

To Determine the Sustainability of Livelihoods Impacted by Climate Change in Kapsokwony Division, Mt. Elgon Sub-county, Bungoma County, Kenya

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Abstract

Mt. Elgon Ecosystem (MEE) is greatly endowed with vast natural resources that include fauna, flora, soils, river water and minerals. However, in recent years the ecosystem has witnessed accelerated environmental degradation and loss of natural capital due to impacts of climate change. The climate change impacts have adversely affected livelihoods of area residents by threatening food production systems, increased poverty levels and slowed down economic development. The societal problems that include lack of clean drinking water, deepened poverty, food security, waterborne diseases, soil erosion, environmental degradation and loss of ecosystem services, economic ruins, decline in agricultural output and poor livelihoods are a big challenge. The farmers in the region have little adaptive capacity due to limited economic resources and heavy reliance on rain-fed agriculture. The ultimate aim of the study was to generate long term policies and adaptive strategies to be implemented to lead to desirable improved livelihoods and sustain development. In general, the study was designed to analyze the impacts of climate change on livelihoods and deepened poverty levels. Both long and short term changes in climate will disproportionately continue to impact the poor smallholder farmers in the future if correct mitigation and adaptation measures are not put in place. Smallholder farmers in the region have continued to depend on traditional technologies to cope with climate change vulnerabilities. The research therefore highlights the existing scientific and indigenous technologies to counter the impacts of climate change in the study area. The collaborative research is characterized by top – bottom and bottom – top integrated research structure and entails dialogue by all the stakeholders. Primary data was collected by informant and in-depth interviews, focused group discussions (384). The data analysis for quantitative and qualitative data was carried out by use IBM statistical packages of the SSPS version 23.0 method. Using descriptive, tabular and graphical statistics, the data was analyzed in terms of frequency distribution and percentage to understand it and meaningful conclusions to be made. The data was then presented in tables, frequencies, figures and percentages. The research study achieved capacity building, adaptive learning, community empowerment and resilience. The application of transformation knowledge will help reduce impacts of climate change and climate variability on livelihoods in the region. The results will play a significant role in attitude and behavior change as well as create awareness amongst area residents. The new societal knowledge was used to elucidate long term policies and adaptive strategies to enhance climate resilience, improve livelihoods and sustain social economic development. The new adaptive policies and knowledge will be down-streamed to household levels in the study area. The study recommends collaboration among stakeholders and integration of various sources of knowledge in addressing climate change and climate variability among residents in Kapsokwony Sub-county. Further research should be carried out in the future to corroborate these findings in order to enhance socio-economic development, improve livelihoods and at the same time counteract the threats of climate change.

1. Introduction

In Kapsokwony Division, household livelihoods are dominated by crop cultivation, livestock keeping and non-farm economic activities. However, impacts of climate change coupled with economical, political and environmental factors have enhanced vulnerability for poor and less fortunate households in the region. The most vulnerable are the women and children because they face cultural, social and political constraints to access resources and take part in making of strategic adaptive decisions. Therefore, there is need for a paradigm shift whereby adaptive technologies and policies have to be put in place by all actors to reduce risks/challenges to secure livelihoods and build resilience. Perhaps the findings and policy recommendations of this Case Study would be a better idea going forward to increase the capacity of the poor and vulnerable households in the region to adapt to climate change and variability.

Climate change combined with over-use of natural resources, exponential population growth, poor cropping systems, poor health infrastructure, poor livestock management, polluted water systems, lack of transformation knowledge, lack of adaptation strategies and lack of robust policies has resulted in many social and environmental stresses in the region. Climate change is the foremost threat to crop production, poor economic sustainability and high poverty index. Crops that are threatened include maize, beans, potatoes, onions, bananas and tea. As climate change takes its toll on livelihoods, income from agriculture is likely to decline in the future

resulting in increase in poor livelihoods. Communities living in the study area have limited access to information and resources and these are some reasons that make them suffer from extreme events of climate change and variability. However, impacts of climate change coupled with economical, political and environmental factors have enhanced vulnerability for poor and less fortunate households in the region. Therefore, there is need for a paradigm shift whereby adaptive technologies and policies be put in place by the actors to reduce risks/challenges to secure livelihoods and build resilience. Residents in the study area have been forced to adapt to variable or extreme conditions as the weather has become unpredictable and unreliable putting livelihoods to greater risks/threats. Climate change is mainly due to a decline in the amounts of rainfall or rather an increase in amounts of rainfall resulting in floods, mudslides, poor food production systems and enhanced animals and plant diseases (Informant interviews). The situation has been exacerbated by anthropogenic activities.

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All sectors in the region depend on the availability of water resource including crop production, livestock rearing, health and sanitation and domestic use. The degradation of the existing water resources due to impacts of climate change and deforestation will affect livelihood activities to the extreme in the future. Many households in the region depend on open water sources for domestic and drinking use. River water becomes heavily polluted during the rainy periods thus, enhancing the chances of outbreaks of water-borne diseases. There is need to analyze the vulnerability of the communities beyond exposure and sensitivity to climate impacts to explore different dimensions of adaptive capacity and identify barriers that communities face in the applying their existing capacity to respond to climate impacts. New adaptation options must be sought to reinforce the existing ones.

Communities living in the study area have limited access to information and resources and these are some reasons that make them suffer from extreme events of climate change and variability. Indicators that are used to measure and understand vulnerability include levels of income, unemployment, literacy levels, pension contributions, health and sanitation, livelihood resilience, self protection, social capital, income groups, type of state, civil society, ethnicity, science and technology, starvation and malnutrition among children. For households to effectively respond to livelihood challenges, they must engage in adaptive decision-making through dialogue and through formulation of policies to reduce vulnerability to climate vagaries.

Mt. Elgon forest has undergone dramatic changes in land use in recent decades, and there has been a reduction in forest cover due to clearing of forest land for agricultural production. Reference. This trend has been shown by satellite observations. The decrease in forest cover from 1973 to 2013 was a crucial input to the landslide and flooding risks. On Mt. Elgon, the climate models did not show significant changes in precipitation but they do predict a significant increase in temperature. The means that a poor family that gains an income through exploitation of ecosystem natural resources including food, construction materials, medicine, wood fuels, fodder, water, pastureland and agricultural activities is badly affected(what supports this claim??). Therefore, poor people are severely affected when the environment on which they depend on for their livelihoods is degraded. As a result of this dependency, any impacts of climate change has on a natural system threatens livelihoods of poor people. (WRI *et al.*, 2008).

Forests play a crucial role in income generation and household food security. Many of those who live in the remaining forested areas around the world have their livelihoods dependence on the availability, access and utilization of forest products (Appiah, 2009; Asamoah, 2007). Forest communities use their surroundings for a variety of activities that include collection and production of wood-fuel, hunt of game, gathering of medicinal herbs, chewing of sticks and un-relented illegal logging. The products obtained from the various activities are considered as important natural resources that contribute towards directly to community's well-being during the lean season (Ahenkan and Boon, 2008).

Many of the impacts of the observed changes are enhanced by anthropogenic activities that directly impact the landscape and play a role alongside natural climate feedback mechanisms in the modification of local to regional climates and environments. With great land - use pressure in the ecosystem, including deforestation and grazing combined with extreme rainfall, flashfloods and flooding will likely increase or too little water increases the vulnerability of mountain livelihoods (Kaltenborn *et al.*, 2010). It is for this reason that adaptation strategies that enhance the resilience of ecosystems, ensuring the continued provision of goods and services, can be particularly important for poor people (Adger, Arnell and Tompkins 2005; Reid and Huq 2005). Poor people with low adaptive capacity are vulnerable to the impacts of climate change, which will contribute to the loss of their natural resource base.

Food production systems in Mt. Elgon are highly vulnerable due to an increase in climate variability. Agriculture activities are constrained by altered frequency, timing and magnitude of climate variables such as temperatures and precipitation. Systemic effects are needed to improve sustainability of the food production systems and ecosystem resilience under changing climatic conditions. Ecosystems particularly those that have already been degraded, are likely to be severely impacted by climate change (Fischlin *et al.*, 2007). Thus, the need to build resilience of ecosystems to maintain their productivity is often stressed in the development literature as a necessary part of adaptation strategies, particularly for vulnerable communities (Corfee-Morlot *et al.*, 2003; Tompkins and Adger 2004; Nkem *et al.*, 2007; Reid *et al.*, 2008; WRI *et al.*, 2008).

2. Objective of the study

2.1 Main objective

To determine the sustainability of livelihoods impacted by climate change in Kapsokwony Division, Mt. Elgon Sub – county

2.2 Specific objectives

- Assess effects of climate change on agricultural systems and livestock keeping;
- Assess the impacts of climate change on the farmers' health and water quality;
- Transform behavioral patterns towards climate adaptation strategies at all levels;
- Identify traditional and modern innovative technologies for climate change mitigation and adaptation;
- Determine long and short term adaptation policies and strategies by the different communities in the study area;
- Build capacity and access transformation knowledge of the communities in the study area to adapt to climate change impacts;
- Generate robust policy recommendations in order to build climate change resilience of the residents in the study area;
- Develop a robust conceptual to enhance policy decisions to adopt Climate Smart Agriculture (CSA) to achieve food security and improve livelihoods;
- Improve degraded water qualities and quantities that threaten human livelihoods; and
- Carry out rehabilitation and reforestation as a sure way/method of climate change mitigation through carbon sequestration.

3. Literature review

3.1 Introduction

Climate change can have significant negative impacts on the natural environment including agricultural output and changes in ecosystem services. According to IPCC (2007a), any increase in global average temperature above the range of 1.5°C - 2.5°C is likely to result in significant alterations in the structure, function of ecosystems, thus negatively influencing livelihoods and human survival. In developing countries with a greater dependence on natural resource based livelihoods, this can impact the socio-economic status of communities, hamper progress towards development goals and present an overall threat to sustainable development (IPCC, 2007a). Together, climate and non-climatic stressors may have considerable impacts on the ecosystems functions and on ecosystem services (Lovejoy *et al.*, 2005). Forests are highly sensitive to climate change. Kenya's forests cover is estimated to be 1.5%, which include both indigenous and plantation forests. Mt. Elgon water tower is one of the main water catchment areas in this country. Forest degradation has caused significant destruction, reducing forest canopy cover and increasing GHG emissions. Environmental degradation is caused by human activities, especially unregulated forest products removal by companies and communities. Changing climatic conditions have also affected the regeneration rate especially for natural forests. This affects the ecosystem services that forests provide, such as reducing soil erosion, natural pest control, preserving water availability, and maintaining water quality (KFS, 2014). Africa is the most vulnerable continent to climate variability and change (IPCC, 2007).

Projected rainfall changes for period 2016-2035 can be up to 20% relative to reference period 1986-2005 whereas surface temperatures can be greater than 0.5°C per decade for interior regions (Kirtman, *et al.*, 2013). Rainfall, temperature, humidity, and flooding are variables that most influence the transmission of malaria, cholera, diarrhoea, kala-azar, and dengue fever; climate change will affect all of these (IPCC, 2007). According to observations reported by the IPCC (2007), future precipitation projections suggest a high likelihood of increases in the higher latitudes and decreases in subtropical regions. Overall, it is projected that the increasing concentration of greenhouse gases would result in several changes in the global climate system over the course of the 21st century that are expected to be larger than those observed over the 20th century (IPCC, 2007). This has significant implications for the survival of natural systems, many of which are already being affected by the

temperature increases (IPCC, 2007).

Smallholder farmers need to choose, use, and capitalize on adaptation technologies to improve their livelihoods and well being, while enabling them to respond effectively to continuous and unpredictable climate change. To achieve food security and economic development, systems of food production and trade systems must be made more accessible for smallholder farmer. Funds from Green Climate Fund (GCF) as per the Paris Climate Change Conference 2015 must be made available for the smallholder farmers so that they can achieve their food production targets. Not all of this money will be invested in agriculture, but some will go into other sectors of investment to secure and improve livelihoods. Most of the financing will likely be offered as loans, not grants, to enable replenishment of the Fund.

Adaptive strategies devised by incorporating the scientific and the indigenous experiences are very important in the designing of adaptive policies that will help residents in the region to adapt to the vagaries of climate change. Knowledge of the indigenous community which is based on observations, perceptions and experiences over the years can effectively be blended with scientific knowledge to improve climate change mitigation and adaptation strategies. Other strategies that should be considered when designing adaptive technologies include cost efficiency, co-benefits, trade-offs and feasibility. Sometimes vulnerabilities of a community may result from differences in traditions, culture, socio-economy, lifestyles and gender differentiated responses. The technologies to be adapted must be beneficial under the current climate conditions and those that might be adaptive under the future climate conditions. Technologies are supposed to build resilience to climate shocks and support adaptation. Without adequate scientific knowledge of future conditions, technologies can be ineffective or even harmful.

Adaptation strategies should use both top-down and bottom-up approaches leading to higher effective, efficient, equal, sustainable, flexible, legitimate, robust and replicable. They need to be shaped in the context of available projected climate and impacts for the area under the study consideration. The way forward is to evaluate scenario methods and compare their strengths, weakness, and infrastructure and capacity requirements. We recommend the implementation of good, dynamic and robust adaptive technologies for poor in the community to recover from climate shocks, achieve sustain economic development and improve livelihoods.

Mountain ecosystems around the world are now affected by the combined impacts of climate factors and their interactions with other anthropogenic stressors such as encroachment, land fragmentation, degradation and destruction of natural resources. Climate change will affect human health through complex systems involving changes in temperature, exposure to extreme events, access to nutrition, air quality, and disease vectors (IPCC, 2007). For instance, losses in agricultural production in the Eastern Himalaya countries may lead to increased malnutrition and reduced opportunities for poverty reduction. Overall, climate change will lower incomes and reduce the opportunities for vulnerable populations. Mountain ecosystems around the world are now affected by the combined impacts of climate factors and their interactions with other anthropogenic stressors such as encroachment, land fragmentation, degradation and destruction of natural habitats (Mano and Nhemachena, 2007; Biggs *et al.*, 2008).

Studies on livelihoods in the Eastern Himalaya (EH) highlands reveal that subsistence farmers and pastoral peoples, who make up a large portion of the rural populations, could be negatively affected by climate changes. A major area of serious impacts is in the field of agricultural production. Agriculture is the direct or indirect source of livelihood for over 70% of the population in the EH and is a substantial contributor to national incomes (Fischer *et al.*, 2002a). Agriculture is highly sensitive to climate change and is expected to impact on the region differently, with some alteration in precipitation patterns. Impacts on livelihoods according IPCC projections in the EH show that there will very likely be decreases in precipitation in the future. Climate change impact and vulnerability (CCIV) in the EH is projected to experience a decline in potentially good agricultural land, while others will benefit from substantial increases in suitable areas and production potentials (Fischer *et al.*, 2002a). Several studies in the past have shown that the production of rice, corn, and wheat has declined due to increasing water stress arising partly from increasing temperature, the increasing frequency of *El Niño*, and a reduction in the number of rainy days (Agarwal *et al.*, 2000; Jin *et al.*, 2001; Fischer *et al.*, 2002b; Tao *et al.*, 2004). Climatic changes are predicted to reduce the livelihood assets of poor people, alter the path and rate of national economic growth, and undermine regional food security. According to a World Bank report on climate change, upland areas are warming faster than lowland areas (World Bank, 2008).

3.2 Agriculture and livestock

Agriculture and livestock rearing is the mainstay of rural livelihoods in Kapsokwony Division, Mt. Elgon District. However, agriculture and livestock are some of the economic sectors in the region that are most vulnerable to climate change. Accordingly, a temperature increase above 1.5⁰C to 2.5⁰C is expected to lead to a decline in the agricultural productivity of crops such as maize, beans and potatoes. Since over 70% of rural livelihoods are dependent on rain-fed subsistence agriculture, the impact of declining agricultural production due to erratic rainfall, rising temperatures and reduced soil productivity through erosion, and increased evapo-

transpiration is quite significant. Livestock is very sensitive to environmental changes, and is already experiencing negative impacts from climate change. Increased frequency of droughts in the region has resulted in livestock morbidity and mortality because of reduced availability of forage, increase of disease incidences and lead to a breakdown of marketing infrastructure. The combined effects of climate change on agriculture and a livestock have a negative impact on the socio-economic status and livelihoods. The degradation of ecosystems results in increased climate vulnerability for communities that live in these ecosystems (Travers *et al.*, 2012).

3.3 Climate change and poverty

Poverty is a complex, multi – dimensional condition that goes beyond lack of financial resources. Factors such as lack of education and skill, poor health condition and sanitation, inadequate access to clean drinking water, inadequate or risk asset base poor quality or insecure housing, weak safety nets to ensure basic consumption can be maintained when income falls or crop failure, inadequate protection of proper group's rights and lack of power and voice (Satterwaite,

D. 2003). The climate change research community has to be involved directly in the production of knowledge, and this is why the poor can be expected to be more vulnerable to impacts of climate change but much less is known about factors that promote and enhance resilience (Leichenko and Silva, 2014). An increase in ecosystem degradation due to climate change will definitely affect many livelihoods. Those who are most vulnerable to climate change are the poorest that live in areas more prone to climate hazards, and yet they have little capacity to adapt to climate change shocks. The residents of Kapsokwony Division, Mt. Elgon District live in an area with limited financial, institutional and human capacity to anticipate and respond to direct or indirect impacts of climate change (Walter *et al.*, 2002).

3.4 Climate change and adaptation

Adaptation is a combination of disaster risk reduction, climate change, environmental management and poverty reduction. Successful adaptation can be accomplished through actions that target and reduce vulnerabilities of poor communities. Communities can develop a common platform to tackle the issue of vulnerability reduction through activities such as disaster risk reduction, climate change environmental management and poverty reduction. Adaptive capacity is key to improving socio-economic characteristics of communities and households as it includes adjustments in both behaviour and in resources and technologies. It is imperative that correct and beneficial technologies are selected for adaptation under prevailing climate conditions and those that might be most adaptive under a future climate. The appropriate are those that build resilience to shocks and support adaptation, and those that represent incremental advances not transformational change (Biagini *et al.*, 2014). Without sufficient scientific knowledge of future conditions technologies can be ineffective, or even harmful, if they are not appropriate under a future climate (Biagini *et al.*, 2014). The researchers are advised to use both top-down and bottom-up approaches adaptation processes because they lead to higher effectiveness, efficiency, equity, flexibility, legitimacy sustainability and replicability (Sherman and Ford, 2014).

3.5 The necessity of local climate change impact studies

Climate change has a profound influence on ecosystems. Climate change affects ecosystems in a variety of ways. For instance, this research will help the researchers develop a resilience framework for climate change adaptation in the study area. The case study will generate new knowledge which will be used to develop the state of the art solutions to societal problems and adaptive policies to demonstrate preparedness for a changing climate future in the region. Naturally, some regions and activities are more sensitive to climate change than others (Saarinen *et al.*, 2012). Secondly, regional climatic variations also mean that the impacts would be experienced differently in different regions. Climate change is likely to have major impacts on health systems through heat exposure, extreme weather events, water pollution, waterborne diseases and spread of disease vectors in any ecosystem (WHO, 2008). It has been reported that approximately one quarter of the global disease burden is due to modifiable environmental factors and that 42 per cent of incidences of malaria are associated with policies and practices related to land use and water resource management (WHO, 2008).

A key consideration in the climate change legislative framework for Kenya should be the establishment of a National Climate Change Council as a high-level policy generating, consultative and coordinating organ. This is principally because of the priority that needs to be placed on climate change response: climate change impacts are visible, adversely affect Kenya's ability to attain sustainable development and threaten to impact on all sectors of the economy. The effects have a bearing on functions of the national and county governments. It is therefore necessary to have a high-level policy organ to provide guidance on the general thrust of policy, provide crucial cross-sectoral coordination and promote cooperation between the national and county governments.

4. Methodology

In this section of the research paper, we highlight the area study together with data collection methods are also

detailed. The data collection include desk review, in-formant and in-depth interviews, focus group discussions and household questionnaire administration with randomly selected households as respondents of the communities in the study area. This Case Study is the first to be carried out in the area.

4.1 Study area

Mt. Elgon Ecosystem is one of the very largest water towers in this country. The study area is found approximately on the Kenyan side between longitudes $0^{\circ} 47'30''N$ - $0^{\circ}52'30''N$ and latitudes $34^{\circ} 37'30''E$ - $34^{\circ} 43'0''E$. Extreme rainfall regimes and temperatures are part of the natural forcings that cause adverse impacts in the upper ecosystem thereby affecting livelihoods in the region. The research area is situated next to the natural forest ecosystem.

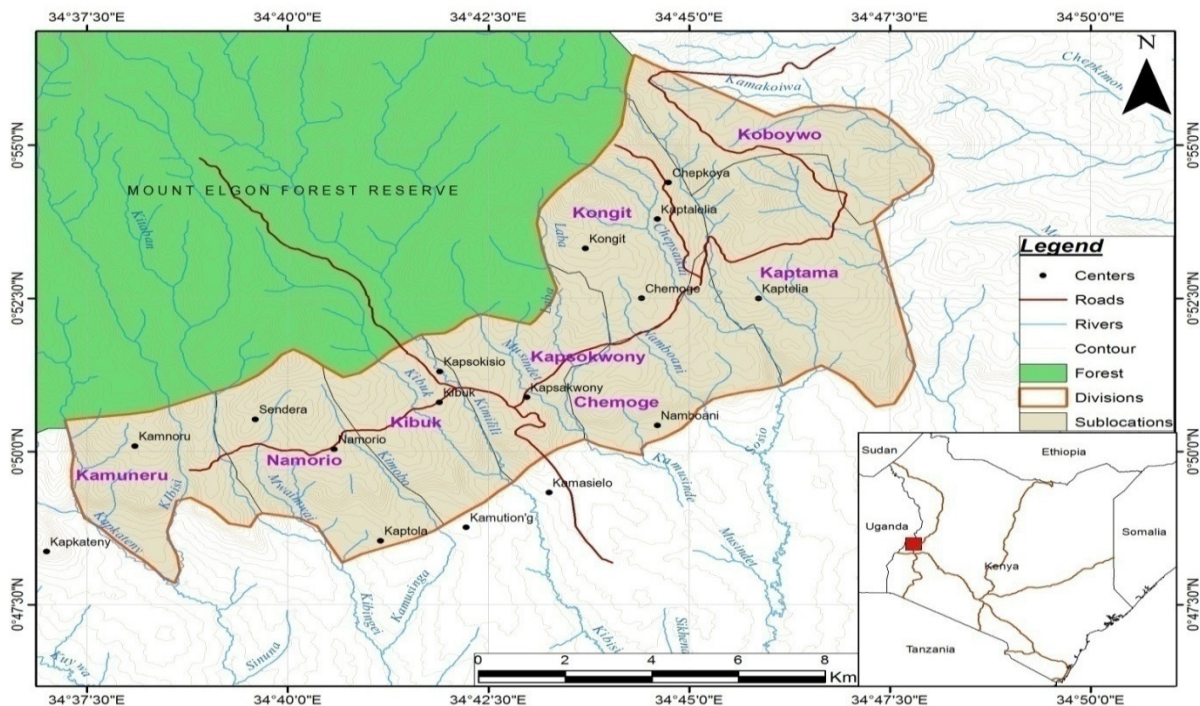
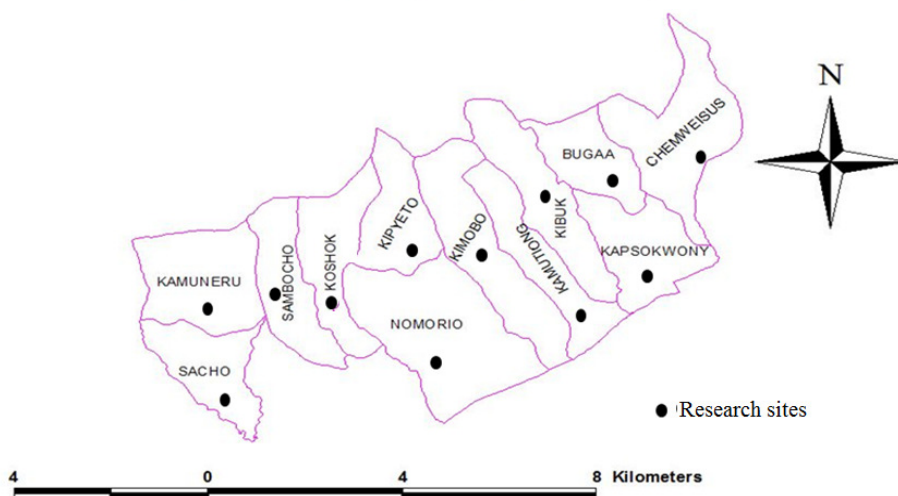


Figure 1: Topography map of Mt. Elgon region, Kenya showing the study area
Coordinates: longitudes $0^{\circ} 47'30''N$ - $0^{\circ}52'30''N$ and latitudes $34^{\circ} 37'30''E$ - $34^{\circ} 43'0''E$

KAPSOKWONY DIVISION SUB LOCATIONS MAP



Source:FEWS NET/USGS/NDMA

Figure 2: Map of study area showing sub-locations and research sites
Coordinates: longitudes $0^{\circ} 47'30''N$ - $0^{\circ}52'30''N$ and latitudes $34^{\circ} 37'30''E$ - $34^{\circ} 43'0''E$

The erratic weather changes due to climate change impacts in the region have greatly affected livelihoods of

the people in the recent past. There is a big relationship between the mountain ecological zones and the people who reside near the forested part of the ecosystem. Thus, the degradation of the existing water supplies is directly linked to the degradation of the forest resources and this is due to impacts of climate change (WWAP, 2009).

Parts of the main physical features in the region are the protruding volcanic rocks which were formed millions of years ago by the process of vulcanicity. The landforms and structures of Mt. Elgon landmass are changing due to landform evolution and the process of weathering. Landform and weathering processes are controlled by forces that include earth movements or plate tectonics and climate change. Continual fault movements and longtime effects of erosion have been responsible for the shaping of the landscape as seen today (Wesche, 2002). Mt Elgon landscape is also subject to climate change and different types of weathering. The annual alternating wet and dry climatic conditions are the main conditions that are responsible for shaping of the landscape. Water in rivers transport sediments, silt, sand and clay particles which are later deposited in the lowland areas. Most of the erosion takes place upstream and deposition takes place downstream on the floodplain (Wesche, 2002).

4.2 Data collection methods

During the research period data collection included literature reviews, informant and in-depth interviews as well focus group discussions. Administration of the structured questionnaire involved a total of 384 heads of households 32 from each of the sub-locations. Data was collected through an approach that combine a household questionnaire survey, three focus group discussions with a total of 80 women, men and youth, six key informant interviews with representatives of public and private organizations, and four in-depth interviews with some respondents who will participate in the household survey.

4.2.1 Desk review

Desk review started by highlighting historical trends of climate change challenges as highlighted in the national climate policies through a review of different policies that addressed climate change issues in different national policies whether directly or indirectly. This took into consideration how smallholder farmers' traditional technologies and indigenous adaptation strategies to climate change impacts within the study area could be implemented. Desk review also mirrored the effective adaptation technologies which were used by farmers in the past to combat the vagaries of climate variability.

4.2.2 Quantitative data

The household questionnaire survey generated mostly quantitative data although it also contained open questions that provided qualitative information. The questionnaire had four sections. The first section dealt with general, socio-economic and demographic characteristics. This was followed by two sections on coping with extreme weather events and adaptation to gradual climatic changes to assess the impact of climate stressors on the households, and their strategies to cope with and adapt to the impacts of extreme weather-related events. The last section of the questionnaire uses open questions to examine local perceptions of vulnerability and the ideas of respondents about policy options to reduce climate risks. The questionnaire interviews took approximately 25 to 30 minutes each to complete.

4.2.3 Qualitative research tools

Qualitative information was obtained through focus group discussions, key informant interviews and in-depth interviews. This information was used to complement the household survey (questionnaire). A Focus Group Discussion (FGD) is a form of interview that involves addressing questions to a group of individuals who have been selected for this specific purpose. In this study, three FGDs were conducted to obtain the experiences of men, women and youth with impact, coping and adaptation to climate extreme impacts. In total there were about 80 participants. The participants were ordinary members of the community and other stakeholders. Interaction among them stimulated ideas and perceptions about climate risks, including perception of change in the frequency and severity of climate impacts over time, drivers of deforestation, impacts, responses, constraints (factors impeding effective coping and adaptation) and policy.

Key informant interviews were used to collect information from people with specific knowledge and experience of climate impacts. The aim is to obtain information that would not easily be obtained from focus group discussions and the questionnaire. The integration of both non-scientific (experiential) and scientific knowledge was of great importance because it had a prominent role in decision making. Observations were made overtime of projected weather patterns/climate change on livelihoods and alterations be recorded and analyzed. Secondary data from meteorological experts of the weather parameters in the region can be of importance in the prediction of climate change scenarios.

4.3 Data analysis

Primary data analysis was carried out by the IBM Statistical Packages for Social Sciences (SPSS) version 23.0. Using descriptive, tabular and graphical statistics, the data was analyzed in terms of frequency distribution and

percentage using the SPSS as raw data was difficult to understand and meaningful conclusions were made. The data was then presented in tables, frequencies, figures and percentages.

5.0 Introduction

This chapter contains results/findings from the field research on sustaining livelihoods impacted by climate change in Kapsokwony Division, Mt. Elgon Sub – county, Kenya. The research was carried out with aim of generating long term transformation policies and adaptive strategies to be implemented to improve livelihoods of smallholder farmers and at the same time build resilience and capacity with climate change impacts in the study area. The chapter aims to provide questions to key specific objectives. The questions that are addressed in this particular chapter include the following:

- The characteristics of the communities in the study area;
- The traditional adaptive as well as the emerging technologies at individual and institutional levels within the study area;
- Behavioral changes of the area residents towards climate change impacts and the measures to be taken to compact the impacts of climate change;
- Impacts of climate change on food security and livestock production;
- Transformation knowledge and strategic adaptive strategies to improve livelihoods and sustain development; and
- Analyze the vulnerability of the communities beyond exposure and sensitivity to climate impacts and explore different dimensions of adaptive capacity.

5.1 Demographics, livelihoods and vulnerabilities

The characteristics of the respondents in the study were determined. This was in line with the fact that communities living in the study area have different characteristics in understanding climate variability and its resulting impacts on their agricultural systems and livelihoods at large. The characteristics of the respondents included sex, marital status, education levels and relation to heads of households. Others included the place of birth, year of birth and occupations. They were also asked about their ethnicity, number of children, religion and household composition. They were further investigated as to whether they owned the land they cultivated or not.

5.2 Sex of the respondents

Respondents in this study were mainly aged between 18 to 60 years. These respondents to the questionnaire were both men and women. Data analysis indicated that majority of the respondents were male making a total of 204 as opposed to females who were 180 both making (53.13%) and (46.88%) respectively. This clearly creates a range of about 6.25% as shown in figure 1 below respectively. Men are known to be absent because they are away fending for their families or being polygamous they may be in another household or are dead. Though women are not heads of households, their frequency of response remains high because of absent or dead husbands. Females are also known to contribute enormously to gender roles and for the fact that they understand the issues which are related to climate variability and climate change. However, the trend is very normal where males play big roles and have the mandate to speak on behalf of their households because they tend to understand better on issues of climate change than women.

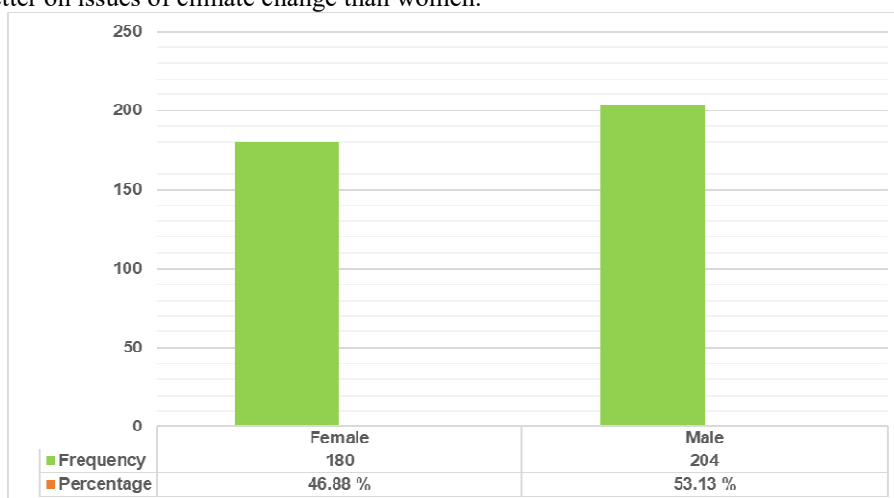


Figure 1: Sex of the respondents

5.2.2 Marital status

The marital status of the respondent's interviewed in the study area was assessed. Table 1 below show that from the survey conducted it was realized that majority of the respondents were in a monogamous marriage set up 271(70.57%) followed by polygamous 59(15.36%) making a total of 330(85.94%). Those widowed also showed 33(8.59%) whereas the remaining forms constituted 21(5.47%). This region was also noted to have farmers who profess Christianity as shown in table 3 below constituting 100 % of the respondents. Respondents in monogamous marital status tend to approach family issues differently than those other marital status because of the cohesion within the families.

Table 1: Marital status

Marital Status	Frequency	Percentage
Consensual Union	0	0.00 %
Monogamous	271	70.57 %
Polygamous	59	15.36 %
Separated/Divorced	3	0.78 %
Single	18	4.69 %
Widowed	33	8.59 %
Total	384	100.00 %

5.2.3 Education of respondents

The majority of the respondents in the study area have acquired some formal education. The table below shows that slightly more than half of the respondents had either primary education or didn't have any education or had only attained literacy course making a total of 210(54.69%). Those who had attained technical, secondary and tertiary constituted a total of 174(45.31%) but overall those with primary and secondary formed a huge majority constituting 191(49.74%) and 137(35.68%) respectively. Together those who had attained primary and secondary education formed a majority of 328(85.42%).

Table 2: Education of respondents

Education of respondents	Frequency	Percentage
Literacy Course	6	1.56 %
None	13	3.39 %
Primary	191	49.74 %
Secondary	137	35.68 %
Technical/Vocational	14	3.65 %
Tertiary	23	5.99 %
Total	384	100.00 %

Table 3: Religion of respondents

Religion	Frequency	Percentage
Christian	384	100.00 %
Total	384	100.00 %

5.2.4 Livelihood sources

The three main livelihood sources for households were crops, economic trees and livestock constituting 364(94.79%) 298(77.6%) and 330(85.94%) respectively making a total number of households to be 992 (258.33%) as shown in figure 2 below. From the findings in figure 2 below, it can also be observed that Farm Labor and Non-Farm Activities have an appreciable contribution making a total of 306(79.69%) whereas fishing was not considered as a source of livelihood contributing to 0(0%) of the responses.

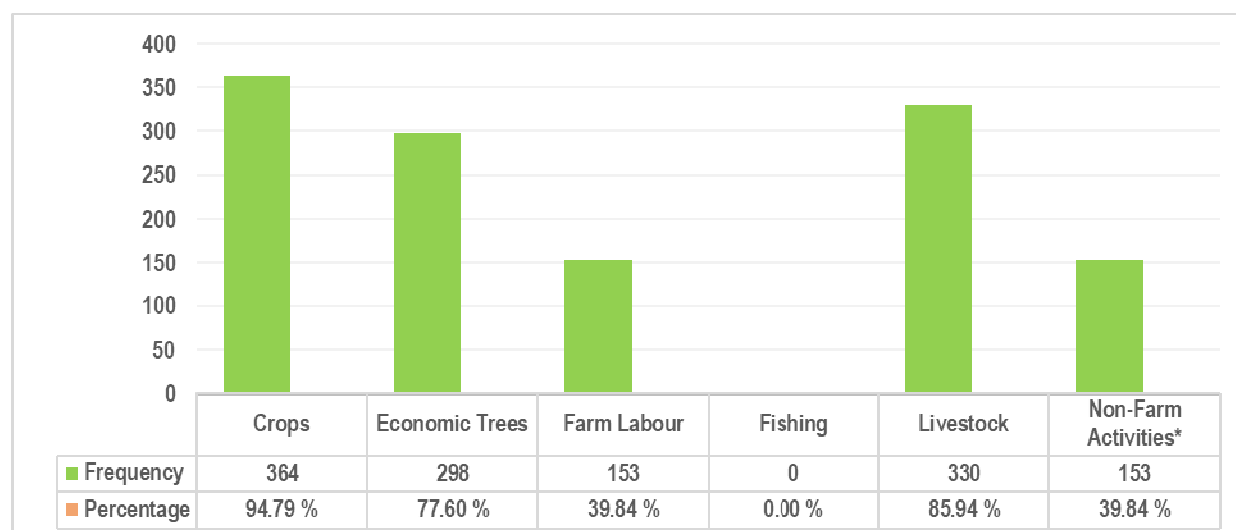


Figure 2: Livelihood sources

5.2.5 Crop production

The farmers in this area mostly cultivate maize 352(91.67%) as well as beans 296(77.08%) closely followed by bananas 107(27.86%) all these three making a total of 755(196.61%) households who till these crops whereas 275(71.61%). Other forms of crop production include bananas, coffee, Irish potatoes, onions, vegetables and other making the number of households that cultivate these crops 53(13.8%), 72(18.75%), 63(16.41%), 39(10.16%) and 48(12.5%) respectively. These findings significantly depict the fact that the staple foods in the region are maize and beans while other crops are sold to earn an income.

Table 4: Crop production

Crop Production	Frequency	Percentage
Bananas	107	27.86 %
Beans	296	77.08 %
Coffee	53	13.80 %
Irish Potatoes	72	18.75 %
Maize	352	91.67 %
Onions	63	16.41 %
Other	39	10.16 %
Vegetables	48	12.50 %
Total	1030	268.23 %

5.2.6 Sale of crops

The highest number of respondents who sold crops were of various categories but the two categories with the greater Approximate Half and more Than Half contributed to slightly more than half of the respondents contributing to 198(51.56%). On the other hand, the two categories with lower number of respondents were less Than Half and Everything making a total of 45(11.72%) and 23(5.99%) respectively with cumulative total of 68(17.71%).

Table 7: Sale of crops

Sale of Crops	Frequency	Percentage
< Than Half	45	11.72 %
> Than Half	91	23.70 %
Approximate Half	107	27.86 %
Everything	23	5.99 %
Hardly Anything	62	16.15 %
Nothing	56	14.58 %
Total	384	100.00 %

5.2.7 Perceptions on crop yield trends

Even though three (3) was a small number of missing responses 9(2.34%) it was clear that the high number agreed that there was little decrease 148(38.54%) and generally the number of households that agreed that there was a some sort of change in yield trends whether increase or decrease was 342(89.06%) cumulatively as opposed to those who thought that yield remained the same 33(8.59%).

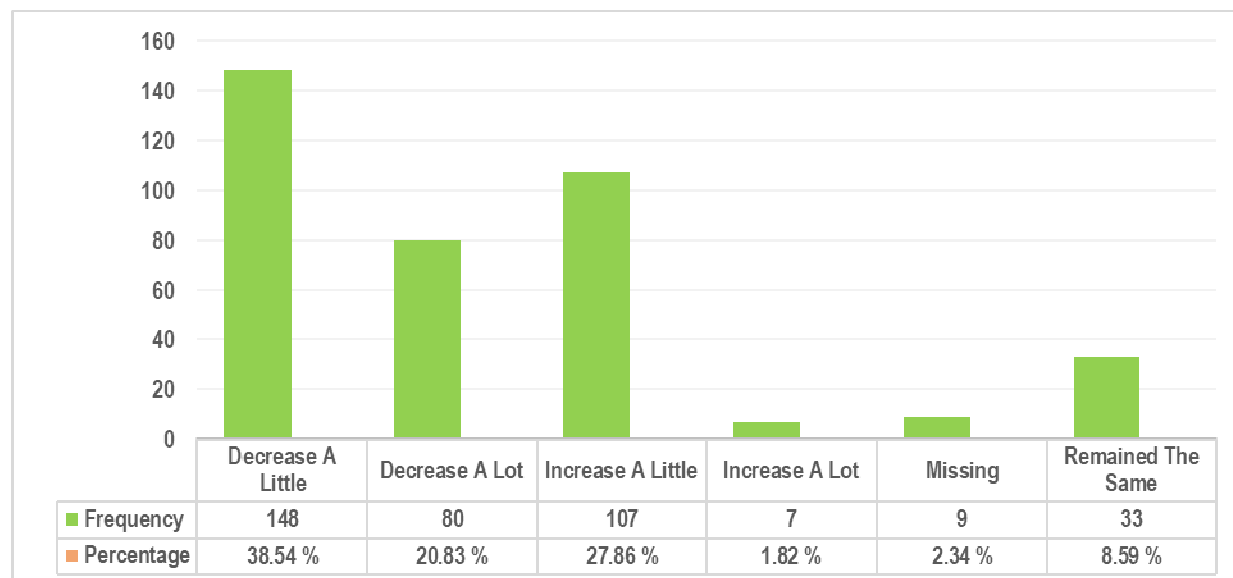


Figure 3: Perceptions on crop yields

5.3 Respondents perceptions on sustainability of livelihoods

An informant interview conducted with the District Crop Officer (DCO) in his place of work about changes in weather conditions. He stated as follows:

“At about 20 ago the vegetation cover in the region was made up mainly by various species of the indigenous trees but as at now indigenous trees have disappeared mysteriously or are extinct. The encroachment by loggers to harvest elgon teak (*Olea capensis*) for its valuable wood set the pace for area residents to move into the forest burn charcoal from the same. This period also marked the time when natives became aware of the value of trees and they earnestly began to harvest the other tree species for sale in order to earn some income. They did this with impunity and they did not know that what lay ahead of them in terms of environmental degradation was threat to livelihoods. Water resources that include springs, rivers and surface water were seriously affected. Soil erosion became prevalent especially on the steep mountain slope areas. Rains have become erratic, unreliable and unpredictable and temperatures are on the rise. Some households can only manage one meal in a day. Livestock per household have significantly dwindled because of decrease of pastureland and decline in quantities of water resource.”

In-depth interview with Samson Chepkuto, 31st January, 2016.

Changes in livestock production could not be wished away as an activity of livelihood in the area. During an interview with the head of livestock production he stated that:

“In 2015 foliage was seriously affected and livestock had little to eat under a changing climate. Heavy rains in the region are normally accompanied by the emergence of new tick-borne livestock infections which kill animals. Highly productive livestock species are hardly bred in the region because the residents do not have the knowledge and the skills to care for them. Dips have completely collapsed in the region due to poor planning and management. The common animals that are kept by farmers are the traditional breeds because they are disease, drought resistant and they eat less.. Decision on how many animals are to be kept by an individual farmer very much depends on the climatic conditions and availability of pasture. Most the animals grazed in the forest are sold before the start of the dry spell, as an adaptive strategy by herders to manage climate shocks and stresses.”

Informant interview with Jimmy Ndiema, the Head of Livestock Production Kapsokwony Division on 11th February, 2016.

“Flashfloods hit my village due to the El-Nino rains experienced late 2015 that made my home inhabitable. There was water everywhere and the expected harvest decomposed in the fields. The farm productivity has tremendously decreased and I managed to harvest only five (5) bags of maize from one acre of land as compared of 20 bags I harvest every other year from the same.. Temperatures have become high so that it is comfortable to sit inside the house during the day. The soils are no longer fertile and they have become acidic and hence, less productive. I have about 350 coffee, 100 tea and 50 banana economic trees to supplement my household income. I have other economic trees for instance eucalyptus, pines and cypress which I occasionally sell for an income or convert to fuel-wood to be used for cooking. Most of our people are illiterate or semi-illiterate, and they are not aware that climate change is real.”

¹⁰In-depth interview with Kiterie Kipsisei on 7th January, 2016 (Bugaa sub- location).4

Focus Group Discussion held with the youth representatives from the study area stated that:

“Focus Group Discussions (FGDs) held with the youth representatives on 24th June 2016 stated that there is a decline in agricultural productivity and dwindling livestock production under a changing climate. This is mainly due to diminishing water quantities and decline in pastureland. Impacts of climate change have greatly reduced income at household levels causing unemployment, rising poverty, insecurity, high food prices, waterborne diseases and under-nourishment among children. To move animals into the forest is an adaptive strategy to enable farmer’s access pasture and water. The sale of animals at the end of the year is another adaptive strategy meant to earn the family some income and reduce the number of animals before the planting season. Exponential population increase has caused competition for land mainly between humans and at times among communities leading to real land conflicts at family levels.. Furthermore, there is poor management of natural resources, rapid degradation of the ecosystem and reduced resources critical for livelihoods. These issues have been aggravated by climate change and anthropogenic activities which together act as drivers of environmental degradation. Some of the youth fall out of school because of poverty and engaging in early sexual activities. Poor illiterate parents do not see the importance of taking their children to school and yet they themselves are not educated. To assist them, boost education standards and enhance of vocational training opportunities.”

FGDs conducted for all the youth representatives in the study area on 24th June, 2016.

6.0 Conclusions and policy recommendations

6.1 Conclusions

The aim of this study was to evaluate sustainability of impacts of climate change on livelihoods among rural households in Kapsokwony Division. The communities living in the study area were investigated from the perspective of a people who experienced the livelihood threats due to climate impacts. The findings of this study will have several policy implications for politicians, planners as well as policy makers and rural dwellers who have different conflicting perceptions and concerns about a changing climate. Dialogue and inclusion of all stakeholders in development initiatives can mitigate this gap. The respondents in this study represent households that face increasingly frequent and severe livelihood impacts. These climate-related stressors come on top of a wide range of structural vulnerabilities, such as high poverty levels, rapid population growth, increased pressure on natural resources, limited livelihood opportunities, and low educational levels. The high incidence of poverty and low education level undermine households’ ability to diversify livelihood sources in ways that could enhance their resilience to climate events. Participants in the household questionnaire survey, FGDs, key informant and in-depth interviews reported significant changes in the frequency and severity of climate events and impacts particularly on crop cultivation, livestock, food prices, and health.

The study revealed how sustainability of impacts of climate change affects livelihoods in the study area. There was evidence of traditional knowledge and adaptive decision making that were essential in the improvement of livelihoods. Further, there was also the evidence of the degradation of livelihoods, risk management systems and increased poverty due to recurrent shocks of climate change. Therefore, in the face of increasing threats to livelihoods brought about by climate change, there is a critical need to support and strengthen existing adaptive capacity, while importing scientific technologies, new transformation knowledge and innovative ideas and approaches to respond to the evolving scenario. Within communities that reside in the study area, variation in vulnerability and adaptive capacity exist, based on livelihood options available, access to resources and information and a range of other factors related to livelihood opportunities. Gender inequality means that women stand out as being disadvantaged due to restrictions by traditional practices and marginalization. The marginalization of women and other social groups reduces possibilities for household and community resilience that is equitable and sustainable over a long period of time. This study must therefore address gender inequality and social marginalization as important underlying causes of vulnerability to climate change.

The policy recommendations below provide actors and practitioners options of reflecting and responding to challenges in practise. These recommendations should be availed to all the stakeholders to improve livelihoods in the region. This is because climate change impacts have contributed to reduction of vulnerability of men, women and the youth. Emerging themes that will follow this particular study will continually be shared through dialogue and results be put to good practise to improve livelihoods and sustain social-economic development in the region. Interventions by the government and NGOs are required to support households in preventing threat impacts that jeopardize lives and livelihoods. An important requisite for interventions to succeed is that the communities be consulted properly and given a voice in decision-making. This is especially true for interventions such as improvement in crop production, livestock rearing, and investments in infrastructure and ecosystem rehabilitation.

Some possible policy interventions listed are based on suggestions from questionnaire respondents (section 4 of the questionnaire), focus group participants, informant and in-depth interviews. As a disclaimer, it should be noted that policies to address loss and damage were not the main focus of this research, and the author

recognizes that some of the interventions and policy reorientations suggested here, might be more complex to achieve than study participants imagine. It would be good to explore the possibilities of interventions that can help exploit the opportunities presented by threats for agricultural transformation to increase food production and incomes of rural households. The Mt. Elgon Environment Conservation Network has an important role to play here and should collaborate with other public and private agencies such as BIKO KAPKORRET Community radio. Although the use modern technology is highly recommended, households may also benefit from traditional early warning signs that are known to some 'local experts'. More research is needed to assess this indigenous knowledge and its applicability in the study area. Proper land use, good planning and efficient use of natural resources are must in order to sustain and improve livelihoods. Indeed, many of the questionnaire respondents, participants in focus group discussions and in-depth interviewees proposed similar interventions that they think could permanently solve the problem of livelihood threats. They proposed better adaptive strategies and robust policy recommendation to increase adaptive capacity and resilience under a changing climate.

Proper land use, good planning and efficient use of natural resources is must in order to sustain and improve livelihoods. Indeed, many of the questionnaire respondents, participants in focus group discussions and in-depth interviewees proposed similar interventions that they think could permanently solve the problem of livelihood threats. They proposed that what are needed are better adaptive strategies and policies to combat climate change.

Laws can help to protect people who fail to see or recognize livelihood threats. Laws and regulations should be enacted and enforced to ensure public safety by controlling the types of agriculture and livestock rearing to be practiced by area residents. For example, practice of modern agriculture and organic livestock farming, planting of indigenous trees along river watersheds and control of soil erosion are strategies that can improve livelihoods. Pressure on land due to population increase is one of the critical factors driving ecosystem degradation in the study area and in the process; households and communities are increasingly exposed to livelihood threats. While the suggestion for policy formulations and interventions will not all be feasible in the short-term, it is clear that with current land-use practices, poor planning and ever increasing population, threats will continue to turn into disasters. The area is already witnessing increased resource – use conflict.

There is the danger of food insecurity due to the intensification of climate change vagaries in the region. Hunger and malnutrition are set to be prevalent in this region soon or later due to environmental degradation. All agricultural systems may collapse, hence, the collapse of the agricultural production. An increase in water pollution could lead to an increase of waterborne infectious diseases, and good quality drinking water is bound to be hard to find. The plundering of the forest and other forest resources could eventually further decrease in water quantities in rivers deepening humanitarian wellbeing. To achieve a sustainable future, there must be a balance between the population and the utilisation of the natural resources. Appropriate adaptive technologies must be put in place in terms of energy harvesting, increase efficiency, re-use, recycling, and avoid policies that promise short term economic returns at the expense of future generations. By engaging communities and other local stakeholders in a process of dialogue and reflections on climate change, livelihoods and gender, the study tried to unravel the critical issues that influence the vulnerability and adaptive capacities of both men and women smallholder communities in the study area. Institutions of learning (e.g. youth and women groups) should be put in place to create an enabling environment for local actions.

6.2 Policy recommendations

- **A decent education is an important tool to drive sustainable development and livelihoods.**

A decent education is an important tool to drive sustainable development and livelihoods. Literacy level in the study area is wanting, worrying and low. To promote human resource development, education must be accorded top priority. The major reason for low education is the high levels of poverty. There is need to put up more institutions to expand education. The government policy of free primary education was received positively and most families took advantage of it to take their children to school. For instance, education will help eliminate glaring gender disparities at household levels and at the same time inspire behavior change by creating awareness of individuals and communities. Decent education will promote knowledge and skills to help apply technologies to protect the environment while working towards a brighter future. Education is an important tool to invest in because it can empower, spur and cushion families against livelihood challenges.. Very few secondary and primary schools and households are connected to electricity grid. A decent education will promote more awareness, knowledge and skills in agriculture production, livestock keeping and agribusiness to improve livelihoods. The youth should access technical and vocational training to acquire knowledge and skills to deal with societal problems and create self employment. The local community members should be encouraged to promote a reading culture and attend adult literacy classes. The national and the county government leadership should provide an enabling environment and the necessary infrastructure for effective learning in schools. Good education among area residents will create cross sector linkages of public and private sector for optimal resource utilization, enrich technical education and training. I highly recommend that education be granted top priority for

realization of socio-economic development and better livelihoods in the region.

- **Adopt Climate Smart Agriculture (CSA) to achieve food security and improve livelihoods.**

Adopt Climate Smart Agriculture (CSA) to achieve food security and improve livelihoods. Due to high population density, most households own small parcels of land for crop subsistence farming (crops and livestock) in the research area. Food security is a major issue in the area is becoming a problem. Over nine out of every ten respondents (90%) reported that they experience food shortage and had to eat less during certain months in the past year. Major food shortages occur between January and June. In addition, a sizeable proportion of the food consumed in households is bought when own production fall short of consumption needs. The adoption of Climate Smart Agriculture (CSA) would be a sure solution to achieving food security and economic development in the study area under a changing climate. Technology Justice (TJ) can be used as a lens to evaluate whether CSA is a climate smart for smallholder farmer in the study area on the basis of the fact that the agro-ecological approaches are essential in achieving sustainable development in the context of climate change. Furthermore, farmers should feature CSA as a solution to resolving many livelihood challenges and make agriculture development a priority in achieving food security and higher incomes in the study area. Under this approach, smallholder farmers will be required to use agro-ecological approaches which are essential in achieving sustainable development in the context of climate change. Despite efforts to maintain the natural resource base, unsuitable agricultural practices are still the norm in the study area and food security is dependent on maize, potatoes, beans, onions and tomatoes. Climate change increases the likelihood of extreme and unpredictable weather, and so crop diseases that are new are likely to occur. This is a likely threat to food security in the area. Uses of chemical fertilizers are justified as climate smart because they can be used to increase yields and reduce deforestation by reducing the need for agricultural expansion. However, uses of organic fertilizers are more recommendable than uses of inorganic ones.

- **Control of livestock diseases that kill livestock thereby negatively impacting livelihoods.**

Control of livestock diseases that kill livestock thereby negatively impacting livelihoods. Disease management remains a pressing challenge among livestock keepers in the study area due to ignorance, animal movement and open grazing systems. Animal diseases and pests contribute significantly to low productivity and lead to low income for livestock keepers. In addition, disease outbreaks impact livestock trade and the prevalent livelihoods. It is for these reasons that diseases be identified as a critical area for livestock management. Good management of livestock will enhance productivity and commercialize the livestock sector, ensuring livestock keepers earn handsomely for their efforts. New organic livestock farming which is taking the whole world by storm is the most important thing to do to improve livelihoods. New livestock management should be done through co-operatives which will provide access to credit at zero interest. This credit can be used to open and scale up agro vets from which farmers can buy drugs to treat their animals thereby help to enhance animal health service delivery for their members. This will enable livestock farmers access animal health services and lessen drug shortages and grow health services. This will enhance monthly income from livestock sales in order to improve livelihoods. A new programme should be put in place for the purposes of vaccination, examination, treatment and de-worming. The programme will also support mass media initiative to educate livestock keepers on diseases management and nutrition. The County government should be involved in outreach activities in livestock keeping and to accelerate investments in livestock productivity. Financial support to the farmers will go a long way to enhance productivity, nutrition value addition and market access. Organic livestock farming requires that you apply organic on-farm inputs with the very minimal off-farm inputs. Organic breeders have an opportunity to select local breeds suited to the particular locality where they will be reared. Bio-security measures aimed at reducing introduction of diseases causing micro-organisms into farms must be observed in addition to provision of a free environment to minimize stress and improve immunity. Use of antibiotics to prevent diseases is not allowed in organic livestock production so is the use of growth promotion hormones. Farmers to strive to control internal parasites by use of proper pasture management strategies for instance do not graze weaned heifers after cows use rotational grazing to break parasite cycles. I recommend that proper measures be put in place to control livestock diseases in order that livestock production can be boosted.

- **Actions on diversification of livelihood sources are important in building resilience and understanding of how society can adapt to climate change.**

Actions on diversification of livelihood sources are important in building resilience and understanding of how society can adapt to climate change. Diversification of livelihoods impacted by climate change is a fundamental strategy in building resilience but it must be done in an informed and empowered way in order for it to be effective. There is currently limited knowledge about the ability of communities in the study region to adapt to future climate change. It is important to improve the understanding of how to enhance community's capacity to adapt to a changing climate in the context of other environmental stresses. The decision to diversify is always driven by recurrent climate shocks and stresses to existing livelihood strategies. Having many options for securing food and income provides a people with alternatives when one strategy fails. However, in the absence of the necessary information and support, the effectiveness of diversification as a strategy for building livelihood

resilience may be limited. Engaging in new activities requires new skills and knowledge that may not exist in the community, requiring capacity development and technical assistance from external actors. New livelihood strategies may also involve new risks, and these must be understood in order that the right mixes of strategies in the household portfolio. These types of information should be systematically gathered and shared with decision makers as they consider a range of adaptation options. The potential situation in the study area demonstrates how impacts of climate change interact with social, political and economic dynamics not to mention the deteriorating ecosystem health. The combination of these impacts places residents in a state of vulnerability and uncertainty with more shocks and how to manage the existing natural resources. To realize this potential, new research would be helpful to document past responses to climate variability and other environmental changes, analyze the underlying reasons for them, and explain how individual and institutional decisions were made. However, there is a likelihood of conflict by members of communities over available natural resources in terms to access to resources such as land. Finally, we earnestly recommend regular assessments of adaptation measures that address combined scenarios of future climate change, population growth, and economic development paths. I recommend creation of shared learning opportunities where researchers, practitioners, and stakeholders corroborate using observations, models, and dialogue to explore adaptation and mitigation as part of long-term, sustainable development planning.

- **Vulnerable social groups are at risk of being adversely affected by climate extremes.**

Climate extreme events are ravaging the most vulnerable especially the poor households in the study area. These groups are those which are restricted access to and control over resources leaving them less able to cope with climate shocks and stresses. Particularly, vulnerable to the impacts of climate events are members of the female headed households, orphans, the disabled, people living with HIV/AIDS, internally displaced, the widows and widowers. While all these groups are at high risks of being adversely affected by climate extremes, more attention should be given to the women because of their household responsibilities and a greater dependence on weather sensitive livelihoods. Women manage smallholder household farms and provide for most of the labour for crop production, and they also spend long hours looking for fuel-wood and collecting water. Climate disasters in the region are likely to increase women's household responsibilities and cause disproportionate economic losses for households. The household responsibilities for women can also increase if the male partners leave households in search of economic fortunes elsewhere. Greater resource scarcity can also increase the likelihood of women and children being affected. Women are also at risk during the occurrence of malaria, typhoid and dysentery to which pregnant women and children are more vulnerable in the study region because of inadequate health care. Women vulnerability is exacerbated by the fact that they are restricted to access resources, and the fact that they lack full control of the land they farm or access to capital and agricultural credit. Therefore, in comparison to their male counterparts, they are less able to control agricultural measures that could reduce their vulnerability to climate events. They also have very little capacity to seek off-farm income generation opportunities. Whatsoever, women are good natural resource managers and this can increase their capacity to cope with various climate hazards. Climate change could compound the vulnerability of women, children and other marginalized groups in the study area. Further changes in weather conditions could very easily complicate matters for these groups resulting in destruction of infrastructure, increase levels of poverty, reduce crop yields, cause in childhood multi-nutrition, make water resources to become less available and also cause increase waterborne and convectional diseases. These changes may further limit marginalized groups' economic opportunities and potentially deepen their levels of poverty. New policies should be put in place to improve livelihoods for vulnerable groups.

- **Smallholder farmers need to choose, use, and capitalize on adaptation technologies to improve their livelihoods and wellbeing.**

Smallholder farmers need to choose, use, and capitalize on adaptation technologies to improve their livelihoods and well being, while enabling them to respond effectively to continuous and unpredictable climate change. To achieve food security and economic development, systems of food production and trade systems must be made more accessible for smallholder farmer. Funds from Green Climate Fund (GCF) as per the Paris Climate Change Conference 2015 must be made available for the smallholder farmers so that they can achieve their food production targets. Not all of this money will be invested in agriculture, but some will go into other sectors of investment to secure and improve livelihoods. Most of the financing will likely be offered as loans, not grants, to enable replenishment of the Fund. Adaptive strategies devised by incorporating the scientific and the indigenous experiences are very important in the designing of adaptive policies that will help residents in the region to adapt to the vagaries of climate change. Knowledge of the indigenous community which is based on observations, perceptions and experiences over the years can effectively be blended with scientific knowledge to improve climate change mitigation and adaptation strategies. Other strategies that should be considered when designing adaptive technologies include cost efficiency, co-benefits, trade-offs and feasibility. Sometimes vulnerabilities of a community may result from differences in traditions, culture, socio-economy, lifestyles and gender differentiated responses. The technologies to be adapted must be beneficial under the current climate conditions

and those that might be adaptive under the future climate conditions. Technologies are supposed to build resilience to climate shocks and support adaptation. Without adequate scientific knowledge of future conditions, technologies can be ineffective or even harmful. Adaptation strategies should use both top-down and bottom-up approaches leading to higher effective, efficient, equal, sustainable, flexible, legitimate, robust and replicable. They need to be shaped in the context of available projected climate and impacts for the area under the study consideration. The way forward is to evaluate scenario methods and compare their strengths, weakness, and infrastructure and capacity requirements. We recommend the implementation of good, dynamic and robust adaptive technologies for poor in the community to recover from climate shocks, achieve sustain economic development and improve livelihoods.

- **Behavioral climate change adaptation measures at individual and institution levels**

Climate change and climate variability has had social impacts on the communities living in the study area. Representatives of the community interviewed concurred that the majority of the area residents have changed their living and working behaviors. The research that was carried out was also meant to change living and working behaviors of members of the households that include cropping systems, use of chemical or organic fertilizers, rearing environmental coping breeds of animals, crop diversification, driving of livestock to the forest for grazing and watering and growing of drought resistant crops. The behavioral changes are attributed to poor harvests leading to more people changing their eating habits and increasing poverty levels. Someday, members of a family may manage only one meal. Prolonged drought has resulted into poor regeneration for livestock, and this has been enhanced grazing through zero grazing where fodders including farm residues are collected and brought to the animals. A number of technological changes have been proposed in this Case Study to be instituted by communities living in the study area. These include practices that restore resources, rehabilitation of the ecosystem by planting indigenous trees, proper land use planning, environmental education, research on crop diseases, restoration of water resources, destocking, enforcement of environmental by-laws, organic livestock farming and empowerment of the human resource. However, priority should be granted environmental education and conservation of natural resources.

- **Need to in-calculate a positive attitude towards correct agriculture to increase food security**

There is a lot of negative attitude towards agriculture and livestock production by area residents that has consequently resulted in low food productivity. Food security can be improved by efficient and effective use of natural resources, practice of correct agriculture and by the growing of traditional food crops. This entails the fact that farmers be trained in issues like farm management, agricultural finance and trade, marketing and natural resource use and management. Further, this will help farmers make correct decisions concerning risks and uncertainty of agricultural production, reliance on natural resource management. Therefore, there is need to train more people to work in the sector and a supportive government which will come up with new adaptive policies to improve agricultural productivity. Area residents should view agriculture as a business and source of an income that can transform livelihoods. Many people in the study area might not be having the slightest idea about agricultural business management. They need to be made aware of the changing trends in agriculture and livestock production under a changing climate. These residents should develop an interest in agricultural and livestock development and at the same time have a sharp analytical mind to increase productivity. Farmers should be able to interact with internal and external worlds involved in agricultural production. They should also go out in the field to collect and analyze data. This will enable them come out with positions on whatever they want to achieve. They should understand things from different angles and simulate scenarios. They must expand their knowledge in agriculture and livestock management. Farmers should be encouraged to practice conservation agriculture, crop rotation, agro-forestry and crop livestock integration. They should grow locally adapted plants and seeds; multiplication of crop varieties adapted which are disease resistant. They should practice low tillage, maintenance of permanent soil cover that can increase soil organic matter, and reduce impacts of flooding, erosion, heavy rain and winds. The farmers should also be encouraged to grow traditional nutritive foods that ripen faster to alleviate food shortages because of the weather variations. Silos to be put up to store farm produce and good marketing structures be initiated and improved road infrastructure be in place to transport farm products. Soils should be tested regularly to know the inputs to be made and at the same time be able to fight diseases. We propose that area residents in-calculate a positive attitude towards agriculture. .

- **Train the youth and the women in entrepreneurship to transform the quality of livelihoods and foster sustainable development.**

Entrepreneurship is the development of a business enterprise from a concept or idea. It entails coming up with an idea and turning it into a profitable business. It is a risk undertaking that involves the exploration of an opportunity and risk management to create value for profit or social good. Further, entrepreneurship entails recognizing the right opportunity, finding resources for instance funding and tools to be able to pursue an opportunity and creating the correct environment to achieve the perceived target. Training in entrepreneurship will enable the participants attain an opportunity to become innovators and increase their creativity through the acquisition of technical skills and information. People who are trained in entrepreneurship will be able to

formulate development strategies, long term policies and shared future visions for generations to come. The training will help women and the youth prosper in the face of climate change by helping them develop adaptive capacity, reduce risks to livelihoods, manage their land and water and livestock sustainably. This concept will help give priority to an investment to transform the quality of livelihoods of the people and foster sustainable development. It will give them a chance to have the ability to choose and use the technology that assist them in leading the kind of life they value without compromising the ability of others and that of the future generations to do the same. Entrepreneurship increases competition and create employment across the board. It requires harmonized, optimal resource utilization and good performance to achieve the end product. The community can set up a revolving fund from which they can access credit and loans to invest in agro-ecological approaches to realize food security and agri-business services.

- **Reforestation is a sure method of climate change mitigation through carbon sequestration.**

Preferably the indigenous trees should be planted instead of the exotic trees because the latter are great consumers especially of the water resources. Some of the indigenous trees include: *Olea capensis*, *Ethrina abyssinica*, *Vitex kinesis*, *Acacia xanthophlea*, *Prunus africana*, *Entada bunchananii*, *Entada abyssinica* and *Lepintha senegalensis*. Forests absorb billions of tons of CO₂ every year and they are good established carbon 'sinks'. Forests contribute to climate change protection through carbon sequestration as well as being able to offer economic environmental and social cultural benefits. Forests are a major store of carbon and when they are haphazardly removed or cut down or burnt, CO₂ is released into the atmosphere. Continued deforestation is currently thought to be responsible for an annual emission of 1:1 to 1:7 tonnes of carbon per year and approximately one-fifth of CO₂ human emissions. Removal of trees or forests also destroys soils or open ground to release the CO₂ that is held therein. When forests are removed by use of fires, CO₂ equivalent of 40% of the world average yearly releases carbon emissions from fossil fuels. The release of GHGs into the atmosphere consequently increases global temperatures. Presence of forests increases water retention capacity especially during drought periods, and reduces the chances of flashfloods and maintenance of vegetation as a carbon 'sink'. To better mitigate the rate and impacts of deforestation of forest communities, sustainable livelihood activities, good planning and decisive policy management should be emphasized to tackle deforestation as a pragmatic integration activity into the national legislative policies. Hence, communities should protect forest resources as a way forward to mitigate their own livelihoods.

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