production, the implementation of gender equity in control of household land is critical to the achievement of effective climate change adaptation, and food security.

5. Kenya Economic Recovery Strategy for Wealth Creation (2003-2007)

The strategy recognizes that women lack equal opportunities in access to resources.in the face of climate change. However, it does not put more emphasizes the impact of denying women access to critical resources that help contribute to women's empowerment and poverty reduction in the country. Studies undertaken by many researchers across the globe agree that paying attention to the implications of these inequalities is important since they risk becoming a stumbling block to development goals such as Sustainable Development and/or Vision 2030 in Kenya.

2.6 Conceptual framework

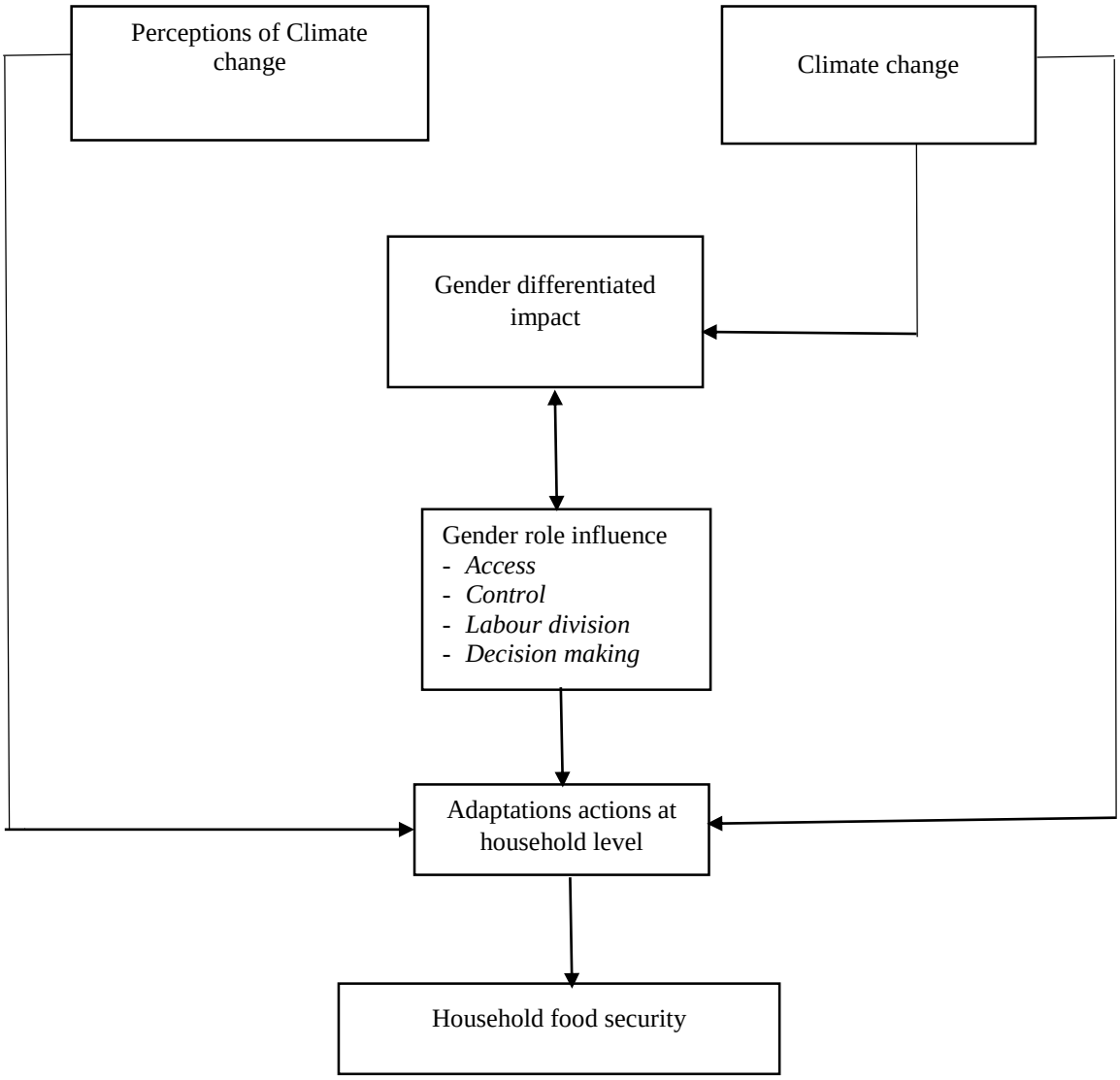

Figure 1: Conceptual framework

Climate change poses a significant threat to agriculture and livestock production especially among the majority of smallholder farmers in the developing world including Kenya. The susceptibility of the sector stems from its dependence on favorable rainfall and temperature patterns which have shifted in the last few decades leading to losses (FAO, 1999). This has undermined the success of adaptation strategies applied by local communities. Adaptation in climate change literature is defined as 'adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities' (McCarthy *et al*., 2001).

Other than extreme climate variations undermining climate change adaptation, smallholder farmers are faced with problems such as inaccurate perceptions of climate change. Perception can be defined as the process by which humans receive information or stimuli from the natural environment and is transformed into psychological awareness. The assumption is that individual households first require to perceive change for them to decide on adapting to climate change or not (Ban *et al*., 2000; Silvestri *et al.,* 2012). Culture, societal norms, knowledge, values, experiences among others influence individuals and society's views on the way they see and interpret the world around them. They provide a framework to make sense of global changes, views, priorities, and the ability to link issues and undertake actions that would impact current and future generations.

Evidence shows the perception of local communities on climate change is not always in line with actual climate patterns. Mwalusepo *et al*. (2015) observed farmers along Kilimanjaro and Taita Hills gradients in Tanzania and Kenya perceived decreasing rainfall trends which was inconsistent with historical data on rainfall in the area. This means the local communities' knowledge of climate change is inaccurate hence most likely to undertake ineffective climate change adaptation actions. Therefore, the perception of local communities about climate change is very critical to the choices of adaptation actions leading to household food security or insecurity.

Also, climate change results in gender differentiated impacts. Gender refers to socially constructed roles rather than biologically-determined differences. Responsibilities and opportunities associated with men and women which includes hidden power structures governing their relationship (Clancy *et al*., 2004). Existing policies are big on mentioning 'mainstreaming' gender but implementation beyond the policy papers is hampered by social-cultural dynamics that create gendered roles for men and women and also avail differentiated options to adapt to climate change. In most cases, women and children make up the majority of the poor in developing countries and remain highly dependent on local natural resources for survival. Dwindling natural resource base coupled with Women's lack of accessing processes of decision-making and ownership of important resources including livestock and land rises their vulnerability to a changing change. To appreciate gender's role in climate change is recognizing the need to bring onboard experiences and perspectives of both genders in developing effective adaptation actions (Kaijser. and Kronsell, 2013). Availing resources to both genders especially women so that they operate at the optimal level in their capacities to contribute to improved food production at the household level thus increasing food security.

Therefore, accurate perception of climate change through enhanced awareness creation among smallholder farmers and gender equity in access and control of critical resources at a household level including land, livestock, finance, labor division, and most importantly equal decision making will translate to implementation of effective climate change adaptation actions at household level leading to food security.

2.7 Theoretical framework

This study is based on two main theories, namely anthropogenic global warming theory and decision theory. Anthropogenic global warming theory proponents contend greenhouse gases from human emission including carbon dioxide, nitrous oxide, and methane are responsible for the warming of the global temperatures leading to droughts, floods, storms, and heatwaves among others currently experienced (IPCC, 2007). This theory is supported by 97 percent of scientists around the world. Scientists advocate for divestment from fossil fuel and investment in clean energy as the solution to climate change. Climate change leads to increasing drought periods and erratic and unpredictable rainfall patterns thus hampering efforts towards food security especially in African countries such as Kenya where the agriculture sector is the major source of livelihood for the majority of the populations. Climate change affects food security

since it has a bearing on the efficiency and also productivity of food systems from availability, accessibility, utilization, and nutrition status.

Decision theory is a theory that approximates how individuals or groups make choices based on their values, uncertainties, and rationality. Values stem from people's culture, religion, education among others. Some people might see cultures that are biased against women as retrogressive while others might see nothing wrong with their culture and the biases as normal. Choices such as allowing women full access and control of resources (including land, education, credits), equal labor division, and decision-making freedoms will influence the success of climate change adaptation actions especially with increased risks such as extended drought periods, floods, heatwaves, and storms (Palmer and Smith, 2014).

A common example of the theory stems from the prisoner's dilemma where two individuals are faced with an uncertain situation of which the likely outcome of the situation is not only based on the individual's decision but that of the other person as well (Hansson, 1994). In the face of climate change where local farmers and pastoralists are faced with shifting rainfall patterns and temperature variability, gender roles determine access, control, and decision making. Women have the least access and control of household land and least involved in major household decision-making such as the sale of land, livestock, and crops and most importantly, how to utilize the proceeds. This affects the climate change adaptation strategies applied since the potential of women to contribute their experiences, skills and unique approaches are curtailed by entrenched cultural norms. To appreciate the role of gender in climate change is recognizing the need to bring onboard experiences and perspectives of both genders in developing effective adaptation strategies (Kaijser and Kronsell, 2014). According to the decision theory, there is a need to avail all resources and opportunities to both genders to have the best chance of effectively adapting to climate change and not risk household food insecurity.

CHAPTER 3: MATERIALS AND METHODS

3.0. Introduction

The chapter describes research design, study domain, data types and sources, methodology, process of data collection and analysis.

3.1 Research Design

The MERRA 2 was utilized in acquiring climate data for the study area. Average monthly temperature and monthly rainfall data for Kajiado and Kiambu Counties were collected for the period 1980 -2017 using a resolution 0.5 by 0.625 degrees. The study employed a cross-sectional survey design using both qualitative and quantitative methods. Before the actual study, exploratory field research was undertaken in the first week of September 2017 in Chura, Kabete constituency, Kiambu County, and Ildamat. Kajiado Central constituency, Kajiado County and a meeting was done with local elders, research assistants, youths, and County government officials. A preliminary discussion on climate change perceptions, impact on household food security, and gender dynamics was held eliciting interesting discussions on the subject leading to the generation of important perspectives including historical backgrounds on traditional methods of climate and weather predictions especially among the pastoralists in Kajiado County, climate change effect on household food security, discussions on gender roles among communities in Kajiado and Kiambu Counties and how they impacted access, control, decision making and labor division in the face of climate change. The data collection tools were further enriched after the discussions. Pilot tests of 24 household questionnaires were undertaken in Chura, Kabete constituency, Kiambu County, and Ildamat. Kajiado Central constituency, Kajiado County. The administration of the pilot field test was to check the suitability and quality of the tools in achieving the study objectives and also to assess the research assistant's capacities in administering the questionnaires.

3.2 Study Domain

The study areas are in Kajiado and Kiambu Counties, Kenya.

3.2.1 Kajiado County

Kajiado County borders Nairobi to the north and covers 21901 km2 area. It is located in the southern tip of the former Rift valley province between longitudes 36° 5 and 37° 5 and latitudes 1° 0 and 3 °0 South (Amwata, 2013). The county population stood at 1,117,840 with 557,098 male and 560,704 females (GoK, 2019). It is part of the ASAL region of Kenya making up 80

percent of the total landmass. It receives an average rainfall ranging from 300-800 mm each year in a sporadic pattern. The county is dominated by arid to semi-arid grasslands, rocky thorn bushlands, acacia woodlands, marshlands, and swamps. The major soil types consist of sandy soils, brown calcareous clay loams, and pumice soils in higher elevated areas and poorly developed clay soils in the floodplains (Ogutu *et al*., 2014). Majorly, the county falls within agro-climatic Zone V (semi-arid) and Zone VI (arid), with Zone V receiving annual rainfall between 450 and 800 mm while Zone VI receives significantly less rainfall. Only eight (8) percent of the county land has good potential for rain-fed agriculture, mostly in the Athi-Kapiti Plains thus making pastoralism and agro-pastoralism the ideal for such conditions.

The majority of the inhabitants in Kajiado County practiced pastoralism as the main livelihood source. The main livestock breeds are cattle including Zebu, Sahiwal, Exotic, and Boran. Goat breeds include Galla, German alpine, and small east African. The main sheep breeds include Dorper and red Maasai (Kajiado County Integrated Development Plan, 2018-2022). Also, wildlife and farming activities contribute to the economy of the county. Because of its proximity to the city, the county has witnessed significant population growth over the last two decades due to individuals opting for affordable housing units as compared to Nairobi County. The traditional approach of the Maasai community dividing their communal land into ranches to provide land for livestock grazing has recently faced environmental degradation leading to diversifying to crop farming as a means of adaptation (Okello, 2005). Figure 2 shows the map of Kajiado County.

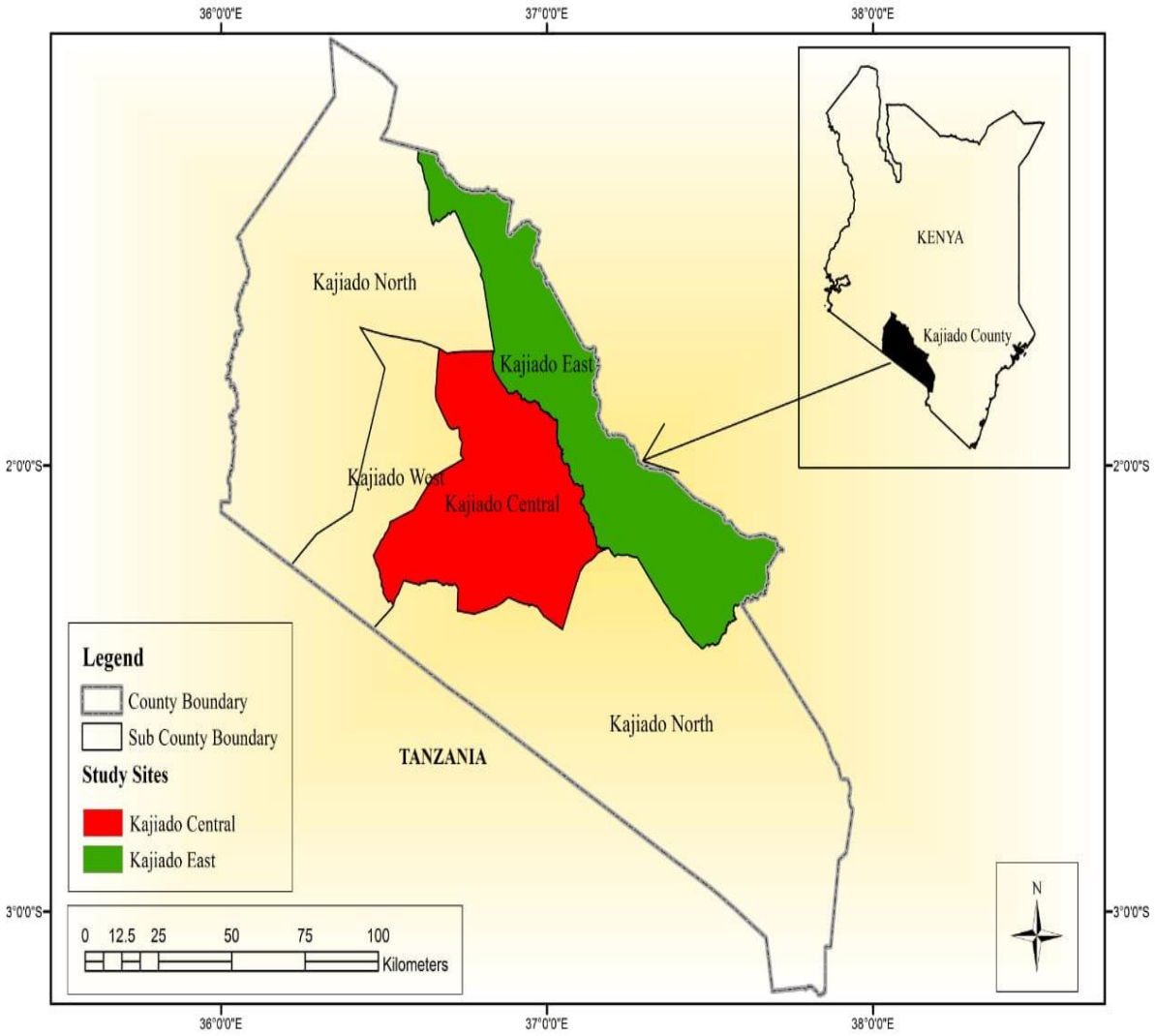

Figure 2: Map of Kajiado County showing the study areas *(Source: Author 2019)*

3.2.2 Kiambu County

Kiambu County covers 2,543.5 Km^2 area between latitudes 0° 25‘and 1° 20‘South of the Equator and Longitude 36° 31‘and 37° 15‘East (Kiambu County Integrated Development Plan 2013-2017) The County population stood at 2,417,735 people with 1,187,146 male and 1,230,454 females (GoK, 2019). According to the Kiambu County Integrated Development Plan (CIDP) 2018-2022, it receives a bimodal type of rainfall averaging 1,200 mm and a mean temperature of 26°C, the total arable land stood at 1, 878.4 Km^2 of which cash crops account for 35,367.41 Ha and 21,447 Ha utilized for food crops. There are three main types of soils in the area, namely, volcanic footbridges soils, high-level upland soils, and plateau soils. The

volcanic footbridges soils with moderate fertility cover much of the County and are mostly suited for coffee and tea production. The high-level upland soils are found mostly in Githunguri, Gatundu, Kabete Kiambaa, and Kikuyu. The soils are from volcanic rocks and are known to be the most fertile soils that support livestock and agricultural production includes the growth of horticultural products, coffee, tea, pyrethrum, maize among others. Low fertile soils are mainly found in Thika town, Juja, and Ruiru area. The soils are mostly sand or clay and are conducive for drought-resistant crops such as soya beans and ranching. The main forest types in the County are natural and plantation forests. The natural gazetted forests produce products including electricity transmission poles, firewood, and timber for construction while plantation forests, mostly privately own produced timber, charcoal, fruits among others. The County falls under agro-ecological zone I to III receiving a bimodal type of rainfall averaging 1,200 mm that makes it conducive for agriculture. Coffee and tea make the main cash crops while Irish potatoes, maize, banana, arrow roots, vegetables, and pineapples make the main food crops (Musa and Odera,2015). Figure 3 shows the map of Kiambu County.

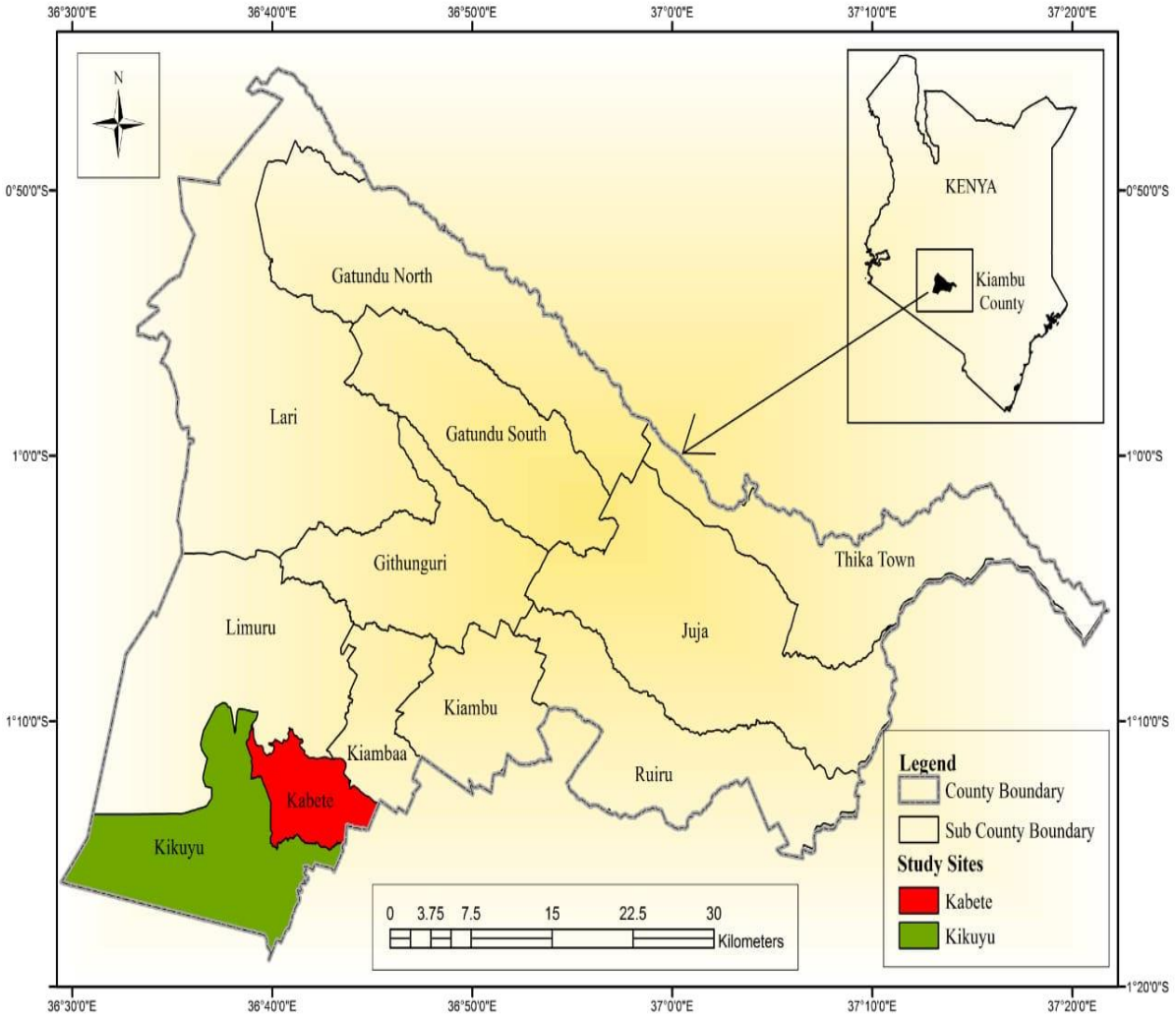

Figure 3: Map of Kiambu County showing the study areas.

Source: *Author 2019*

3.3 Satellite Observations

The Modern-Era Retrospective analysis for Research and Applications, version 2 (MERRA-2) is the latest global atmospheric reanalysis produced by the NASA Global Modeling and Assimilation Office (GMAO). The MERRA-2's goals are to provide a frequently-gridded, homogeneous record of the global atmosphere, and to include similar aspects of the climate system such as trace gas constituents (stratospheric ozone), cryospheric processes, and improved land surface representation. Among the key strengths of The Modern-Era Retrospective analysis for Research and Applications, version 2 (MERRA-2) includes its high resolution, the inclusion of observations from recent satellite instruments, and enhanced

estimations of surface temperatures over ice sheets and surface mass balance (Gelaro, *et.al*, 2017).

The MERRA 2 was utilized in acquiring rainfall and temperature data for Kajiado and Kiambu Counties due to lack of full and consistent rainfall and temperature data from 1980-2017 in the study areas (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/). In Kiambu County, rainfall data were available only from 1991 onwards (Jaramillo *et al*., 2013) while in Kajiado County rainfall and temperature data were not easily accessible from the Meteorological Department in the County. Average monthly temperature and monthly rainfall data for Kajiado and Kiambu Counties were collected for the period 1980 -2017. The type, resolution, span, and source of these datasets are as shown in Table 2.

Table 2: The data type, sources and resolution/span used in the study

Data Type	Data Source	Resolution/Span
Satellite observations: Rainfall Minimum and maximum Temperature	NASA's MERRA 2-Model	Monthly Rainfall 1980-2017 Monthly Temperatures 1980-2017 Resolution 0.5 by 0.625 degrees
Primary data	Household Questionnaire Key Informant Interviews Focus Group Discussion	Observational Study: - one point in time

3.4 Methodology

In this study, the analytical methods used included additive model and Chi square.

3.4.1 Additive model- Time series analysis

A time series are data points in sequential set, typically measured over successive times. Mathematically it is defined as a set of vectors;

$$x(t), t = 0, 1, 2 \ldots \quad (1)$$

Where t represents the time elapsed, the variable

x(t) is treated as a random variable.

In time-series events, measurements taken are arranged properly in a chronological way (Hipel and McLeod, 1994; Adhikari and Agrawal, 2013). Univariate is the term used to refer time series of single variables while multivariate time series are those with more than one variable. Usually time series is discrete or continuous, discrete involves making observations in a discrete set of times while Continuous involve continuously recorded observations across some time interval.

The four components that are supposed to affect time series analysis include trend, cyclical, seasonal, and irregular components. The trend involves determining long term downward or upward movements of a given variable by critical analysis of its historical trajectory. Seasonal variations refer to variations within a year which are repeated more or less often. Cyclical variation gives more details on the medium-term fluctuations in the series. One of the important questions is whether the extreme weather event exhibit cyclic variation. Most of the time, meteorological data do have more than one cycle superimposed on each other which makes it difficult to identify them.

In time-series visualization, two different models are used namely, Multiplicative and Additive models.

Multiplicative Model: $Y(t) = T(t) \times S(t) \times C(t) \times 1(t) \ldots \quad (2)$

Additive Model: $Y(t) = T(t) + S(t) + C(t) + I(t) \ldots \quad (3)$

Here Y(t is the observation and) T(t ,) S(t ,) C(t) and I(t) are respectively the trend, seasonal, cyclical and irregular variation at time t respectively.

The multiplicative model assumes that the four components influence each other and thus not necessarily independent of each other; whereas the additive model assumes that the four components are independent of one another (Adhikari and Agrawal, 2013).

In this study, Additive model was applied for time series analysis.

Additive Model: (Equation 3)

3.4.2 Chi Square

The Chi-Square test is vital when analyzing cross-tabulations of survey response data. It enables researchers to test hypotheses about variables measured at the nominal level. As with all inferential statistics, the results are more accurate when sourced from randomly selected subjects, and when bigger sample sizes are used to acquire appropriate statistical power. In summary, the Chi-Square test informs the users or researchers about whether or not there is a statistically significant difference between how the various segments or categories answered a given question. It simply brings about whether an observed distribution is due to chance or not. Chi-square tests that the null hypothesis is independent. The observed data is compared to a model that distributes it with the assumption that the variables are independent. When the observed data doesn't fit the model, the more likely that variables are dependent gets stronger, thus confirming the null hypothesis incorrectly.

In this study, Chi-square (χ^2) was used to study the difference between observed and expected data values (McHugh, 2013).

$$\chi^2 = \sum \frac{(o-e)^2}{e} \quad \text{..... (4)}$$

Where

O = Observed frequency, and

e = Expected frequency

3.5 Data collection

Before actual fieldwork commenced, background documentation of the study sites was undertaken using various sources such as National and County government reports, documents from research institutions, NGO reports among others. Access to materials from different sources allowed a better understanding of the challenges, uniqueness, and potentials of the

study areas. The researcher got an introductory letter from the Department of Meteorology, School of Physical Sciences, the University of Nairobi detailing a request to do research in Kikuyu and Kabete within Kiambu County and Kajiado Central and Kajiado East within Kajiado County.

3.5.1 Primary Data Collection methods

The primary data collection process involved the preparation of the data collection tools including household questionnaires, key informant interviews, and focus group discussions. In this study, the data collection tools took into consideration the perception of local communities on climate change, the effects of climate change, and gender dynamics affecting climate change adaptation. Household questionnaires had demographic data on household heads, gender, age, level of education, type of land ownership, and source of employment to allow a better understanding of household socio-economic status. Fieldwork was started with a reconnaissance survey in the first week of September 2017 to get firsthand information on the study sites and meet the research assistants and local administrators. This was followed by the training of the two research assistants on the last two days of the first week of September 2017.

The process of data collection involved the following;

3.5.2 Reconnaissance Survey

Before carrying out the fieldwork, a reconnaissance field survey was undertaken in both Kajiado and Kiambu County. The mission was to get acquainted with the target populations and get a firsthand experience of the study area. The researcher met the two research assistants and local administrators, youths, local County officials in the area, and, elders thus helping introduce the subject of climate change and gain an earlier understanding of their perspectives on the issues.

3.5.3 Training of Local Field Assistants

Training of two (2) field assistants from Kiambu and Kajiado Counties respectively was done in two days. Training the research assistants was to allow them to familiarize with data collection tools and understand the study objectives. The assistants were well qualified to comprehend the subject since the one from Kajiado had a degree in livestock production systems and, the research assistant from Kiambu had a Masters in environmental planning from the University of Nairobi. The involvement of two locals in the research enhanced community participation since they viewed the data collection as their own.

3.5.4 Sampling Criteria

This study used a cross-sectional survey design using both quantitative and qualitative methods. Fieldwork took place between September 2017 to December 2017 covering, Kajiado East and Kajiado Central within Kajiado County and Kabete and Kikuyu within Kiambu County. Kajiado County was selected to represent Arid and Semi-Arid regions of Kenya characterized by dry conditions and pastoralism practice while Kiambu County was selected to represent highland region of Kenya characterized by favorable climatic conditions and high agricultural yields (Orindi *et al*., 2007; Kiambu County Integrated Development Plan 2018-2022). Data were collected from respondents of all gender above 18 years using both structured and semi-structured questionnaires. Stratified systematic random sampling was applied in identifying households' interviewees. Areas that had a combination of both rural and urban settings were identified by considering the population density, land uses, infrastructure, isolation, and distinct socio-cultural milieus. (Hart *et al*., 2005). The study sites consisted of Kajiado East and Kajiado Central within Kajiado County and Kabete and Kikuyu within Kajiado County.

According to the 2009 population census, Kajiado East and Kajiado central had a combined total population of 239,460 while Kabete and Kikuyu sub-counties had 373,658 people. The total population was 613,118, of which the sample size chosen has a 95% confidence level and a 5.55% margin of error. 156 households were chosen from each county using a formula by Taro (1967) which translated to a sample size of 312 households. Purposive sampling was applied in selecting the target respondents for the key informant interviews (KII) and focused group discussions (FGD).

Table 3: Total Population

Respondents	**Total Population**	**Sample Size**
Residents of Kajiado East & Kajiado Central Sub-Counties	239,460	156
Residents of Kabete & Kikuyu Sub-counties	373,658	156
Total	**613,118**	**312**

3.5.5 Key Informant Interviews (KII)

Key informant interviews were applied to study local communities' perception of climate change over Kikuyu and Kabete in Kiambu and Kajiado Central and Kajiado East in Kajiado County, the effects of climate change on household food security, and the role of gender in climate change adaptation actions in Kikuyu and Kabete within Kiambu County and Kajiado Central and Kajiado East within Kajiado County. Key informant interviews play a critical role in providing crucial information about the subject under study. Individuals identified as key informants are considered most knowledgeable on the topic hence their selection. Before the actual fieldwork, selection of the most critical departments from National, County, and local organizations was undertaken. Fourteen (14) Key informant interviews were done in both Kajiado and Kiambu with seven (7) in each County. The KII targeted County Agriculture Director, County Livestock Director, County Gender and Social Development Director, Kenya Meteorological Department county officer, National Drought Management Authority County Coordinator, an NGO (civil society representative), and local elder.

3.5.6 Focus Group Discussion

Members of the focus group discussion were identified with the help of the research assistants and local elders. People who hailed from Kikuyu and Kabete in Kiambu County and Kajiado Central and Kajiado East in Kajiado County and stayed in the area for the last 15 years and above, with mixed ages, gender and most importantly knowledgeable on the subject matter were chosen. Three (3) focus group discussions were held in each County with gender considerations totaling six (6) focus group discussions. The total number of respondents in each group was seven (7) men, seven (7) women only, and a mix of four (4) women and men.

Men only focus group discussion session at Sholinke Sub-Location, Kajiado East Sub-County.

Women only focus group discussion session at Sholinke Sub-Location, Kajiado East Sub-County.

In all the focus group discussion sessions, the participants were guided using checklists to ensure in-depth discussions on local communities' perceptions of climate change, the effect of climate change on food security, and gender dynamics in relation to climate change adaptation in their respective locality. Since there was no direct translation for climate change, the checklist referred the participants to climate change indicators in their vernacular which was included after the pre-field test, for example, *Olameyu*, (drought), *Olari* (famine) ,*Ngolongi nairowua* (hotter days) and *Enkewarie Nairobi* (colder nights) were included in the Kajiado County focus group discussion checklist while *Ng'aragu* (drought) *Urugari* (hot days) *Heho* (cold) and *Mbura* (rain) was included in the Kiambu County focus group discussion checklist to cater for the illiterate and semi-illiterate. The participants were asked to discuss the influence of climate change on food security in the last few decades eliciting debates on how it has impacted the availability of food in their area. On discussing gender roles and climate change, the checklist focused on the understanding historical context of the role of

culture/customary laws among the majority of the inhabitants of Kikuyu and Kabete in Kiambu County and Kajiado Central and Kajiado East in Kajiado County who are the *Kikuyu* and *Maasai* communities respectively.

Women only focus group discussion respondents pose a group photo with the PhD student outside the market in Kabete, Kabete Sub-County, Kiambu County.

The Focus Group Discussion serves an important role of triangulation and validation of data from house-hold interviews and allows deeper interaction with many respondents at once eliciting interesting discussions that enrich the study. The discussions captured a historical perspective of rainfall and temperature patterns in Counties, the increasing drought phenomenon, how it has affected household food security, and most importantly gender and its interaction with climate change.

3.5.7 Household Interviews

The household interviews were applied to study local communities' perception of climate change over Kikuyu and Kabete in Kiambu and Kajiado Central and Kajiado East in Kajiado County, the effects of climate change on household food security, and the role of gender in climate change adaptation actions in Kikuyu and Kabete in Kiambu and Kajiado Central and Kajiado East in Kajiado County. In order to quantify the results from the focus group discussions, household questionnaires were administered targeting individuals at the household level. The questionnaire was made of different aspects of the study including the demographic characteristics of the individual household, natural resources available, floods and droughts frequencies, climate change effect on food security at the household level, social-cultural characteristics of the household.

During the administration of the household questionnaires, the most senior person in the household was chosen for the interview. When the head of the house was not available, the next senior person responsible for the house is interviewed to ensure getting reliable information. Before commencing the interviews, the respondents consented to take part in the interview with the assurance of utmost confidentiality in relation to the information they provided thus creating trust and mutual respect between the researcher and the respondent.

3.5.8 Secondary Data Collection

An in-depth literature review was undertaken covering climate change, perception of climate change, food security, and gender dynamics. Data on climate change perceptions of local communities and observed trends, international and national enabling policies and legislative frameworks related with climate change was collected from climate change reports. Data on climate change impact on food security from global, regional to local context and food security related policies was collected from food security reports while data on gender dynamics from global, regional and local context including enabling polices was collected from existing gender reports among others that were relevant to the study.

3.5.9 Data Processing and Analysis

Before analyzing data, the household data, it was subjected to quality control measures which included sorting out different questionnaires to ensure they are representative of the different study areas and then coded accordingly. All the filled-in questionnaires were cross-checked to ensure they were done with utmost honest by, for example, checking responses to some of the standard questions thus pointing out any inconsistencies.

Frequency analysis was used for descriptive statistics. Chi-square was used to test if significant differences existed in the local perception of climate change-related and actual climate patterns in Kajiado and Kiambu Counties and the difference in access and control of household land during rainy and extended drought seasons between men and women in both Kajiado and Kiambu counties.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents demographic characteristics of the study, the results of temporal characteristics of temperature and rainfall patterns over Kiambu and Kajiado, perceptions of local communities on climate change, the effects of climate change on household food security and gender influence on climate change adaptation actions are presented in sections 4.1, 4.2, 4.3, 4.4 and 4.5, respectively.

4.1 Demographic Data

The demographic characteristic of the respondent was considered critical to the study foundation hence collection of data related with socio-economic characteristics of the target groups as shown below.

Table 4: Demographic characteristics of the respondents

	Kajiado County		**Kiambu County**	
Household type	**Frequency**	**Percent %)**	**Frequency**	**Percent (%)**
Adult male decision-maker	130	83	100	65
Adult female decision-maker	26	17	56	35
Total	**156**	**100**	**156**	**100**
Gender				
Male	85	54.5	90	57.7
Female	71	45.5	66	42.3
Total	**156**	**100.0**	**156**	**100.0**
Age category				
18-29Yrs	43	27.6	16	10.3
30-49Yrs	76	48.7	71	45.5
50Yrs and above	37	23.7	69	44.2
Total	**156**	**100.0**	**156**	**100.0**
Highest level of Education				
Never attended school	51	33	18	12
Primary	32	20	52	33
Secondary	40	26	40	26
College	20	13	36	23
University	13	8	10	6
Total	**156**	**100.0**	**156**	**100.0**
Total	**156**	**100**	**156**	**100**
Source of Livelihood				
Employment	24	15	14	9
Self employed	53	34	42	27
Livestock keeper	71	46	18	12
Farming	7	5	78	50
Poultry	1	0.6	4	2
Total	**156**	**100**	**156**	**100**

Number of household members				
1-3 members	34	22	45	29
4-6 members	49	31	98	63
7 and above members	73	47	13	8
Total	**156**	**100**	**156**	**100**
Type of Land ownership				
Private Ownership (With title)	97	62	143	91
Community land (no title deed)	53	34	-	-
Leased land	6	4	13	9
Total	**156**	**100**	**156**	**100**

The demographic results indicate that the majority of the households in both Kajiado and Kiambu County had majority adult male head decision-makers as indicated by 83% and 65% in Kajiado and Kiambu respectively. There were 17% adult female decision makers n Kajiado County and 35% adult female decision-makers in Kiambu. In the face of climate change, the role of the household head is critical to the choices of climate change adaptation actions applied. Due to the patriarchal nature of majority of local communities in Kenya, women have limited access and control of household resources needed to adapt to climate change. Also, major household decisions such as sell of livestock, land and adoption of insurance schemes among others are majorly made by men. This means women's perceptions of climate change, unique skills, and experiences lack in the adaptation actions applied which affects household food security. Female-headed households were more inclined to perceive an increase in rainfall than male-headed households (Bryan *et al*., 2013).

In Kajiado County, the majority of the respondents from the household interviews were male as indicated by 54.5% while female respondents registered 45.5% of the respondents. On the other hand, in Kiambu County male respondents registered the majority as shown accounting for 57.7% of the respondents while female respondent's registered 42.3% .This implies that there were more male respondents than their female counterparts in both Counties. Women are thought to be more susceptible to climate change in Sub-Saharan Africa in comparison to their male counterparts (Beuchelt and Badstue, 2013). During extended drought periods, women and girls especially in the Arid and Semi-Arid Lands of Kenya trek a number of kilometers daily in search of water and fuelwood thus denying them the opportunity to invest their time in productive ventures such as education, economic activities among others. Also, women have

limited access to critical resources at the household level such as land, financial services, livestock coupled with limited decision making that derails efforts towards enhancing their resilience against the vagaries of climate change (Jost *et al*., 2016). In Africa, 40-60% of women are thought to be involved in agricultural production, and thus increasing their resilience to changing climatic conditions has the potential to improve food security in the region (Doss, 2018; Partey *et al.,* 2020). The gender of the household head influencing even moderately the perception of climate change has been recognized. (Gifford and Comeau, 2011).

On the age structure of the respondents, the result from Kajiado County showed the majority of the respondents were aged between 30-49 years, 27 percent of the respondent was in the age bracket of 18-29 years of age while those above 50 years old were 23.7 percent of the respondents. On the other hand, in Kiambu County, the majority of the respondents were in the age bracket of 30-49 years, 44.2 percent were above 50 years while 10.3 percent were in the age bracket of between 18-29 years. the result on the age of the respondents shows the majority of the respondents in both counties were above the age bracket of 39-49 years which means they were able to perceive climate change which has been defined as ‘‘a permanent shift in global climatic patterns over several decades which can be assessed by use of statistical methods observing changes in the mean and/or the variability over a longer period usually decades. This can be attributed to natural variability or due to anthropogenic activities’’ (IPCC, 2007).

The result on the highest level of education attained by the respondents in Kajiado County indicated 33% of the respondents had never attended school, 20% had primary school level of education, 26 percent attained secondary school level of education, and 13% had college education while only 8% of the respondent confirmed having attained university education. On the other hand, results in Kiambu County indicated that only 12% of the respondents had never attended school, 33% attained primary school level of education, 26% had secondary school level of education, 23% attended college and 6% of the respondents indicated having university-level education. There was a high prevalence of illiteracy in Kajiado County as compared to Kiambu County. Pastoral communities in the Arid and Semi-Arid (ASAL) regions including Kajiado remain among the most illiterate populations in Kenya due to a high number of children dropping out of school especially during the extended drought periods related to climate change coupled with a high prevalence of poverty (Orodho *et al*., 2013, Munene and Ruto, 2015). The importance of education (Akompab *et al*., 2013; Roco *et al*., 2015) in climate

change perception has been recognized. However, education has also been found to not automatically translate to positive judgments about the importance of climate forecasts (Hansen *et al*., 2004).

The results on the livelihood sources from the two study areas indicated that the majority in Kajiado County practiced livestock keeping, 34% of the respondents indicated being in self-employment, 15% were in employment, 5% registered farming as their source of livelihood. In Kiambu County, the majority of the respondents stated that they practiced farming as their major livelihood source, 27% indicated that they were self-employed, 12% were in livestock keeping, 9% of the respondents were on employment while only 7% indicated that they practiced poultry farming as a major livelihood source. Pastoralism is the main source of livelihood for the majority of the households in Kajiado County. However, the changing climate has disrupted the livelihood system leading to increased household food insecurity and poverty in the County (Mwangi and Desanker, 2007; Huho and Kosonei, 2014; Bobadoye *et al*., 2016). There has been observed illiteracy among the majority of the local communities which risks perceptions on climate change. This coupled with the influence of gender roles hamper the success of climate adaptation actions applied at the household level thus leading to food insecurity (Amwata, *et al*., 2016). Farming as the main livelihood source in Kiambu has been observed in other studies (Njuguna and Nyairo, 2010; Ndungu, *et al*, 2012). However, in recent decades the County has experienced increased rainfall and temperature variations linked with climate change thus undermining the profitability of agricultural production (Jaramillo *et al.*, 2013).

The number of household members in the study areas showed 47% of the respondents in Kajiado County had a total of more than seven (7) members in their households, 31% indicated having between 4-6 members in their households, and 22% registered 1-3 members in their households. The case was not the same in Kiambu County which registered only 8% having more than seven (7) members in their households. Almost 63% of the respondents indicated having household members of between 4 and 6 while 29% indicated having between 1 and 3 members in their households. The Maasai community is usually polygamous and is known for having large families. A study by Pertet *et al*. (2018), on nomadic Maasai pastoralists in Kenya, found out that the majority of households had an average of 6 children with the biggest family registering 12 members. This increases the burden on the household especially with increased climate change-related extended drought periods and floods leading to loss of livelihoods.

The result of land ownership type indicated that 62% of the respondents in Kajiado County had private land ownership, 34% of the respondents indicated they were settled on community land which they have stayed for generations while 4% stated they were on leased land. On the other hand, in Kiambu County, the result indicated that 91% had private ownership while 9% were on leased land while there was no community land ownership indicated by any of the respondents in Kiambu County. The land is a crucial resource for both communities due to their dependence on livestock and crop production respectively in Kajiado and Kiambu County. However, in the last few decades, climate change has decreased the productivity of both livelihood systems leading to increased household food insecurity, especially in Kajiado County. Also, due to their proximity to Nairobi, both Counties face increased population pressure and rapid urbanization leading to reduced agricultural and pasturelands thus exacerbating the problem. Land ownership has been found to be biased against women in both Counties with consequences for climate change adaptation at the household level (Musalia, 2010; Makena *et al*., 2014; Amwata, *et al*., 2016). Women lack control of the land hence limited decision-making abilities on how to utilize the land in the face of climate change. This negatively impacts the choices of climate change adaptation actions applied on the household land thus undermining food security (Amwata, *et al.*, 2016).

4.2 Analysis of temporal characteristics of temperature and rainfall patterns

Before establishing the association of the different variables, time series plots were developed in order to set the foundation of the study.

4.2.1 Time series analysis for annual temperature –Kenya

Figure 4 shows air temperature using MERRA 2-Model satellite data. These were monthly values running from January 1981-October 2017. The years 1986 and 1996 recorded the lowest temperature (21.5 and 21.7°C respectively) and the highest temperature was recorded in 2015 (26.8°C*).* Over the period between 1981 and 2017, there has been an increase of 0.5 degrees as indicated by the positive trend between 24.0-25.0 °*C* showing increased temperature variability especially in the last three decades. Evidence of climate change-related increase temperature variations has been observed in other studies in Kenya indicating from early 1960's, the country has witnessed an increased 1°C in the mean annual temperature, an average rate of 0.21°C per decade (WWF, 2006; McSweeney *et al.* 2008).

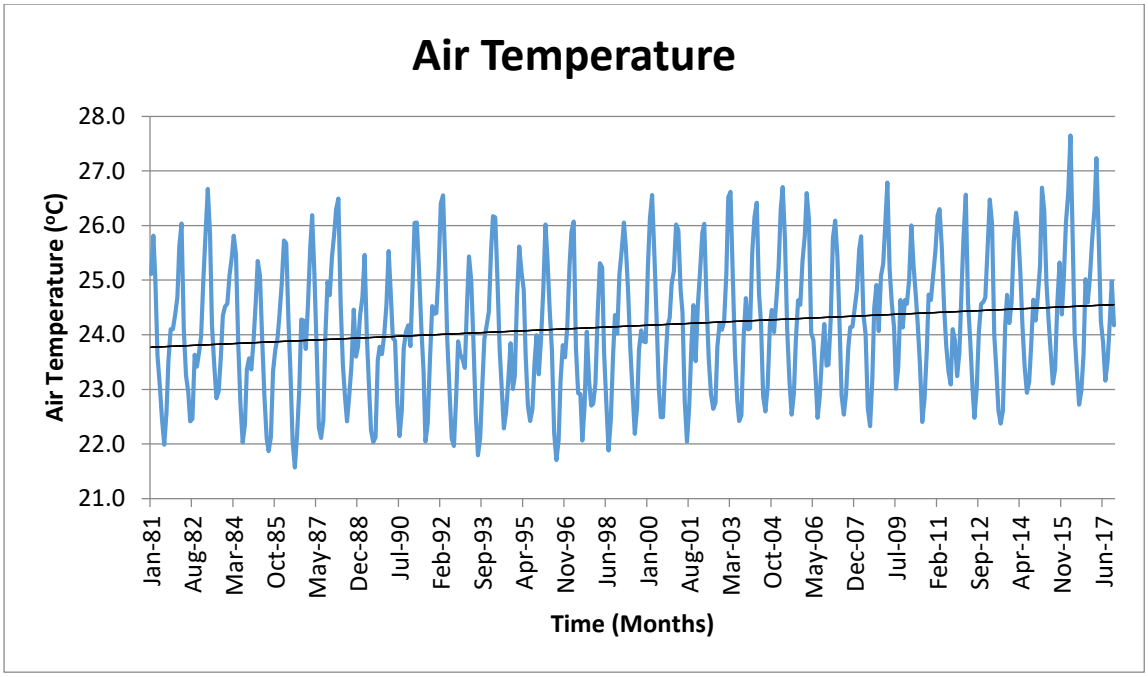

Figure 4: Time series analysis for annual temperature in Kenya

4.2.2 Time series analysis for seasonal Temperature in Kenya

The results for seasonal temperature analysis for Kenya from 1981-2017 are shown in Figure 5. The findings indicated that MAM, JJA, SON and DJF seasonal patterns of temperature were all increasing with the highest magnitude (slope) in JJA and least during SON. This is in line with other studies on climate change in Kenya such as Ngaina and Mutai, (2013) and IPCC (2014) which established trends of seasonal temperature variability.

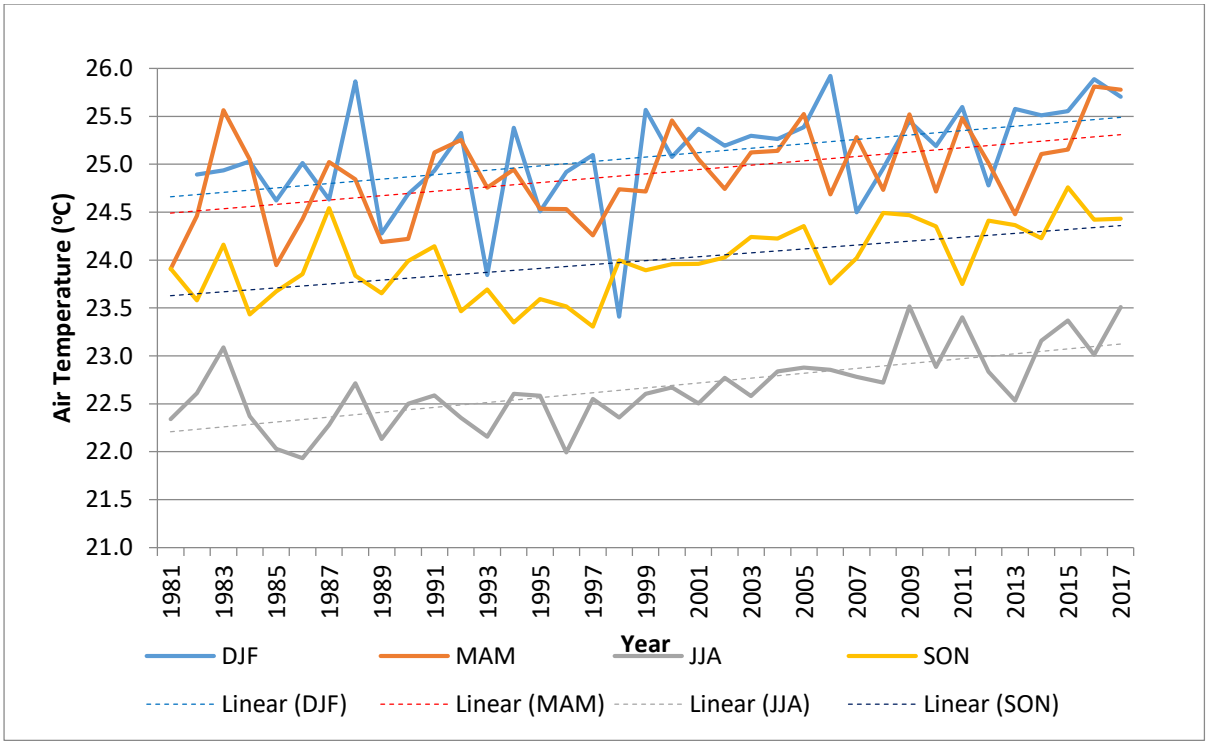

Figure 5: Time series analysis for seasonal temperature –Kenya

4.2.3 Annual rainfall analysis in Kenya

The Figure 6 shows the monthly values of the amount of rainfall experienced running from January 1980-July 2017 in Kenya. The year 1997 recorded the lowest amount of rainfall experienced and the highest amount of rainfall was experienced in 1998. The trend analysis shows an increasing rainfall pattern. Over the period between 1980 and 2017, there has been an increase of 50 mm as shown by the upward slope between 50 mm – 100 mm. However, whenever it rains, mostly it is intense downpour that is poorly distributed across the country leading to flash floods that do not mostly benefit local famers or pastoralists in the country frequent (Indeje *et al.*, 2001). Significant rainfall variability has been observed in Arid and Semi-Arid Regions of Kenya where average rainfall ranges from 300-800 mm per year occurring sporadically in both time and space (Onyango *et al.*, 2016).

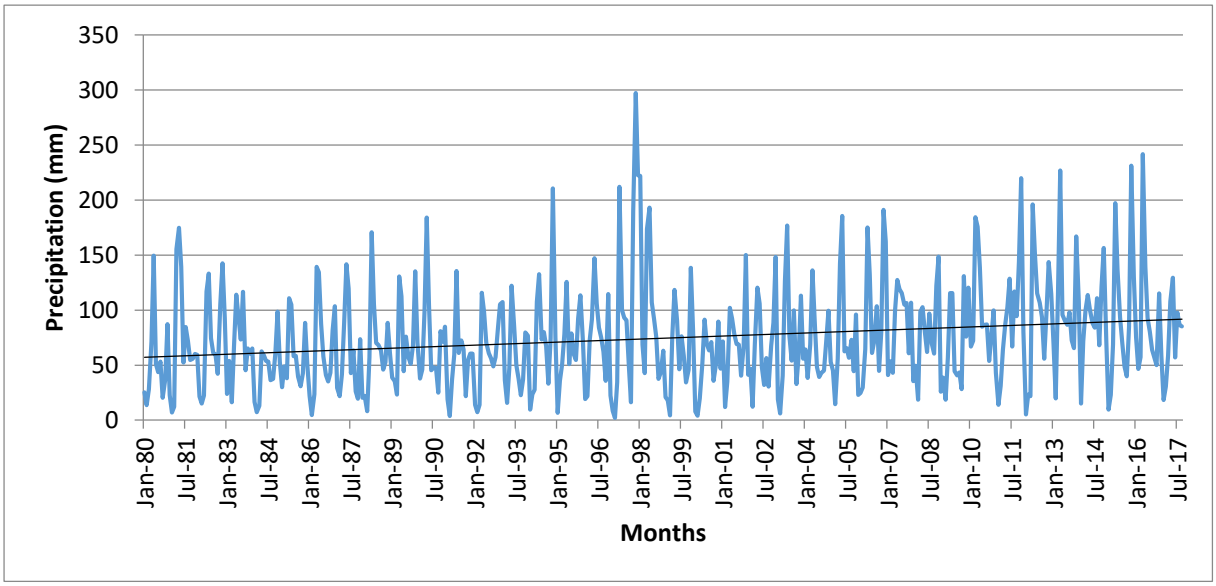

Figure 6: Time series analysis for annual rainfall –Kenya

4.2.4 Seasonal rainfall Analysis in Kenya

The results for seasonal rainfall analysis for Kenya from 1980-2017 are shown in Figure 7. It indicates that MAM, JJA, SON and DJF seasonal patterns of rainfall all increased with the highest magnitude (slope) in SON and least during DJF. Evidence point to a change in the amount of rainfall received in Kenya over the last three decades. The seasonal rainfall amount received in a given year is different from the amount of rainfall received in the preceding years. Climate change-related drought has been experienced in Kenya from the year 1982/1983, 1991/1992/1994/1995, 1997/1998/ 2008/2009/, 2011/2012 indicating increased rainfall variability due to climate change (Kenya, 2013). The most affected region in the country in terms of water shortage is Northern Kenya and part of Eastern and Coast region thus affecting pastoral and agro-pastoral activities.

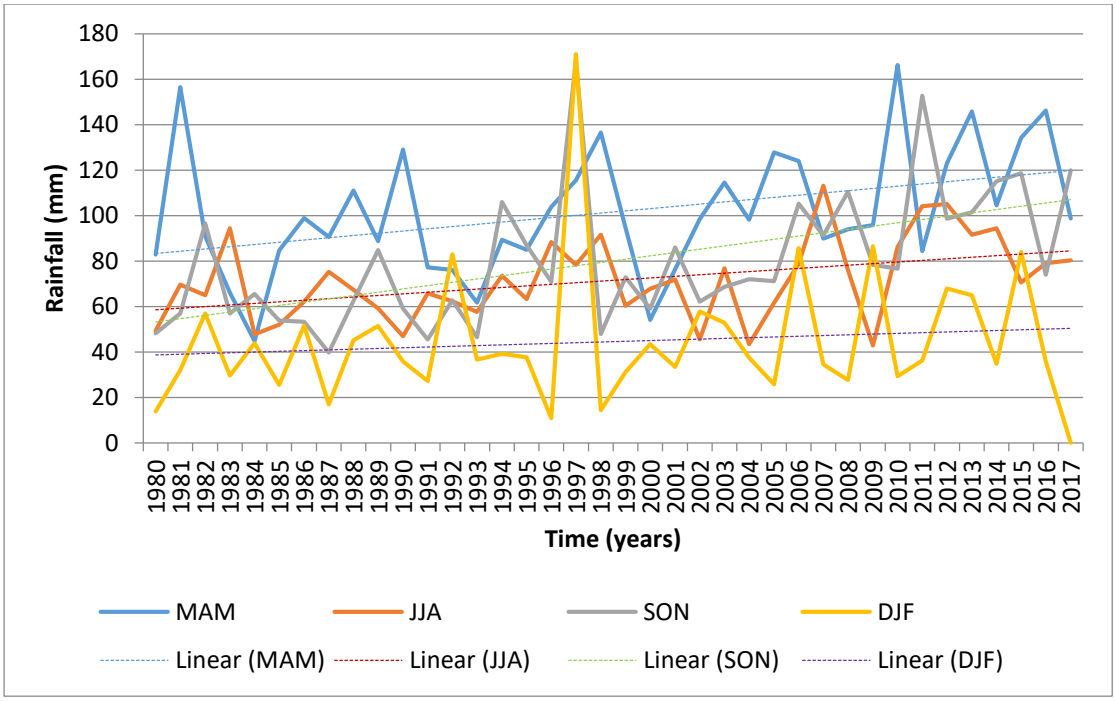

Figure 7: Time series analysis for seasonal rainfall –Kenya

4.2.5 Time series analysis for annual temperature –Kajiado and Kiambu Counties

Figures 8 and 9 show annual temperature patterns for Kajiado and Kiambu respectively running from January 1980-July 2017. The trend analysis shows an increasing temperature pattern in both counties. However, the trend line for Kajiado has a steeper slope as compared to Kiambu, for example, over the study period, there has been an increase of 1.0 degrees in Kajiado as compared to 0.75°C for Kiambu. This implies climate change in both Kiambu and Kajiado with Kajiado being the most affected of the two counties.

Kajiado is part of the Arid and Semi-Arid region of Kenya which makes up 80 percent of the total landmass. These parts of the Country experience high temperatures beyond 35° especially during the day time (Amwata, 2013), and climate change has further exacerbated the situation by creating extended drought periods leading to disruption of the livelihoods of agro-pastoral communities thus making them more food insecure (Orindi *et al*., 2007; Huho and Kosonei, 2014). Kiambu County is part of the highland regions of Kenya falling under agro-ecological zones I to III where the leading income-generating cash crops include tea, coffee, pineapples, sisal, and horticultural crops including fruits, vegetables, and flowers. The mean temperature in Kiambu County over the last century has increased at a rate of 0.005°C per year from 1929 to 2009. From the year 1991, an increased temperature was observed negatively affecting the

coffee and tea sector (Jaramillo *et al*., 2013). Although climate change-related increased temperatures in Kiambu County has been observed to be less destructive than its impact in Kajiado County and the larger ASAL regions, it has also led to increased loss of crop yields and pest and diseases in Kiambu County and the larger central highlands of Kenya (Kuria, 2009; GoK, 2010a; Macharia *et al*., 2012).

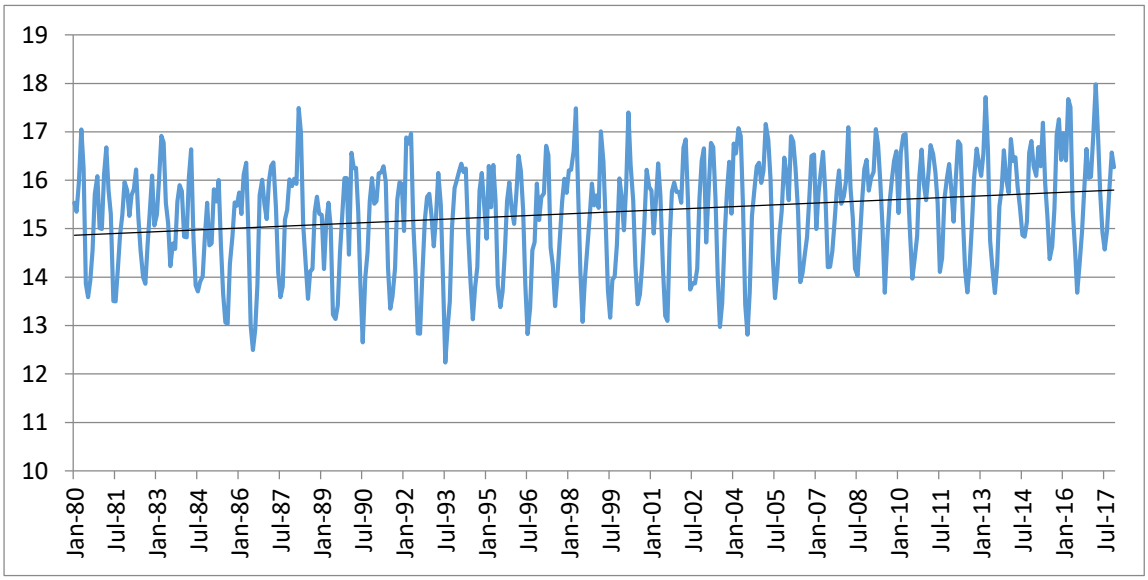

Figure 8: Time series analysis for annual temperature –Kajiado County

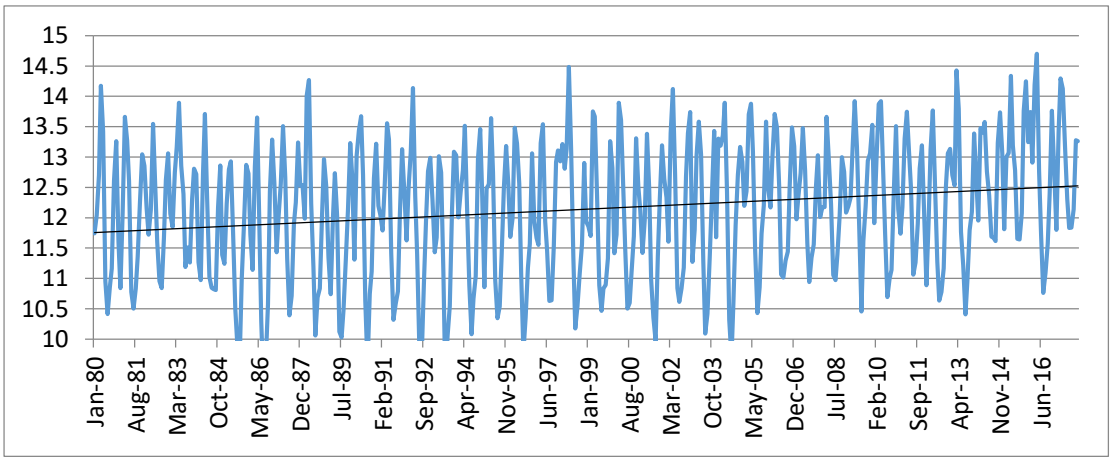

Figure 9: Time series analysis for annual temperature –Kiambu County

4.2.6 Time series analysis for seasonal temperature –Kajiado and Kiambu Counties

Figures 10 and 11 show seasonal temperature changes for Kajiado and Kiambu from 1980-2017. It indicates that MAM, JJA, SON and DJF seasonal patterns of temperature were all increasing in both Kiambu and Kajiado counties with the highest magnitude (slope) in JJA season. The seasonal and inter-annual temperature variability evident in Kajiado and Kiambu implies climate change in both counties. The findings are in line with what has been reported by Kenya Meteorological Department (KMD) where the minimum temperature trend has been rising by 0.8-2.0°C, the maximum temperature by 0.1-0.7°C (GOK, 2010a). A rise in average temperature of about 0.2°C per decade in Kenya has also been predicted by the Intergovernmental Panel on Climate Change report (IPCC, 2014). However, the increased seasonal temperature is experienced more in Kajiado County in the ASAL regions of Kenya with extreme heat during the days and extreme cold during the night. This has put more pressure on the livelihoods of the pastoralists leading to reduced availability of pasture and water. The locals are forced to develop climate change adaptation strategies including herd mobility and livelihood diversification (Omondi *et al*., 2013; Anwata, 2013; King'uyu *et al*., 2000).

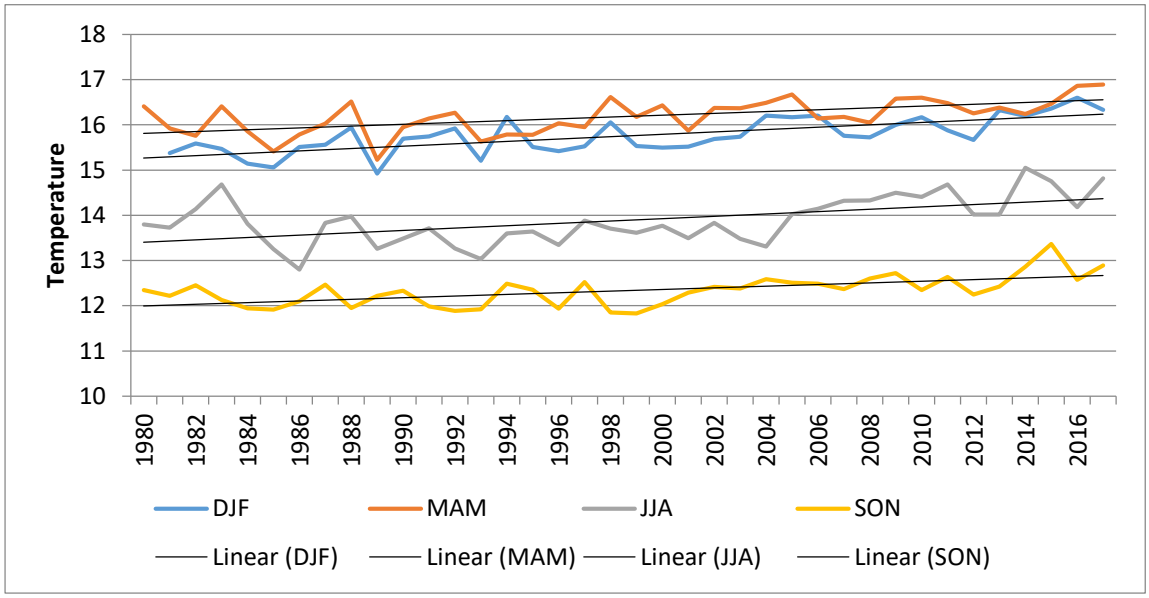

Figure 10: Time series analysis for seasonal temperature –Kajiado County

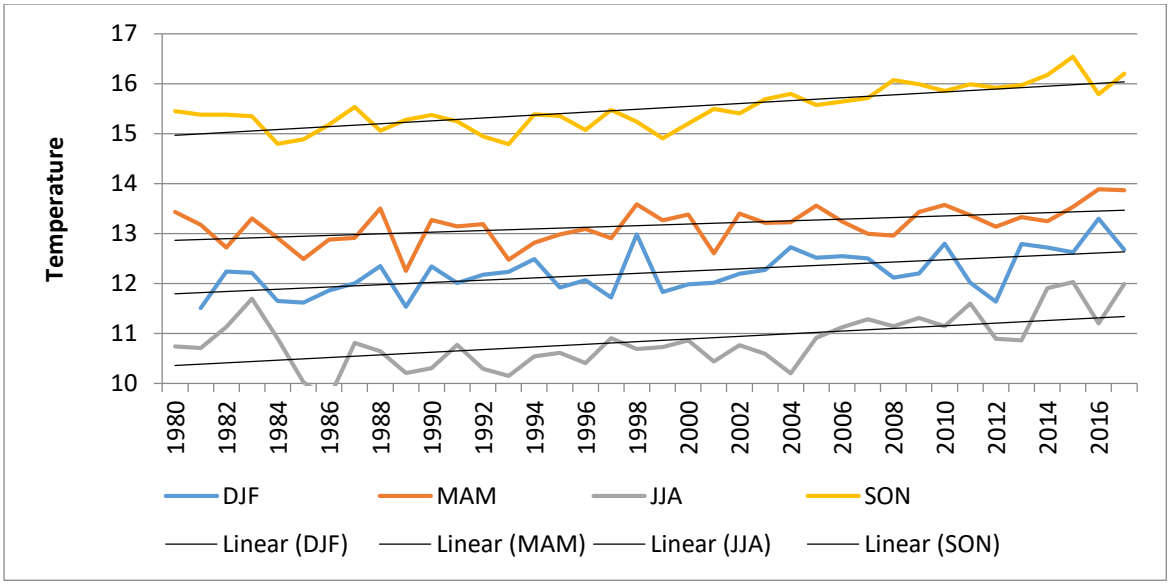

Figure 11: Time series analysis for seasonal temperature –Kiambu

4.2.7 Annual rainfall Trends-Kajiado and Kiambu Counties

Figures 12 and 13 indicate variations of rainfall trends in both Kajiado and Kiambu from 1980 to 2017. The graphs show from the year 1980-1997 annual amount of rainfall experienced in Kajiado County remained within a range of 40-80 mm while the Kiambu County graph shows the annual amount of rainfall experienced remained within a range of 1000-2000 mm. The result indicated many years of low rainfall were observed in Kajiado including 1980, 1981, 1984, 1987, 1992, 1996, 2000, 2003, 2004, 2007, 2008, 2011, 2012, and 2017. The findings are in agreement with other studies which observed Kajiado and the greater ASAL part of Kenya witnessed significant variations of the amount of rainfall received in a given year due to climate change since the 1970s resulting in increased drought phenomena (Orindi *et al*., 2008; Amwata, 2013; Opiyo, 2014). On the other hand, Kiambu County experienced the highest peak in rainfall amounts in the years 1980, 1990, 1997, 2006, and 2016. This has also been observed by other studies (Jaramillo *et al*., 2013). Significant rainfall trends variations were observed from the year 1998 which has contributed to reducing water availability affecting both livestock and agricultural production in the two Counties.

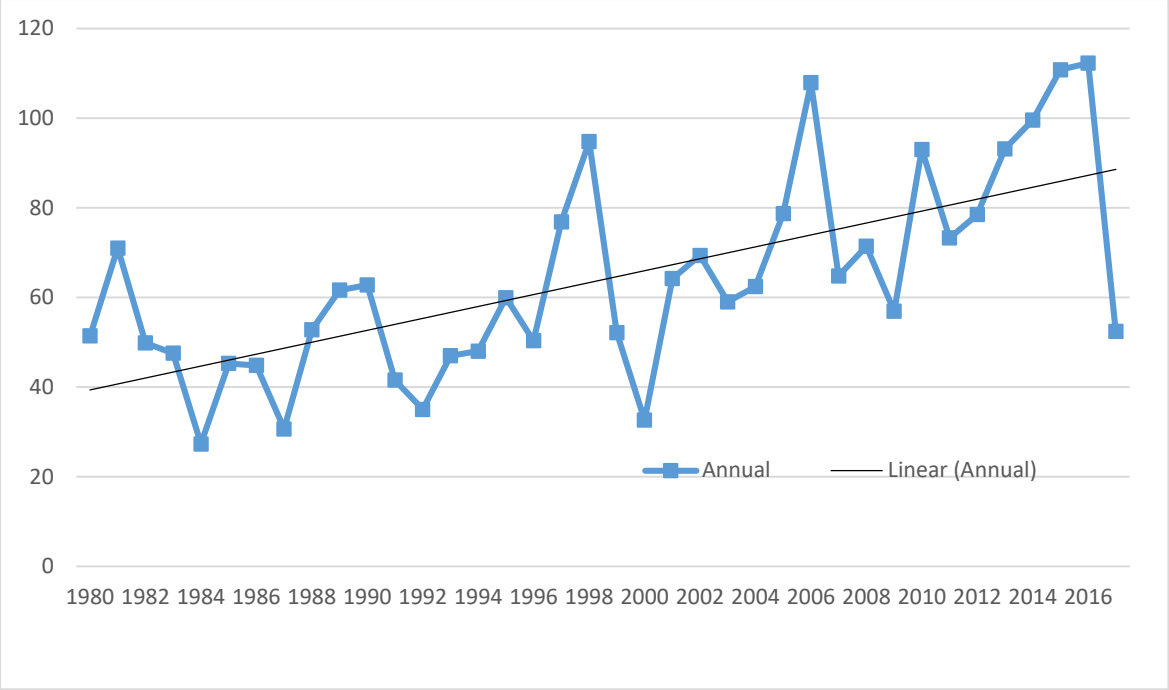

Figure 12: Annual rainfall Trends –Kajiado County

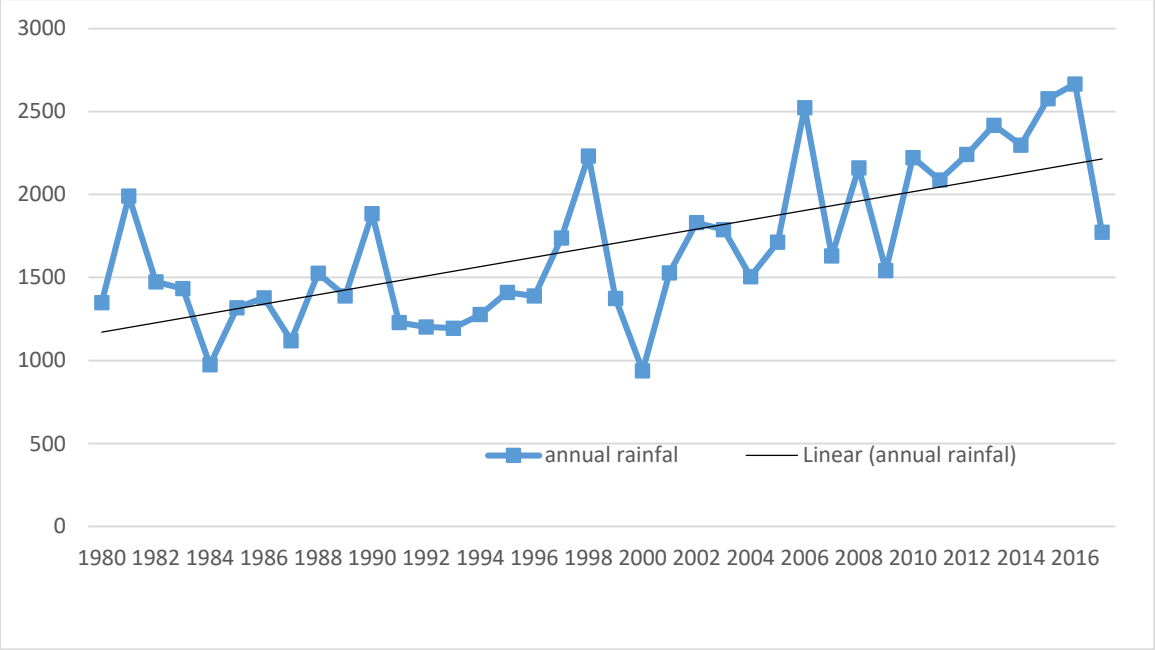

Figure 13: Annual rainfall Trends –Kiambu County

4.2.8 Seasonal rainfall Analysis-Kajiado and Kiambu Counties

Figures 14 and 15 show seasonal rainfall changes for Kajiado and Kiambu County respectively from 1980-2017. In all the seasons the amount of rainfall experienced varied in both counties. This is evidence of seasonal and inter-annual rainfall variability in Kajiado and Kiambu implying climate change in both counties. Rainfall variability in Kajiado County in the ASAL region of Kenya has also been observed in other studies (Opiyo 2014, 2015; Amwata, 2013; Huho and Kosonei, 2014) while in Kiambu other studies had observed climate change-related rainfall variability leading to increased loss of crop yields and pest and diseases (Kuria 2009; GoK, 2010a; Macharia *et al*., 2012). They opined that the increased seasonal rainfall variability has led to a reduction of agriculture production in the area and more and more people were changing their farmland into real estate or selling to real estate agents due to demand for land. This has been contributed partly by the increased inconsistency of rainfall and temperature patterns especially the onset and offset of rainfall seasons thus pushing farmers away from crop production due to less guaranteed profits (Musa and Odera, 2015; Gebreeyesus, 2017).

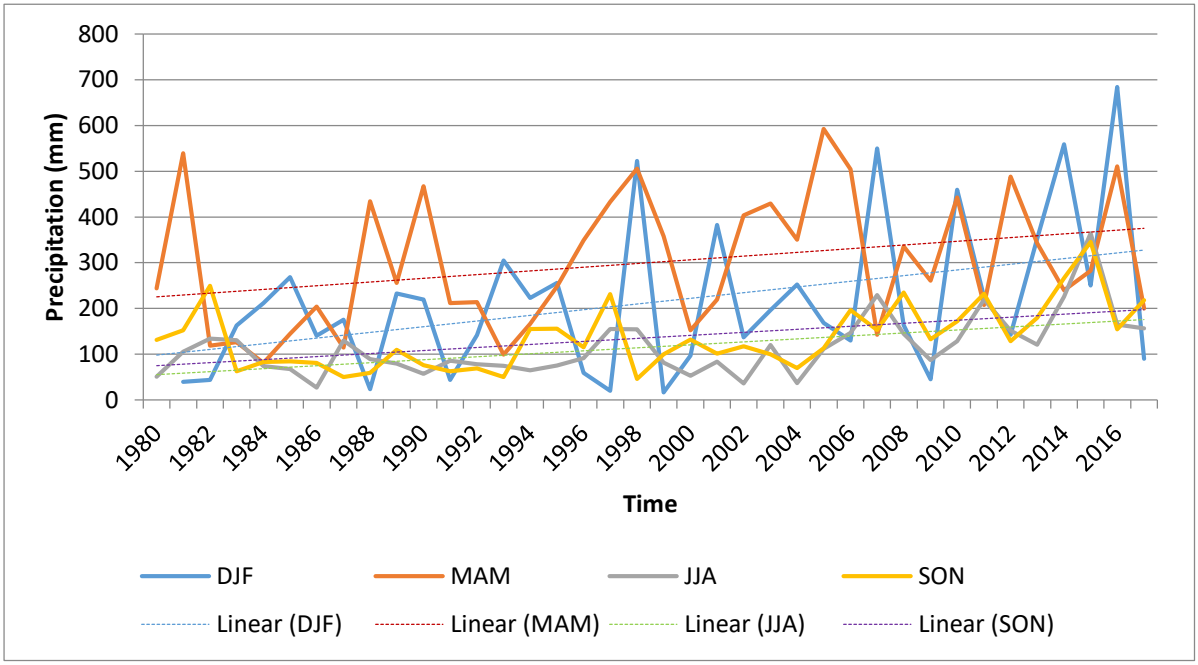

Figure 14: Time series analysis for seasonal rainfall –Kajiado County

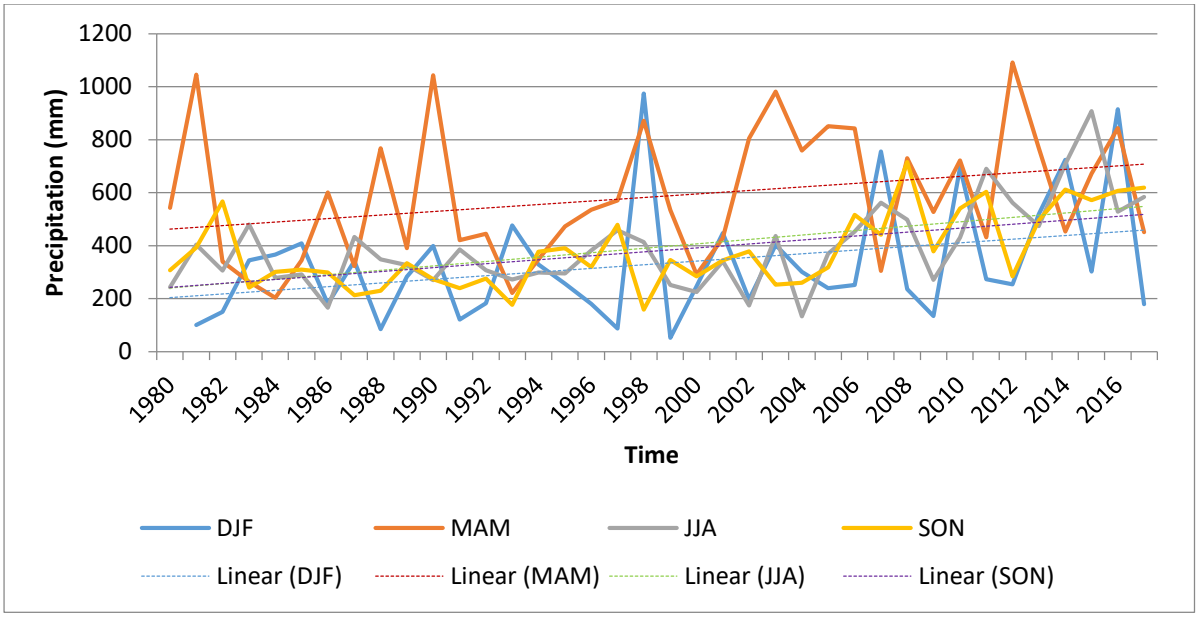

Figure 15: Time series analysis for seasonal rainfall –Kiambu County

4.2.9 Maximum and Minimum Temperatures in Kiambu County

Figures 16 and 17 shows time series for maximum and minimum temperatures in Kiambu County respectively for the period January 1980 – December 2017. The result reveals an increasing trend in minimum temperature and increased variation of maximum temperature since the *Elnino* year of 1998. The mean temperature in Kajiado County has been observed to have risen at a rate of 0.005°C per year from 1929 to 2009 (Jaramillo *et al*., 2013). Accelerated increased temperatures were observed in the last two decades leading to a loss in crop production including coffee, tea, and horticulture (Macharia *et al*., 2012).

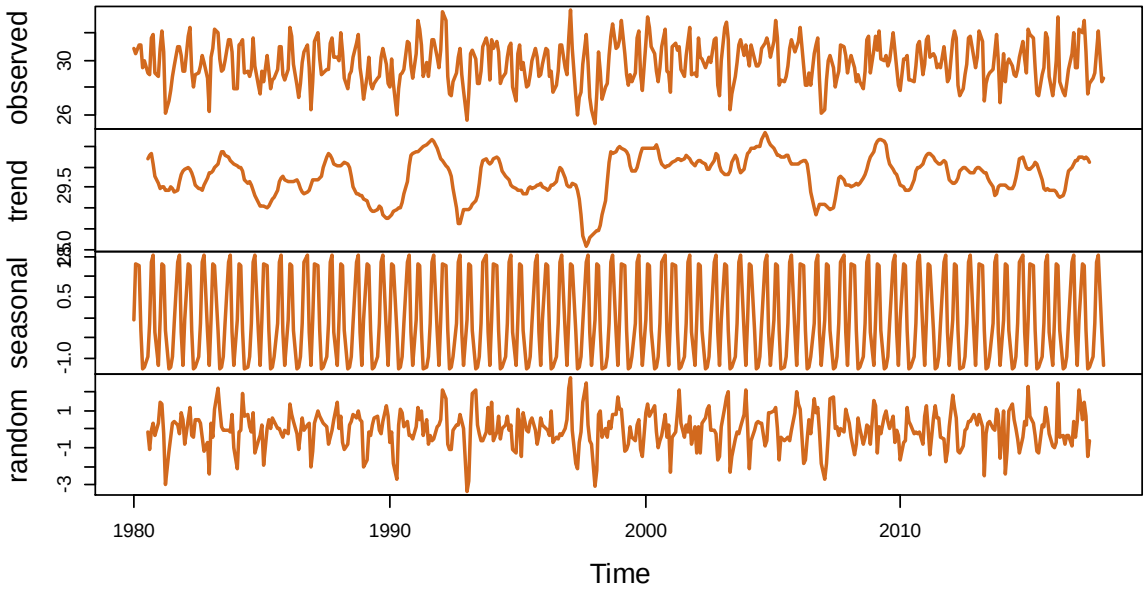

Figure 16: Maximum temperature time series for Kiambu County

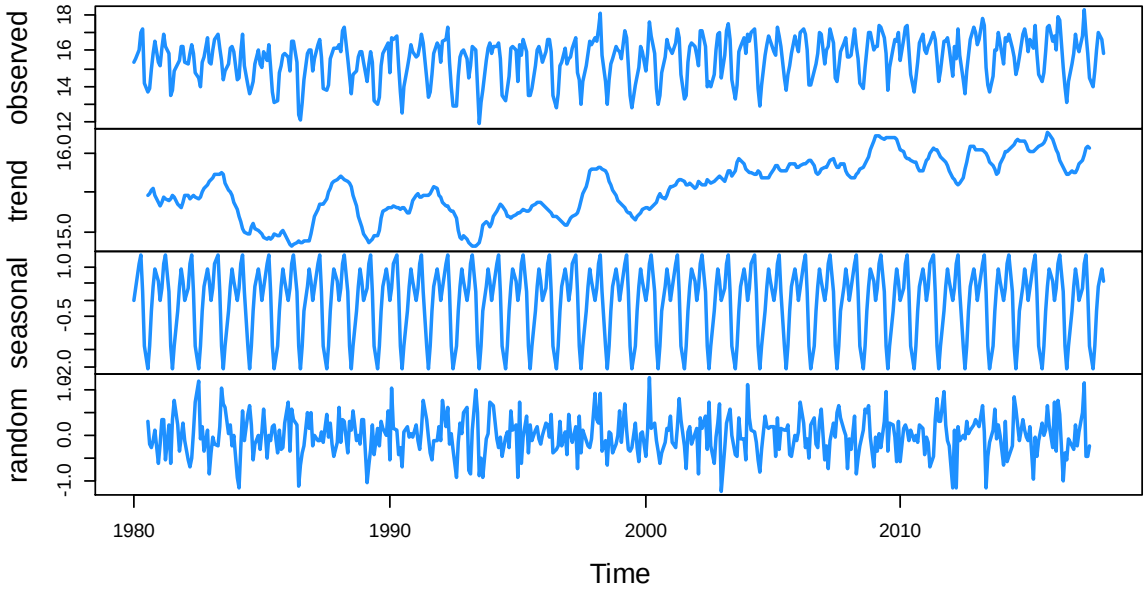

Figure 17: Minimum temperature time series for Kiambu County

4.2.10 Maximum and Minimum Temperature in Kajiado County

Figures 18 and 19 shows maximum and minimum temperatures in Kajiado County respectively for the period January 1980 – December 2017. The result reveals increasing trends in both minimum and maximum temperatures. Kajiado County and the greater Arid and Semi-Arid region of Kenya has experienced climate change-related rise in both minimum and maximum temperatures, putting stress on the livelihoods of majority pastoral communities in the area (Kenya, 2010; Amwata, 2013). According to Bobadoye *et al*. 2016, from 1970 to 2013, Kajiado County has experienced an increased rate of minimum and maximum temperatures leading to both warmer days and nights.

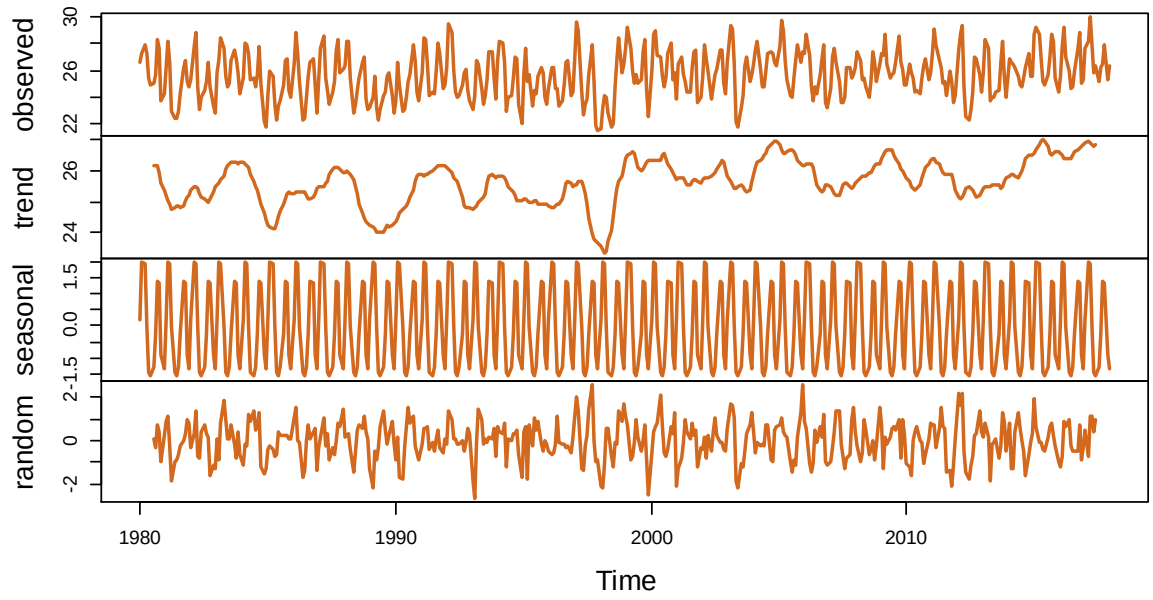

Figure 18: Maximum temperature time series for Kajiado County

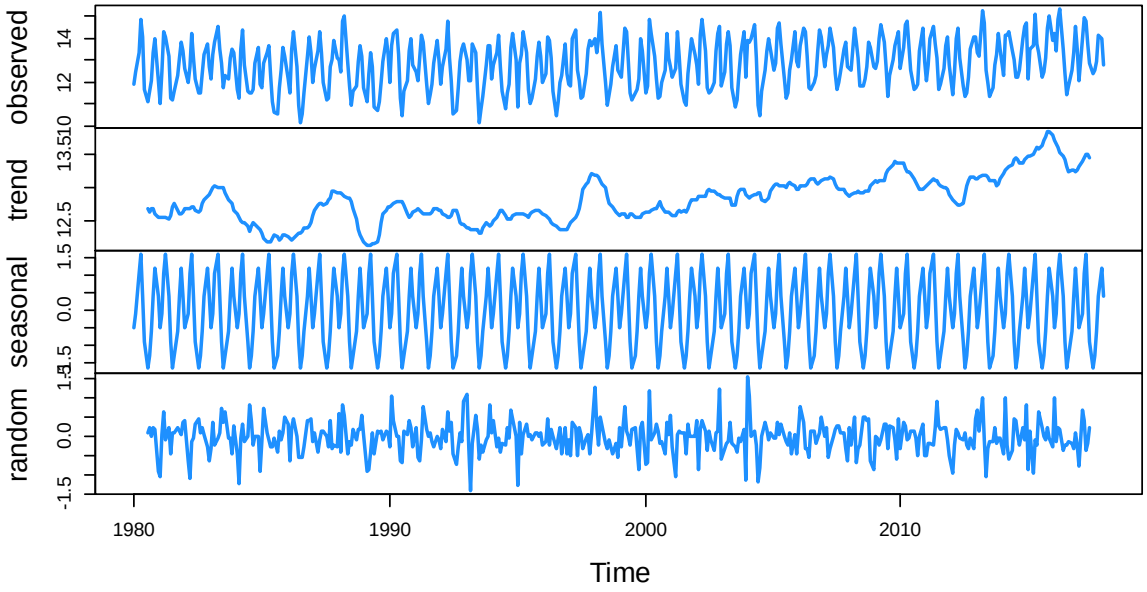

Figure 19: Minimum temperature time series for Kajiado County

4.3 Local community's perception of climate change over Kiambu and Kajiado Counties

This section presents the results of how local communities perceive climate change in Kajiado and Kiambu Counties.

4.3.1 Perceptions on minimum and maximum temperature variations

The respondent's perception of minimum and maximum temperatures was assessed as shown in Tables 5 and 6. The questions were to what extent do you agree or disagree with the following statements about climate change indicators? Please answer with a five-point scale. The majority of the respondents in Kajiado County and Kiambu County have observed excessive heat during the day in the last few decades as shown by 60.9% of the respondent agreed and 36.5% strongly agreed in Kajiado County while in Kiambu County 41.5% of the respondents agreed and 32.6% strongly agreed with the statement excessive heat has been observed during the day in the last few decades. In Kajiado County 9.6% of the respondents strongly agreed while 52.5% agreed that excessive cold has been observed during the night in the last few decades while in Kiambu County, 18.5% of the respondents strongly agreed while 39.7% agreed with the statement that excessive cold has been observed during the night in the last few decades.

Table 5: Perceptions of household interview respondents on maximum and minimum temperatures in Kajiado County

	Strongly Agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly Disagree (%)
Excessive heat has been observed during the day in the last few years	36.5	60.9	0	0.6	1.9
Excessive heat has been observed during the night in the last few years	12.1	33.3	17.3	31.4	5.7
Excessive cold has been observed during the day in the last few years	1.9	7.0	5.1	73.0	12.8
Excessive cold has been observed during the night in the last few years	9.6	52.5	12.1	20.5	5.1

Table 6: Perceptions of household interview respondents on maximum and minimum temperatures in Kiambu County

	Strongly Agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly Disagree (%)
Excessive heat has been observed during the day in the last few years	32.6	41.5	6.14	12.1	3.2
Excessive heat has been observed during the night in the last few years	0	15.3	5.7	77.5	1.2
Excessive cold has been observed during the day in the last few years	0	8.3	7.05	83.3	1.2
Excessive cold has been observed during the night in the last few years	18.5	39.7	3.8	36.5	1.2

Chi square test of independence

Table 7 shows the chi square test results. We test the null hypothesis that the respondents' perception is not related to the actual observations at 0.05 significance level. The test result indicated that all the p-values were below 0.05 significance level for example, Kiambu Max (χ^2 = 143.23, df = p≤ 0.1, Min (χ^2 = 70.87, df = p≤ 0.1and Kajiado Max (χ^2 = 140.41, df = p≤ 0.1), Kajiado Min (χ^2 = 62.65, df = p≤ 0.1. Therefore, conclude people's perceptions of the trends of both minimum and maximum temperature and the actual observations are similar in Kajiado County and Kiambu County.

Both female and male respondents from the focus group discussions in Kiambu and Kajiado County agreed to have observed changes in temperatures. In Kajiado County the majority of the respondents observed higher temperatures during the day and colder temperatures during the night. However, two respondents from the women-only focus group discussions observed warmer nights especially the earlier parts of the night. In Kiambu County, the majority of the respondents observed higher temperatures during the day and colder nights which they attributed to climate change and variability in the last few years. Other studies in Kajiado County have found consistency between local perceptions of trends of minimum and maximum temperatures and meteorological trends (Bobadoye *et al*., 2016). Also, in Kiambu County, there has been an observed rise in temperatures especially minimum temperatures leading to losses (Jaramillo *et al*., 2013). Other studies have found the perception of people on climate change-related variabilities are consistent with meteorological trends. For example, Shameem et al., 2015, on local perceptions and adaptation to climate change and variability among shrimp farming communities in the coastal region of Bangladesh, found out that they perceived changes in hydro-climatic parameters accurately. Ayanlade *et al*. (2017), comparing meteorological trend and climate change perception of smallholder farmers from southwestern Nigeria, found out that the perceptions of rural farmers on climate change and variability are consistent with the climatic trend analysis. Also, Roco *et al.* (2015), in studying the perception of farmers in Mediterranean Chile, concluded that the majority of the farmers recognized changes in temperatures in their region.

Table 7: Chi-square test results for maximum and minimum temperature variations versus observed meteorological trends

	Observed trend	X-squared	df	p-value	Accept/Reject
Kiambu max	Increasing	143.23	2	$<2.2x10^{-16}$	Reject
Kiambu min	Increasing	70.87	2	$4.05x10^{-16}$	Reject
Kajiado max	Increasing	140.41	1	$2.2x10^{-16}$	Reject
Kajiado min	Increasing	62.65	2	$2.48x10^{-14}$	Reject

4.3.2 Perception on Climate change related drought frequencies

In Kajiado County, 47% of the respondents agreed climate change-related drought periods had become *very extreme* in recent years while 52% agreed that droughts attributed to climate change had become *extreme.* The majority of the respondents from both the key informant interviews and focus group discussions in Kajiado stated that the drought frequency used to be ten years period in the 1970s, 1980s, 1990s, and up to early 2000s while nowadays it has increased to less than three years. One of the male respondents aged 54 from the FGD summed it up by saying;

‘' When I was young the drought intervals used to 10 years and we counted on receiving rainfall every other year regardless of the amount but in the last two- or three-decades droughts are occurring after every two or three years at best and our lives are never the same as before since we struggle to provide for our families sufficiently"

The extended drought periods diminished the food security potential of many households in the County through the loss of their livestock, the major source of livelihood. The disruption of the livelihoods of agro-pastoral communities by a changing climate leading to food insecurity has been observed in other studies (Orindi *et al.*, 2007; Ngaina and Mutai, 2013; Huho and Kosonei, 2014). The majority of the respondents in Kiambu also confirmed increasing drought periods over the last few years with 20% experiencing *very extreme* drought and 73% experiencing *extreme* droughts. According to respondents from the key informant

interviews in the old day's locals expected the long rains from 15th march up to May sometimes the rains continued until early June. The short rains used to start late September to December and sometimes to January. Currently, the onsets are getting late, for example, the long rains start in April instead of mid-march and the rains do not continue up to June like before. In the last couple of decades, it used to rain heavily and well distributed but nowadays the intensity is high for like one week and the rest of the days remain dry or dry spells in between MAM. Nowadays in the short seasons (OND), the onset starts mainly in October, the intensity is more and is characterized by dry spells. In both seasons (MAM and OND) rainfall distribution is getting poor it is very variable from one sub-county to another. Over the last century, the mean temperature in the Kiambu region has increased every year from 1929 to 2009 at a rate of 0.005°C. An accelerated increase in temperature was observed from the year 1991 having an impact on the cash crop and horticultural farmers in the area. The increased drought-related shortage of water and high prevalence of pests and diseases has hampered efforts to increase production, especially in the coffee and tea sector although horticulture has been affected as well. However, the situation is not as worse as in Kajiado, which is part of the ASAL counties of Kenya with already unfavorable climatic conditions before climate change exacerbated the drought situation (Amwata, 2013).

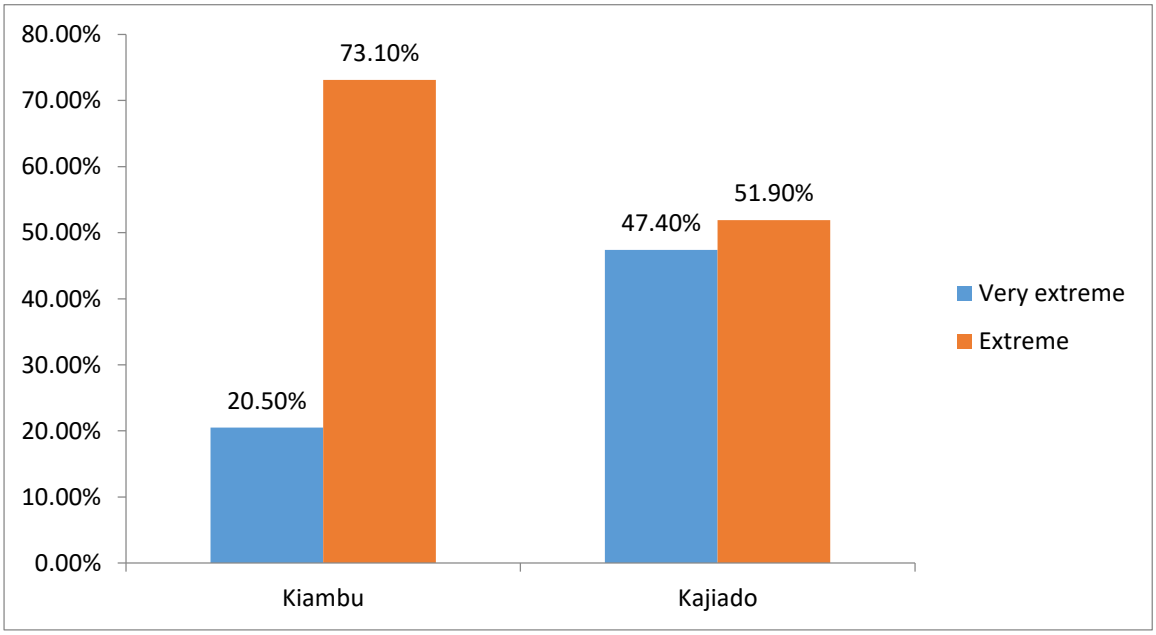

Figure 20: Perception on climate change related drought frequencies

4.3.3 Perception on major resources found in the area

According to the results on perceived major resources in their locality, land was considered as the major resource found in their region by respondents from Kiambu and Kajiado Counties. This illustrates that both communities attach the most value to land as a resource. The majority of the respondents in Kiambu County are farmers and generate their livelihood sources by growing cash crops and food crops for both export and subsistence use. Due to the productivity of land in Kiambu and proximity to ready markets in Nairobi, land values have skyrocketed in the last few decades leading to a boom in the real estate business (Marete, 2011). In Kajiado County the majority of the residents practiced pastoralism due to favorable climatic conditions. The practice of traditional pastoralism requires the availability of pastureland that can be accessed by local herders from across the County and nearby areas depending on the rainfall seasons. Also, the majority of the respondents considered land an important resource due to the pressure the County has experienced recently from population influx as a result of its proximity to Nairobi. Many people have moved from Nairobi to Kajiado County especially Kitengela, Ngong and Isinya areas which have grown in size and urbanization in recent years. Therefore, the local communities feel that they are losing their pastureland due to increased urbanization (Galaty, 2013; Morara *et al*, 2014). Consideration of land as an important social capital across the world has been reported by other studies (Pinckney and Kimuyu, 1994).

Table 8: Perception on major resources found in the area

Kiambu County			**Kajiado County**		
	Frequency	**Percent**		**Frequency**	**Percent**
Water	19	12	Soil	5	3
Land	137	88	Land	151	97
Total	**156**	**100.0**	**Total**	**156**	**100.0**

4.3.4 Perceptions on major threat to natural resources in their County

The study result indicated that the majority of the respondents in Kajiado County considered overpopulation as the major threat to natural resources in their area followed by the threat posed by climate change (Since there was no one-word translation for climate change in their language, local communities identified indicators which they associated with changing climatic conditions in their area, for example, The community in Kajiado mentioned increased

frequencies of drought (*Olameyu*) and famine (*Olari*) leading to loss of livestock and human lives, increased number of hotter days (*Ngolongi nairowua*) leading to extra demand for drinking water for both cattle and humans and colder nights (*enkewarie Nairobi*) especially in the latter part of the night devastating the elderly and those with less insulated grass-thatched mud houses. Respondents from Kiambu mentioned increased drought (*Ng'aragu*) and hot days (*Urugari*) beyond the normal level they were used to leading to unheard before cases of Malaria, reduced productivity of coffee, tea and horticulture due to high temperature related crop diseases, and new species of invasive weeds. Also, sometimes there is increased cold (*Heho*) forcing people to dress heavily when it's not even the cold season and also unpredictable and reduced rain (*Mbura*) makes predicting planting seasons difficult thus leading to reduced household food production and income for both smallholder and large-scale tea and coffee farmers.

Also, some respondents considered poverty as a major threat to natural resources in the area as shown by the 10 percent it registered while 2 percent considered weak enforcement as a major problem. In Kiambu County, the majority of the respondents also considered overpopulation as the major threat to natural resources in their area followed by changing climatic conditions as shown by 62 percent and 37 percent respectively. The problem of overpopulation related to urbanization especially in areas such as Kajiado and Kiambu that have close proximity to major cities such as Nairobi has been noted in other studies (Campbell *et al*., 2000; Museleku, 2013; Morara *et al*, 2014; Newsinger, 2015)

Table 9: Perceptions on major threat to natural resources in Kiambu and Kajiado Counties

	Kiambu County		Kajiado County	
Major threat to natural resources	**Frequency**	**Percent**	**Frequency**	**Percent**
Climate change (Kajiado respondents mentioned increased *Olameyu* (drought), *Ngolongi nairowua* (hot days), *enkewarie Nairobi* (cold nights) and reduced *enchan* (rain) in the last three decades. Kiambu respondents mentioned increased *Ng'aragu* (drought), increased *Urugari* (hot days), increased *Heho* (cold) during the night and reduced *Mbura* (rain) in the last three decades	57	37	53	34
Overpopulation	97	62	84	54
Poverty	0	0	15	10
Weak enforcement	2	1	4	2

4.3.5 Perceptions on activities attributed to Climate Change

According to the results in Table 10, the majority of respondents from Kajiado County indicated that they had no idea of any activities that was attributable to changing climate in their area, 36 percent confirmed industries as the biggest contributor to local climate change, 19% of the respondents indicated use of *Jikos* (charcoal), 13% indicated vehicles, 8% indicated deforestation (reduced carbon sink) while 4% of the respondents indicated bush burning as a major contributor to climate change. In Kiambu County, deforestation (carbon sink reduction) was rated by the majority of the respondents as the local activity attributed to climate change while industries were rated as the lowest source of greenhouse gas emissions contributing to climate change. This is in agreement with what has been indicated in both the KII and FGDs in Kiambu where the forests that acted as carbon sink are destroyed at a higher rate due to demand for real estate and agricultural land. Other studies also observed deforestation in Kiambu was happening at a rapid rate due to urbanization that creates the conversion of agricultural and forest land into real estates (Musa and Odera, 2015). Also, in Kajiado increased

number of industries in the County has been reported in other studies (Keriko *et al*., 2016) leading to emissions

Table 10: Perceptions on activities attributed to Climate Change

	Kajiado County		**Kiambu County**	
Activities attributed to climate change	**Frequency**	**Percent**	**Frequency**	**Percent**
Bush burning	6	4	5	3.2
Vehicles	20	13	10	6.4
Use of Jikos (charcoal)	30	19	-	-
Deforestation (carbon sink reduction)	13	8	77	49.4
Industries	36	23	3	1.9
Not Applicable	51	32.7	61	39.1
Total	**156**	**100.0**	**156**	**100.0**

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4.3.6 Perceptions on flooding in the last three decades

According to results shown in table 11, 64% of the respondents from Kajiado County indicated that the frequency of flooding in the previous years has decreased, 30% indicated that it was normal while 3% indicated that the frequency of flooding in the last few years has increased. In Kiambu County, 92% of the respondents were not sure of any flooding events in the area for the last few years while 5% indicated normal flooding situation. The decreased amount of rainfall and increased drought frequencies has been reported in other studies (Orindi *et al*., 2007; Kenya, 2010) leading to reduction in both livestock and agricultural production. According to the respondents from the key informant interviews, the few times heavy rainfall has been experienced, it has also led to increased loss of lives, animals, crops and destruction of infrastructure.

Table 11: Perceptions on flooding in the last three decades

	Kajiado County		Kiambu County	
Observed Flooding	**Frequency**	**Percent (%)**	**Frequency**	**Percent (%)**
Decreased	100	64	-	-
Increased	4	3	5	3
Normal	47	30	7	5
Not sure	5	3	144	9
Total	**156**	**100**	**156**	**100**

4.3.7 Perceptions on time spent in search of water in the last three decades

The study indicated that 56% of the respondents in Kajiado County observed decreased time spent in search of water in the last few years, 23% indicated time spent in search of water hasn't increased while 21% indicated increased time spent in search of water in last few years. On the other hand, majority of the respondents in Kiambu County observed decreased in time spent in search of water in the last few years, 15% indicated time spent in search of water has increased while 12% stated that it has not increased. The reduction in the amount of time spent in search of water has been attributed to the County Governments increasing water points within the Counties especially in Kajiado as also accorded by respondents from the key informant interviews. However, some of the respondents in Kajiado indicated that they still trekked long distances in search of water. The Kajiado is still considered water stressed and there are measures in place to improve water distribution infrastructure in the County by extension of Nolturesh water pipeline by another 100 Kms, construction of 80 more sand dams, 3 mega dams and sinking more boreholes to cater for increased water demand for public use including schools (Kajiado County Integrated Development Plan 2018-2022). Kiambu is part of the central highlands of Kenya where water shortage has not been a major problem as also confirmed by respondents from both the focus group discussions and key informant interviews. Domestic water supply in Kiambu County has recorded a noticeable growth in the last 5 years (Kiambu County Integrated Development Plan 2013-2017).

Table 12: Perceptions on time spent in search of water in the last few decades

	Kajiado County		Kiambu County	
Time spent in search of water	**Frequency**	**Percent (%)**	**Frequency**	**Percent (%)**
Increased	32	21	23	15
Not increased	36	23	18	12
Decreased	87	56	112	72
Not sure	1	0	3	2
Total	**156**	**100**	**156**	**100**

4.4 Effects of Climate Change on Household Food Security in Kajiado and Kiambu.

This section presents results related to the impact of climate on household food security in the study area namely, Kiambu and Kajiado Counties.

4.4.1 Area under agriculture

In Kajiado County, majority of the respondents agreed that the area under agriculture was shrinking. This has been shown by 60% of the respondents indicating that area under agriculture was *slowly decreasing* while 24% agreed it was *sharply decreasing*. This is in agreement with what has been observed in Kenya's Arid and Semi-Arid Lands especially in Maasai land where population pressure from farming communities are continuously encroaching into the known spaces of pastoralists due to social and environmental pressures (Mbithi and Barnes, 1975; Thom and Martin, 1983). According to Campbell *et al.* (2000), over the last three decades Kajiado has witnessed significant land use and land cover change as a result of social-economic, political and cultural interactions. Climate change has further reduced agricultural production in ASAL regions including Kajiado through reduction of water availability which could be utilized for subsistence farming or small-scale irrigation. Climate change-related rising temperatures, without a corresponding increase in rainfall amount to balance the increased plant water needs as a result of higher evapotranspiration lead to significant reductions in agricultural production potential in Arid and Semi-Arid Regions of Kenya. (Fischer and Velthuizen, 1996). This has led to the majority of the Maasai community maintaining the pastoralism lifestyle instead of venturing into farming as an alternative source of livelihood.

On the other hand, 77% of the respondents in Kiambu County indicated the area under agriculture was *sharply decreasing* while 19% indicated that the area under agriculture was *slowly decreasing*. The County is part of the Central Highlands of Kenya known for its high agricultural potential. Major crops grown in the area include coffee, tea and high-value cash crops targeting export markets (Jaetzold and Schmidt, 1983). However, due to its proximity to Nairobi, Kiambu has experienced high population growth in the last few years (Ekbom et al., 2001). This created demand for housing units thus resulting in a boom in real estate across the county. Much of the forested land and significant agricultural land were converted into commercial properties or destroyed to pay way for developments such as roads and other infrastructures. Because of shifting from agriculture to real estate in major sub-counties such as Ruiru, Juja, Thika Municipality and parts of Kiambu sub-counties, there has been loss of forests leading to increased temperatures in the county. Where there has been less forest degradation e.g. Gatundu, Lari, and Limuru temperature rise is less gradual according to the key informant interviews. This does not mean they are not impacted by climate change but the severity of its impact is less as compared to other parts of Kiambu. The sustained population growth from urbanization, environmental degradation coupled with climate change is leading to low agricultural productivity (Lewis, 1985; Ekbom *et al*., 2001; Okoba and De Graaff; Okoba and Sterk, 2010; Asamoah, 2010). According to the key informant interviews, climate change has reduced food availability at household level because few years back Kiambu region used to produce enough food but now can feed itself for only 6 months in a year and have to depend on importing food such as maize, potatoes, and cereals from the neighboring counties.

Both genders in Kiambu were undertaking intensified agriculture production to maximize the available house-hold lands although there was involvement of more women in farming activities in comparison to men. Land fragmentation as a result of urbanization has pushed farmers into making use of greenhouses and home gardening. This is in agreement with Asamoah (2010), study which linked urbanization with reduced land available for agriculture in Ghana.

Table 13: Area under agriculture

	Kajiado County		Kiambu County	
Area Under Agriculture	**respondents**	**Percent (%)**	**respondents**	**Percent (%)**
sharply decreasing	38	24	120	77
slowly decreasing	93	60	30	19
Not changing	9	6	-	-
Slowly increasing	13	8	5	3
sharply increasing	3	2	1	.6
Total	**156**	**100.0**	**156**	**100.0**

4.4.2 Effects of climate change on livestock and crop production

According to figure 21 and 22, climate change effects are felt more by the pastoralists in Kajiado County than the farming communities of Kiambu County with many respondents agreeing that there has been increased loss of livestock, crops, decrease in availability, fodder availability, increased pest and diseases and increased use of fertilizers due to climate change-related reduced land productivity. In Kiambu majority of the respondents agreed with increased loss of crops as shown by 41% *strongly agreed* and 52% *agreed* on the statement of climate-related crop loses. Also, 74% of the respondents in Kiambu *agreed* with increased pest and disease.

The majority of the respondents from the focus group discussions in both Kiambu and Kajiado County perceived climate change-related increased rainfall and temperature variabilities especially in Kajiado County. According to female respondents, the warmer temperatures have gotten worse in the last decade accompanying frequent drought seasons. Also, in Kiambu majority of respondents from the FGD and KII indicated observing increased seasonal temperature variations affecting their planting seasons. Farmers indicated having less confidence in the seasons in comparison to the 1980's and early 1990.This is in agreement with what has been observed in ASAL areas of Kenya where rainfall and temperature patterns have shifted thereby putting pressure on livelihoods (Darkoh *et al*., 2014; Orindi *et al*., 2007; Christensen *et al*., 2007; Hoffmann, 2010; GoK, 2010a). Majority of the people in ASALs practice pastoralism due to its adaptation advantage of herd mobility (Fratkin *et al*., 1999; Wasonga *et al*., 2010). The increased loss of crop yields and pest and diseases in the central

highlands of Kenya has been observed by other studies (Kuria, 2009; GoK, 2010a; Macharia *et al*., 2012). However, the majority disagreed with the statements of climate change-related to increased loss of livestock, decreased in fodder and water availability in Kiambu. The result indicates that although both Kajiado and Kiambu County are faced with the threat of climate change, communities in Kajiado County bear its brunt more than their counterparts in Kiambu County as shown by the respondents from both Counties.

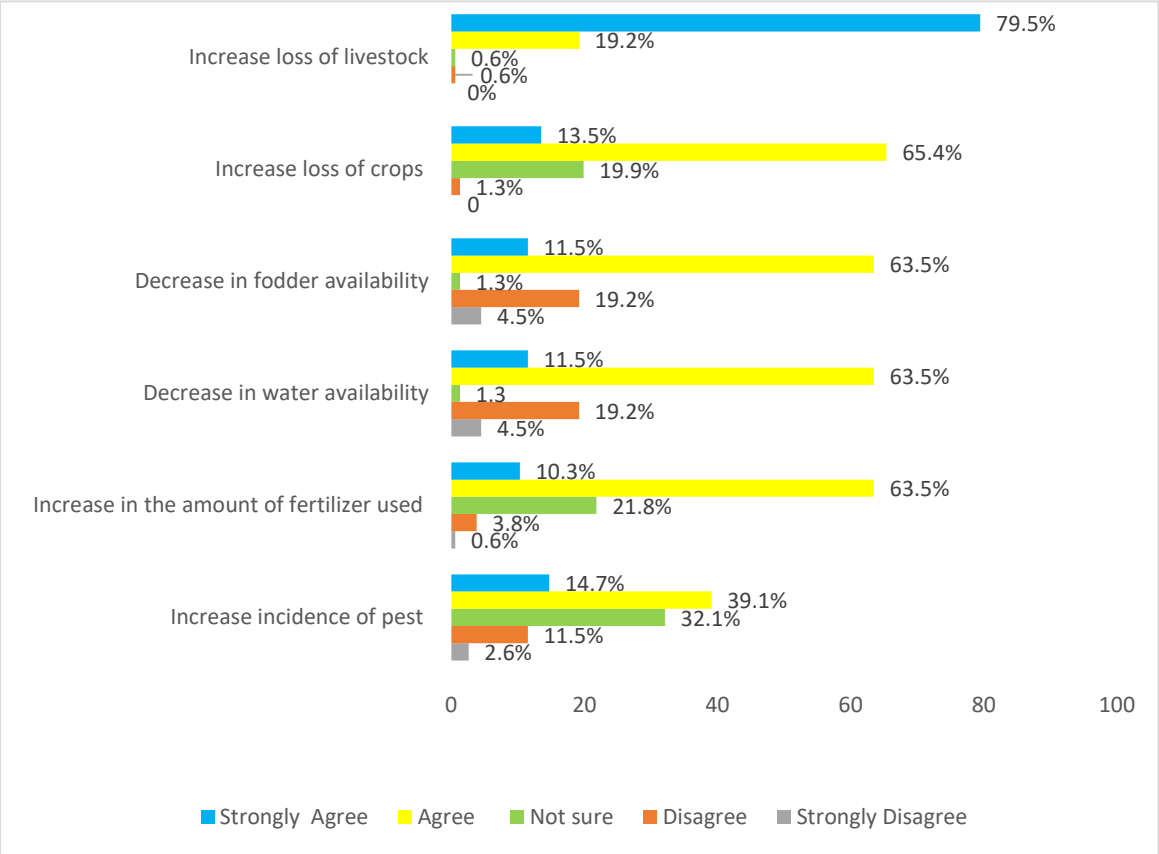

Figure 21: Effects of climate change on livestock and crop production in Kajiado County

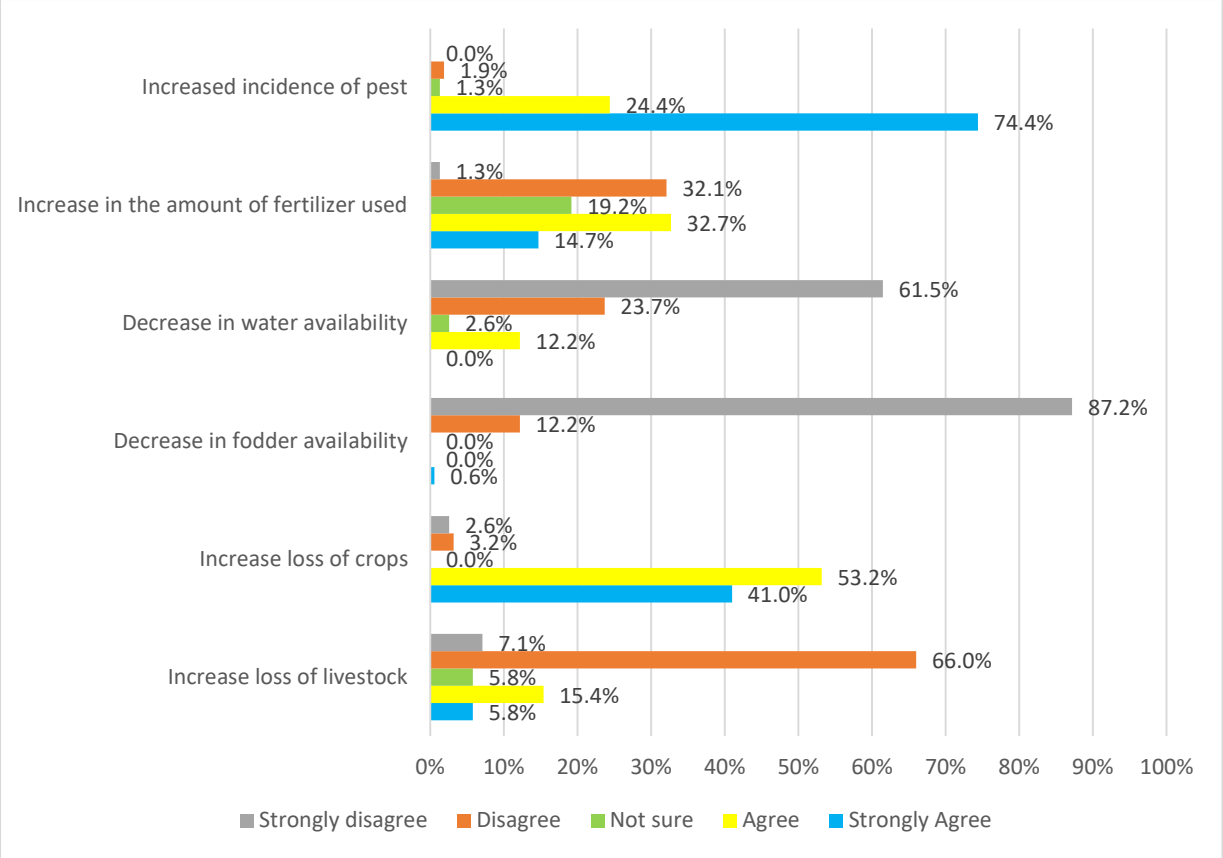

Figure 22: Effects of climate change on livestock and crop production in Kiambu County

4.4.3 Climate change adaptation strategies

According to the results from Table 14, both communities in Kajiado and Kiambu undertook adaptation strategies to cushion themselves against changing climate. In Kajiado County, 66% of the respondents considered herd mobility as the biggest adaptation strategy, 20% indicated livelihood diversification, 9% indicated buying hay while 5% indicated destocking as their major adaptation strategy. Pastoralism provides the advantage of herders moving with their livestock to different water points within and outside the Country (Swift, 1998; Fratkin *et al*., 1999; Wasonga, 2009; Wasonga *et al*., 2010). Women's FGDs indicated men migrated with house-hold livestock to Tanzania or Coastal region of Kenya following pasture and water. Sometimes they stay away from their families for several months leaving women with the responsibilities of serving children, elderly, disabled and emaciated livestock throughout drought periods until their husbands or sons returned (Ellis, 2000). The emaciated cows compete for resources in the house-holds since they need water and hay which are very rare commodities most of the time. A similar study in India by found out that men migrate to other

parts of the country in search of jobs during climate change-related disasters such as flooding leaving women behind with the burden of taking care of the children and the rest.

In Kiambu County, 56% of the respondents identified Change of planting dates as the major adaptation strategy against climate change, 23 % indicated irrigation, and 12% mentioned growing of drought-tolerant crops as a critical adaptation strategy to maintain house-hold food security while 9 % identified livelihood diversification as a way of increasing their resilience against climate change..Women are involved in tree planting such as indigenous trees, fruit trees and coffee trees. Due to the increased climate variability in the region, men in Kiambu emphasized that they store hay in bulk during the rainy seasons to feed their dairy cows during the extended drought periods. Some households have opted to introduce fleckvieh dual-purpose cattle breed to maximize meat and milk production on the lowest maintenance cost. According to respondents, their innate resistance to tropical diseases such as udder infections and East Coast Fevers is a massive advantage for the few farmers who keep the fleckvieh cows. Some large-scale farmers in Kiambu are involved in water harvesting to do irrigation during the drought seasons. Farmers in the region including Kenya and Ethiopia have adopted rainwater harvesting technologies such as building water pans and farm ponds which significantly reduces the effects from climate related extended droughts on those specific farmers (Ngigi, 2009).

The importance of farming in Kiambu is due to the favourable climatic conditions in the region. Kiambu County is considered an area with high agriculture potential falling in the agro-ecological zones I to III, with majority practicing farming. The cash crops grown include coffee, tea, pine-apples, and sisal. Also, farmers grow horticultural crops including fruits, vegetables and flowers are grown. This is in agreement with Jaetzold and Schmidt (1983) statement regarding the central highlands as an area with massive potential for agriculture due to its favorable climate and fertile soils.

Table 14: Climate change adaptation strategies in Kajiado and Kiambu Counties

Challenge	**Adaptation strategies**			
	Kajiado County	**Percentage (%)**	**Kiambu County**	**Percentage (%)**
Extreme rainfall and temperature variations	Herd mobility	66%	Change of planting dates	56%
	Livelihood diversification	20%	irrigation	23%
	Buying hay	9%	Drought tolerant crops	12%
	Destocking	5%	Livelihood diversification	9%

4.4.4 Monthly average spending on food in Kajiado and Kiambu in the face of climate change

Table 15 indicates the amount of money spent monthly on food by the respondents in the face of climate change. In Kajiado County, 72% of the respondent indicated that they spend between 5,000 to 10,000 Kenya Shillings on foods every month, 21% stated that they spent between 2,000 to 5,000 Kenya Shillings in food in a given month while 8% of the respondents utilized between 15,000 to 25,000 Kenya Shillings every month. In Kiambu County, 52% of the respondents indicated that they utilized between 5,000 to 10,000 in food every month, 33% indicated that they utilized between 2,000 to 5,000 Kenya Shillings in food per month, 12% stated they utilized between 15,000 to 25,000 Kenya Shillings on food every month, 2% of the respondents indicated they were either utilizing between 30,000-50,000 or Over 50,000 Kenya Shillings on food every month. This illustrates that a large population of the constituents in Kiambu County utilize more on food above 30,000 a month as compared to their counterparts in Kajiado County. The difference in expenditure on food indicates the level of disparity in terms of poverty between Kajiado and Kiambu County. The majority of the respondents in Kajiado County are mainly pastoralist communities that are heavily dependent on livestock

production. The increased climate change-related drought frequencies in the Arid and Semi-Arid regions where Kajiado County falls has contributed to increased loss of livelihoods.

On the other hand, Kiambu County is among the Counties in the Central Highlands of Kenya characterized by good climate conditions that support agricultural production. Also, the proximity of Kiambu County to Nairobi has allowed increased investments in the County especially the booming real estate business and tea and coffee production thus empowering the local communities. Kiambu County has the lowest poverty index in Kenya only second to Nairobi County contributing 11.1% to the national wealth while the poverty index ranking put Kajiado County position 11 out of the 47 Counties in Kenya. The contribution of Kajiado County to the national wealth has been rated at only 3.8% which is less significant in comparison to Kiambu County even though they are both close to the capital city, Nairobi (KNBS and SIDS, 2013).

Table 15: Monthly Average Spending on Food

	Kiambu County		**Kajiado County**	
	Frequency	**Percent (%)**	**Frequency**	**Percent (%)**
2,000-5,000	52	33	32	21
5,000-10,000	81	52	112	72
15,000-25000	19	12	12	8
30,000-50,000	2	1	0	0
Over 50,000	2	1	0	0
Total	**156**	**100**	**156**	**100**

4.4.5 Climate change related food shortage at household levels in Kajiado and Kiambu Counties

The result in Table 16 indicated that the majority of the respondents in Kajiado County experienced food shortage due to climate change-related extended drought periods leading to loss of livestock and also reducing its market value, thus making them poorer and more vulnerable. The findings indicated that 12% of the respondents in Kiambu experienced extreme food shortages related to changing climate. However, more people in Kajiado County experienced food shortage in the last few years in comparison to their counterparts in Kiambu County.

This has been pointed out by one of the respondents from the women focus group discussion sentiments on her livelihood status;

‘‘It has become hard to get food and you find that one packet of *Unga* (wheat flour) goes for 200 shillings and sugar goes for 160 per kg and tea leaves at 60 shillings. You find when you go to the shop with 1000 shillings you only buy 2 packets of *Unga*, a kilogram of sugar and half a kilo of rice which is not enough for my children…. It’s only God for us now because this drought has become too much... So, my children just get some little food to sustain them to go to school and back’’.

Also, one of the male respondents from the focus group discussions stated that in the rainy seasons the price of a cow was around 30,000 Kenya Shillings but the long droughts leave people with emaciated herds and if one were to sell a cow it would fetch around 1,200 shillings, a telling indication of how their unique livelihoods remain threatened. The perception in food insecurity among the respondents is supported by Amwata *et al*., 2015 stating the inability of more than 70 percent of ASAL populations of Kenya including Kajiado operating below the poverty line and being dependent on government or external food aid. Kajiado is part of ASAL Counties in Kenya where climate change impacts are more severe while (Orindi *et al*., 2007; GoK, 2010a; Fraser *et al*., 2011) Kiambu is part of the highland regions of Kenya falling under the agro-ecological zones I to III. The region has more favorable soils and climatic conditions that can support agriculture hence household food security (Jaetzold and Schmidt 1983). The percentage of the respondents in Kiambu that remain food insecure are those lacking nutritious food especially among children under five and the elderly that are dependent on the national Government’s cash transfer program. The safety net is aimed at improving the lives of the poor and vulnerable persons above the age of 65 years (Marangu, 2014; Chege *et al*., 2016).

Table 16: Climate change related food shortage at household level in Kiambu and Kajiado Counties

	Kiambu County		**Kajiado County**	
	Frequency	**Percent (%)**	**Frequency**	**Percent (%)**
Very extreme	0	0	14	9
Extreme	18	12	72	46
Normal	1	1	47	30
N/A	137	77	23	15
Total	**156**	**100**	**156**	**100**

4.4.6 Household need for food relief in the last few decades as a result of climate change

According to Figure 23, the majority of the respondents in Kajiado County pointed to an increasing need for food relief over the last few years while the majority of the respondents from Kiambu pointed to not needing food relief in the last few years. Extended drought periods coupled with weak management of climate change associated risks using livestock insurance and mobile-based early warning systems on drought emergencies increased the vulnerability of households in Kajiado County. This is in agreement with what has been observed in the Arid and Semi-Arid region of Kenya, Kajiado included where climate change has increased pressure on communities' livelihoods (Orindi *et al*., 2007; Christensen *et al*., 2007; Darkoh *et al*., 2014) as they already operated below the poverty line and remain dependent on frequent government interventions during extended drought periods. (Fraser *et al*., 2011; Amwata *et al*., 2015). The result is further supported by Mwangi (2013) and the report of Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID) (2016) report ranking Kiambu as the second county after Nairobi with the lowest poverty index of 24.2% while Kajiado ranked position 12 contributing 11.1% to the national wealth while Kajiado was ranked 12 contributing only 3.8 percent to national wealth.

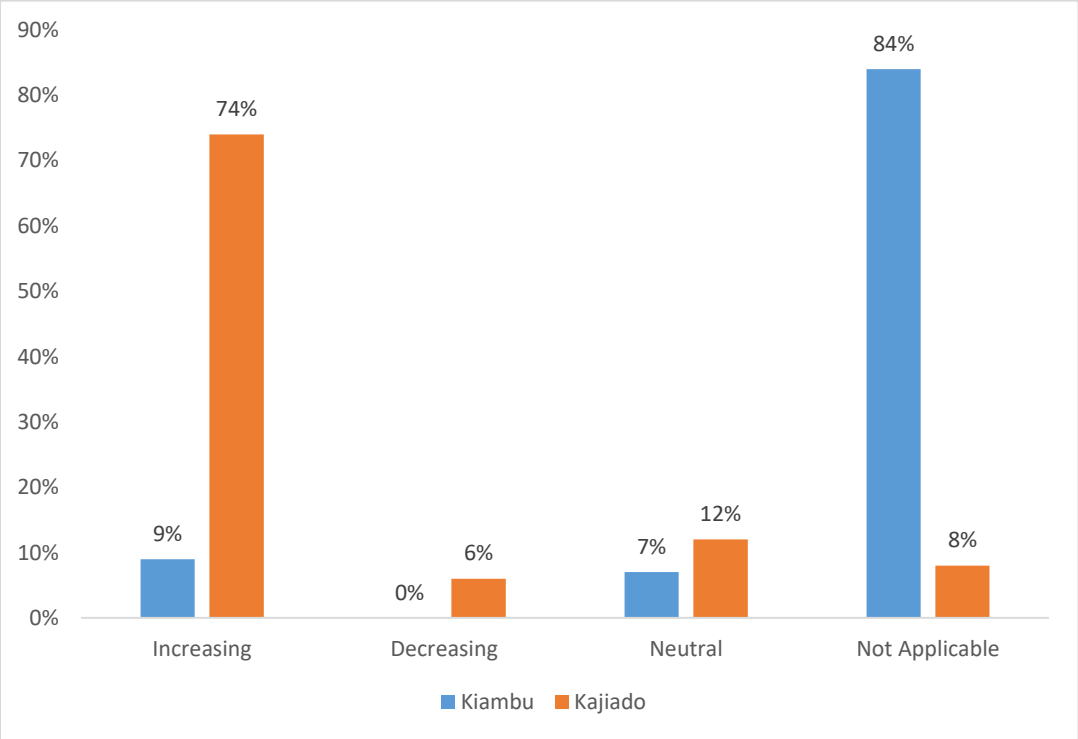

Figure 23: Households needs for food relief in the last few years

4.4.7 Coping Strategies during climate change related food shortage at household level

Table 17 indicates the respondent's alternative means of accessing food when they experienced climate change-related food shortages. Since the majority of the communities in both Kajiado and Kiambu are dependent on agriculture as the major source of livelihoods, its susceptibility to climate change increases people's vulnerabilities through the loss of crops and livestock thus making them poorer. According to the result, the majority of the respondents in Kajiado relied on family members and friends support, followed by dependence on relief aid from donors including Government and Non-Governmental Organizations. Also, they adopted climate change adaptation strategies included herd mobility, selling beads, herbs, and honey.

In Kiambu County, 63% of the respondents had sufficient household food security and they practiced climate change adaptation strategies included water harvesting, irrigation, apiculture, agroforestry, fodder conservation, and poultry. Kiambu is the second county after Nairobi with the lowest poverty index in Kenya and contributes 11.1% to the national wealth while Kajiado was ranked 12 in the poverty index contributing only 3.8 percent to national wealth (KNBS and SIDS, 2013).

Table 17: Coping strategies during climate related food shortage at household level

	Kiambu County		**Kajiado County**	
	Frequency	**Percent (%)**	**Frequency**	**Percent (%)**
Relief aid	1	1	41	26
Family &friends support	26	17	72	46
Remittance	3	2	6	4
Charity	0		1	1
Loans	28	18	11	7
N/A	98	63	25	16
Total	**156**	**100**	**156**	**100**

4.5 Gender roles in climate change adaptation actions in Kajiado and Kiambu Counties

Despite the gender differentiated climate change impacts, men and women also have gendered roles that dictates access, control, labor and decision making as they adapt to climate change. This is discussed below.

4.5.1 Access and control of household land

Table 18 indicates women in Kajiado have the least access to household land during the extended drought seasons and rainy seasons in comparison to women in Kiambu as shown by a comparative percentage difference of -82% during rainfall seasons and -82% during the extended drought periods respectively. Also, the result indicates that women in Kiambu have more control over the household land in comparison to their counterparts in Kajiado as shown by -12% and -12% difference during the rainy seasons and drought periods respectively.

Table 18: Comparative analysis of the gender roles in the implementation of adaptation options between Kiambu and Kajiado Counties

Item	Gender	Season	Comparative percentage (%) difference relative to Kajiado
Full access to household land	Men	Rainy Seasons	+10
		Extended drought seasons	-28
	Women	Rainy Seasons	-82
		Extended drought seasons	-82
Full control of household land	Men	Rainy Seasons	+37
		Extended drought seasons	+20
	Women	Rainy Seasons	-12
		Extended drought seasons	-12

Chi-square test

The chi-square analysis results of the influence of gender on access and control of household lands in the face of changing climate are shown in Tables 19 and 20. The null hypothesis was 'Men and women have equal access to household land in both rainy and extended drought seasons and Men and women have equal control of household land in both rainy and extended drought seasons. However, in both counties, there was gender disparity in access and control of land for all the seasons considered as confirmed by the chi-square test, through rejection of

the hypothesis in Tables 19 and 20 for example, the chi-square test results for full control of household land during the extended drought season in Kajiado county was ($\chi^2 = 102.3$, df = p≤ 0.1). All the p-values obtained are much less than 0.05. We, therefore, reject the null hypothesis and conclude that there is a difference in access to household land between men and women in all the seasons considered.

Frequency analysis results point to more gender disparity in Kajiado than Kiambu County as indicated by women having the least access and control over household land in all seasons. The inability of women from the Kajiado County to have more access and control over household resources such as land has been rooted in the patriarchal nature of their traditional system. In the Maasai community, gender roles are shaped through the lens of their customs. Men usually belong to an age-set system which gives a platform to voice their concerns about wider issues affecting them or the community. However, women do not belong to age groups or any democratic setting recognized within the customary law. According to Talle (2007), the social age-set system is a man affair where appointments and delegations are done solely by men. This customary power system has been applied traditionally in sharing and sub-division of landholdings among the Maasai elders, both rich and poor herders, and the youth. Since women were locked out of these opportunities coupled with the inability to challenge their exclusion, it has entrenched a culture of dependence on men thus creating unequal gender dynamics in terms of access, control, and critical decision-making at household levels (Meinzen-Dick and Mwangi, 2009). This hampers climate change adaptation efforts since women who make half the population in the County lack adequate resources such as access and control of the household land thus deeming their unique experiences and knowledge to utilize the land and contribute to household food security almost nonexistent. During extended drought periods, Maasai men migrate with the livestock mostly cattle, leaving women, children, the elderly, and the sick behind. Sometimes the men stay away for a long period depending on the length of the drought season. Even under these circumstances, women lack the authority to utilize the household land or sell some plots if the family owns a number of plots so as to cushion themselves against climate change.

On the other hand, the Kikuyu community had a patriarchal system where men were considered to be the head of the household automatically. In the case of the death of the father, the eldest son assumed the role (Muriuki 1974). Girls, women, and uncircumcised boys were responsible for performing domestic/household duties. Once circumcised, boys were considered ‘men' and

qualified to be exempted from such tasks. This cemented men's authority at household levels and was exploitatively used to gauge ‘good wife' by the level of obedience to their husbands (Wamue-Ngare and Njoroge, 2011). According to Kenyatta (1938), women had no ownership rights to land, livestock, and/or valuable assets. They were allowed to access and control household goods such as pans, baskets, utensils, pots, and milk. Even if women worked on the farms and generated income from selling the produce, they were still bound to send the profits to their husbands even if they worked outside the area of residence. This means it was a system of dominance where women were marginalized in resource ownership, labor divisions, and decision making. However, the gender dynamics among the Kikuyu men and women shifted around the 1980s when Kenya experienced economic deterioration. This was a result of external shocks especially falling oil prices of the late seventies. These led to high rates of inflation in the country resulting in deliberate government policies such as massive layoffs to keep its economy remain afloat. As men dominated the formal sector jobs, they were significantly affected in comparison to their female counterparts thereby rendering most of them jobless. As gender roles are specified in the Kikuyu household setting, it became a nightmare for men to switch smoothly to the informal sector since it was women's territory.

Women including those that were laid off took care of domestic responsibilities and also slowly filled gaps left by the men who drained their slow self-esteem on illicit brews after losing prestige in the eyes of their families and general society. Importantly, this period coincided with the 1985 UN women conference held in Nairobi which discussed pushing women agenda forward all over the world. As the debate on gender equality was taking shape around the world, at the local level change was in the air too. Kiambu Women become more enterprising with the adoption of *Chamas* (women groups) which made access to loans easier than before. They became more independent and broke societal barriers that prevented them from owning resources, defining roles, and also curtailing their ability to make decisions that affected their families, However, because of the strong cultural influences which stayed for long periods, gender equality has not been fully realized in Kiambu County since critical resources especially land ownership is dominated by men which affect climate change adaptation options available for women (Wamue-Ngare and Njoroge, 2011).

Table 19: Chi-square test results of difference in access and control of household land between men and women in all the seasons for Kiambu County

		Chi-square value	df	P-value	Remark
Full access to household land	Rainy seasons	226.7	9	$2.2x10^{-16}$	Unequal access
	Extended drought seasons	218.8	9	$2.2x10^{-16}$	Unequal access
Full control of household land	Rainy seasons	149.5	9	$2.2x10^{-16}$	Unequal control
	Extended drought seasons	148.5	9	$2.2x10^{-16}$	Unequal control

Table 20: Chi-square test results of difference in access and control of household land between men and women in all the seasons for Kajiado County

		Chi-square value	**df**	**P-value**	**Remark**
Full access to household land	Rainy seasons	174.0	9	$2.2x10^{-16}$	Unequal access
	Extended drought seasons	246.1	9	$2.2x10^{-16}$	Unequal access
Full control of household land	Rainy seasons	120.3	9	$2.2x10^{-16}$	Unequal control
	Extended drought seasons	102.3	9	$2.2x10^{-16}$	Unequal control

4.5.2 Labor Division

Women in Kajiado County spend more time on-farm activities in both the rainy seasons and the extended drought periods than women in Kiambu County while women in Kiambu County spend more time on livestock production in both seasons than their counterparts in Kajiado as shown in Table 21. These points to biased labor divisions where women are involved in both livestock and crop production in both seasons except for women in Kajiado during the extended drought periods. However, Kajiado County women are engaged in alternative sources of income such as home gardening, beads making, selling honey while still doing their household duties including serving their children, elderly family members, the disabled, trekking long distances fetching water and firewood. Women in Kiambu are engaged in alternative sources of livelihoods including beekeeping, rabbit rearing, pigs rearing, livestock keeping and poultry. The biased labor divisions against women in developing countries have been cited by Modi *et al*.,2005) stating the extra labor-intensive time could have been utilized in increasing income for households and education.

Two young girls fetching water for their families on their backs telling the PhD student how far they trekked from the point of collection in Oloosirkon, Kajiado East Sub-County.

Table 21: Farm labor during wet and dry seasons

Crop farming During rainy season	**Kiambu County**		**Kajiado County**	
	N0- of persons	**Percent (%)**	**No of persons**	**Percent (%)**
Men	45	29	15	10
Women	99	63	136	87
Casual labor	12	8	5	3
Total	156	100	156	100
During drought season				
Men	48	31	43	28
Women	94	60	108	69
casual labor	14	9	5	3
Total	**156**	**100**	**156**	**100**
livestock keeping During rainy season				
Men	64	41	100	64
Women	65	42	54	35
casual labor	27	17	2	1
Total	156	100.0	156	100.0
During extended drought periods				
Men	64	41	127	81
Women	65	42	27	17
casual labor	27	17	2	1
Total	**156**	**100**	**156**	**100**

4.5.3 Decision making on marketing farm produce and selling livestock

On decision making, women in Kiambu have more authority to decide on marketing farm produce and selling livestock than women in Kajiado as shown in Table 22. This is shown by the difference of 50% in marketing farm produce and 24% in selling livestock. The empowerment of women in Kiambu and the greater central region is drawn from the experiences of women involved in the *Mau Mau* movement thus made them conscious of social injustice within and outside their environment. Later these experiences led the focus on local issues such as inheritance, land ownership, and decision-making which women questioned after acquiring wealth through women groups and small businesses (Rosberg and Nottingham, 1966; Mugo, 1975; Kenyatta 1938; Wamue-Ngare and Njoroge, 2011).

Table 22: Decision making on marketing farm produce and selling livestock

Marketing of Farm Produce	**Kiambu County**		**Kajiado County**	
	No. of persons	**Percent (%)**	**No. of persons**	**Percent (%)**
Men	58	37	137	88
Women	96	62	19	12
casual labor	2	1	0	0
Total	**156**	**100**	**156**	**100**
Selling livestock				
Men	68	44	128	82
Women	65	42	28	18
Casual labor	23	15	0	0
Total	156	100	156	100

4.5.4 Decision making on how to utilize the money from sales proceeds

Decision making on the utilization of sales proceeds from both crop and livestock indicate women in Kiambu are more independent to decide how to utilize the money than women from Kajiado County as shown in Table 23. The patriarchal system practiced by communities in Kajiado County excludes women from economic decision making thus becoming dependent on men at the household level. The inability of women to make decisions on how to utilize financial gains from agricultural production or alternative sources of income has also been reported in other studies (Sanday, 1981).

Table 23: Decision making on how to utilize the money from sales proceeds

farm produce	**Kiambu County**		**Kajiado County**	
	Frequency	**Percent (%)**	**Frequency**	**Percent (%)**
Men	58	37	137	88
Women	96	62	19	12
casual labor	2	1	0	0
Total	**156**	**100**	**156**	**100**
Livestock sale				
Men	75	48	101	65
Women	72	46	47	30
casual labor	9	6	6	4
Total	**156**	**100**	**156**	**100**

4.5.5 Gender inclusivity and climate change adaptation actions

The result below shows gender inclusivity in climate change adaptation actions applied by the local communities in Kajiado and Kiambu Counties.

4.5.5.1 Men and women Participation in agro forestry initiatives

The findings in Table 24 showed 67% of the respondents in Kiambu County agreed between 81-100 percent of men participation in agroforestry initiatives while in Kajiado County, 47% of the respondent indicated between 61-80 percent of men participation in agroforestry initiatives. On the other hand, 68% of the respondents in Kiambu indicated between 0-20 percent of women participated in agroforestry initiatives while in Kajiado 48% of the respondents indicated between 21-40 percent of women participated in agroforestry initiatives. Due to gender divisions of labor, men and women usually have different roles and responsibilities, opportunities, and priorities (Bechtel, 2010; Mai *et al*., 2011). While men utilize natural resources for cash-crop based agriculture, logging, and forest products that fetch high prices women on the other hand are said to put more emphasis on subsistence farming/agriculture and collecting forest products such as firewood, medicinal plants among others to be used at home or sold in the markets to so as to make quick money for household use (Cavendish, 2000; Shackleton and Cousins, 2001). Access to natural resources including water, trees, land, and animals is usually decided by cultural norms in many societies around

the world. With this patriarchal nature, women do not have the same rights of ownership of critical resources such as land as men where they can practice their own choices climate-smart agriculture including agroforestry (Coulilay-Lingani, *et al*., 2009). In cases where women were involved in natural resource management including forest resources, it has been found that they do not only contribute to the sustainable management of the resources but increase incomes for the group (Agarwal, 2001, 2009; Upadhyay, 2005; Mwangi *et al*., 2011).

Table 24: Men and women participation in agro forestry initiatives

	Kiambu County		**Kajiado County**	
Men	**Number of persons**	**Percent (%)**	**Number of persons**	**Percent (%)**
0-20	17	11	7	5
21-40	5	3	21	14
41-60	22	14	52	33
61-80	7	5	74	47
81-100	105	67	2	1
Total	**156**	**100**	**156**	**100**
Women				
0-20	106	68	29	19
21-40	15	10	75	48
41-60	18	11	40	26
61-80	1.0	1	2	7
81-100	16	10	0	0
Total	**156**	**100**	**156**	**100**

4.5.5.2 Men and Women participation In Soil Fertility Enhancement

The result in Table 25 shows findings on men's and women's participation in soil fertility enhancement in Kajiado and Kiambu Counties. There are more men involved in soil fertility enhancement initiatives in both Kajiado and Kiambu Counties than the number of women involved in the same activities. This is in agreement with other studies which point to the fact that women's inability to make important decisions as a result of biased gender roles in access to technology and information and poor skills limit their potential to contribute to enhancing

agricultural production (Reed, 2010; Nuggehalli and Prokopy, 2009; Bandiaky-Badji, 2011; Lewark, *et al*., 2011).

Table 25: Men and women participation in Soil fertility enhancement

	Kiambu County		**Kajiado County**	
Men	**Number of persons**	**Percent (%)**	**Number of persons**	**Percent (%)**
0-20	38	24	0	0
21-40	28	18	22	14
41-60	21	14	65	41
61-80	31	20	69	44
81-100	38	24	0	0
Total	**156**	**100**	**156**	**100**
Women				
0-20	57	37	21	14
21-40	33	21	91	58
41-60	15.0	10	39	25
61-80	30	18	22	3
81-100	21.0	14	0	0
Total	**156**	**100.0**	**156**	**100.0**

4.5.5.3 Men and Women participation in water management initiatives

According to table 26, there were more women involved in water management initiatives in the face of climate change than men in both Counties. Studies indicate that when there are extended dry conditions related to climate change and climate variability, women are burden more than men in search of water especially in Arid and Semi-Arid regions such as Kajiado. Gender roles at the household level push women towards labor-intensive activities with minimal rights in decision making. Men remain the major stakeholders in controlling resources including water and form the majority of the management involved in decision making on water points such as dams, pans, or boreholes especially in ASAL regions (Kunst and Kruse, 2001; Lambrou and Piana, 2006).

Table 26: Women and Men Participation in Water Management Initiatives

	Kiambu County		**Kajiado County**	
Women	**Number of respondents**	**Percent (%)**	**Number of respondents**	**Percent (%)**
0-20	37	24	3	2
21-40	11	7	15	10
41-60	7	5	69	44
61-80	32	20	69	44
81-100	69	44	0	0
Total	**156**	**100.0**	**156**	**100.0**
Men				
0-20	25	16.0	32	20.5
21-40	42	26.9	45	28.8
41-60	34	21.8	39	25.0
61-80	29	18.6	28	17.9
81-100	26	16.7	12	7.7
Total	156	100	156	100

4.5.5.4 Breaking from defined gender roles can contribute to improved community adaptive capacities

The findings on Figures 24 and 25 indicated that 23% of the respondents from Kiambu *strongly agreed* breaking from defined gender roles can contribute to improved community adaptive capacities while 75% of the respondents *agreed* with the same statement. In Kajiado County, 21.8% of the respondent *strongly agreed* that breaking from defined gender roles can contribute to improved community adaptive capacities while 59% of the respondents *agreed* to break from defined gender roles contributed to improved community climate change adaptation capacities. The study indicates that both respondents in Kiambu and Kajiado County perceived defined gender roles are contributing to ineffective climate change adaptation hence the need to advocate for improved gender equality. Importantly, more respondents in Kiambu believe doing away with defined gender roles as a positive initiative than respondents in Kajiado.

A previous study by Wamue-Ngare and Nancy (2011), agrees that gender dynamics in Kiambu have improved in the last few decades. Although defined gender roles have their roots in cultural embedded believes that had stayed for hundreds of years, the result indicated slowly improving awareness on issues related to gender especially in Arid and Semi-Arid regions including Kajiado County where the majority of these communities have patriarchal systems in which women lack same access and control of household and community resources including land, livestock and the ability to make important decisions that would contribute to building their resilience against changing climatic conditions.

4.5.5.5 Climate change adaptation training is accessible to both men and women

In Kiambu County, 82.6% of the respondent *agreed* that climate adaptation training was accessible by both men and women in their area while in Kajiado 46.2% *agreed* that climate adaptation training was accessible by both men and women in their area. However, in Kajiado County, 24.4% of the respondents *disagreed* that Climate adaptation training was accessible by all meaning whenever training opportunities are availed its mostly men that make the majority of the participants in comparison to women who are usually busy with domestic labor. This is in agreement with other studies that indicated improved gender equality in Kiambu which has been attributed to combined factors included taking household leadership when their husbands and sons were involved in the *Mau Mau* resistance movements against the colonial British rule in Kenya, the influence of women activists from Central Kenya namely the late Prof Wangari Maathai from Green Belt Movement thus giving women more space for leadership at the household level. On the other hand, the Maasai still practiced patriarchal systems where the same opportunities are not mostly available to both genders thus creating gender inequality in economic, social, and political spheres. Some literature indicates that the Maasai women are viewed as property of men hence limiting their decision-making at the household level including the ability to acquire knowledge such as capacity building training on climate change (Ortner and Whitehead, 1981; Hodgson, 1999).

4.5.5.6 Climate information is available to all regardless of gender

In Kiambu, 80.1% of the respondents *agreed* that climate information was available to all community members regardless of their gender while in Kajiado 39.1% *agreed* that climate information was available to all without gender bias, 30.8% of the respondents *disagreed* while 11.5% *strongly disagreed* with the same statement. This in agreement with other studies done on the Maasai community both in Kenya and Tanzania. The Maasai practice their culture manifesting throughout their lives in all phases. The Maasai patriarchal system gives men more

authority over women hence limiting the potential for women to play significant roles hence involved in labor-intensive household duties such as trekking several kilometers daily fetching firewood and water. Maasai women are viewed as property once they get married thus limiting their potential to make decisions on their own even though they are sometimes most equipped to provide better solutions to household and community problems (Spencer, 2004; Schneider, 1980).

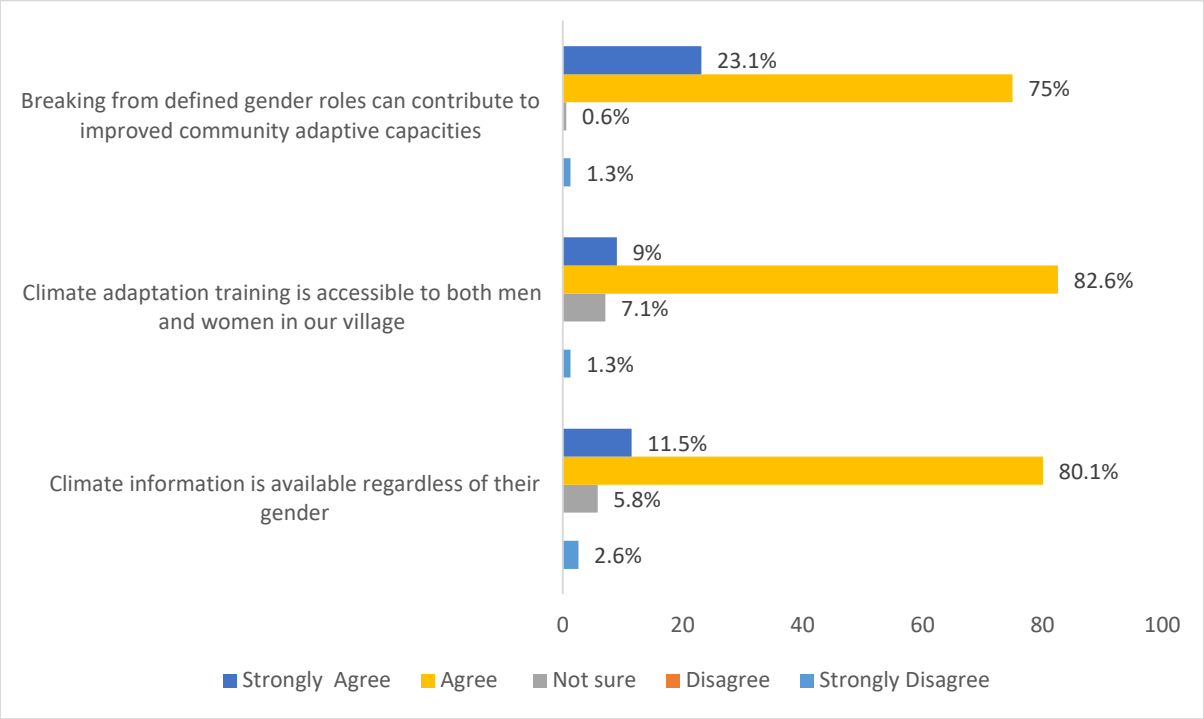

Figure 24: Kiambu County

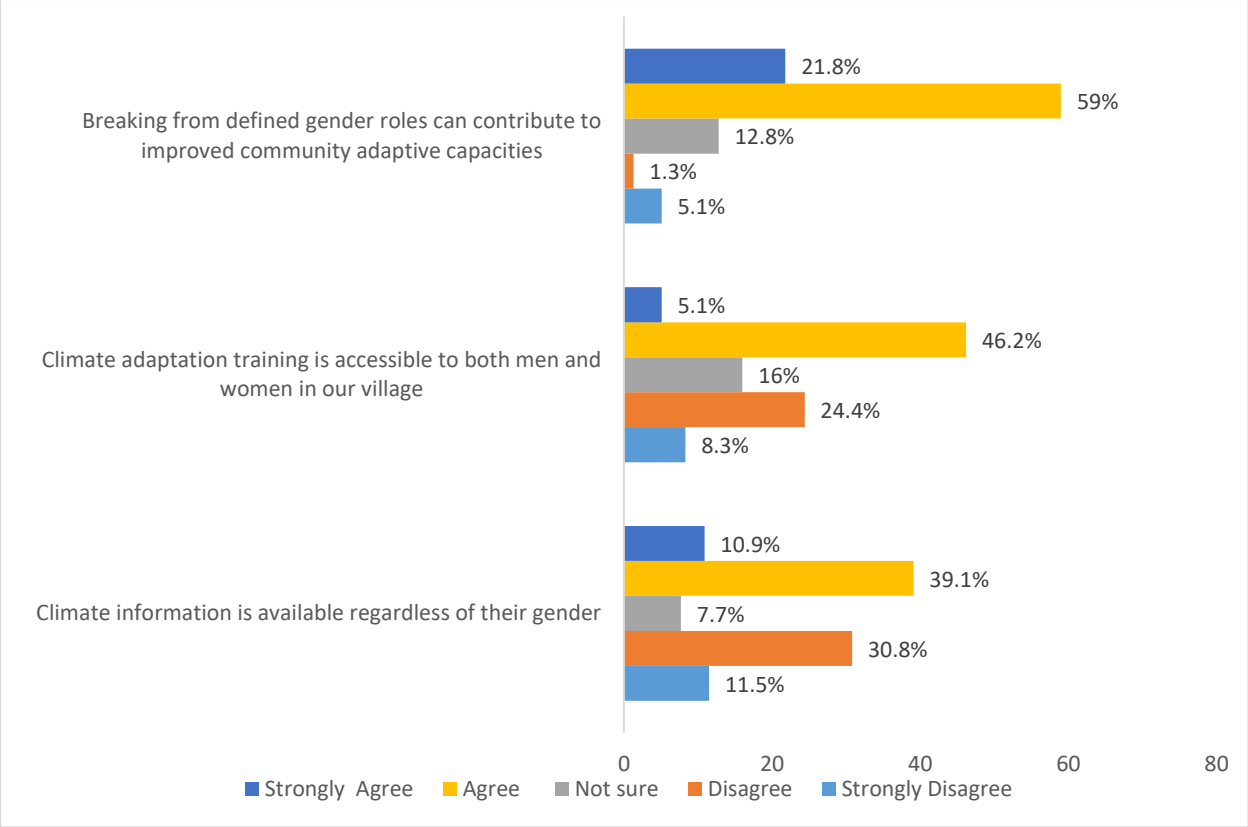

Figure 25: Kajiado County

4.5.5.7 Participation in climate change adaptation training

In Kiambu County, 80% of the respondents did not participate in climate change adaptation training hence no idea of its usefulness while in Kajiado County 68 % of the respondents indicated that they participated in some training related to building resilience against climate change and it was somehow useful to them. Evidence indicates that many smallholder farmers including in Kiambu and Kajiado County in Kenya are dealing with climate change without a deeper understanding of its difference from the weather. Therefore, there's a need for more awareness creation especially for smallholder farmers that are often ignored. The combination of scientific climate data with traditional knowledge can greatly enhance their resilience. The importance of indigenous knowledge in addressing community needs while playing a critical role in resource conservation such as forests has been observed in many studies (Masika, 2002).

4.5.5.8 Beneficiary of loan accessed from local institution

According to the results, 75% of the respondents from Kiambu County had not accessed loans from any institution in their area meant for specifically enhancing their resilience against climate change. In Kajiado County, 67% of the respondents indicated to have accessed loans,

especially during extended drought seasons even though the majority of them agreed not to have gotten it from local banks but family and friends. Studies show smallholder enterprises usually lack opportunities to access loans or credits in comparison to larger enterprises. (Beck and Demirguc-Kunt, 2006). The situation is worse for poor individual households that lack anything to offer as a guarantee to financial institutions since they are more likely to be rejected. The respondents from Kiambu indicated having not received loans from any local institution meant for addressing household food shortage related to changing climate because they are less susceptible to climate change in comparison to respondents from Kajiado County.

4.5.5.9 Beneficiary of agricultural association to deal with climate change

In Kiambu, 93% of the respondents indicated that they did not belong to any agriculture association to deal with climate change hence not benefiting from any such group to enhance their household resilience while in Kajiado 71% of the respondents indicated that they did not belong to any agriculture association meant to deal with climate change hence not acquired benefits associated with it. According to the feedback from the focus group discussions, the majority of the respondents in both counties especially women from Kajiado County indicated not receiving any benefits from National Government Affirmative Action Fund (NGAAF), UWEZO fund, and Women Enterprise Fund kitties. Lack of organization significantly reduces farmers and pastoralist's potential to acquire resources such as loans to engage in livelihood diversification and also increase farmer-farmer/pastoralist-pastoralist exchange programs that can contribute to enhancing knowledge on increasing productivity. With the absence of organization from the local farmers and pastoralists, the political and financial institutions will continue to ignore poor individual farmers with no leverage in numbers and return investments (Serageldin and Steeds, 1997).

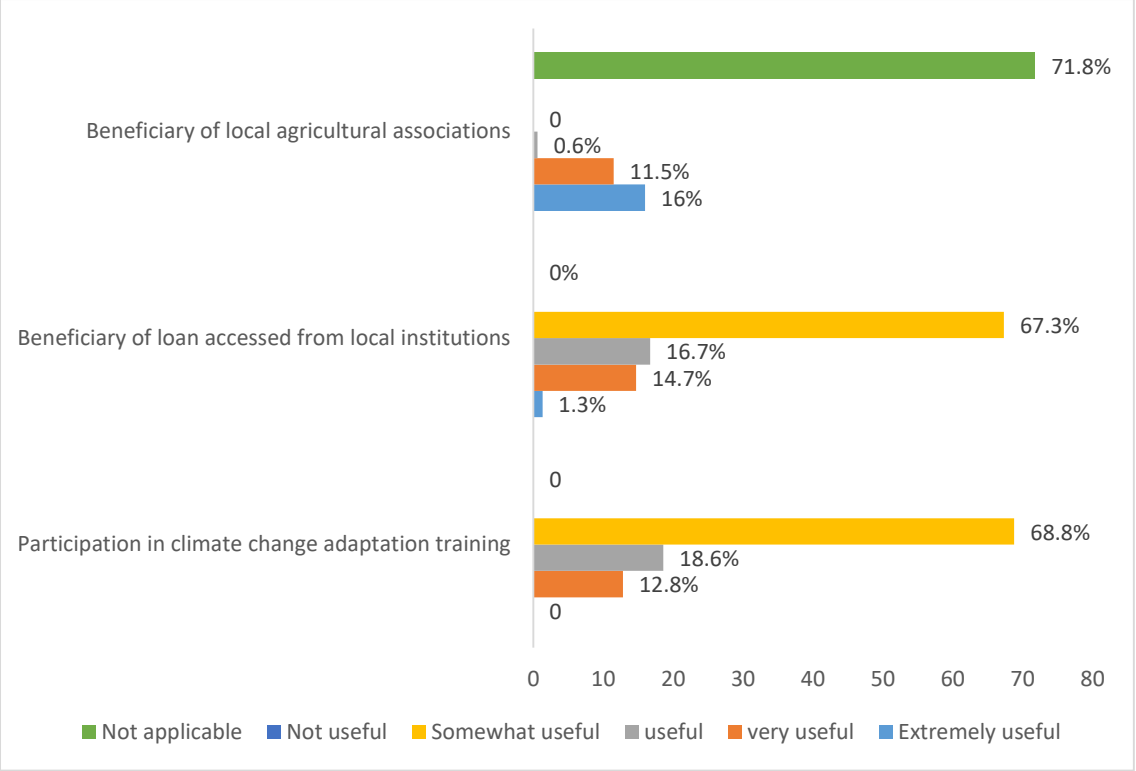

Figure 26: Kajiado County

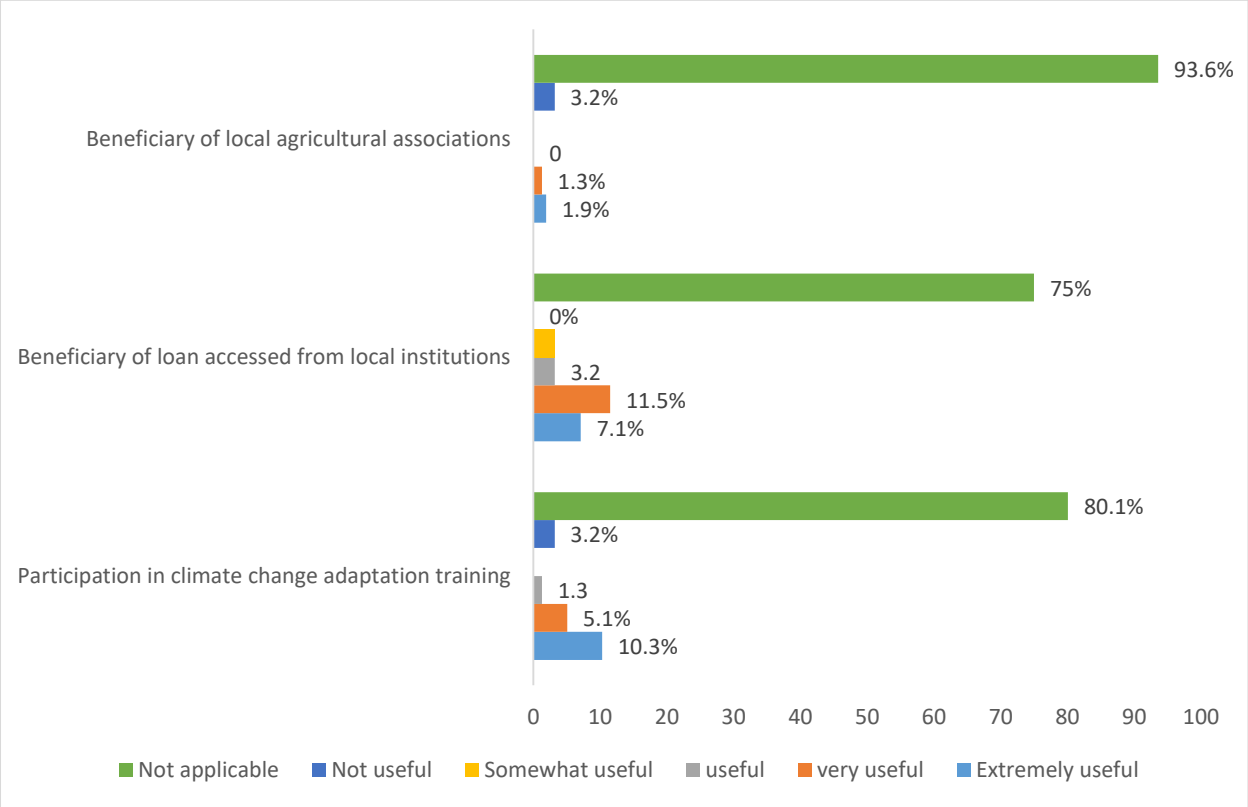

Figure 27: Kiambu County

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Temporal analysis of monthly minimum and maximum temperatures confirm an increased trend in minimum temperature and increased variation of maximum temperature in Kiambu County since the *Elnino* year of 1998. There was observed seasonal and inter-annual rainfall variability, especially in Kajiado County manifesting itself through increased extended drought periods. Temporal analysis of annual and seasonal temperatures in Kenya confirmed increased temperature variations, especially in the last three decades. Temporal analysis of seasonal rainfall over Kenya in the last three decades indicated that the seasonal rainfall amount received in a given year is different from the amount received in the preceding years. Also, the trend analysis indicated increased rainfall patterns although it is mostly intense downpour and poorly distributed across the country leading to flash floods that are less beneficial to local pastoralists and farmers.

The perception of the local communities on climate change was in line with the climate patterns. Perceptions of the trends of both minimum and maximum temperature, and the actual observations are similar in Kajiado and Kiambu Counties. The perception of local communities on the frequency of climate change-related droughts indicated a perceived increase in rainfall variation leading to the prevalence of drought situations.

The study indicates there has been an observed increase in climate change-related food insecurity in the two Counties. While Kajiado has been found to experience an increased loss of livestock and crops, a decrease in water availability, fodder availability, and increased pest and diseases, Kiambu County experienced an increased loss of crops and increased climate change-related pest and disease. The results further point to differentiated climate change-related effects in Kajiado and Kiambu Counties. Kajiado County has been found to be more food insecure than Kiambu County. Dependency on food relief from donors including the Government has been observed more in Kajiado than Kiambu County indicating high poverty prevalence among the majority of its population.

Results on gender roles influence on climate change adaptation actions indicated that women in Kajiado County have limited access to and control of critical resources including land and livestock than their counterparts in Kiambu County. On household decision making in the face of climate change, the study found out that women in Kiambu have more independence to make decisions on marketing farm produce and selling livestock than women in Kajiado. Also, they have more independent authority to decide how to utilize proceeds made from selling farm

produce and livestock. Although more gender disparity exists in Kajiado County in comparison to Kiambu County, many respondents in Kajiado County have recognized the detrimental impacts of gender roles on access and control of resources, labour division, and decision making in the face of climate change thus agreeing with the statement breaking from defined gender roles can contribute to improved community adaptive capacities.

Thus, the study has shown inaccurate perception of climate change coupled with gender roles impede choices of climate change adaptation actions applied at the household hence the need not to focus on climate change in isolation but putting into consideration local communities' perceptions of climate change and gender roles rooted in patriarchal systems.

5.2 Recommendation of the Study

Based on the study findings. The following recommendations are made;

1. Due to paucity of climate data at the Sub-County level, the study recommends extension of weather station's observational networks to Sub-County level. Availability of localized, accurate and timely climate information will greatly help various stakeholders assess climate variability in their sector and lead to enhanced decision making in dealing with climate changed related droughts, famine, forest fires, and floods in a timely and cost-effective manner. Also, representative climate data is critical to understand climate change issues at Sub-County level leading to enhanced climate adaptation actions applied at household level.
2. The extent of climate change awareness needs to be improved in Kiambu and Kajiado County. The National and County Governments should ensure the sensitization of farmers and pastoralists on climate variability and monitoring of crop and livestock in relation to climate change. This will help the farmers visualize climate change in its totality with regard to their main livelihood base thus addressing the challenge of information gap that hampers efforts towards household food security.
3. In order to address climate change related household food insecurity there is need to pay attention to the challenge faced by agricultural and pasture lands including pressures from urbanization thus leading to increased land sub-divisions. The study recommends new models of land sub-divisions requiring minimum economical/optimal agricultural land sizes in various agro ecological zones and putting in place measures to regulate agricultural land prices so that demand for real estate land does not undermine effort towards food security which is already impacted by climate change.

4. Gender mainstreaming in climate change policies, projects and plans is critical especially at the County level so that County specific local community gender issues are incorporated and do not become a hindrance to climate change adaptation actions. This should be followed up with targeted campaigns by all stakeholders in addressing culturally entrenched gender bias where women lack equal opportunities to benefit from accessing and controlling resources, The Kajiado County government is already involved in initiatives aimed at reducing gender disparity in the county but their efforts need to be supported by the National government and development partners. The National government should increase funds for the National Government Affirmative Action Fund (NGAAF), UWEZO fund, Women Enterprise Fund kitties and ensure women are given more opportunities to sustain their livelihood diversification efforts.

5. Since the study intention was aimed at assessing perceptions of climate change and gender influence on adaptation actions in Kajiado East and Kajiado Central within Kajiado County and Kabete and Kikuyu within Kiambu County, limitation that arises as a result of its short-term nature and smaller scope of coverage is acknowledged. In order to establish the critical causal relationship between interactions of perception-climate change and gender, scaling up of the study coverage to Counties level other than Sub-Counties and in-depth long-term studies that go beyond the scope of this study is recommended.

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APPENDICES

Appendix I: Questionnaire

Household questionnaire

Dear Sir/Madam, We are conducting university of Nairobi doctoral survey on **Perceptions of climate change and gender influence on adaptation actions in Kajiado East and Kajiado Central within Kajiado County and Kabete and Kikuyu within Kiambu County, Kenya.** We would therefore like to ask you some questions that should take no more than 45 minutes of your time. We kindly seek your consent.

Section I: Demographic characteristics of the respondent

DATE:	
QUESTIONNAIRE NO:	
NAME:	
WARD:	
COUNTY:	
1. Household decision making type?	i. Adult male decision-maker ii. Adult female decision-maker
2. Gender of the respondent	i. Male ii. Female
3. What is your age category?	i. 18-29yrs ii. 30-49 iii. 50 and above
4. How many members does your household comprise of?	

5. What is your highest level of education?	i. Never attended school ii. Primary iii. Secondary iv. College v. University Any other (specify)…… ……
6. What is the type of land ownership in your household? (Tick one that apply)	i. Private Ownership (With title) ii. Community land iii. Leased land iv. Other (Specify)
7. What is the source of your livelihood?	i. Employment ii. Self employed iii. Livestock keeper iv. Farming v. Poultry v. Other (Specify)

Section II: Local communities' perceptions of climate change in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County. in Kiambu and Kajiado Counties

1. In the last three (3) decades, the frequency of drought has been

   Very extreme [ ] Extreme [ ] Normal [ ]

   Not sure [ ] Decreased [ ]

2. In the last three (3) decades observed flooding has

   Decreased [ ] Increased [ ]

   Normal [ ] Not sure [ ]

3. Excessive heat has been observed during the day in the last three (3) decades

   Strongly disagree [ ] Disagree [ ] Not sure [ ]

   Agree [ ] strongly agree [ ]

4. Excessive heat has been observed during the night in the last three (3) decades

   Strongly disagree [ ] Disagree [ ] Not sure [ ]

   Agree [ ] strongly agree [ ]

5. Excessive cold has been observed during the day in the last three (3) decades

   Strongly disagree [ ] Disagree [ ] Not sure [ ]

   Agree [ ] strongly agree [ ]

6. Excessive cold has been observed during the night in the last three (3) decades

   Strongly disagree [ ] Disagree [ ] Not sure [ ]

   Agree [ ] strongly agree [ ]

7. Strong winds are becoming more frequent during the day in the last three (3) decades

   Strongly disagree [ ] Disagree [ ] Not sure [ ]

   Agree [ ] strongly agree [ ]

8. Strong winds are becoming more frequent during the night in the last three (3) decades

   Strongly disagree [ ] Disagree [ ] Not sure [ ]

   Agree [ ] strongly agree [ ]

9. The observed climate variations are as a result of climate change (reference to climate change indicators in local languages, *Maasai* and *Kikuyu* as there is no direct translation for climate change

Strongly disagree [ ] Disagree [ ] Not sure [ ]

Agree [ ] strongly agree [ ]

10. In your opinion are there any local activities that can be attributed to climate change?

Yes [ ] No [ ]

11. If yes, please rank in order of priority according to you

	Ranking
(i) Bush burning	1
(ii) Vehicles	2
(iii) Use of *Jikos* (charcoal)	3
(iv) Deforestation (Reducing carbon sink)	4
(v) Industries	5
Other [ ] Please specifies…….	

12. In your opinion, the area under agriculture is

(a) sharply decreasing (b) slowly decreasing (c) Not changing

(d) Slowly increasing (e) sharply increasing (f) Not applicable

14. In the last few decades, time spent in search of water has

Increased [ ] not increased [ ] decreased [ ] not sure [ ]

15. In the last few decades, time spent in search of firewood has increased

Strongly disagree [ ] Disagree [ ] Not sure [ ]

Agree [ ] strongly agree [ ]

Section III: Effects of climate change on household food security in Kiambu and Kajiado counties.

1.Decline in food production as compared to five years ago is **mainly** because of

Extreme drought [ ] Extreme floods [ ]

Excessive heat/cold[ ] Non climatic factors [ ]

Other [ ] please specify……

2.To what extent do you agree with the following statements in the context of the last five years?

	Strongly Disagree	**Disagree**	**Not sure**	**Agree**	**Strongly agree**
i. There has been an increase incidence of pest					
(ii).There has been need for increase in the amount of fertilizer used to produce enough food					
(iii).There has been decrease in water availability					
(iv).There has been decrease in fodder availability					
(v)There has been an increase loss of crops					
(vi). There has been an increase loss of livestock					

3. In your opinion what percentage of your income do you use on food on a scale of between 0-100percent?

10% [ ] (B)20% [ ](C) 40% [ ] (D) 50% [ ](E) Over 60% [ ]

4. How much do you spend on food average per month in your household?

Bellow 2000 [ ] 2,000-5,000 [ ] 5,000-10,000 [ ] 15,000-25000 [ ] 30,000-50,000 [ ] Over 50,000 [ ]

5. Food shortage in my household is

Very extreme [ ] Extreme [ ]

Normal [ ] N/A [ ]

6. Please rank the combinations of food and drink depending most frequent on your menu?

MAIN FOOD 1	DRINKS
(a) Githeri (b) Ugali vegetable (c) Ugali vegetable and fruits (d) Ugali vegetable, beans & meat (e) Ugali, vegetable, beans, meat and Fruits (f) OTHER [ ] Specify…… <u>Main food 1</u> (i) [ ] (ii) [ ] (iii) [ ] (iv) [ ] (v) [ ]	(a) Water (b) Juice (c) milk (d) Soda (e) OTHER [ ] Specify…… <u>Drinks</u> (i) [ ] (ii) [ ] (iii) [ ] (iv) [ ]

7. How do you cope when there is no money to purchase food for the household during droughts related to climate change?

(a)Relief aid [ ] (b) Family &friends support [ ] (c) Remittance [ ] (d) Charity [ ]
(e) Loans [ ] (f) N/A [ ]
Others (specify)……..

8. My family's need for food aid over the last few decades has been
(a)Increasing [ ] (b) Decreasing [ ]
(c)Neutral [ ](d)Not applicable [ ]

Section IV: The role of gender in climate change adaptation actions in Kajiado East and Central, Kajiado County and Kabete and Kikuyu, Kiambu County

1. In your opinion which of the following is the main natural resource found in this area? 1.1 In your view what is the major threat facing the above mentioned resource? 1.2 Do men and women have equal access to the above mentioned resources?	Please tick where appropriate (A)Water (B)Forests (C)soil (D)Minerals (E) land (F) Fisheries Others (please Identify) …….…… (A) Climate change (extreme droughts & floods) (B) Overpopulation) (C) poverty (D) Weak enforcement Others (Please identify) …….. Yes [ ] No [ ]	
2. Please rate level of access exercised to the household land by:	1. Zero access 2. Least access 3. Moderate access 4. full access	
	In the rainy seasons(s)	In the extended drought seasons
(i) Men		
(ii) Women		
3. Please rate level of control exercised to the household land by:	1. Zero control 2. Least control 3. Moderate control 4. full control	
	In the rainy seasons(s)	In the extended drought seasons
Men		
Women		

4. In your household, who spend(s) more time working on…?	1. Men 2. Women Other [ ] Specify……	
	In the rainy seasons	In the extended drought seasons
(i) Crop farming		
(ii) Livestock production		
5. Who mainly makes the following decisions regarding livestock production over the last few years under changing climatic conditions?	1.Men 2.Women Others [ ] please specify……	
i. Feeding livestock		
ii. Watering		
iii. selling		
iv. how to utilize the money		
6. Who mainly makes the following decisions regarding crop production over the last few years under changing climatic conditions?	1. Men 2. Women Others [ ] Please Specify	
i. What crop to plant		
ii. labor		
iii. marketing of farm produce		
iv. How to utilize the money		

Gender Inclusivity and Community Climate Change Adaptation Capacity

Local Climate Adaptation Practices	**What is the percentage between men and women that participate in the climate adaptation practices?**	
	Men %	Women %
(i) agro forestry initiatives		
(ii) Soil fertility enhancement initiatives		
(iii) Water management initiatives		
(iv) Crop or livestock productivity enhancement activities		
1. Climate information is available to all regardless of their gender.	Strongly disagree [ ] Disagree [ ] Not sure [ ] Agree [ ] Strongly agree [ ]	
2. Do you belong to any agriculture association?	Yes [ ] No [ ]	
3. If yes, how beneficial was it	Extremely useful [ ] very useful [ ] useful [ ] Somewhat useful [ ] Not useful [ ]	
4. Have you accessed loan from any institution in your area?	Yes [ ] No [ ]	
5. If yes, how beneficial was it?	Extremely useful [ ] very useful [ ] useful [ ] Somewhat useful [ ] Not useful [ ]	
6. Have you participated in climate change adaptation training?	Yes [ ] No [ ]	

7. If yes, how beneficial was it?	Extremely useful [ ] very useful [ ] useful [ ] Somewhat useful [ ] Not useful [ ]
8. Climate adaptation training is accessible to both men and women in our village	Strongly disagree [ ] Disagree [ ] Not sure [ ] Agree [ ] Strongly agree [ ]
9. Breaking from defined gender roles can contribute to improved community adaptive capacities	Strongly disagree [ ] Disagree [ ] Not sure [ ] Agree [ ] Strongly agree [ ]

Appendix II: Key informant interview guide

Good morning/afternoon. I am conducting university of Nairobi doctoral survey **on perceptions of climate change and gender influence on adaptation actions in Kajiado East and Kajiado Central within Kajiado County and Kabete and Kikuyu within Kiambu County.** I therefore, would like to ask you some questions that should take no more than 45 minutes of your time. I kindly seek your consent.

1. PERCEPTIONS OF CLIMATE CHANGE (TEMPERATURE AND RAINFALL PATTERNS) OVER KIAMBU AND KAJIADO COUNTIES.

1. In your view, are day and night time temperatures getting warmer or colder in the last three decades or more?
2. How has the rainfall been in your area in the last three decades or more? (For example, is the rainfall season coming earlier or later than it used to be? Are the rainfalls heavier or lighter as compared to previous years? How about the distribution? Are you experiencing more floods or droughts than before? How is it different?)
3 Do you think there have been local activities that can be attributed to the changes in rainfall and temperature patterns in this County?

2. ESTABLISH THE EFFECTS OF CLIMATE CHANGE ON HOUSEHOLD FOOD SECURITY IN KIAMBU AND KAJIADO COUNTIES

1. What is the trend in food availability, accessibility, affordability and nutritious status of households in the face of a changing climate?
2. Is food readily available? How has it changed?
3. How are the prices of food in the market in comparison to few decades ago?
4. Has the climate change related drought made your household poorer or not? What about floods?
5. How do you cope with climate change related food insecurity?

3 EXAMINE THE ROLE OF GENDER IN CLIMATE CHANGE ADAPTATION ACTIONS

1. Tell me about gender roles according to your tradition/customs
2. Has there been observed change in gender roles in this County in the recent years? What led to the changes?
3. Do your traditional gender roles play a role in access, control, labor division and decision making in the face of climate change?
4. Are gender roles becoming disadvantageous to either of the gender?
5. Are climate change adaptation actions impacted by gender roles?
6. What are some of the intervention measures implemented in this county to bridge the gender gap?

Appendix III: Focus group discussion

Good morning/afternoon. We are conducting university of Nairobi doctoral survey on **perceptions of climate change and gender influence on adaptation actions in Kajiado East and Kajiado Central within Kajiado County and Kabete and Kikuyu within Kiambu County**. We would therefore like to ask you some questions that should take no more than 45 minutes of your time. We kindly seek your consent.

1. **Perceptions of climate change (temperature and rainfall patterns)**.

What would you say are some of the remarkable changes in climate patterns in this region that have affected the way you undertake your farming or livestock production? (*Probe if not mentioned: temperature changes at early morning and night as compared to previous years, shifting of rainfall seasons, drought, floods and extreme climate events*. *climate change indicators in Maasai and Kikuyu languages to be used by the research assistants when locals don't understand the conversation about climate change Olameyu, (drought), Olari (famine), Ngolongi nairowua (hotter days) and Enkewarie Nairobi (colder nights) in the Maasai language in Kajiado County and Ng'aragu (drought) Urugari (hot days) Heho (cold) and Mbura (rain) in Kikuyu language in Kiambu County).*

2. **Establish the influence of climate change on household food security in Kiambu and Kajiado counties**.

In light of changing climate how has increased temperature and rainfall variations affected food availability, access and affordability and nutrition status in your area? Has droughts or floods affected your source of livelihood? How is your situation currently in comparison to few years ago? How are you adapting? Are you getting any support from the County or National government during climate change related drought/floods crisis?*)*

3. **Examine the role of gender in climate change adaptation actions**

1. I would like us to first discuss gender roles in your area…
2. In your view is there relationship between climate change and gender disparity…if yes, tell me about it?
3. Who has full access, control and final decision making on resources within the household under a changing climate and who doesn't?...For example, land (how it should be utilized whether for farming or not, which crops to plant, when and where to market etc. family

livestock (whether to sell some or not under increasing drought conditions, where to migrate to in search of water and pasture, whether the whole family moves with the herd including kids in school or not etc. how is labor division at the household level *?* Are men and women equally involved in household activities? For example, who takes care of the family during extended drought periods or rainy seasons, who takes care of the animals both during drought periods and rainy seasons, who fetches water and firewood for the household during the extended drought seasons and rainfall seasons as well? Who takes care of the emaciated cows especially during the extended drought seasons? Is it only men? Only women? Or the aforementioned tasks are shared equally within the household?*).*

4. Are the existing climate change adaptation strategies been formulated through gender lens? (Probe by mentioning examples such as If there is rain water harvesting who participated in where to locate it? men only? women only? both men and women? Who decides access and control of the dam/borehole/water point? Cash transfer donations from government or support from donor aid organizations during the drought seasons (who decides who to receive the money on behalf of the household? How to utilize the money received from the government, Non-Governmental Organizations or from family and friends, etc.), if the practice of agroforestry exists as an adaptation strategy, who chose to establish it? Men only? Women only? both men and women? If livestock and crop insurance scheme is in place as an adaptation strategy who decides if the household should adopt the If livestock and crop insurance scheme or not? How to utilize the benefits of adopting the scheme? etc.)
5. What are the challenges to gender mainstreaming in climate change in Kajiado County/Kiambu County according to your experiences and how can it be addressed to ensure gender inclusivity in community climate adaptation capacity leading to household food security?

THANK YOU!!!