Kenya's Water Towers Protection and Climate Change Mitigation and Adaptation (WaTER) Programme

LAND TENURE PROFILES IN 'HOTSPOTS' AND VULNERABLE AREAS ON PUBLIC AND COMMUNITY LANDS IN MT. ELGON AND CHERANGANY HILLS ECOSYSTEMS

Component 4: Science to Inform Design of Community-Level Actionsand Policy Decisions

Project Report August 2017

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Cover Photo:

Paddocks for livestock grazing in seasonal wetland near Cheptongei area. (Photo by Griphin Ochieng)

Consulting Services for client

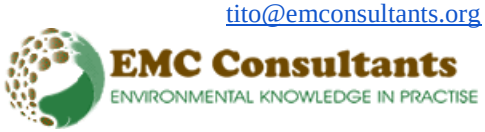
Kenya Forestry Research Institute

P.O Box 20412-00200

Nairobi

Final Report Compiled by:

Environment Management Consultants
Shelter Afrique Centre, 3rd floor Wing 3A
Longonot Road, Upperhill
P.O.Box, 9648-00100, NAIROBI
Landline: +254-020-520-6162
Cell: +254-722-579272
tito@emconsultants.org



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List of Acronyms/Abbreviations

CDF	Constituencies Development Fund
CLB	Community Land Board
DLB	District Land Board
ECD	Early Childhood Education
EMCA	Environment Management and Coordination Act
EMC	Environmental Management Consultants
FGD	Focus Group Discussion
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GoK	Government of Kenya
KEFRI	Kenya Forestry Research Institute
KES	Kenya Shilling
KFS	Kenya Forest Service
KII	Key Informant Interview
KNBS	Kenya national Bureau of statistics
KNBS	Kenya National Bureau of Statistics
KWS	Kenya Wildlife Service
KWTA	Kenya Water Towers Authority
LVBC	Lake Victoria Basin Commission
MoL	Ministry of Lands
Mt.	Mount
NLC	National Land Commission
REA	Rural Electrification Authority
SACCO	Savings and Credit Cooperative Organization
SOP	Standard Operating Procedures
UNEP	United Nations Environment Programme
WCU	World Conservation Union
WRMA	Water Resources Management authority

EXECUTIVE SUMMARY

Mt. Elgon and Cherangany Hills forests are among the five major Kenya's water towers that give rise to several rivers that runs across the landscapes. The forests together with the drainage networks forms a distinct system through the ecological connectivity phenomenon. Thus, the two water towers are exemplary ecosystems in the country that besides their biodiversity endowment, they support immense socio-economic activities of the local communities and of county governments. The two water towers are unique in that they commonly has the headwaters of Turkwel river that flows to the north and pours its waters into Lake Turkana, and; also, Nzoia River that flows in a south westerly direction pouring its waters into Lake Victoria. Mt. Elgon and Cherangany Hills forests has been affected adversely by the increasing human population that has created demand for more cultivation areas. As a result, water supply downstream has decreased in the recent and biodiversity support systems are potentially affected to detriment. The main objective of this consultancy is to profile land tenure system in Mt. Elgon and Cherangany Hills ecosystems in order to design better land management approaches.

This report has seven chapters which begins by setting up the background of the study area and environment conservation as briefly covered above. The study area for this project cover two ecosystems of Mt. Elgon and Cherangany Hills. These include the upper catchment in the higher elevation consisting of the forests and the lower elevations occuring in the downstreams of the drainage systems. The ecosystems are located in western side of Kenya and is defined by spatial extent bounds; in the east 35.79^0 E, west extent 33.91^0 E, in the north 2.67^0 N and southern extent is defined by 0.42^0 S. This extent can be described by administrative boundaries that consist of 11 counties which include Trans Nzoia, Bungoma, Busia, Kisumu, Siaya, Vihiga, Kakamega counties in Mt. Elgon ecosystem and in Cherangany ecosystem include Elgeyo-Marakwet, West Pokot, Uashin Gishu and Nandi Counties.

Information was generated through a proper planning where requirements of the project was evaluated through a consisderation of the scope of work. The team began by reviewing related reports and maps on human settlements, landuse systems and land tenure systems in the ecosystems. This was followed by a field survey in the project area with the aim of determining nand understanding the actual landuse practices and degradation occurring in the upper catchment of the two ecosystems. Issues that were considered during the field survey were related to: the

socio-economic characteristics of the households; crop and livestock production system and constraints; natural resource utilizations; land tenure and land use intensifications; land degradation, and; soil conservation measures.

Chapter three of this report contain reviewed information on land tenure system. Land tenure systems is known to be defined by property rights which have evolved over decades by government interventions. This chapter indicate that land tenure systems is more diverse and the diversity is determined by a range of cultural, ecological, social, economic and political factors. Land tenure system in Kenya has been operated on two broad system since independence, the statutory and customary tenure systems working under seven statutes. Land tenure systems in Kenya include the public land which is owned by the government; community lands which consist of land legally registered to a group or declared community land by an act of parliament, and; lastly, private land which consist of land registered under freehold and leasehold tenure. Traditional land tenure management among the ethinic groups in the ecoysystem was reviewed. These include the Luo, Luhya, Teso, Kalenjin (Tugen, Nandi, Kipsigis, Keiyo, Marakwet, Sabaot, Ogiek and Pokot). The chapter covers consideration of biodiversity sensitive areas under the land tenure system policies in Kenya.

Chapter four land use and economic resources in Mt. Elgon and Cherangany ecosystems. Various types of land use in the two ecosystems are determined by socio-economic needs, cultural practices, climatic conditions, soil fertility, ecology and level of social development. Land tenure system influences land access and hence; land use system, which are focused on each county within the two ecosystems. Major natural resources, forests and wetlands, in the ecosystems are provided necessary attention in the review. Major forests in the ecosystems are Cherangany forest fragments, Mt. Elgon forest, Kakamega forest, Nandi forests (North and South forests). While, major wetlands in the two ecosystems are Yala swamp, Saiwa Swamp, Lake Ziwa and King'wal swamp.

In Chapter five, review was made on land use, degradation and conservation hotspots in the upper catchments of Mt. Elgon and Cherangany ecosystems. It is apparent that the upper catchments consistute fertile areas and they receive high rainfall that attract agricultural activities. Change in land use has been conspicuous on forest conversion into agricultural land. A large proportion Mt. Elgon forest cover has degraded due to the conversion to other land use. Cherangany forest experienced degradation in the recent while that of Mt. Elgon is older in history. There are existing

potential threats in the two ecosystems observed during the field survey. These threats include road construction projects, quarrying of murram, mono-cropping, sawmilling, agricultural expansion, firewood collection, burning of vegetation and invasive alien species. There are areas that are deemed vulnerable to these potential threats in the ecosystems. These include areas that human population is high, areas around the forest, and areas in higher elevation and high slope angles.

Chapter six covers field survey results on socio-economic, land tenure system, land use types, perceptions on land degradations and soil conservation methods. Observation made in the field shows maize is the commonly planted crop in the two ecosystems throughout the elevation gradient; its only the scale of farming that varies with the elevation gradient. A lot of Irish potatoes are grown in Cherangany areas in the upper catchment. In Mt. Elgon, most farms range between 1-2 acres while in Cherangany Hills most of the farms range from 3-4 acres. Crop production forms the larger part of land use pattern estimated at 56.9% in Mt. Elgon and 63.0% in Cherang'any. An estimated 97 % of people in Mt. Elgon and 95.1% in Cherang'any has their lands affected by land degradation on their farms. Most of land degradation is caused by water erosion estimated at 58% and 63% in Mt. Elgon and Cherangany, respectively. Land degradation is also manifested in the form of decline in fertility. Opinion on causes of land degradation varies from Mt. Elgon to Cherangany Hills; in Mt. Elgon, the main cause of land degradation is related to poverty and income inequality and growing population; while in Cherangany it's the growing population followed by poverty and income inequality are the main cause of land degradation. Local people practice three common methods of conserving the soil. The most practiced soil conservation methods in Mt. Elgon and Cherangany are intercropping, crop rotation and organic manure application.

Recommendation is provided for the best practice that conserve soil and indirect ways of reducing pressure on land. Soil conservation practices proposed for the areas are development of agroforestry, composting, cover cropping, management of soil fertility and prevention of soil erosion. Farmer education should be adopted in order to improve further an understanding of the local communities. Provision of alternative livehood sources in the two ecoystems such as bee keeping would generate income that would consequently divert pressure from the forest.

INTRODUCTION

1.1. Project Background

Land has been and continues to be the most significant form of property in rural Kenya (Nzioki 2000). This is because among the poor households land plays a very important role determinaning the economic well-being and livelihoods. Further, property rights have been noted to increasingly play a central role in the management of land resources (Mugagga and Buyiza 2013).

Mt. Elgon and Cherangany Hills ecosystems are two of the five most important water towers in Kenya. The mountain is the upper catchment area for the several rivers such as the Suam River, which forms the Turkwel River downstream and drains into Lake Turkana, and the Nzoia River which flows in to Lake Victorria, while the Cherangany Hills ecosystem form the upper catchment for Kerio, Nzoia and Turkwel rivers. The water towers perfom numerous other ecosystem fucntions and services that include, storing rainwater, regulating river flows and preventing runoff, recharging ground-water aquifers, improving soil fertility, reducing soil erosion and sediment loads in river water, regulating local climatic conditions for commercial agriculture, and acting as carbon reservoirs and sinks.

The increase in human population has led to increased pressure and diminishing of natural resources such as forests, grassland and water in the catchment areas. Demand for cultivable land to cope with high increase in human population has necessitated the degazettement of foresst reserves in to farmlands, followed with letters of allotment to secure land rights. This tendency has caused clearing and removal of indigenous forest trees. Deforestation has reduced forest coverage from 12% in the 1960s to currently 6.9%. This has affected the ability of Kenya forest ecosystems to provide critical ecosystem services. It is estimated that deforestation costs the Kenyan economy an estimated KES 5.8 billion per year. The contribution of forests to GDP is estimated to around 3.6% but climate change is estimated to cost Kenya's economy as much as KES 50 billion a year, equivalent to 2% of country's GDP hampering long-term economic growth.

Kenya Forest Research Institute has commissioned this study whose general objective is to provide land tenure profiles in the two ecosystems which will be used to inform forest rehabilitation and conservation actions.

1.2. Objective of the study

The purpose of this study is to understand both the demographic and economic profile of the most degraded areas in the two ecosystems as identified through satellite imagery, and vulnerable areas on public and community land.The objective of this consultancy is to map land tenure in both ecosystems in order to design better land management approaches.The information generated will be key to understanding the role of population increase/decrease in degradation of the ecosystems. Further, the economic profile sequence will show the relationship between population dynamics with degradation of the hotspots. The information obtained will in turn lead to development of guidelines for community interventions in conserving the ecosystem.

CHAPTER TWO: STUDY APPROACHES

2.1. Study Area

Study area for this project cover two ecosystems of Mt. Elgon and Cherangany forests. The area thus, include 11 counties which include Trans Nzoia, Bungoma, West Pokot, Busia, Kisumu, siaya, Vihiga, Kakamega counties in Mt. Elgon ecosystem and in Cherangany ecosystem include Elgeyo-Marakwet, Uashin Gishu and Nandi Counties (Fig. 1).

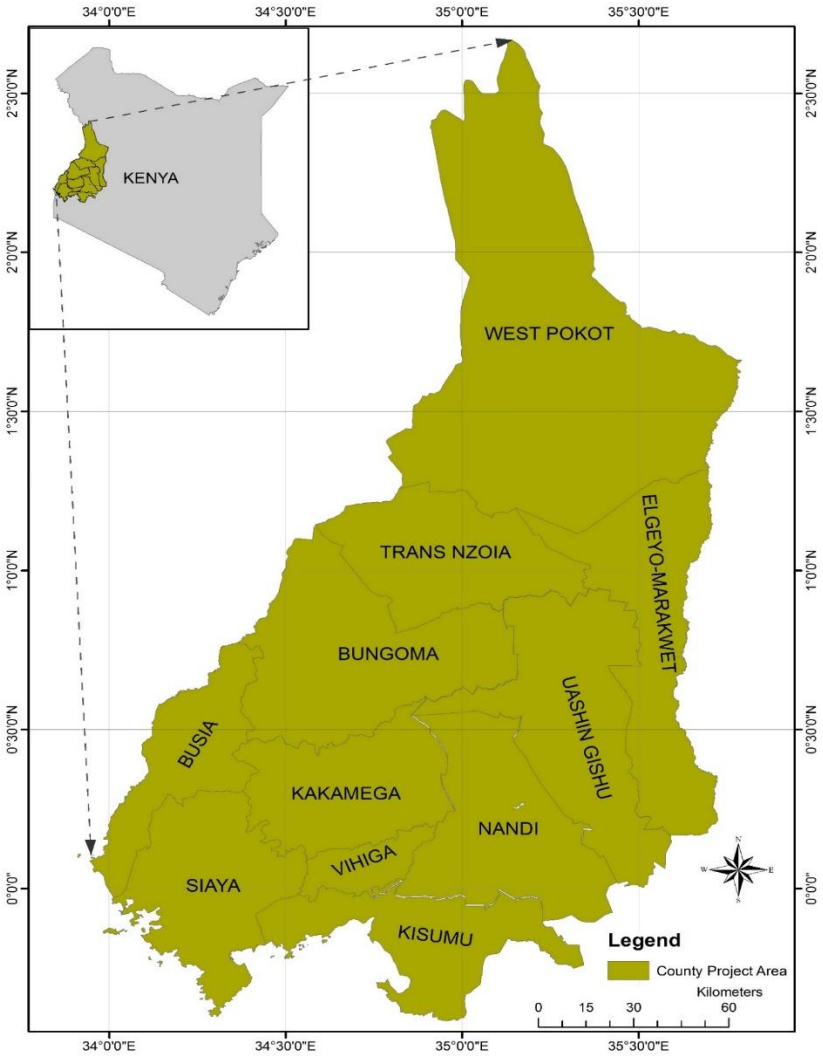

Figure 1: Geographic location of the study area

2.2. Task 1. Literature Review (Desktop Review) & Project Planning

2.2.1. Project Planning and Initial Contacts

As the initial task, we undertook a consultative planning process together with the client (KEFRI**)** in order to evaluate in detail the requirements of the assignment, the actual logistics involved, the scope of work and the eventual signing of the contract. We conducted a thorough planning process for all the project activities including mobilization, initial contacts and discussions with relevant government departments and ministries and relevant stakeholders involved in this project.

2.2.2. Literature Review (Desk Review of Secondary Information)

The consulting team reviewed and collected relevant data and information related to maps and qualitative information on human settlement and land tenure. The following documents were reviewed:-

- Land Use Plans
- Human Settlement Maps and Reports
- Vegetation Maps
- Livelihood Maps and Reports

The review of the documents helped the study team to understand among others:

- The existing land tenure systems in the project area
- The current land use practice in the project area
- The current settlement arrangement and patterns in the project area
- The current "hot spots" i.e. land degraded areas
- The vegetation cover and unique/sensitive ecosystems in the project area

Among the relevant secondary data which we are familiar with and expect to contain the above information include among others;

1. County Integrated Development Plans
2. Water Towers Atlas of Kenya
3. Kenya Water Towers Status Report
4. Kenya Demographic Indicator Survey Report

5. Kenya Population and Housing Census Report
6. Socio-Economic Atlas of Kenya

2.2.3. Fieldwork/Field Trips to Select Sub Project Sites

Under the guidance of the study Team Leader, the team carried out fieldwork and field trips to the project areas. The purpose of the direct field visits was to determine and understand using **direct expert observation** and **consultation** among others;-

1. **Unsustainable land use practices in the Mt. Elgon and Cherengany Hills Catchment Area including degraded hot spots (spatial targeting)**- Output of the spatial mapping of land use practices in the catchment were identified via mapping of the hotspots within the catchment where degradation is significant as a result of unsustainable land use practice. Mapping of degraded hot spots and unsustainable land use practices included causal factors of unsustainable land use practices within the catchment. Mapping entailed use of remote sensing and GIS technology in order to develop a spatial platform highlighting the current land use practices.

2. **Identification of activities** to mitigate the unsustainable land use practices within the Catchment. The consultant identified in a consultative and participatory process and manner, activities and interventions to mitigate the unsustainable land use practices. These intervention activities proposed land management changes aimed at the entire catchment with a view of improving downstream water quality and quantity.

2.2.4. Fieldwork survey description

EMC research team departed to the field on July 11th, 2017 from Nairobi to Kitale Town. First day was used for setting up field logistics, reconnaissance and pre-testing of questionnaire in Mt.

Elgon area. Pre-testing of questionnaire was performed to ensure questions are relevant and underscore the main objectives of the exercise. Reconnaissance involved identification of areas for conducting survey which assisted on adjustment of activities to fit within planned days. Five days was committed for administration of questionnaire while the last days was used for travelling back to Nairobi. We adopted a strategy of involving the local youths to assist in administering the questionnaire in order to cover sufficient sample size.

Fieldwork was conducted in the upper catchments of Mt. Elgon and Cherangany ecosystems where there environment degradation has occurred in the recent especially on areas around major forests.

The questionnaire was structured in a way that it captured interrelationships of human socio-economic activities with land degradation in Mt. Elgon and Cherangany ecosystems. Thus, the following areas were covered and survey conducted

- **Socio-economic characteristics of the households**: Aspects that were covered in this area included sources of livelihood and incomes. We focused mostly on sources that relates with environment resources in order to determine the contribution of the environment to livelihood of the local communities.
- **Crop and livestock production system and constraints**: These section involved survey on what is involved in the production of crops and livestocks. These include survey on productivity of land, the use of fertilizers, pesticides to enhance production.
- **Natural resource utilization**: these part involved survey on sources of timber for building, firewood for domestic cooking, water for drinking and cooking. It also looked into agroforestry development among households in the areas.
- **Land tenure and land use intensification**: Questions asked in this section involved land ownership and accessibility to land for cultivation (farming). Land use characteristics within lands owned or accessed by local farmers.
- **Land degradation**: Elements of land degradation on farms were surveyed among the local communities. Among them included soil erosion, loss of soil fertility observed through reduced yield. Local farmers were asked if they know causes of the land degradation.
- **Soil conservation measures**: methods of soil conservation used by local farmers/land owners were surveyed. Also, sources of knowledge on the methods of soil conservation were sought from farmers.

Participants were selected through the local administrators (local Chiefs and/or Sub-Chiefs). Criteria were set for selecting the participants. The candidate must have:

- An O-Level certificate
- National Identification Card
- Must come from the administration area e.g. location or sub-location
- Person with ethical integrity in the village
- Female candidates are mostly preferred

Participants were taken through the questionnaire in order to familiarize themselves with the questions. The training was performed in order for participants to understand answers expected for each questions. In addition, the participants evaluated understand how to interpret questions into local languages.

Plate 1: Training exercise of administrators of questionnaires. Plate 1A - Training Ms. Lydia Cheptoo at Endebess, Mt. Elgon area. Plate 1B - Training Peter Mara at Kaboywa.

CHAPTER THREE: LAND TENURE SYSTEM

3.1. Land tenure systems

Land tenure is the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land. It is an institution with rules invented by societies to regulate behaviour; rules of tenure define how property rights to land are to be allocated within societies, (FAO, 2002). The tenure systems have been profoundly changed by decades all over the world by government interventions, diverse cultural interactions, population pressures, socioeconomic change and political processes (Cotula, 2007). Cotula further stated that land tenure systems are extremely diverse, possibly changing from village to village as a result of a range of cultural, ecological, social, economic and political factors. Land tenure can therefore be considered as one of the most significant tool for nation-building in the world, (Brian, 1990).

The African continent is one endowed with high natural resources and cultural diversities. The two diversities brings different forms of interaction between natural resources and humans. This brings to question land management and land tenure systems. In the pre-colonial. Africans lived in traditional communities guided by their cultural beliefs and taboos. Land was owned communally and everybody had equal rights to use land through guidance from the community elders or other such law traditional authorities. The coming of missionaries and introduction of Islam religion lead to resolving of land conflicts by the religious leaders though many Africans still embraced their traditional cultures (Rutten, M.M. et al., 2005).

From 1880s Africans were under the colonial rule and this implied an existence of some kind of management of resources from the colonial government. The vacant lands were termed as “waste lands” and were declared colonials land but this did not affect the existing communal ownership of land. There was existence of both customary tenure in communities and statutory that guided the acquisition of land by the Europeans (Shivji, I.G., 1998). In East Africa, The East African Acquisition of Lands Order-in-council gave room for selling of lands acquired by the British Colonials on freehold or leasehold system to Africans. After the colonial period, most African countries remained under the two tenures customary and statutory.

Kenya adopted a new constitution after Independence in 1963 which recognized government or state land, trust land and private land (GoK, 1963). In 2010, Kenya promulgated a new constitution that recognizes three forms of land tenure under chapter five of the constitution: Public land, community land and private land (GoK, 2010). Other studies done in Kenya has revealed that the tenure system in place determines access to land which is a critical variable in the management of the natural and environmental resources, soil conservation, water resources as well as wildlife management (Ogolla and Mugabe, 1996) the study by Ogolla and Mugabe further highlighted that When tenure rights are certain, they provide incentives to use land in a sustainable manner and invest in resource conservation whether for the individual or group of individuals hence making the land tenure system to be critical tool for natural resource management .

3.2. Legislation, policies related to land tenure system in Kenya

Kenya has been operating on two broad land tenure systems since independence; statutory and customary tenure systems working under seven statutes. These are Registration of Titles Act (Cap 281); Government Lands Act (Cap 280); Land Titles Act (Cap 282); Registered Land Act (Cap 300); The Land (Group Representatives) Act (Cap 287); The Trust Land Act (Cap 288) and Sectional Properties Act No.21 of 1987.

Prevailing inequalities in land access and distribution coupled with a ballooning population sharpened the contradictions in land ownership in Kenya which were captured in far reaching reforms brought about by the Constitution of Kenya 2010 that necessitated the development of a national land policy. Existing policies were focused on economic productivity of land at the expense of other socio-cultural dimensions. The national land policy thus sought to address issues such as use land is put under, tenure systems, constitutional aspects, administration challenges, institutional framework and implementation.

The Constitution of Kenya 2010 is the supreme law and no Act of Parliament or any other legislation can override its authority. Land is such an emotive issue in Kenya and has a whole chapter dedicated to it. Part 1 of chapter 5 of the Constitution of Kenya 2010 deals with land. Article 61(2) of the Constitution identifies only three types of land classification: Public,

community or private. Essentially, public land is state land which no individual or community can lay claim to and which has no apparent heir as per legal processes of identifying heirs.

Non-citizens can only hold land in lease hold tenure which should not exceed 99 years. Corporations are only regarded as citizens when wholly owned by one or more citizens. Article 66 of the constitution however grants the state regulatory powers over any land in interests of defense, public health, public morality, public order and land use planning.

Article 67 creates the National Land Commission which should formulate a National Land Policy and recommend it to the National Government for implementation. Parliament is also tasked with legislation of land policies regulating land management.

Article 60 lists seven principles that mostly border on equity and fairness in land management. Particular emphasis is in part (g) which encourages communities to "settle land disputes through recognized local community initiatives consistent with this Constitution". This is aspect delegate's authority and vests it with the communities when disputes arise in relation to community land. Sensitivity of handling community land disputes is alluded to here.

A three tier system was created in land management through the national land policy. These are the National Land Commission (NLC), District Land Boards (DLB) and the Community Land Boards (CLB). Supporting agencies that will complement the work of these entities include ministry overseeing land, local authorities, land courts, land property tribunals and land reform transformation unit district land tribunals.
There are several Acts of parliament and statutes that govern specific aspects of land management such as The Land Acquisition Act Cap 295, The Government Lands Act, Registered Lands Act Cap 300, EMCA act.

3.3. Forms of land tenure systems in Kenya

3.3.1. Public land

Public land includes (among others) government-owned or occupied land. The State retains the right to regulate the use of land in the interest of defence, public safety, public order, public morality, public health, or land use planning. The State has the right to acquire other land for a public purpose or in the public interest provided the acquisition is carried out in accordance with the Constitution, which requires prompt and just compensation for owners as well as good-faith occupants.

3.3.2. Community land

Community land consists of land legally registered to a group, transferred to a community through a legal process, or declared community land by an act of Parliament, as well as lands traditionally occupied by hunter gatherer communities, lands held, managed, or used by specific communities as “forests, grazing areas, or shrines”, and land held in trust by a county government for a specific community.

3.3.3. Private land

Private land consists of registered land under freehold tenure and land held under leasehold tenure. The Private land owners have absolute proprietorship and the rights of exclusion except in cases of compulsory acquisition by the Government, as outlined in sections 107-120 of the Land Act, 2012.

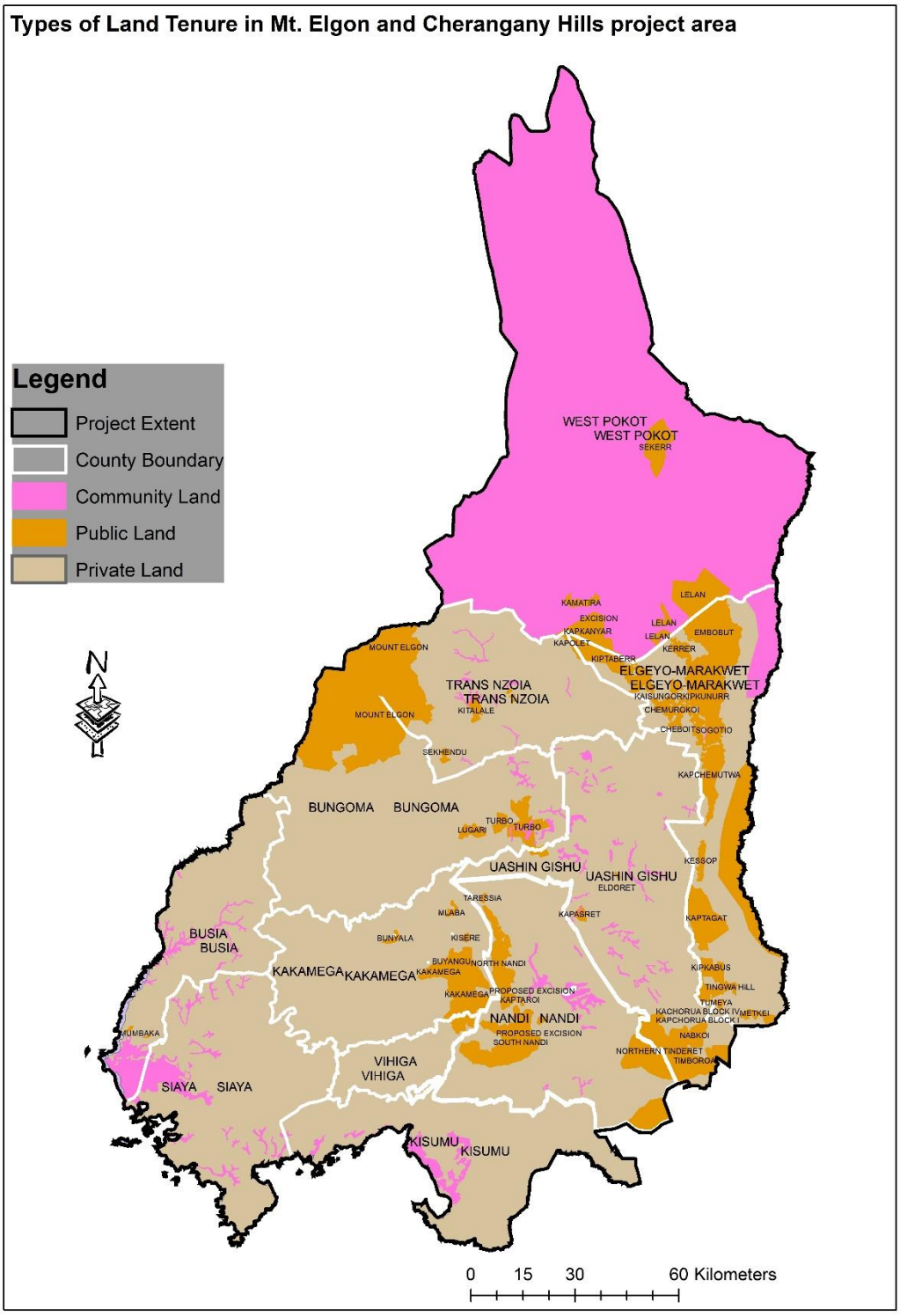

Figure 2: Distribution of types of land tenure in Mt. Elgon and Cherangany Hills Ecosystem project area.

3.4. Traditional land tenure management among communities in selected counties in Kenya

3.4.1. Traditional Land Tenure Systems in Kisumu and Siaya Counties.

The two counties have the Luo community, before Kenya become colonised, the luo communities living in the Nyanza region had their own traditional land management system. During that period, Luos practiced patriarchal system of land inheritance in which, sons inherited land from their fathers. Land was transmitted through the permanent members of the family - who were men and therefore, it was patrilineal succession, (CICLS, 2005). Women did not normally inherit land when married; they held well recognised rights in the lands of their conjugal families, holding these in trust for their own unmarried sons, (Shipton, 1989).

This luo traditional system provided a woman with rights of land belonging to her husband's patrilineage, her role in agriculture and food production was recognised by customary rights of access to land and support from the family labour. Men and Women as individuals or groups did not have the legal rights to allocate or dispose of land, (Pala, 1980). The luo custom allowed them to have the council of elders who were settling the land disputes among the community members, the custom also gave the woman the right to prevent the husband from giving out land, to sue trespass, eviction, settle boundary disputes of her husband's land and retain all rights to the land until the sons got married (FAO, 2002) the decisions on land were usually taken by chiefs or elders on behalf of, and in trust for, the clan or family , (Martin and Hashi, 1992 and FAO, 2002).

3.4.2. Traditional Land Tenure Systems in Kakamega, Bungoma, Vihiga and Busia counties

The Luhya community, also known as Avaluhya, Abaluhya, or Luyia (Human Rights Watch, 2003) is a Bantu ethnic group in Kenya. The Luhya community is considered as one tribe though it has over 18 sub-tribes. Among this community land was communal and the Traditional land was considered as a measure of wealth among the community; the community used the customary laws to govern their land, land was primarily controlled and allocated at the clan level ,Land in particular clan could not be transferred without approval of clan elders, who were always men. (Human Rights Watch, 2003). The clan land was allotted to household heads who were men and was

inherited by males down the line and women did not own any land but had the right to use the land. In this community access to land was acquired through clearance of bush and the planting of crops; the person who cleared the bush was deemed to be the rightful owner, (Perpetua 1991).

3.4.3. Traditional Land Tenure Systems among Teso community

This community used customary land tenure system where land was communal, the clan elder were the once in control and the distribution of the land to the head of the households. The head of house hold were held responsible of taking care of the land assigned to them by the elders. When head of house hold dies he was to hand over this responsibility to the eldest son. Women were given right to own land only if the husband dies early before their children are mature or on condition that she is not married and yet she has children. The community had common grazing lands (along rivers, wetland and forests) which ware managed for the benefit of all and no individual house hold could claim ownership, (Judy and Lavine, 2007).

3.4.4. Traditional Land Tenure Systems in West Pokot, Trans-Nzoia, Nandi, Uasin Gishu and ElgeyoMarakwet counties

These counties are majorly inhabited by the Kalenjin speaking people who are made up of six main communities with sub communities, these communities include: Tugen, Nandi, Kipsigis, Keiyo, Marakwet, Sabaot, Ogiek and Pokot. (Grace, 2005) The Kalenjin peoples are believed to be linguistically and culturally related (Kandagor, 1993).

3.4.5. Traditional Land Tenure Systems among Pokot community

The pokot are mainly found in West Pokot County which is located in a climatically arid and semiarid area and inhabited by the traditionally nomadic pastoralists. Traditionally the land was communally owned and used collectively for the grazing of the animals. (Nangulu 2001, Wernersson, 2013). According to the custom, only male members of the family can inherit land after reaching 18 years. Women normally get user rights to land belonging to their husbands or fathers (Cohen, 2002).

3.4.6. Traditional Land Tenure Systems among Nandi community

The Nandi inhibited western part of the Rift valley province currently the Nandi County (Kenya National Bureau of Statistics, 2009), they were pastoralists, hunters and gatherers. The land ownership in the community was communal. Access to land for grazing was based on membership of community by birth, (Pacifica, 2015). Their control of land was vested in council of elders who hold them in trust for all members of the community, the council of elder's were the ones allocating land to individual indigenous household for farming where land had no conflicting rights. Land was passed from generation to generation with customary rules of succession. Communal land tenure focused more on ecology and conservation as they did not encourage overgrazing and over harvesting of the fruits (Pacifica, 2015 and Hollis, 1909).

3.4.7. Traditional Land Tenure Systems among The Tugen

In Tugen community, rights to hold land were drawn along clan lines. The division of land along clan lines took root at the time the Tugen began to settle in the Mosop. The division of land, was done among the clans by the clan elders. One could hold land around his homestead or outside his homestead - the land left fallow was for communal purposes of grazing. There was no way an individual of a certain family could infringe another family's land whether crops were planted or fallow. However, it was possible for a person to acquire uncultivated land elsewhere without breaking the customary laws since acquisition of land was done after seeking audience with elders. (Kandagor, 1993).

3.4.8. Traditional Land Tenure Systems among Marakwet community

Among this community the tenure system used was communal ownership with the clan being the form of identity, the Marakwet elders allocate the land to different clans and for different uses. The care of the land and other resources was a responsibility of the whole community whereas access and user rights were vested upon the elders who ware controlling the accessibility and utilization (Grace, 2005) in her study it is noted that the women were having little say in decision making.

3.4.9. Traditional Land Tenure Systems among Sabaot group

This community can be sub-divided into; Kony, Bok, Bongomek, Sabiny or Sebei and Ndorobo or Ogiek. This community is the remaining forest dwellers in Kenya, they are traditionally honey gatherers and hunters who were surviving mainly by collecting wild fruits and roots in the forest, this their life style pose no threat to the forests hence are known as the care takers of all plant and animals. Among them land was communally held and administered through the council of elders (*poisionik*) who were selected according to the clan and family units, it was the duty of the elders to solve all the land disputes and control the movement of the community in the forest (Sang, 2001) the community still lives in harmony within most forests like Mt.Elgon, Nandi Hills, Charangani and Mau forest.

3.4.10. Traditional Land Tenure Systems among Kipsigis community

Land was communally owned among the Kipsigis community and it was never an individual property but instead it was the property of the community. But as long as a man kept a piece of land in cultivation he had the right to use it. But as soon as he left it to go back to bush or grass, it became a public property again. When reverting to a previously cultivated land each family had to take up their former portion of land. Any vacated land was open to anyone to cultivate, (Toweett, 1979). As the Kipsigis did not own land individually there were no elaborate rules, laws or customs of inheritance regarding land. Some of the exceptions in which land was privately owned included the space outside one's hut, place where cows are milked, the small vegetable garden surrounding a hut (Peristiany, 1939). There was no sale of land in this community and any transaction involving land had to take place in the presence of elders to provide witness and blessings (Samson, 2000).

3.4.11. Traditional Land Tenure Systems among Keiyo community

In this community traditional land tenure focused on three things: (1) method of acquiring land; (2) rights over the acquired land; (3) the use. The land was communal and it was the duty of the clan elder to apportion land to each male member of the clan hence no man was land less among them. Sons were inheriting land from their fathers, the whole clan had ownership of the land during cultivation. Women had no inheritance rights, they had unquestionable access to agricultural use of the land (Toweett, 1979). Apart from inheritance, one could strive individually to acquire a piece of land, either by moving onto it and clearing it, or by purchase (Chesang, 1973).

3.5. Land tenure systems governing biodiversity conservation

Article 60(1)(e) of the Constitution affirms that "sound conservation and protection of ecologically sensitive areas" is a key principle in developing a land management policy in Kenya. With the exception of forests that are lawfully held, managed or used by specific communities as per Article 63(d)(i) of the constitution which are regarded as community land and land specifically designated as private under an Act of parliament, all other government forests, the continental shelf, sea bed, territorial sea, government game reserves, rivers, lakes and water bodies defined by Acts of parliament, land between high and low water marks, government animal sanctuaries and specially protected areas are regarded as public land. Article 69 through to 71 grants the state and parliament latitude in management of environment and biodiversity where parliament is restricted to a legislative role only.

The state is thus practically in charge of all land that supports essential biodiversity. This means that land that supports biodiversity is primarily public land, but access to such land is limited by state in most cases. Recent developments in the scramble for land have pitted communities against private lease holders of large tracts of land who run conservation ranches. Northern Rangeland Trust which comprises 26 private ranches has recently come under intense physical attacks on ranch owners. Community members have revolted in what they claim are insidious schemes by the ranch owners to disposes them of their community land. The government has been seemingly helpless to curb the situation. The ranchers have been seeking to have some of their ranches declared sites of national heritage which essentially prevents any alterations on the land use, for example, since they conserve some critically endangered species of mammals. Communities previously used such land for pasture and the overlapping interests in such cases make it difficult to address such matters outside courts.

The state gazette national parks and game reserves as well as important wildlife corridors to protect biodiversity from destructive infrastructural developments. Some instances have however seen destruction of biodiversity areas since the state has a leeway in acquisition of land when it comes

to issues touching on public order as expressly generalized in Article 66 of the constitution of Kenya 2010. Several critical habitats for endemic avian species are feared to have been destroyed with the construction of the Kenyan standard gauge railway through the national park.

Other legislation governing biodiversity conservation with regards to land include; Environment Management and coordination Act (EMCA) 1999, Environment and Land Court Act 2011, Sessional, Paper No. 3 of 2009 of the National Land Policy, The Land Registration Act 2012, The National Land Commission Act 2012, Forests Act (No. 7 of 2005)/Revised 2012, The County Governments Act 2012, Wildlife Conservation and Management Act 2013 among others.

CHAPTER FOUR: LAND USE AND ECONOMIC RESOURCES IN MT. ELGON AND CHERANGANY ECOSYSTEMS

4.1. Background of Land use in Mt. Elgon And Cherangany Ecosystems

Different community's practice various forms of land used based on their social-economic needs and cultural practices, weather patterns, soil fertility, ecology and level of social development. The land use is mostly influence by the land tenure in place, since tenure determines access to land. This is a critical variable in the management of natural and environmental resources, soil conservation, and water resources as well as wildlife management (Republic of Kenya, 2005). Land use in urban and rural areas vary, in the urban areas, there is intensive land use due to high population densities compared to the rural areas. Land use in Kenya is influenced by different zoning laws in place whether the land has been set up for agricultural, commercial, industrial, residential or recreational purpose. The multiplicity of land uses to which land can be put present a challenge in coming up with appropriate arrangement that secures the conservation of all the natural resources in it (Republic of Kenya, 1989)

4.1.1. Land use and economic resources in Vihiga county

The County is categorized into two main agro-ecological zones, the upper and lower Midlands; these zones dictate the land-use patterns. The upper midland zones which are well drained and fertile comprise Hamisi, Sabatia and parts of Vihiga Constituencies. The lower midland zone has mainly red loamy sand soils derived from sedimentary and basalt rocks comprise Emuhaya and Luanda constituencies. The county experience high equatorial climate with well distributed rainfall throughout the year with an average annual precipitation of 1900 mm. The rainfall ranges from 1800– 2000mm. Temperatures range between 14ºC - 32ºC, with a mean of 23ºC.

The main land use types include livestock, crop farming, mining, tree planting fishing and settlements. Farming as an activity is the major land use in the county 97.8% of the land; the major farming's include crop growing, livestock keeping and fish farming. The area of land under food and cash crop production in the County is approximately 40,000 hectare and 8,000 hectare respectively with the major farming in Sabatia, Hamisi and Emuhaya Constituencies which have

fertile soil coupled with abundant rains. The main food crops produced are maize, beans, millet and sweet potatoes, other food crops being planted are sorghum, casssava, sweet potatoes and bananas. The main cash crops are Tea and coffee.

The main types of livestock kept in the County are zebu cattle, dairy cattle and poultry. Annual milk production is 6,195,099 litres. Chicken is the main poultry reared with a production of 10,585,000 kgs, although guinea fowls rearing are emerging in some parts of the County.

The county has 1,634 farmers engaged in fishing activities mainly in established fish Ponds in all the constituencies with few fishing taking place on river Yala and Esalwa, main fish species are cat fish and tilapia.

Mining activity is also going on in the county, the major ones are clay for brick making and pot making, Sand and stone harvesting. Most of the gold bearing rocks in Vihiga and Sabatia sub-counties ismined by using local technologies yielding very low outputs. Prospecting for gold and other minerals is underway at Kichutu mines in Vihiga and Kaimosi Forest.

Some part of the county land is also set aside as forests. The main forest type in the county is the tropical rain forest covering a total area of 4,160.9 hectares. These forests include; Kibiri forest consisting of indigenous and exotic tree species and Maragoli Forest consisting of exotic tree species. There are also community forests for cultural rites and private forests owned by individuals and churches. Most indigenous forest species have been destroyed and exotic trees have now dominated most farms in the county due to human encroachment.

4.1.2. Land use and economic resources in Trans Nzoia County

Land use in the county is influenced by the agro-ecological classification of the land. In the region, there are three major agro-ecological zones which include: the Upper Highland Zones (covering hills and slopes of Mt. Elgon, Cherangany with altitudes of 2,400 and 4,313 metres above sea level), Upper Midland Zones (lies between altitudes 1,700 and 2,000 metres above sea level) and the Lower Highland Zones (slopes of Mt Elgon and Cherangany Hills with an altitude ranging from 1,800 - 2,400 metres above sea level). The County has an altitude of averagely 1,800 metres

above sea level, which varies from 4,313 metres above sea level in Mt. Elgon and gradually drops to 1,400 metres above sea level towards the north. The area has highland equatorial climate.

The major land uses are cultivation of maize, sunflower, coffee, wheat and barley as well as dairy, beef, sheep and horticulture production. The total land acreage under food crops is 143,807.5 hectares while that under cash crops is 1,477.12 hectares, this is practiced both on the small scale and at large scale which are distributed throughout the county including the slopes of the major mountains like cherangany and Mt. Elgon.

Main livestock bred in the Trans Nzoia County include: cattle, goats, chicken and sheep. Fishing activity is carried out on the 7 major dams, 150 ponds and on 2 major rivers of Nzoia and Suam with their tributaries, the major fish species are tilapia and cat fish.

The county land under forest and agro-forestry is 18% (48,463.90 Ha) 0f the whole county, this places the county at an enviable position in Kenya as one of the top 10 forested counties. Main forest types in the county are natural (indigenous forests), plantation forests, bamboo, moorland and grass. The major forests are; Kiptogot Forest, Kimothon Forest, Suam Forest, Kitalale Forest, Kitale Township Forest, Sosio Forest, Saboti Forest, Kapolet Trust Land Forest and Kapolet forest. These forests act as water catchment zones for the rivers that flows through the county.

Within Mt. Elgon, there is National park that has a variety of key attractions such as elephants, sitatunga antelopes, buffalos, waterbucks, primates, leopards, among others hence promoting tourism in the county.

4.1.3. Land use and economic resources in Siaya County

Land in Siaya county is geomorphological categorised into; Dissected Uplands, Moderate Lowlands and Yala Swamp. These have different relief and soils which have make them to have different land use patterns. The altitude of the County rises from 1,140m on the shores of Lake Victoria to 1,400m above sea level on the North. Approximately 2059 Km^2 of land is arable and a major form of land use is peasantry agriculture, fishing, mining and forestry. Only small potion Siaya town has been set aside for industrial use.

Farming in the county is mainly for the peasantry, the acreage under food crop cover a total land area of 150,300 ha while the cash crops occupy 2,500 ha. The main food crops include; maize, sorghum, millet, beans, cowpeas, cassava, sweet potatoes, groundnuts and finger millets while the main cash crop include cotton, rice, sugar cane and groundnuts. Some of the emerging crops in the County include: irrigated rice, palm oil, chili, passion fruits and grain amaranth. Vegetables produced in the County incude: tomatoes, onions and kales while fruits grown in the region are; mangoes, pawpaw, bananas, oranges and watermelon. The areas around Yala Swamp and Ramogi Hill have potential for large scale- irrigation using river Yala.

Livestock breeds in the County include: zebu cattle, up-grade and pure dairy cows, dairy goats, poultry, local goats, sheep, pigs, rabbits, donkeys and bees. Among these zebu cattle forms the largest part of the cattle population approximately 90%. Local sheep and goats are also widely kept by 70% of the farm holds. Nearly 99% of the households also own chicken. The grazing of the animals is still done on the communal lands, along rivers, hills and within private land.

Fishing is carried out in Lake Victoria, Lake Kanyaboli as well as dams and fisheries aquaculture undertaken in fish ponds and it is one of the main economic activities in the county. The capture fisheries resource users land their fish at Fish Landing sites, there are a total of 81 fish landing sites along the shores of Lake Victoria with the major ones being Luanda Kotieno, Wichlum Uhanya, Usenge, Nango Kamariga and Osindo while On Lake Kanyaboli there are 3 fish landing sites.

On the forestry and agro-forestry land use, the county has hill top forests with varied indigenous tree species while some parts are enriched with exotic species (Eucalyptus species, Callitris robusta, Grivellea robusta, Cupressuss lusitanica, Pines species, Cassia species, Tarminilia species and Jacaranda mimisifilia). Most of the hills are under County government as trust lands and they include; Regea hill, Akara hill, Got Osir, Mbaga, Ramogi and Odiado. The county has two gazetted forests: Got Abiero and Ramogi Forests.

The portion of land in the county has been use for mining, these are mainly sand mining along river Nzoia and Gold. Other minerals include fluorite near Rata within the larger Asembo; granite and black sand from Yala valley.

4.1.4. Land use and economic resources in Kisumu county

The county area is divided into three topographical zones namely: the Kano Plains, the upland area of Nyabondo Plateau and the midland areas of Maseno. The land use in the county depends on the population density, topographical zones, rainfall and the temperature. The major land use in the county are; agriculture, forestry, fishing and mining. The county has three major rivers flowing into the Winam Gulf namely: the Nyando, Kibos and Sondu. The rivers are heavily silted, resulting in the extensive formation of lakeside swamps.

The land under agriculture is used for both the food crop and cash crop production, with total acreage under food and cash crops is estimated at 26,865 acres and 25,815 acres respectively. The main crops grown for subsistence include beans, maize, sorghum, finger millet, potatoes, groundnuts, kales and cotton. The main cash crop grown in the county is sugarcane while some rice growing is practiced along Rivers Nyando and Awach, Chemelil, Miwani and Kibos. Rice is grown under 2,000 ha. At the Ahero Irrigation Scheme in Nyando Constituency. Rice is also grown on a smaller scale at the Kabonyo Irrigation Scheme in Nyando Constituency. Sugar cane is grown extensively in Muhoroni and parts of Nyando Constituencies and is indeed the most important cash crop of the two areas. Most production (90%) is grown on small scale farms, with smaller amounts on nucleus estates around the cane factories. The crop farming are concentrated in the Kano plain and midland areas.

Livestock farming is common in most part of the county, the most common livestock kept in the large-scale commercial farms are dairy and beef cattle, goat and sheep while those on small scale are poultry, rabbits and bee keeping. The county has no ranches.

Fishing in the area is mainly done a long shoreline of Lake Victoria. This shoreline is 90 km long and has more than 17 beaches all of which are fish landing bays in the county, Kaloka Beach,

Ndere Island, Kisumu Port, Dunga Beach, Sango Beach and Kusa Beach. With the advent of fish ponds, households are investing in the ponds and there are over 1,330 fish ponds in the county. Kisumu County has got no gazetted forest and few existing ones are on hill tops of Fort Tenan and Songoh, these two hills helps in soil and water conservation within the county. Hence efforts need to be put in place in agro-forestry to increase land forest cover of the county.

Some land within the county are also used for mining, Quarrying and sand harvesting are the main mining activities. Sand harvesting concentrated along river banks of Nyando and Awach. Brick making is also common around Maseno and Nyakach.

The county land that are used for wild life are found at Ndere Island National Park in Seme Sub-county and the Kisumu Impala Sanctuary in Kisumu City, these two host different wild animals which include silver backed jackals, leopards, baboons, ostriches, hyena, guinea fowls, duikers, lion, impalas, vervet monkeys, bird species, sitatungas, crocodiles, pythons, monitor lizards, hippos, among others.

4.1.5. Land use and economic resources in Kakamega County

The county is divided into two ecological zones, Upper Medium and the Lower Medium. The Upper Medium covers the Central and Northern parts of the county such as Lurambi, Malava, Shinyalu and Ikolomani, Lugari and Likuyani. The second ecological zone, the Lower Medium, covers a major portion of the southern part of the county which includes Mumias, Matungu and Butere and Khwisero. Annual rainfall in the county ranges from 1280.1mm to 2214.1 mm per year, temperatures range from 180 C to 290C. The land use in the county is influenced by tenure system, ecological zones, climatic condition and the population density. The major land uses in the county are; crop farming, livestock rearing, forestry, mining, settlement among others.

The county practice both food crop and cash crop farming, the acreage under food crops is 114,053.6 Ha while the land under cash crops is 141,429.7 Ha. The main cash crop is sugar cane and the main food crop is maize. The area with upper medium ecological zone practise intensive maize, beans and horticultural production mainly on small scale and large scale while the lower medium ecological zone mainly practice sugarcane production with some farmers practising

maize, sweet potatoes, tea, ground nuts and cassava production. In the entire county maize and sugar cane are grown on large scale taking most part of the land.

Livestock farming taking a small portion of the available arable land in the county, the livestock bred are cattle, sheep, goats, pigs and chicken rearing.

Fishing is only being carried out at subsistence level mainly through the aquaculture. Most of the land that is suitable for other agricultural activities is also suitable; for aquaculture are swampy and marshy areas which are intensively used for sugar cane and maize growing.

The County has different types of forests; natural forest (3) covering Shinyalu and Lurambi, farm forests have been integrated with agricultural farming. The natural forests covering an approximate area of 244.25 km2 is gazetted. The non-gazetted forests is one covering an approximate area of 26.5 km^2. Commercial forests are found in the northern parts of the County in Lugari constituency. There is need to conserve these forests and encourage on-farm afforestation and involve the community in these efforts for sustainability. These forests help to reduce soil erosion and protection of the water catchment zones of Kakamega forest hence need of their conservation.

Mining activity is another land use in the county, the minerals are; gold mining in Ikolomani, sand, ballast, murram and hardcore. The Kakamega forest house numerous wild animals like, monkeys, birds, snakes, baboons, hares, hippos, monitor lizards and coloured butterflies. This calls for proper management of the forest.

4.1.6. Land use and economic resources in Busia County

Busia County have sandy loam soils, dark clay soils cover the northern and central parts of the County. The altitude is undulating and rises from about 1,130m above sea level at the shores of Lake Victoria to a maximum of about 1,500m in the Samia and North Teso Hills. The central part of the county, especially Butula and Nambale Sub-counties, are occupied by a pen plain marked by low flat divides of approximately uniform height, often capped by lateritic and a shallowly incised swampy drainage system. The County receives an annual rainfall of between 760mm and 2000 mm and the temperature range between 14°C (minimum) to 30°C (maximum). These

ecological and climatic conditions in the area affect the land use. The major land uses are; Agriculture, forestry, mining, construction of human settlements, business, social and public amenities. Land is also used as collateral to obtain credit as well as for aesthetic purposes.

The agriculture practiced in the county involve rearing of animals and crop farming. The crop farming involves both the cash crop and food crop, the total acreage under food crop cultivation (maize, cassava, finger millet, beans, sorghum, rice, sweet potatoes, cowpeas, groundnuts, bananas, green grams, sesame, soya beans) is 145,412.5 acres, while 33,652.5 acres are under cash crop cultivation (cotton, tobacco, sugarcane, oil palm and pepper). This is mainly carried out at subsistence level for local consumption and minimal commercial purpose. The main livestock in the county is the zebu cattle, sheep, goats, pigs and free-range local chicken.

Fishing in the county takes place in the following rivers; Malakisi, River River Nzoia and parts of Lake Victoria in the Budalangi. The communities residing close to dams and these main rivers engage in fishing activities on subsistence basis while those at Budalangi and Funyula Sub County do fishing as the main economic activity. Fish farming has also been practiced in the county as several fish ponds and hatcheries have been constructed in all the sub-Counties.

Busia County has a natural forest covering the hills of Samia and Budalang'i while other parts of the county have on farm woodlots that have been integrated with agricultural farming. Busia County has two gazetted replanted forests mainly located in Budalang'i sub-county totaling to only 528.8 Ha. The land under forest has been on decline in the County as most of the woodlots and forest are cleared down to give land for settlement and agriculture to support the ever increasing county population.

Mining is also practiced in some parts of the County. The minerals mined include: sand harvesting (commonly along river banks), brick making, quarrying, and ballast mining in the hills covered by granites. Mining is currently being done by the locals for subsistence and the county government need to invest in this industry in order to exploit its minerals but before investing heavily into it, there is need to enact appropriate policies and legislation for the mining sector development so as to avoid environmental degradation.

4.1.7. Land use and economic resources in Bungoma County

The County is within the Lake Victoria Basin, rising from 1200 metres in the west and southwest to over 4,000 metres to the North of Mt. Elgon. The county ecological zones are: Upper highlands, Lower Highlands, Upper midlands and Lower midlands. The annual rainfall in the County ranges from 400mm (lowest) to 1,800mm (highest). The annual temperature in the County vary between 0°c and 32°c due to different levels of attitude, with the highest peak of Mt. Elgon recording slightly less than 0°c. The land use in the county is influence by both the climatic condition and the ecological zoning of the county. The most common land uses are; Agriculture, forestry, mining, construction of human settlements, business, social and public amenities. Land is also used as collateral to obtain credit as well as for aesthetic purposes.

Shelter and housing is an integrated land use issue and a basic need. The housing sector in the county is characterized by low levels of urban home ownership, unserved land and unplanned settlements which has encroached into wetlands, riverbanks and protected forests. This has led to poor quality and quantity of water resources, increased intensity of flash floods, river bank erosion and sedimentation which is a major cause of eutrophication, leading to reduced quality of water and land suitable for agriculture and consequently a reduction in aquatic and terrestrial species.

Agricultural land use in the county has both the animal husbandry and crop farming. The crop farming covers large tract of land both for food crop and the cash crop, the area under food crops is 201,654.6 Ha which is 70% of the land under agriculture, while that under cash crops is 86,423.4 ha or 29.9%. Main crops produced include maize, beans, finger millet, sweet potatoes, bananas, Irish potatoes and assorted vegetables. Sugar cane, cotton, palm oil, coffee, sun flower and tobacco are grown as cash crops in the County. The crops are grown in different ecological zones: Upper highlands (no crop supported), Lower Highlands (Tea, wheat, maize, pyrethrum and Coffee), Upper midlands (sugar cane, Coffee, maize, Sunflower and Cotton) and Lower midlands (cotton and sugar cane).

Animal husbandry is another land use in the county. Main livestock in the County include; cattle, sheep, goats, donkeys, pigs, poultry and bees. Dairy farming is practiced on the lower Highlands,

grazing of animals is practised traditionally in wetlands, hill slopes and river banks. The emphasis on crop production has reduced grazing land, hence reduction of animal stock. The average land carrying capacity is 3 livestock units per acre. Indigenous chicken and cattle are the most common livestock kept by families though their productivity is low.

In terms of forestry use, the County has one gazetted forest reserve in Mt Elgon covering an area of 618.2 km^2 with other small scale forests and woodlands owned by individuals and institutions such as Webuye Pan Paper Mills. However, the County has several hill tops and high grounds such as Sang'alo, Chetambe and Kabuchai. The county has also practice Agro forestry systems which integrate the cultivation of trees with food crops and animal husbandry in the same area of land. By developing positive ecological interactions between species, agro-forestry systems aim at providing a range of environmental, economic, and social benefits to farming communities such as reducing soil erosion, enhancing the water cycle and nutrients formation and supporting greater biodiversity.

Small portion of the county land is used for mining, the areas prone to mining are (Malakisi and Sirisia) along the river banks where sand harvesting is practiced. The major minerals are; sand, brick making and quarrying.

Within Mt. Elgon there is land set aside for national park that is managed by the Kenya Wildlife Service. This park (Mt Elgon National Park) has amazing caves, wetlands, rare birds, tree species and animals. The most common wild animals are buffalos, leopard, cheetahs, baboons, water back and elephants. These animals need proper management and protection measures as the area sometimes experience illegal hunting by both the locals and Ugandan's.

Fishing in the county is done on subsistence scale, this practiced on the dams, rivers and on the fish ponds that have been established in all constituencies in the county. Major rivers used for fishing are, Nzoia, Kuywa, sosio, Kibisi and Sio-Malaba/Malakisi.

4.1.8. Land use and economic resources in West Pokot County

Climate: West Pokot has very varied altitudes and thereby large variation in climate and agro-ecological zones. Rainfall varies from 400 mm (lowlands) to 1,500 mm (highlands) per annum, and the annual mean temperature ranges from a minimum of 10 °C to a maximum of 30 °C in different parts of the county. The land is put into different uses depending on the ecological zones, the dominant farming and livelihood system in major parts of West Pokot is pastoralism, while in the southern-central parts with higher altitudes and more rainfall, agro-pastoralism and mixed farming is common (NDMA 2014). The land in the County is used in various ways; pastoralism, farming, forestry and agroforestry, fishing, water catchment zones, mining, tourism, industrialisation and wildlife.

Pastoralism: The County being in arid and semi-arid region, pastoralism is majorly practiced on the ranches and land which is communally owned. Main livestock bred include traditional zebu in Pokot Central and North Sub-Counties for meat production while West Pokot and Pokot South Sub-Counties keep improved dairy cows such as Ayrshire and Friesian. Others include; sheep, goats, camels, donkeys and pigs. The county has 16 group ranches covering an area of 125,072 ha. Most of these ranches are situated in Pokot Central and North Sub-Counties.

Agriculture: Crop farming in the County includes both cash and food crops. The total acreage under food and cash crops is 22,000 ha. This consists of 17,000 ha under food crops and 5,000 ha under cash crops. The main cash crops in the County are coffee and pyrethrum. Coffee is grown in West Pokot Sub-County while pyrethrum is grown in Pokot South Sub-County. Food crops production continues to increase due to existence of Weiwei irrigation scheme at Sigor.

Fisheries Resources: Fishing activities is very minimal in the County and confined mainly to Turkwel Dam, Suam River, Muruny River and Weiwei River. The government through the Economic Stimulus Projects has been promoting fish farming through construction of fish ponds.

Land under forest in the County covers an area of 20,857 ha, with natural forests mainly found on the highland side of Pokot South and Pokot Central which forms Cherangany Hills. Exotic forests are found in in west pokot and pokot south which has been in rise as the farmers practice agro-

forestry in their farms. The natural Forest cover is continuously being depleted in most parts of the county due to human activities and deforestation largely in areas of Kamatira, Sondany, Solion, Kawuk, Kuper, Seker, parts of Alale, and most parts of Pokot South. These forests act as water catchment areas.

Some land in the county is used for mining, the minerals that are being mined include gold along river Muruny, Seker and parts of Alale, limestone at Sebit, Ortum, Muino and parts of Alale and Sand harvesting in Kongelai Division.

The county has land set aside for wildlife and tourism, the wild life are found mainly at Nasolot Game reserve housing the following animals; Elephants, Buffalos,Hyenas, Impalas, Leopards and Lions. Tourist attraction sites are Marich escarpment, Kaisagat viewpoint, Mtelo and Koh hills. The County has not set aside most of its land for industrial activities; the only available ones are the National Cereals and Produce Board at Sigor, Makutano, Kacheliba and Lelan Highland Dairies cooler plant.

4.1.9. Land use and economic resources in Nandi County

The topography of the county is mainly hilly and its physiographic outlook is composed of five units with typical topography namely: the rolling hills to the West of the County, the Kapsabet plateau (part of Uasin Gishu plateau), the wooded highlands and foothills of Tinderet Volcanic mass in the South East, the King'wal Swamp in the centre (Baraton-Chepterit) and the dissected Nyando Escarpment at the Southern border. All these have varied effects on the County development and land use. A large expanse of the County consists of forest, derived grasslands, shrubs and scrubland

The county has several swamps have not been put to use. Most of them are poorly drained hence conserved as wetlands within the county even though some few are being used for horticultural production which makes them sources of vegetables and pineapples consumed in the County.

The forest constitute 12% of the total county land and it is declining, the major tropical rain forests are, The North Nandi forest covers a total of 16,004 Ha , South Nandi Forest covers an area of

20,150 Ha. North Tinderet Forest Reserve, Kimondi and Serengonik Forest. These forests have tree species (Bamboo, Croton Macrogarcapus, Elgon Teak, Bischofia Favonica, Spathodea Nilotica, Prunus Africana) which are best for protection of water catchment areas.

Farming is one of the major land use in the county, the main food crops produced are maize, beans, cow peas, potatoes and cabbages which cover a total of 125, 756 Ha. The main cash crops are tea, coffee and sugar cane which covers a total of 26,290 Ha. Dairy and beef cattle are the main livestock bred in the county. Others are poultry, goats, sheep, pigs and bees. Fishing is done mainly on the individual farms on the fish ponds with little on the rivers that flows through the county.

Very small part of the county is used for mining, the main mining activity is sand mining, which is done along the river banks of Kundos, Kipkaren and Mokong. This has however an adverse effect on the environment as it promotes erosion and pollution of the environment. There is also minimal gold mining around Kapsaos in Nandi South.

In the Nandi South Sub County, portion of the land at Bonjoge is used as National Reserve for wildlife management. The Kingwal Swamp near Chepterit area which is host to the famous Sitatunga, a rare gazelle species hence need proper management.

4.1.10. Land use and economic resources in Elgeyo Marakwet County

The land in the county is divided divided into three topographic zones namely: the Highlands (2700 -3350 m), the Kerio Valley (900-1000 m) and the Escarpment: all of them separated by the conspicuous Elgeyo Escarpment. Each of the three zones has different land uses. The area receives rainfall between 850mm-1500mm per annum while the temperature range between17^{o}C to 30 ^{o}C depending with the season of the year. The average land holding size in the county is 7.0Ha with the small scale farming acreage of 1.36Ha. The major land uses in the county are; crop farming, livestock rearing, forestry, mining, settlement among others.

Crop farming is the major land use in the county which comprise both the food crop and cash crop. The total acreage under food crop farming is 88,639.3Ha whereas that under cash crop farming is 4,003.74Ha. Most of the farming is located on the highlands with Over 70% of this is found in

Keiyo North and Keiyo South sub-counties while about 30%is found in Marakwet West and Marakwet East sub-counties. Irrigated farming is mainly found at Arror and Korober covering 6,070Ha of land. Crops grown in the county include; maize, wheat, Irish potatoes, beans tea, pyrethrum, coffee, mangoes, pawpaw, watermelon, oranges, bananas, cassava, millet and sorghum.

The livestock farming is practiced in the forest highlands and within the Kerio Valley. The main livestock breeds are Zebu, Boran and Sahiwals cattle types, Dorper sheep and Galla goats. Large portion of the land in the county is covered under both indigenous and exotic forests. The total area under forest is 93,692.48Ha; The County has a total of 16 gazetted forests with over 3000 households settled as squatters in them.

The county land under mining is very minimal, the few mineral mined are Fluorspar at Kimwarer area of Keiyo South, limestone at Kapkata and sand at Kerio Valley. There is land used as game reserve within Kerio valley (Rimoi Game reserve), this area is endowed with different wild animals like elephants, baboons, antelopes, birds and snakes which are essential components of the ecosystem.

The major rivers in the county which are also influencing the land use in the county include the following rivers: Moiben, Chepkaitit and Sabor, Kerrer, Muruny, Torok, Chesegon, Embobut, Embomon, Arror, Mong and Kimwarer.

4.1.11. Land use and economic resources in Uasin Gishu County

The County is physiographically divided into three zones: the upper highlands, upper midlands and lower highlands. These zones greatly influence land use patterns as they determine the climatic conditions. The geology is dominated by tertiary volcanic rock. soils which comprise of red loam soils, red clay soils, brown clay soils and brown loam soils It is a highland plateau. It has high and reliable rainfall which is evenly distributed throughout the year the average rainfall ranges between 624.9 mm to1, 560.4mm. The temperatures range between 7 ^{0}C - 29 ^{0}C.

The main land use types include livestock keeping, crop farming, forestry, fish farming and settlements. The county has several settlement schemes which are used to settle the land less; these

include Turbo settlement scheme accounting for 658 households; Jabali settlement Scheme 161 and Maili Tisa 100 households. Some of the landless are squatters living in gazetted forests. The county practice mixed farming (food crops and livestock), mixed farming (commercial crops and livestock –dairy).

The farming is done both on small scale and large scale level. 80% of the land tenure in the county is being privately owned. This has encouraged investment in permanent and long term improvements of development on farms. The county land is also covered with major forests, the forests are Nabkoi, Timborwa, Sangalo, Lorenge, Kipkurere and Kapsaret forests.

There are also private forests in farm woodlots and the residual portions of the farms these make the county to act as source of various rivers which drain into the Lake Victoria basin. The county also has numerous man-made dams (120 dams), rivers (4 major rivers), namely; Moiben with its 3 tributaries; Sosiani also with its 3 tributaries; Sergoit with 2 tributaries; Kipkarren with 9 tributaries and River Nzoia.

4.2. Major Forests

4.2.1. Cherangany Forests

The Cherangani Forest is composed of 14 forest blocks scattered along the Cherangani Hills that cover an area of 114,416.2 ha. The blocks include; Kapolet 1551.6 ha, Cheboyit 2488.8 ha, Chemurkoi 3965.9 ha, Embobut 21933.9 ha, Kaisungor 1085.8 ha, Kererr 2160.2 ha, Kipkenurr 15175.7 ha, Kiptaberr 12886.4 ha, Toropket 117.4 ha, Sogotio 3561.2 ha, Kapkanyar 6037.4 ha and Lelan14820.0 ha. These fragments are distributed among the following counties Trans Nzoia, Elgeyo Marakwet and West Pokot. These Cherangani Hills are all gazeted forest area hence fall under the central government forests and managed by the forest department.

The forest taxa are very divers. The forest has over 163 plant species which are spread out in the different blocks. The lower western parts of Kiptaberr-Kapkanyar are dominated by Aningeria-Strombosia. Drypetes forest, with a large area of mixed Podocarpus latifolius forest on the higher slopes. The southern slopes hold Juniperus–Nuxia–Podocarpus falcatus forest, with heavily

disturbed Podocarpus falcatus forest on the eastern slopes. Valleys in the upper peaks area shelter of Juniperus–Maytenus undata–Rapanea–Hagenia forest. Tree ferns Cyathea manniana occur in stream valleys, and there are patches of bamboo Arundinaria alpina, though no bamboo zone as such. In clearings, Acacia abyssinica occurs among scrubby grassland with a diversity of flowering plants. At higher altitudes, the forest is interspersed with a mixture of heath vegetation and swamps. In the east especially, there is a mosaic of vegetation types with little obvious altitudinal zonation, possibly as a result of the hills' varied topography and the long history of interchanging practices of cultivation, grazing and bush fires, and the establishment of plantations of Cupressus lusitanica, Pinus patula and a few Eucalyptus species.sizeable remnants

The fauna Cherangani forest has both the mammals, herpes and the avifauna. The mammal species are the elephants, buffaloes and leopards on the higher sides of the hills. Black and white Colobus monkeys, otters, genet cats, mongooses, bushbucks and De Brazzas monkeys as well as the sitatunga antelope. The ungulate Tragelaphus eurycerus has been recorded in the area. Among the insects is the butterfly Capys juliae which is endemic to the Cherangani Hills. The avifauna of the Cherangani are Gypaetus barbatus and Stephanoaetus coronatus.

The major environmental threats in cherangani forest are illegal loging, poaching, charcoal burning, forest fires, and cattle grazing, infrastructural development,

The degradation types noticed include; road expansion project that cleared swathes of the forest, encroachment of the forest land converting it into farmlands. Parts of Kapkanyar forest has been converted to grazing grassland.

Figure 3: Cherangany forest fragments in the background

4.2.2. Mt. Elgon Forest

Mount Elgon is located north of Lake Victoria on the border between Kenya and Uganda. Mount Elgon forest was gazetted as a government forest reserve in 1932. It currently covers an area of about 49,382.9 ha. The forest is divided into three management units namely the natural forest reserve, the commercial exotic plantations and the national park. These are named Kimothon forest, Mt. Elgon and Chorlem forest blocks respectively. The national park was gazetted in 1968 and covers an area of 16 900 ha while the plantations of cypress, pines cover an estimated area of 4,500 ha. The Forest Department manages the forest reserve while the Kenya Wildlife Service manages the National Park. The remaining moorlands are part of the Mount Elgon Trust, managed by Bungoma County Council.

The Mount Elgon ecosystem contains habitats which support unique and diverse fauna and Flora. A number of plant species are endemic to the mountain, and it is one of the locations where the Elgon Teak (*Olea capensis*) is found, planted species (*Markhamia lutea*, *Dombeya goetzenii*, Grevillea robusta (should not have been planted since it is an exotic species), *Olea capensis*, *Albizia gummifera*, *Sizygium* and *Podocarpus* spp).

Animal life is varied and comprises of 144 bird species, diurnal forest primates, 36 species of forest butterflies and various species of small and large mammals such as Elephants, buffaloes, duikers, giant forest hog, waterbuck, reedbuck, bushbuck, leopard duiker and various monkeys. Elephants and leopards are of special concern due to their threatened/endangered status. Mt. Elgon represents the western limits of species/races known to occur in the Eastern African highlands. The caves on the slopes of the mountain are home to large colonies of various types of bats.

Threats to the Kenyan side of the Mount Elgon include; Excisions, encroachment (clearings for farming by the local population or reportedly even more often by influential persons in search of fertile land), Poaching, illegal logging, firewood collection, charcoal burning and other activities such as honey gathering and illegal grazing.

In recent times, the forest has been degraded causing changes in vegetation due to an increase in the local human population and conflicts, about one quarter of indigenous forest cover of Mt. Elgon has disappeared due to clearance for farming activities. There has been considerable forest disturbance and further deterioration, degradation and deforestation is continuing at an alarming rate through cultivation and other human activities –mostly by communities from outside the area who have invaded the forest. Forest fires have also destroyed some trees, causing overgrowth of non-palatable species. The destruction caused on trees by medicine harvesters, and big animals have also contributed to decrease in tree species and density.

Figure 4: Mt. Elgon forest in the background, partly in Uganda and Kenya

4.2.3. Kakamega Forest

Kakamega Forest was first gazetted as Trust Forest under proclamation No. 14 in 1933 and has since been managed by the Forest Department; in 1964 it was declared to be a Central Forest. Three small Nature Reserves, Isecheno, Kisere and Yala, were established and gazetted within the Forest Reserve in 1967. In 1986, the northern part of Kakamega Forest called Buyangu together with the adjacent Kisere Forest was gazetted as Kakamega National Reserve and fell under management of the KWS. Today, Kakamega Forest is part Forest Reserve, part Nature Reserve and part National Reserve, and management is under the authority of both KFS and KWS, on behalf of the state. The forest covers about 238 Km^2, and less than half of this area currently remains as indigenous forest. The main fragments include; Kaimosi Km^2, Kisere 4.58 Km^2, Malava 7.03 Km^2, Buyangu39.58 Km^2, Isecheno 2.95 Km^2, Yala4.60 Km^2 and Kakamega Main block189.19Km^2.

Kakamega Forest is an exclusive sanctuary for an extraordinary variety of endemic flora and fauna, including insects, reptiles mammals and birds which are not found in other parts of the country. An estimated 10 - 20% of the animal species in the forest are unique to this forest. The forest is habitat to five out of the eight primate species found in Kenya. Monkeys are the most conspicuous group of mammals in the forest, with the Blue Monkey (Cercopithecus mitis stuhlmanni), the Redtail Monkey (Cercopithecus ascanius schmidti), and the Black-and-White Colobus Monkey (Colobus guereza) as the most common species. The forest is also known to host some of the most unique snake species. To date, 36 snake species have been recorded. A majority of these snakes originate from West Africa including the Forest Cobra, the Black-lipped Cobra, Jameson's Mamba, the Bush Viper, the Rhinoceros-horned Viper and the Gabon Viper. The Gold's Cobra and Kaimosi Blind Snake are prevalent in the Kakamega forest, but are believed to be in danger of extinction.

The forest has about 400 taxa of vascular plant species, among them 112 trees, 62 shrubs, 58 climbers and 114 herbs. Several species are restricted to this forest in Kenya, but only one endemic species, the herb Commelina albiflora, could be discovered. About 15 species were recorded as new for Kenya and probably at least one species is new to science. The forest is home to the Elgon teak and Prunus africana, which are species of special conservation concern (locally threatened and rare).

Some of the human activities which have posed serious threats to the survival of the forest ecosystem include the following: population increase in the neighbouring community leading to encroachment of forest boundaries; overgrazing, hunting and trapping, back stripping of medicinal plants, charcoal burning, pole and fuel wood harvesting, inadequate resources to manage the forest; gold extraction, logging, over-exploitation of valuable species, invasive species and deforestation.

The major degradation noticed in the forest include the encroachment of the neighboring community into the forest land which makes part of the forest to be converted into farmlands.

Figure 5: Kakamega forest in the background

4.2.4. Nandi forests

Nandi Forests are made up of Nandi South forest and Nandi North forest block.

Nandi south forest.

The South Nandi Forest is located in South Nandi District (00° 05'S, 35º 00'E), is a mid-elevation forest lying west of Kapsabet town and south of the main Kapsabet-Kaimosi road. The forest was first gazetted in 1936 as a Trust Forest covering 20,200 ha. Later, in 1964, it changed status and was conserved as a Forest Reserve. Unfortunately, forest conversions also accompanied these legal declarations. In 1951 (Legal Notice No 15) and 1968 (Legal Notice 39) 400 Ha and 276 Ha were excised respectively from originally 20,200 Ha. The Forest which is currently managed by Kenya Forest Service as a forest reserve, covering 18,000 ha after 2,200 ha was excised for settlement. It comprises 13,000 Ha of closed-canopy forest, 1,400 Ha of exotic trees plantations, 340 Ha planted with tea and 3,260 Ha of scrub, grassland, or under cultivation. The Nandi south block is made up of the following forest fragments; Nandi south 19502.8 ha and Ururu fragment 433.4 ha.

Nandi north forest

North Nandi Forest was first gazetted in 1936 as a Trust Forest covering 11,850 Ha. In 1968, it was changed to North Nandi Nature Reserve with a total area of 3,434 Ha. Since gazettement, a total of 1,343 Ha have been excised, including part of the nature reserve. An additional 410 Ha have been converted to Nyayo Tea Zone. Of the present gazetted forest area (10,500 Ha), approximately 8,000 Ha is indigenous with closed-canopy forest, the remainder consisting of cultivation, scrub, grassland, plantations and tea. It is made up of the following forest fragments; Kaptaroi 327.8 ha, Nandi North 10500.7 ha and Teresia 384.5 ha.

Both The Nandi south and North forests can generally be considered as indigenous forest. While there is presently no defined area for community utilization, and whereas they let their livestock roam freely and collect fire wood from anywhere, the management plan envisages delineating the belt adjacent to settlement areas as utilization zone and marking some sites as seasonal grazing areas, especially the natural glades.

The forest blocks of the Nandi south and north forms an important area for biodiversity in Kenya. The forests are considered one of the 'IBAs' (Important Bird Areas) of Eastern Africa. The forest has around 891 species of native plants and animals (birds, butterflies and dragonflies) from the forest patches on the estates which is expected to rise with time. Surveys of the forests over the past have yielded a checklist of 125 butterfly species, 47 dragonflies and damselflies, 247 bird species, 96 trees, shrubs and lianas, and 376 wildflowers and herbs. The bird diversity so far recorded represents around 22 % of the total bird diversity of Kenya, such as the Black-and-White Casqued Hornbill (found in all the main forest patches on most of the estates). Common trees in the forest include Tabernaemontana stapfiana, Macaranga kilimandscharica, Croton megalocarpus, C. macrostachyus, Drypetes gerrardii, Celtis africana, Prunus africana, Neoboutonia macrocalyx and Albizia gummifera. Apart from birds and plants, the forest also has a remarkable richness in other biodiversity including several species of mammals, reptiles, amphibians and invertebrates.

Some of the environmental threats to the forest are; Illegal grazing and overgrazing, Encroachment, Illegal charcoal production , Illegal logging , Growing of "Bhang" and brewing of chang'aa in forest, Forest fires, Over-exploitation of forest resources - debarking of Prunus africana for medicinal purposes, Felling trees for honey harvesting.

There forest has been degraded and area under glades, swamps and riverine forests are declining. The major cause being human encroachment especially excisions for settlement, the agro based 'shamba' system, and charcoal burning.

Figure 6: Nandi North Forest (at the middle), left side is part of Kakamega forest:

Figure : Nandi South forest in the background. Part of Nandi North forest

4.3. Major Wetlands

4.3.1. Yala Wetland

It is Kenya's largest freshwater wetland and one of 60 IBAs in the country. Habitat for several papyrus endemic species.

Status: Unprotected, with the exception of the satellite Lake Kanyaboli which was gazetted as a national reserve in 2010.

Size: 3,262km^2

Taxa

Animals: African spoonbill (Platalea *alba*), Papyrus Canary (Serinus *koliensis),* red-chested sunbird (Cinnyris *erythrocercus*), Sitatunga (Tragelaphus *spekii*), Northern-brown Throated Weaver (Ploceus *castanops)* great egret (Ardea *alba*), papyrus gonolek (Laniarius *mufumbiri*), crested crane (Balearica *regulorum*), Caruthers's Cisticola (Cisticola *carruthersi*), hammerkop (Scopus *umbretta*), White Winged Warbler (Bradypteus *carpalis),* African sacred ibis (Threskiornis *aethiopicus*), papyrus yellow warbler (Chloroptera *gracilinostris*), Vervet monkey (Cercopithecus *aethiopicus*), Hippopotamus (*Hippopotamus amphibius*), African python (Python *sebae*), Spottednecked Otter (Lutra *maculicollis*), Oreochromis *esculentus,* Oreochromis *variabilis,* oreochromis *niloticus,* Lates *niloticus,* Brachythemis *leucosticte*, damsel flies, bailon's crake (Porzana *pusilla*), ducks, great snipe (Gallinago *media),* Astatoreochromis *allaudi,* Lipochromis *maxillaris.*

Plants: Papyrus, phragmites, Typha

Environmental threats: unsustainable harvesting of papyrus, grazing in the swamp, mechanization of the swamp, burning of papyrus, unregulated fishing

Degradation

- 6,900 ha is under intensive agriculture leading to wetland encroachment which reduces the size of the wetland. This gradual degradation has denied local communities services from the wetland such as fish, papyrus, clay, wood, medicinal herbs and land for grazing (Muyodi et al, 2011; Waititu 2009)
- Engineering works on the wetland alter the drainage of the wetland leading to reduction of conducive habitat for fish species which cause reduction in fish stocks. (Swales, 1989)

- Aerial spraying of the rice fields poisons the birds, some of which are endemic to the wetland. Yala wetland is an important IBA and thus this threatens its status as a critical habitat for birds, some of which are radically declining in population.
- Small scale farming on the periphery of the wetland as well as burning of papyrus and grazing of cattle reduces the total area under papyrus hence degrading the papyrus habitat. These also hamper the ecological functions of the wetland such as filtering and sequestration, which are critical in maintain the ecological integrity of the wetland.
- Siltation caused by agricultural practices destroys the breeding and spawning sites for fish species. This affects the restocking rates and population of critically endangered species.
- Overfishing, especially due to use of unregulated net sizes, can lead to rapid decline in the fish stocks, some of which are already critically endangered. This may drive species such as Oreochromis *esculentus* and *Oreochromis variabilis* to extinction.
- Macrophytes help reduce rapid movement of water thereby reducing re-suspension rates of sediments (Schallenberg et al, 2013). Destruction of the papyrus and other vegetation leaves the soil bare encouraging erosion which reduces the ability of the soil to remain compact and support successive vegetation. This has led to destructive flooding due to absence of papyrus that controlled the velocity of water.

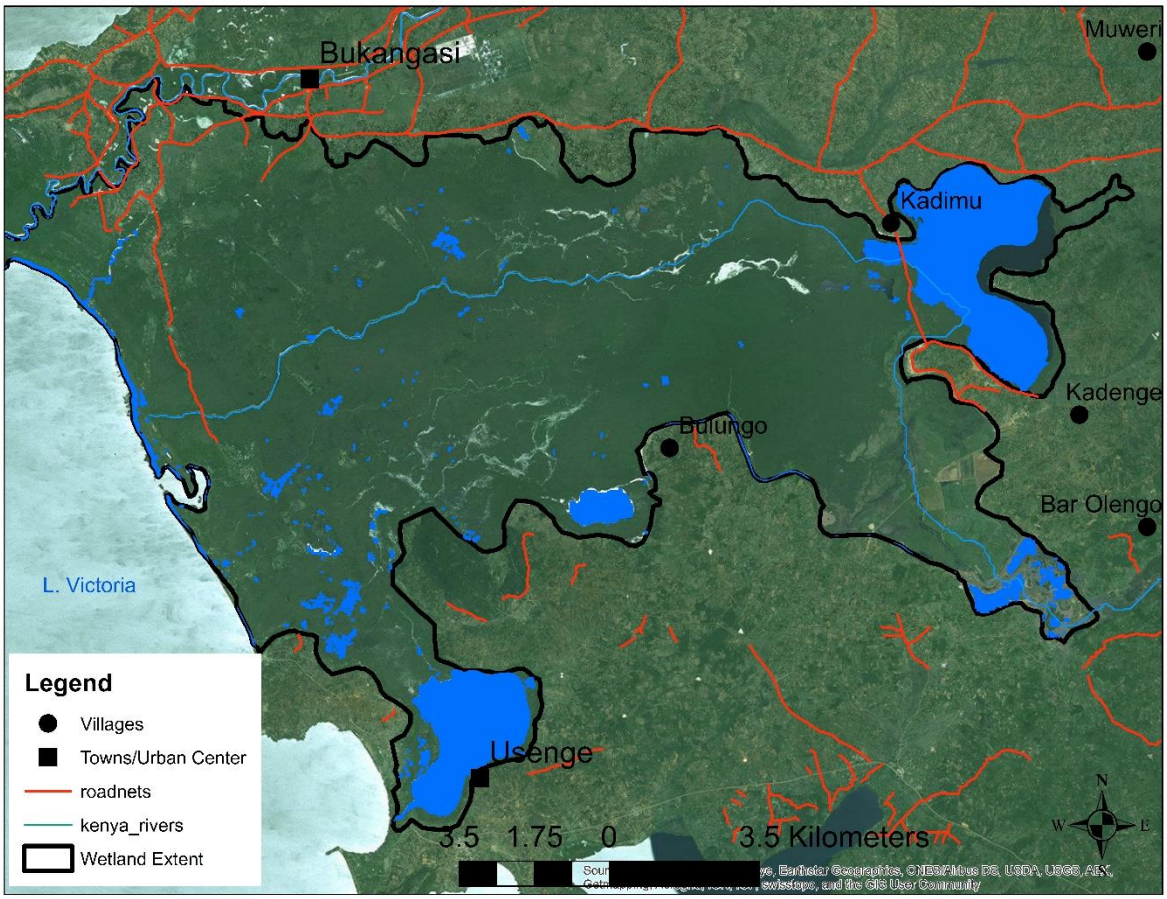

Figure 7: Yala wetland, Siaya County. Unique for Sitatunga and Critically Endangered Oreochromis

4.3.2. Saiwa Swamp

Status: Gazetted 1974 and is a National Park managed by Kenya Wildlife Service.

Size: 3km^2

Taxa

Animals: Over 400 species of birds including, Narina trogons, lesser jacana, grey heron and African black duck, collared and orange-tufted sunbird, yellow bishop, Hatlaub's marsh widow, Ross's turacos, Gonolek, Ludher's bush-shrike and Grey Crowned-cranes. Insects such as dragonflies, damselflies,swallowtails and charaxes, African mocker swallowtail, Papillion dardanus. Reptiles include frogs, toads, Bell's hinged tortoise, blue-headed tree agama lizard, forest cobra, African rock python and side-stripped chameleon.

Plants: eulophia horsfallii, satyrium crassicaule, satyrium sacculatum, sedges and acacia woodlands,

Environmental threats: Silviculture, encroachment of sugar cane farming, unregulated grazing and poor farming methods

Degradation

- Farming of sugarcane on the areas bordering the swamp has reduced the total area under the swamp threatening the existence of the swamp. This has also affected the function of the swamp as a habitat since its carrying capacity to hold the Sitatunga antelope and other species is greatly reduced.
- Poor farming methods around the swamp has led to increased nutrient loading in the swamp. High nutrient loads reduce the ability of the wetland to carry out its functions and provision of services.
- Uncontrolled grazing of livestock and burning of vegetation has destroyed the habitat for some of the species including the Sitatunga antelope.
- Silviculture using eucalyptus in the areas bordering the swamp has reduced the total size of the wetland and affected the ecological flow of water for species.

Figure 8: Saiwa Swamp in the background

4.3.3. Ziwa Lake

Status: Unprotected

Size: 0.518km^2

Dominant Plants: Typha domigensis

Animals: Cattle Egret, Sacred Ibis, Hadada ibis, Common stonechat, Laughing dove, Mousebird, Pied crow, Little grebe, Red-rumped swallow, Red-billed firefinch, Speckled pigeon, Tropical boubou, Grey-crowned Crane, Fan-tailed raven, Lilac-breasted roller

Intensive agriculture exposes the soil to agents of erosion. This leads to runoff sweeping soil into the dam causing siltation which damages the habitat for animals. Sediments from farms also affect light penetration into the bottom parts of the lake affecting oxygen levels. This may inhibit growth of water plants.

Kitale-Cherengani road can alter the ecological flow of the water as it can encourage more runoff during heavy rains. This also leads to a lot of siltation and sedimentation in the lake which affects the aquatic plants.

Effluent from the dairy facility at Sirikwa can be released into the river feeding Lake Ziwa hence encourage nutrient loading which may cause eutrophication which can cause ecological imbalance due to reduced levels of oxygen in the lake.

Figure 9: Ziwa Sirikwa wetland in the background

Figure 10: Lake Ziwa in the background

4.3.4. King'wal Swamp

It is located north of Nandi Hills and is mainly fed by Kesses River including its tributaries of Legetet and Kibore.

Status: Unprotected

Size: 17.8km^2

Taxa

Animals: Sitatunga antelope (*Tragelaphus spekii*), Grey Crowned-crane (*Balearica regulorum*)

Plants: Papyrus (*Cyperus papyrus*), Water berry (*Syzgium guineense*), *Phragmites karka*, Bulrushes (*Typha domingensis*), reeds (*Echinocloa pyramidalis*), sedge (*Pycreus lanceus*), *Polygonum setosulum*, *Hydrocotyle ranunculoides*, *Oenanthe palustris, Hygrophila spiciformis*, *Ranunculus multifidus* and *Pennisetum sp.*

Environmental threats: Grazing, excavation of soil, poaching of Sitatunga antelope, draining of swamp waters, intensive agriculture, fires

Degradation

- Planting eucalyptus trees has reduced the area under the wetland Excavation of parts of the wetland to sustain the thriving brick-making industry has also shrunk the size of the

wetland (Amabasa, 2005). Reduced size of the wetland negatively affects the services offered by the wetland to the species.

- Residents poach the Sitatunga antelope hence further reducing their already dwindling numbers. Arrests by KWS officials anger the locals who once retaliated by torching 5,000 acres of the swamp killing several Sitatunga antelopes and destroying vegetation. This undermines the ecological functions and health of the wetland.
- Intensive agriculture encourages leaching which helps invasive species thrive through eutrophication. Elephant grass (Pannisetum *sp*) has displaced native Typha (Mohamed, 2002).

Figure 11: Kingwal swamp in the background

CHAPTER FIVE: LANDUSE, DEGRADATION AND CONSERVATION HOTSPOTS IN THE UPPER CATCHMENTS OF MT. ELGON AND CHERANGANY HILLS ECOSYSTEM

5.1. Land use Overview in Upper Catchments

The upper catchments of Mt. Elgon and Cherangany Hills constitute fertile areas that receives considerably high rainfall throughout the year. Due to this, the higher elevations of the catchment has become attractive to agriculture and settlement that has seen invasion of forest mosaics bordering forest area. The upper catchment zones of Mt. Elgon and Cherangany Hills Forests are characterized into several land uses as shown in the table below. In Cherangany Hills upper catchment, about 11 land uses are identified; while 9 land uses are identified in Mt. Elgon. It is however, worth noting that annual crop cover constitute large percentage of the areas in the catchment in the two catchments. The annual crop cover in the upper catchment of the two ecosystems has relative area size but high proportion is observed in Mt. Elgon where it constitute 67% and it is only 40% in Cherangany Hills (Table 1). Cherangany Hills upper catchment is unique with the distribution of open water bodies such as dam reservoirs. However, wetlands are distributed in the form of swamps in the entire areas of the two ecosystem. Also notable occurrence of riparian vegetation in significant area in the upper catchment of Cherangany Hills compared to Mt. Elgon that has very few riverine area. Even though shrubland occur in upper catchment of both system, very significant area and proportion has been noted in Cherangany Hills upper catchment. Other land use characteristics has relative propotion occupancy in the upper catchments of the two ecosystems.

From the unique occurrence of the above mentioned land uses (presence of rriparian and shrubland) amids cropland in the cherangany Hills it is apparent that the environment experience a recent land use change. Presence of these land use characteristics indicate the invasion of cultivated areas is conservative and can actually be controlled in order to protect such land covers for biodiversity conservation and prevent further deterioration of land condition.

Both ecosystem experiences degradation but according to characterization of land use, Mt. Elgon seems to have been affected long time ago before Cherangany Hills. The latter has recent areas that has been converted into cultivated areas for Potatoes and Maize which indicate recency in processes causing degradation in Cherangany Hills. It is however a matter of time and the forest

and land degradation levels in Cherangany Hills reach similar proportions in Mt. Elgon ecosystem.

Table 1: Area in percentage of land use types in Mt. Elgon and Cherangany ecosystem.

Land use	Cherangany Hills	Mt. Elgon
Annual Crops	40	67
Bare Surfaces	2	5
Built up Areas	0	1
Closed Natural Forest	13	12
Forest Plantation	1	0
Grassland	6	3
Open Natural Forest	12	10
Riparian Vegetation	2	Insignificant
Shrubland	25	1
Tea Zone	Insignificant	Insignificant
Water body	0.	Insignificant
Grand Total		

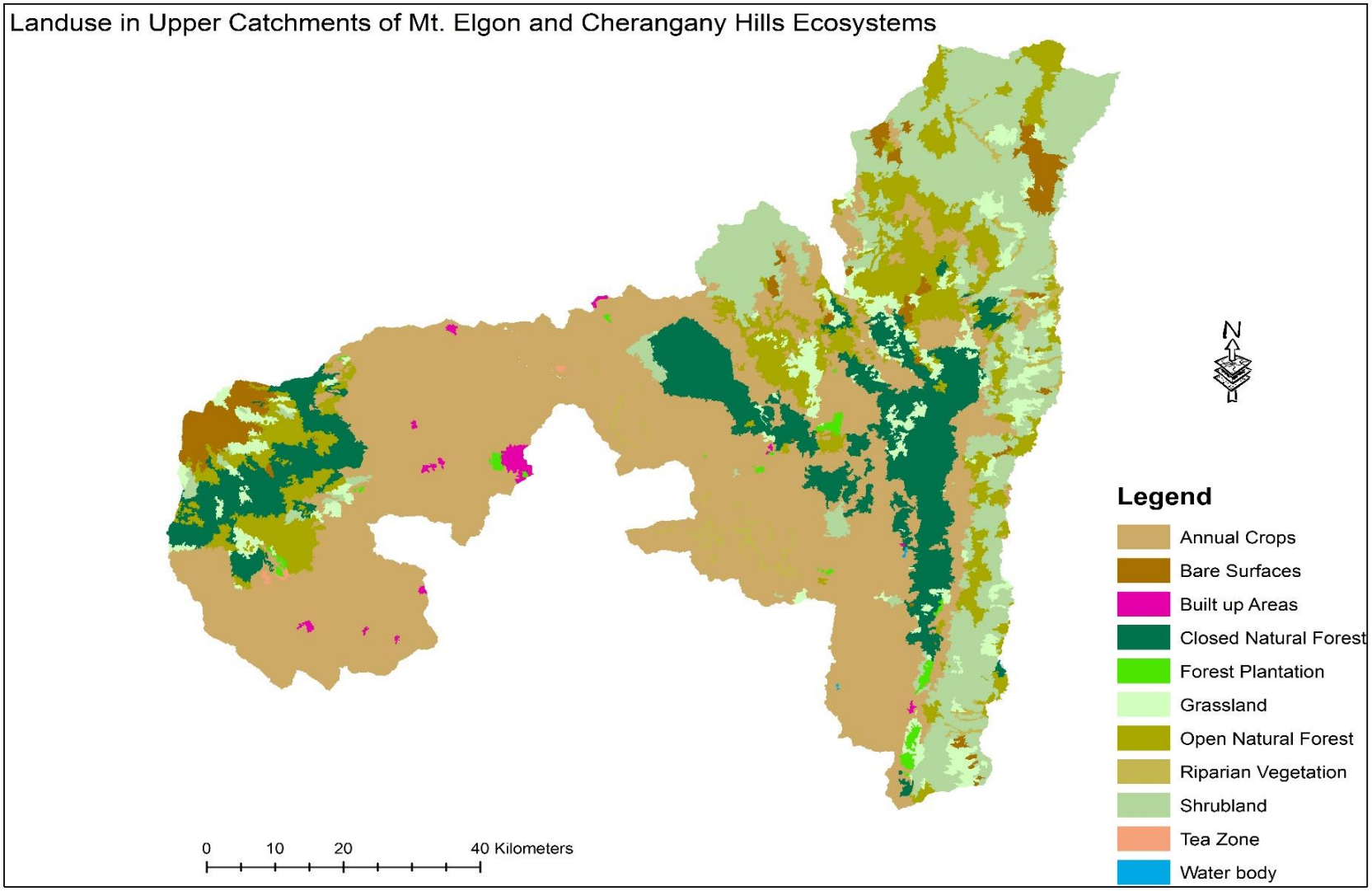

Figure 12: Landuse in the upper catchments of Mt. Elgon and Cherangany ecosystems.

5.1.1. Land use in upper Cherangany Hills catchment

The upper catchment of Cherangany Hills has a total area of 4,982 km^2 as estimated by KEFRI. This area has an estimated 11 characterized land uses in the upper catchment of Cherangany Hills (Fig.13.). The annual crop cover area has the largest an estimated cover percentage of 40%. This is followed by shrubland and natural forest cover area that each occupies 25% of the upper catchment of Cherangany Hills. The latter which is further characterized into two land uses shows closed natural forest is 13% and open natural forest 12% of the upper Cherangany Hills catchment area (Fig.13.). Grassland constitute 6% of the upper catchment that is immensely used for grazing livestocks .

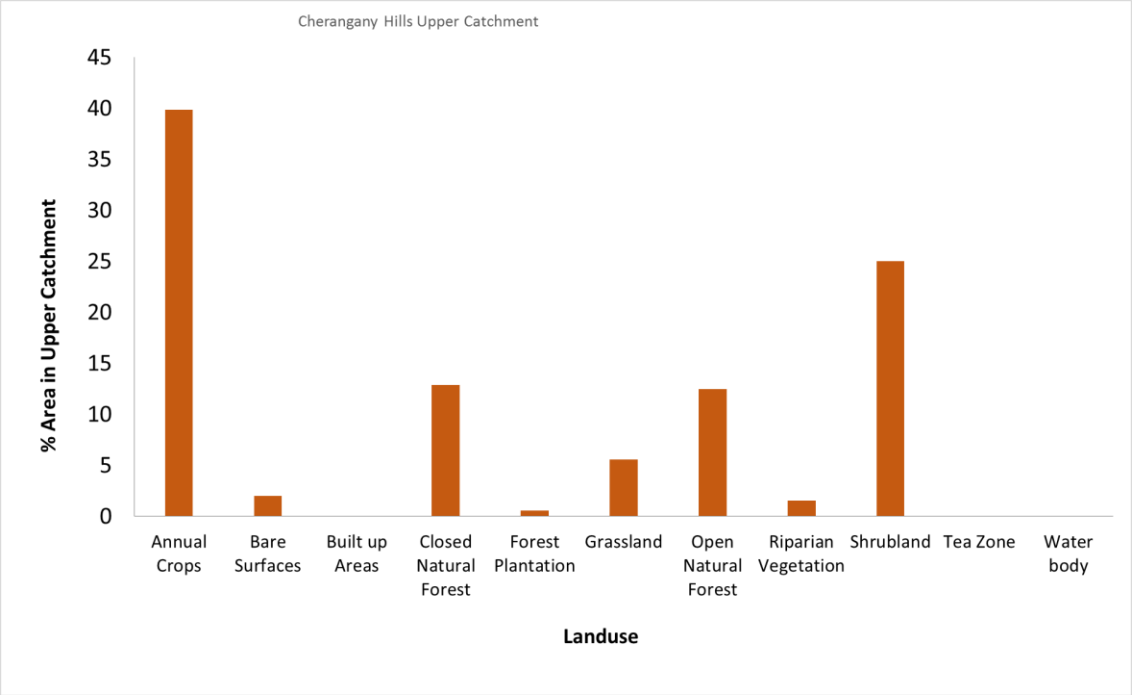

Figure 13: Land use characteristics in the upper Cherangany Hills Ecosystem showing 11 types of land uses. Source: KEFRI, 2017)

5.1.2. Land use in upper Mt. Elgon catchment

The working area size of the upper catchment of Mt. Ellgon is 2,136 km^2. This area is predominanted by annual crops which forms an estimated 67% of the upper catchment. The total forest cover area constitute a total of 22% of Mt. Elgon upper catchment. However, the closed natural forest area covers 12%; while open natural forest has 10%. Bare soil follows with an estimated 5% of the upper Mt. Elgon catchment area. Grassland in the upper Mt. Elgon catchment area only forms about 3% (Fig. 14).

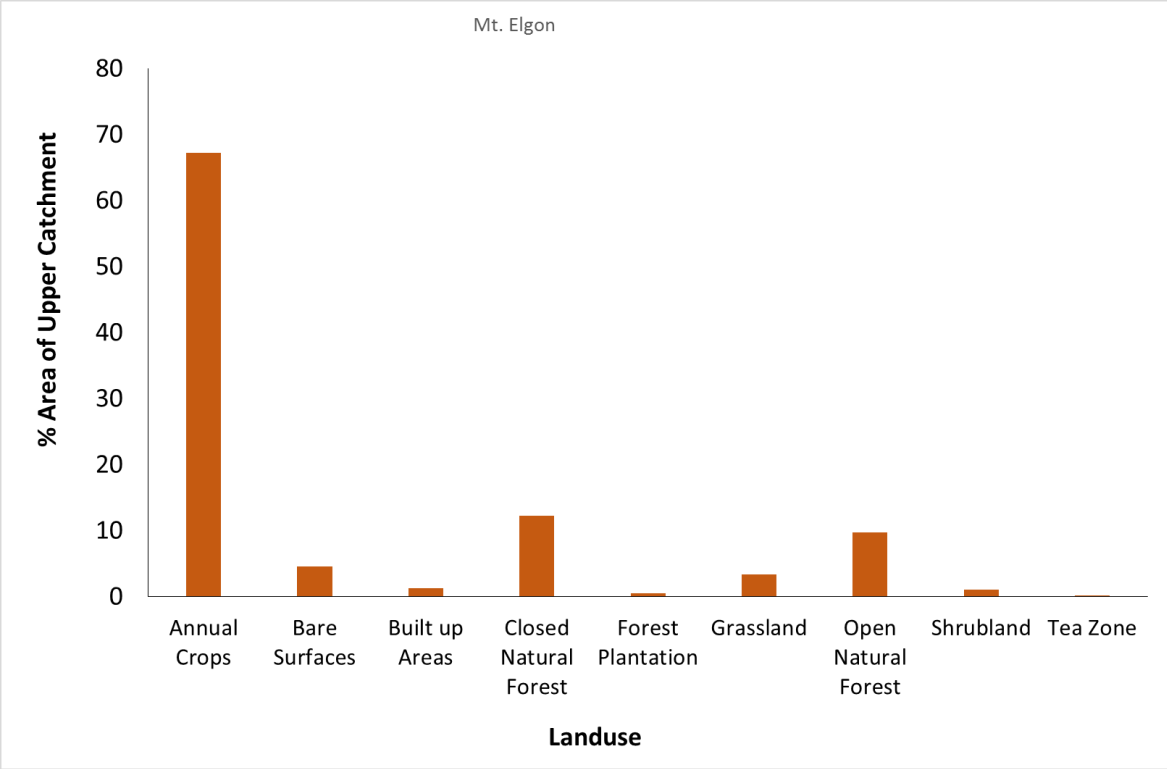

Figure 14: Land use characteristics in the upper Mt. Elgon Ecosystem showing 9 types of land uses. Source: KEFRI, 2017)

5.2. Land degradation in the Upper Catchments of Mt. Elgon and Cherangany Hills

Change on land use has been observed in the upper Cherangany Hills and Mt. Elgon catchments in the recent past. Decrease in sizes of various land use that support major and essential ecological functions has been affected adversely with their areas invaded by socio-economic

activities. Decrease in forest areas is associated with the invasion for tree resources such as timber for construction and fuelwood. These often leeds to open forest areas that once further degraded is occupied by shrubs and bushland types of vegetation. Conversion of forest areas by agricultural expansion seriously affect the forest biodiversity and the ability to recharge ground aquifers. The process of forest conversion into agricultural area is very much destructive affecting resilience of the system in terms of species diversity and habitat connectivity. In areas that has high potential for forest such as Mt. Elgon and Cherangany Hills, forests is regarded as a high level of conservation and protection endowed to the ecosystem. Any agent or process that change the forest is regarded as a threat and a risk to the ecosystem functioning.
Loss of biodiversity occurs when land degradation takes place.

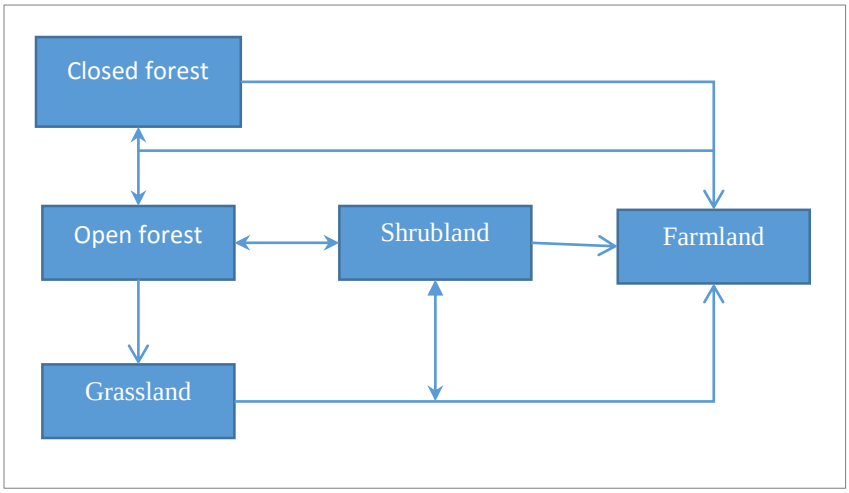

Figure 15: General direction of change of land cover land use

5.2.1. Land degradation in Upper Cherangany Hills catchment

Land use land cover has over the last period in Cherangany Hills has changed in area of distribution and quality. Some has changed negatively while others have increased; the latter mostly advancing into land uses that decreases in size. Degradation of land covers are noted by decrease in area size and quality of the land cover type. For instance, closed forest in Cherangany Hills constituted 19% of the upper catchment in 1980s. The land cover has however decreased in its cover area by 9% of its total area. Most of this loss has manifested into open natural forests that currently forms 31% but has decreased in 2000s. Decrease in open natural forest is currently estimated at 33% of its previous area in 1980s. Cultivated areas has increased in cover area by

about 95 %, twice its area, of its previous size in 1980s. while, grassland has increased by 41% of its previous cover area in Cherangany Hills upper catchment (Table 2). Increase in areas of these land covers is inferred to be caused by clearing of forest and shrubs for agricultural expansion, timber and fuelwood resources. Grasslands and farmland increases in cover area at the expense of forest cover area.

Table 2: Land use land cover change of 1980s and 2000s in Cherangany Hills upper catchment. (Source: KEFRI 2017)

Class Type	1984(Area Sq. Km)	1995 (AreaSqkm)	2000(Area Sq. km)
Closed Forest	949.66	938.8	860.55
Open Forest	1555.57	1424.58	1036.85
Grasslands	822.54	779.33	1162.9
Farmland	623.59	718.27	1214.5
Water body	0.94	1.44	1.21
Others	1042.22	1131.6	918.01

5.2.2. Land degradation in the Upper Mt. Elgon catchment

Degradation in Mt. Elgon upper catchment has adversely affected the closed forest cover than other lond cover types. The closed forest cover which covered 22% of the upper catchment of Mt. Elgon in 1980s has decreased by 44% of its previous area. In 1980s, open forest cover was small occupying on 6% of the upper catchment area. This cover has for the last period increased by 53% in 1990s but was then affected and decreased to an area 9% more than area covered in 1980s. Mt. Elgon upper catchment has seen current increase of grassland by 15% and farmlands has increased by 26% of their cover areas in 1980s (Table 3).

Closed forest cover area has severely been affected by changes of the clearing of forest for timber and fuelwood, also expansion of agricultural area in the catchment has driven the negative change in closed forest area.

Table 3: Land use land cover change of 1980s and 2000s in Cherangany Hills upper catchment. (Source: KEFRI 2017)

Class Type	1984(AreaSq Km)	1995(AreaSqkm)	2000(AreaSqkm)
Closed Forest	469.21	388.06	262.2
Open Forest	121.4	185.63	131.97
Grasslands	536.98	559.13	618
Farmland	691.32	727.76	872.13
Water body	0.51	0.31	0.76
Others	318.71	277.84	253.07

5.3. Environmental Threats in the Upper Catchments of Mt. Elgon and Cherangany Hills

5.3.1. Road construction

Construction of roads leads to direct habitat loss for terrestrial ecosystems. This may lead to loss of endemic species in the process. A 1974 report by the Council on Environmental Quality estimated that one mile of interstate highway consumes up to 48 acres of habitat.

Roads alter the hydrology of an area in terms of quality, quantity, stream channel morphology and ground water levels. Roads increase the effect of impervious surface increasing peak runoff. This leads to flooding downstream which can cause temporary or permanent siltation and increased sedimentation which is responsible for decline of fish. Roads with beds raised above the surrounding surface act as dams and may limit flow of water downstream which may dry off seasonal rivers and streams.

Excavations made during road construction can lead to severe destruction to wetlands and complete drainage of smaller wetlands. Roads in mountainous landscapes with steep unstable slopes can create landslides. Impervious nature of road surfaces increase water discharge rates hence increasing the possibility of landslides and flash floods. Bare road embankments expose loose soil particles which are easily carried off by agents of erosion. Severe water erosion on such embankments can lead to gullies which eat into land of people near roads.

Pollution of noise during road construction and operation may cause some animals to alter their behaviour patterns. Animals such as birds which communicate using auditory signals may be disadvantaged. Elements such as Pb, Ni, Cd, and Zn arise from petroleum products and car tires and find their way into roadside biota (Lötschert & Köhm, 1978). Air pollution from vehicles emitting fumes may lead to bioaccumulation or as they are accumulated in the environment and they find their way into plants, soil and water bodies.

Plate 2: Bare road bank along Iten – Cheptongei road

5.3.2. Mining/Quarrying

The main impact of quarrying is the removal of rocks resulting in the destruction of habitat (Gunn and Gagen, 1987). One impact on the natural system may trigger a series of other impacts. A change in geomorphology and conversion of land use mostly associated with degrading the aesthetic value of land. This may be accompanied by loss of habitat, noise, dust, vibrations, chemical spills, erosion, sedimentation, and dereliction of the mined site. Both the area for mining and the area used for waste dumps, occupy and degrade land that could be used for e.g. farming

and agriculture. The biosphere is adversely affected by mining mainly by pollution and by degradation of land and vegetation resulting in loss in biodiversity.

Dust, if uncontrolled, may spread to adjacent areas during dry weather, leach into the soil during storms, and create harmful conditions for the flora and fauna (Vermeulen and Whitten, 1999). Dust smothers leaf surfaces damaging vegetation through the blocking of leaf stomata, thus inhibiting gas exchange and reducing photosynthesis (Howard and Cameron, 1998).

Engineering works during mining can alter the flow of surface water. Quarrying in the unsaturated zone can result in fairly local impacts such as increased runoff, reduced water quality, rerouting of recharge water through the aquifer, and localized reduction in ground-water storage. This has the effect of lowering the water table. Ground water being pumped from quarries changes streams from gaining streams to loosing streams and can drain other nearby surface water features such as ponds and wetlands. Blasts from quarrying can modify groundwater flow, which influences or modifies surface water flow. Discharging quarry water into nearby streams can increase flood recurrence intervals.

The removal of vegetation permits increased infiltration and also deprives the soil of covering making it susceptible to erosion. This alters the drainage properties of the soil. Depending on the rock types, mining can also alter the geochemistry of an area especially due to acidic trailings washed into water bodies, for example, from a reducing one to an oxidising one.

Plate 3: Soil excavation along Cheptongei – Kapsowar road in Cheptongei forest

5.3.3. Mono-cropping

Mono-cropping places emphasis on select crops and this has the potential of leading to disappearance of other neglected crops.

Mono-cropping has the effect of reducing the number of predators (both birds and predatory insects) in an area of farmland; this can cause pest populations to get out of control. To deal with such pests, farmers apply pesticides which indiscriminately kill even those organisms useful to the crops.

Another effect of this practice is that it tends to make the soil lose its fertility. Farmers hence apply a lot of fertilizers which are prone to surface run off and can lead leaching to groundwater or nutrient loading in surface water bodies.

Plate 4: Wheat farm in Uashin Gishu along the Iten – Cheptongei road.

5.3.4. Sawmilling

Harvesting of trees for commercial milling has reduced total area under forests. Adverse effects caused by operations of forest industries include loss of biodiversity, migration of wildlife, ecological imbalance, soil erosion, flooding, desert encroachment and disruption in hydrological cycle. These must be seen in the main context of deforestation.

Sawmill wood waste has a negative effect on fish distribution and their communities (Akpata and Ekundayo, 1983). In sawmill wood waste discharge areas, microbial decomposition of these wastes exert high biochemical oxygen demand and creates anaerobic conditions. Under these conditions aquatic life suffers resulting in a loss of productivity of the natural waters and a deterioration of water quality.

Plate 5: Sawmilling observed at Kapcherop, Marakwet East

5.3.5. Agricultural expansion

Agriculture is expanding across a range of tropical ecosystems, but its impacts on forests are among the most serious from an environmental perspective. In Ethiopia, Haiti, and Togo, for instance, poverty traps have forced farmers to clear their remaining forests for farming. This portends serious negative impacts on biodiversity hotspots. Tropical or subtropical ecosystems predominate in over half of the 35 terrestrial biogeographic hotspots with over 1500 endemic species. Agricultural expansion has however led to the destruction of over 70% of these habitats threatening the existence of the endemic species.

Intensive agriculture coupled with high mechanization on largescale farms has led to air pollution, water pollution, deforestation, soil degradation and this complexity of interaction of effects has led to destruction of once healthy ecosystems. Pressing demands to increase food production, promote

economic growth, and exploit natural resources could inflict high environmental costs on hotspot nations since hotspots have unusually dense and rapidly growing human populations that are often suffering from poverty and score low on any measure of development (Laurance et al., 2013).

Agricultural expansion is likely to exert particularly heavy pressures on freshwater ecosystems, whose biodiversity is even more severely threatened by human activities than that of terrestrial ecosystems. In the tropics, large increases in water harvesting, damming, and diversion of rivers will be needed for agricultural expansion, intensification, and associated electricity needs.

Agricultural expansion and intensification near reserves tend to erode biodiversity most of which are found in protected areas only. This puts pressure on these places to meet human agricultural demands and at the same time offer the original ecosystem services.

Plate 6: Agricultural expansion (Part of Kapcherop forest)

5.3.6. Firewood collection

Poverty has limited access for many rural poor to conventional fuels and hence they rely solely on firewood. This forces many to resort to indiscriminate cutting of trees to supplement daily fuel needs.

Firewood collection impact plant communities through encouraging weed invasion due to soil disturbance while other indirect impacts likely occur through interruptions to nutrient cycling. With demand for wood fuel on the increase, even in the foreseeable future, this will lead to degradation of forests.

Plate 7: A man transporting firewood on bicycle from Mt. Elgon Forest to the market

5.3.7. Burning of vegetation

Effects of burning vegetation on animals are little as most are able to flee or seek refuge. Soil acts as a very good insulator and only severe fires may kill animals. Fires have had adverse effects on tropical forest fauna. In Sumatra, for example, primary forest specialists such as squirrels, hornbills, and other fruit-eating and frugivorous birds, and some primate species disappear altogether from burnt and adjacent forests (Bond and Keane, 2017).

The immediate effect of fire is gaseous loss of carbon and nitrogen from burned dead and live biomass. Nutrient losses are greatest when the greatest biomass is burnt, which is often during the most severe fires. Strong winds accompanying fire often lead to losses of phosphorus and cations blown away in ash. Cation nutrients in ash tend to be mobile and in a plant-available form and can be washed away in runoff from post-burn rain. Their presence leads to increases in soil pH – large increases in acid forest soils and smaller increases in neutral or alkaline soils in grasslands or savannas. Increased solar radiation, decreased evaporation, and higher pH lead to increased microbial activity, increased rates of mineralization, and increased availability of nutrients after a burn. Fires reduce vegetation height, reduce woody vegetation to be replaced by grasslands, promote flammable species or communities and to reduce biomass (Scott et al., 2014). Burning causes structural changes, opens up the forest canopy, dries out the understory and contributes to an increase in flammable understory biomass, increasing the risk of a second fire. Weedy vines and grasses quickly colonize twice-burned forests, further adding to the flammable biomass.

Plate 8: Burnt Papyrus vegetation in Marura wetland

5.3.8. Invasive Species

Invasive species often change the abiotic characteristics of the ecosystem through their feeding or engineering activities. These changes can be cumulative and slow, taking many years to play out, and provide another example of how slow responses in important ecosystem components can prevent the full effects of an invader from appearing for many years. Many invasive plants transform ecosystems by increasing sedimentation over time. They can also alter the chemistry of water bodies, for example, the water hyacinth has led to anoxia in Lake Victoria affecting aquatic life. Just as the cumulative effects of invasive species on the environment can take years to decades to be fully expressed, the effects of displaced native species can take years to centuries to disappear. For example, the displacement of woody species can lead to massive erosion only decades after their removal, because woody roots persist in the soil. European cheatgrass (Bromus tectorum) is dramatically changing the vegetation and fauna of many natural ecosystems. This annual grass has invaded and spread throughout the shrub–steppe habitat of the Great Basin in

Idaho and Utah, predisposing the invaded habitat to fires (Kurdila, 1995; Vitousek et al., 1996, 1997).

Plate 9: Invasive plant species (*Datura stramonium*)

5.4. Environment Conservation Hotspots

5.4.1. Human Population Hotspot

Human population density is deemed in this analysis as hotspot due to its nature of interaction with environmental resources (land, water and forest resources). It has a potential to cause land degradation by exerting pressure on various land related resources.

The size and density of population is associated with the quality and size of the resources in an area. In this particular case land, forest and water are vital resources that has in the past seen attraction for settlements in the catchments of Mt. Elgon and Cherangany Hills forests. Such attraction for settlement has been driven mainly by the need for expansion of land for agricultural and livestock production. The need for fuelwood from forest is another element associated with human population size and density. More resources would be extracted in order to sustain demands of population in the area. This implies area extraction would expanded in an area and/or intensification of efforts for extracting respources adopted in the area. In the process, environment in terms of habitat or ecosystems is adversely affected. Since the population growth has been increasing in the ecosystems demand for resources increases steadily and thus, degradation of the ecosystem has also risen uncontrollably.

According to the population hotspot model map (Fig.16.), areas with red colour indicate areas with high population density while blue colour has low density population. According to this model, high density occur around Mt. Elgon than in Cherangany Hill areas. This implies degradation in the catchment is potentially affected by the population size and density around the mountain than in Cherangany area. These population exert direct and indirect pressure on the land resources which are unsustainably exploited.

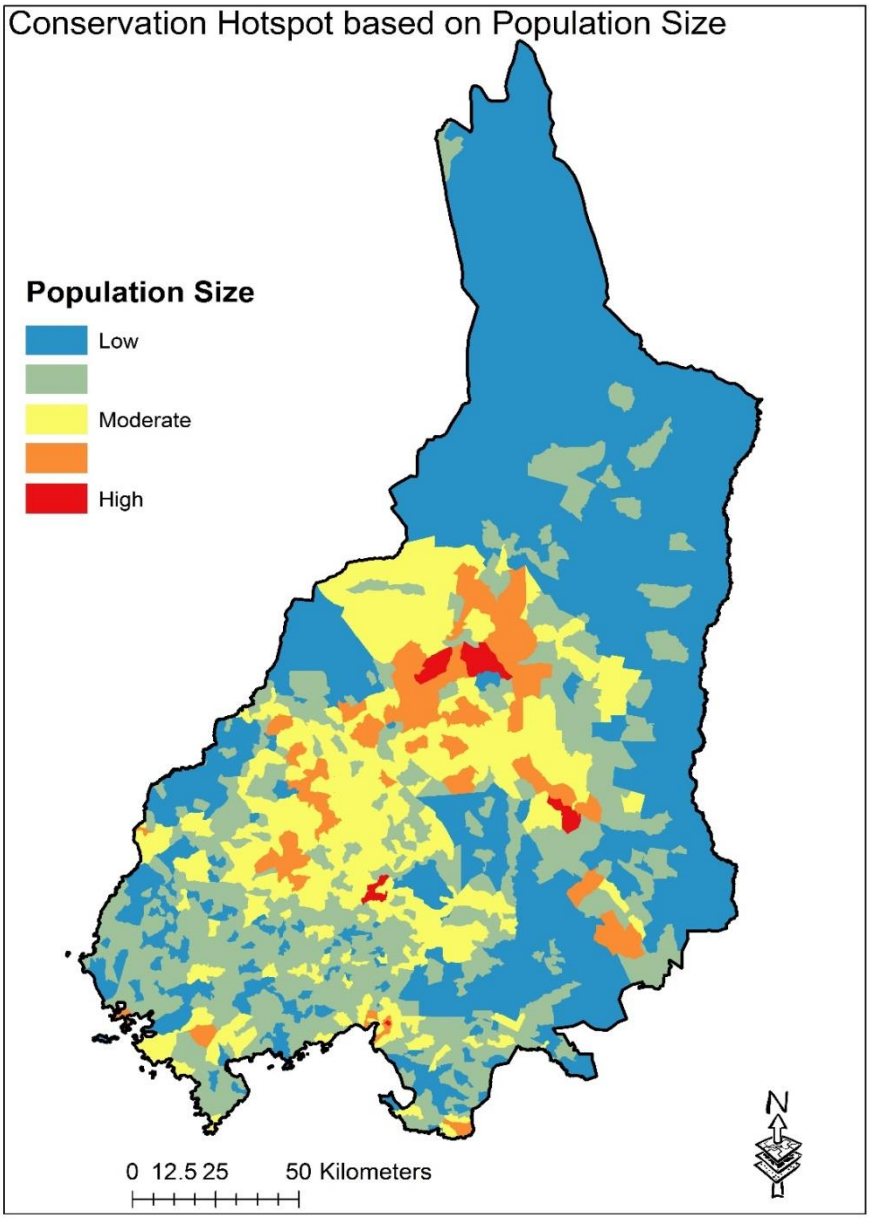

Figure 16: Human population size distribution depicting level of potential hotspot to environment degradation in Mt. Elgon and Chrangany Hills Ecosystems. Source: KNBS 2009.

5.4.2. Forest Conservation Hotspot

Forests areas are perceived to be a hotspot due to the endowed resources which are of potentially sought by local people for socio-economics around the forest and at distance within the transport networks. Due to the greater demand for the forest resources, the conditions of forest biodiversity is adversely affected since the extraction of these resources are done without regard for the integral ecological functions. Area around the forest are attractive to agricultural expansion due to their soil fertility.

The forest conservation hotspot model map (Fig. 17) shows the red areas to be hotspots for conservation due to the attraction unsustainable extraction of forest resource and expansion of agricultural areas into the forest. The yellow areas are deemed to be moderately attractive due to the occurrence of woodland/shrubs that would attract uses such as grazing and fuelwood extraction. Green areas in the map are actually cropland that does not have large forest as observed in the upper catchment.

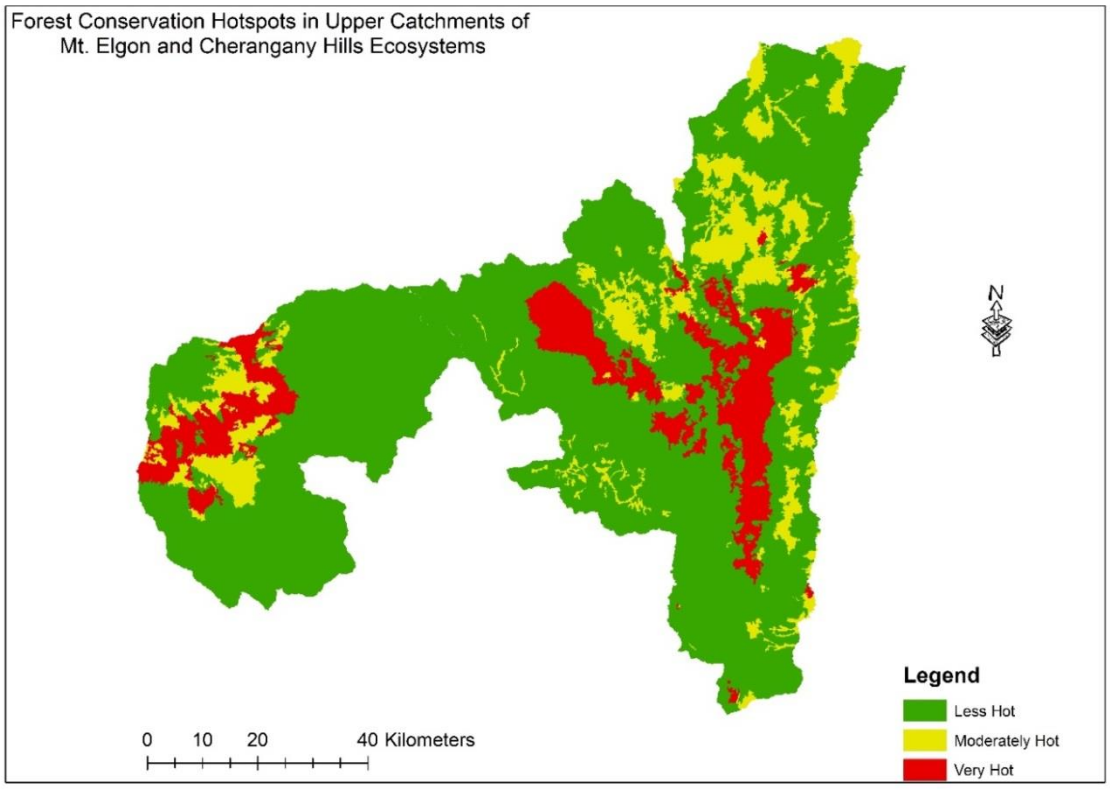

Figure 17: Forest conservation hotspot areas in the upper catchment of Mt. Elgon and Cherangany Hills ecosystem

5.4.3. Altitude and slope Hotspots

The high altitude areas are unique with their endowed high rainfall, fertile soil and forest covers that attracts agricultural activities and exploitation of forest resources. Such areas are also known for steep land gradients that influence erosivity of runoffs during rainy seasons and free fall of loose soil. Cultivation of crops and clearing of forest by logging predispose steep areas in high elevation areas to erosion that contribute land degradation. The higher elevation of Cherangany Hills especially in Kapsowar and part of Nandi Hills and their environ are mostly vulnerable to degradation by runoff erosion human activities which makes the soils vulnerable to erosion. A photo below (Plate 10) show crop cultivation taking place on steep and rugged landscape that when left opened can make the areas vulnerable to erosion by runoffs. Sound management of land in higher elevation and steep areas is therefore a requirement for conservation of top soils from being eroded and the silent threat of losing soil fertility in the egions. The larger areas of north Elgeyo-Marakwet constitute both elevation and slope hotspot (Fig. 18); while, small areas in north of Bungoma and west of Trans Nzoia counties has the same hotspot. The north and eastern parts of West Pokot county constitute slope hotspot.

Plate 10: Crop cultivated on the steep landscape in Kapsowar area. Photograph taken near Kapsowar town, at the Chief camp while facing north

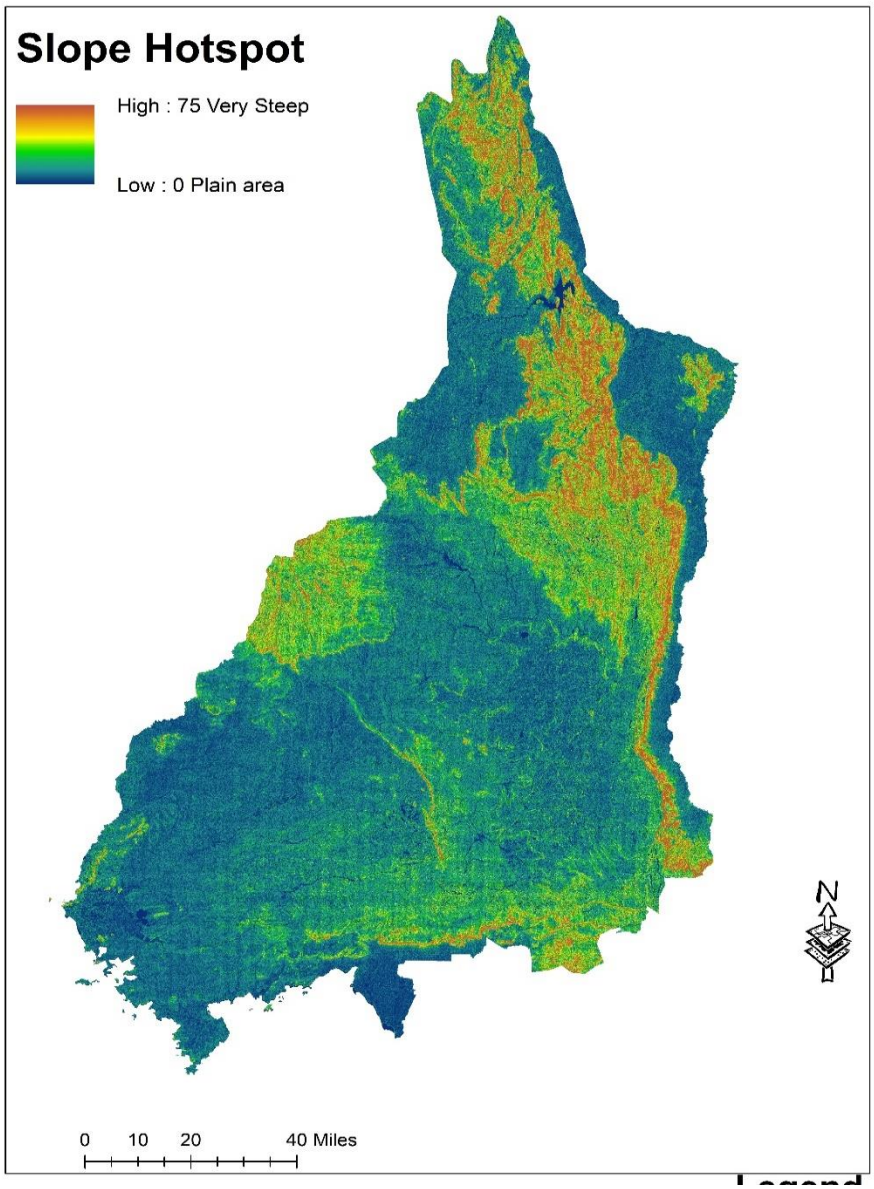

Figure 18: Hotspots for land degradation based on slope angle. Blue areas represent areas with less slope angle and therefore less hot. The yellow colour represent areas with moderate slope angle hence moderately hot. The red areas has high slope angles that are potentially vulnerable to runoff erosion and therefore are very hot.

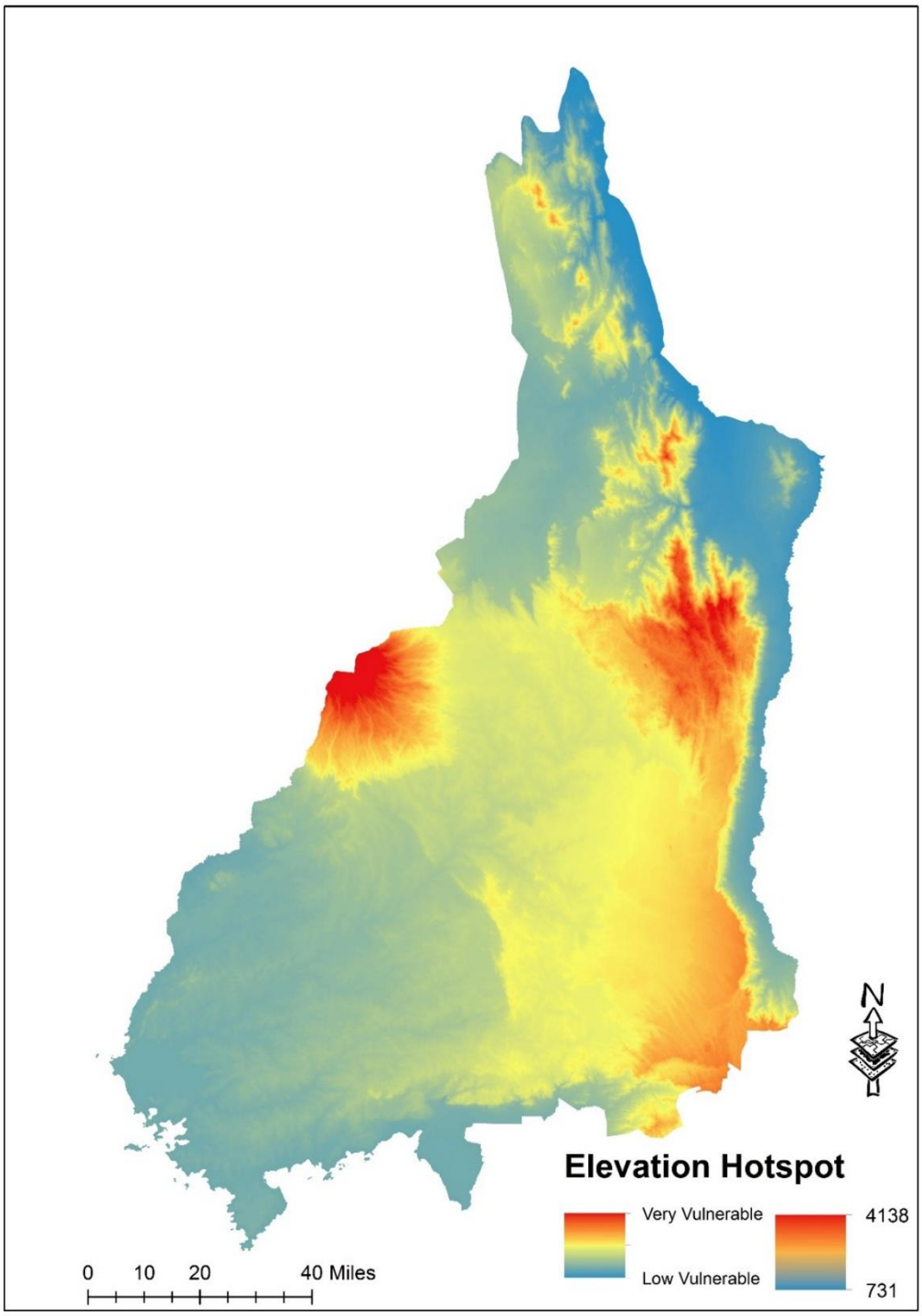

Figure 19: Hotspot for land degradation due to higher elevation. Areas with red colour in the map

CHAPTER SIX: FIELDWORK RESULT AND DISCUSSION

6.1. Distribution of respondents by age and gender

The respondents are not equally distributed in the category of age and gender. Results from In Mt. Elgon ecosystem, total number of respondents interviewed was 129 represented by 95(74%) males and 34(26%) females (Table 1a). Males of 33(25.6%) households were in the age category of 36-50, 26(20.2%) in the age group of 51-65 years, 17(13.2%) in the category of 26-35 years, 14(10.9%) in 18-25 years and 5(3.9%) >65 years. Females were 45(34.9%) in 36-50 years, 33(25.6%), 28(21.6), 16(12.4%) and 7(5.4%) in these age ranges. In Cherang'any, the total number of respondents was 46, represented by 33 (72%) males and 13(28%) females (Table 1b). Males of 13(28.3%) households were in the age category of 36-50, 11(23.9%) in the age group of 51-65 years, 9(19.6%) in the category of 26-35 years, 0(0%) in 18-25 years and 0(0%) >65 years. Females were 13(28.3%) in 36-50 years, 11(23.9%), 9(19.6), 28(21.7%) and 3(6.5%) in these age ranges.

This survey revealed that the participation of youth (ages 18-35 years old) in the local economies is nearly one third (34.1%) and (41.3%) in Mt. Elgon and Cherang'any, respectively. However, these findings are inconsistent with reported by Awiti & Scott (2016), which show about 80% of Kenya's population is below 35 years. The sample size use in this survey was smaller may perhaps contribute to the wide discrepancy. The differences in these results The underrepresentation of women in this survey can be attributed to patriarchal relations in African families that control land and other resources for production (Asiyanbola 2005); Wamue-Ngare & Njoroge 2011).

Table 4: Distributions of respondents by gender and age in Cherangany

Age	Gender				Total	
	Male		Female			
	Frequency	%	Frequency	%	Frequency	%

18-25	0	0.0	10	21.7	10	21.7
26-35	9	19.6	0	0.0	9	19.6
36-50	13	28.3	0	0.0	13	28.3
51-65	11	23.9	0	0.0	11	23.9
>65	0	0.0	3	6.5	3	6.5
Total	33	71.7	13	28.3	46	100

6.2. Common Trees on Farms

Common trees occurring on farms were identified by assistance of local farmers. About 26 tree species were identified common on farms in Mt. Elgon upper catchments, and 17 tree species in Cherangany upper catchment. Only 53% of tree species common on farms in Cherangany are found in Mt. Elgon upper catchment farms. 47% of the trees on farms in the Cherangany upper catch are not found on farms in Mt. Elgon upper catchment areas.

Botatinical names: *Azadirachtca indica, Casuarina spp. Citrus spp, Croton spp, Cupressus spp, Olea capensis, Eucalptus spp, Flacourtia indica, Grevillea robusta, Markhamia lutea, Spathodea campanulata, Persea americana, Pinus pituda, Podocurpus falcutus, Prunus africana, Sesbania sesban*

Local names: *Chepkunyuk, Sokonteet, Sananatet, Marambachet, Tendwo, Jorwo, Lele, Mononik, Sayit, Bonet, Mkenegeret, Toposwet, Toposonok, Kahaweet, Armotinok, Sokwonteet, Armotit*

Plate 11: Woodlot plantation in Kamukuywa area, Bungoma

Plate 12: Shamba system practiced by farmers on their farm. Eucalyptus (Blue gum) planted with beans

Table 5: List of common tree species on farms in the upper catchments of Mt. Elgon and Cherangany Ecosystems

	Cherenganyi				Mt Elgon							
Row Labels	**Cheles**	**Kapcherop**	**Kapsowar**	**Singore**	**Chekukwa**	**Chemetei**	**Chesito**	**Endebes**	**Kaboywo**	**Kapkomon**	**Terem**	**Tywondet**
Azadirachtca indica							√			√		
Casuarina spp							√			√		
Citrus spp	√											
Croton spp		√	√	√					√	√		√
Cupressus spp				√	√	√		√	√			√
Olea capensis					√							√
Eucalptus spp					√	√		√		√		√
Flacourtia indica	√		√		√		√					
Grevillea robusta	√		√		√	√	√	√	√		√	√
Markhamia lutea				√				√				
Spathodea campanulata												√
Persea americana	√				√		√					√
Pinus pituda										√		
Podocurpus falcutus			√									
Prunus africana	√			√	√							
Sesbania sesban					√					√	√	
Chepkunyuk			√									
Sokonteet	√				√							
Sananatet				√			√					
Marambachet				√			√			√		
Tendwo		√										
Jorwo		√										
Lele		√										
Mononik					√					√		
Sayit										√		

Mkenegeret							√			√		
Toposwet					√		√					
Toposonok					√	√						
Kahaweet					√							
Armotinok					√							
Armotit							√					

6.3. Socio-economic and livelihood characteristics

The lower slopes of Mt. Elgon and Cherangany Hills are mostly used for maize plantation. These areas has large scale plantation of maize. Part of the lower slopes of Mt. Elgon has sugarcane plantation especially In Bungoma and western part of Trans Nzoia County (bordering Bungoma County).

Mid slopes of Cherangany area is predominated by large scale wheat, medium scale maize plantation, growing of Irish potato. In Mt. Elgon area, maize plantation (mixed with beans), small scale coffee plantation are commonly observed.

Small to medium scale maize occur in the upper slopes of Cherangany areas. Plantations of tea and Irish potato are also predominant in the upper slopes of Cherangany; while, in Mt. Elgon, medium scale maize plantation is most predominant.

Maize plantation in Kaboywa area, Mt. Elgon

Harvested Irish Potato in Kapcherop area, Cherangany Area

Mixed cropping of Banana and Coffee in Terem, Mt. Elgon area

Tea plantation near Kapcherop town center

Sugarcane farming in Lukhome, Bungoma County, Mt. Elgon area

Wheat farming around Iten, Cherangany area

Plate 13: Agricultural activities in Mt. Elgon and Cherangany ecosystems.

The five most important sources of livelihood recorded in all the households are shown in Figure 2a & b. In Mt. Elgon the three main sources of livelihood were crop farming in 80(44.7%), small stock livestock farming 55(30.7%) and casual labour 23(12.8%). These constituted nearly 88% of all livelihood sources among the respondents. The main sources of livelihood in Cherang'any

were crop farming in crop farming in 48(29.8%), small stock livestock farming 37(23%), small trading 19(11.8%), casual labour 17(10.6%), bee keeping and government employment were both tied at 13(8.1%). Together the five sources of livelihood contributed to about 91% of household incomes.

Plate 14: Grazing paddocks on seasonal wetlands towards Cheptongei

The majority of farmers cultivated on moderate slope and moderate steep slopes were landscape segments with high risk of land degradation and low levels of soil fertility resulting in low crop yields. Major crops grown in the study area include maize, beans and potato grown during the long rainy season. Maize and potato are the staple food and source of income. Feed for livestock which is the second most important source of livelihood cultivated fields, fallows and crop residue after harvesting.

The agronomic requirements of non-native crops can have serious ecological implications in their new habitats. The amount of environmental degradation observed in these areas support the evidence that cultivation of cereal crops which requires fine-tilled soil bed and single cropping of fields encourage soil degradation in the highlands areas (Woldeamlak, 2003).

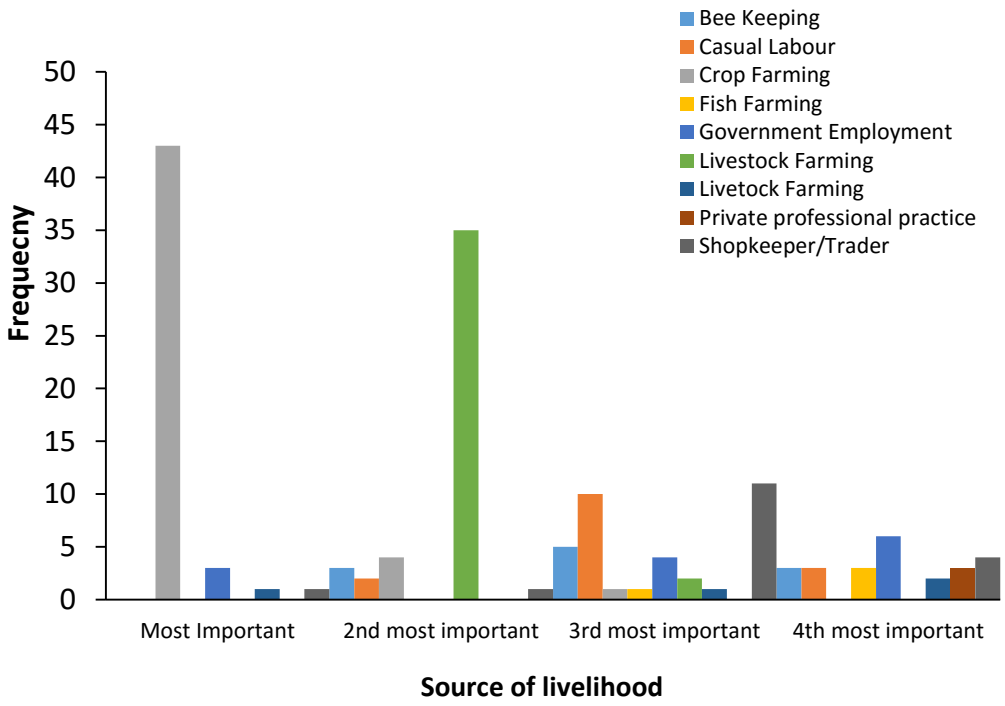

Figure 20: Main sources of livelihoods in Mt. Elgon

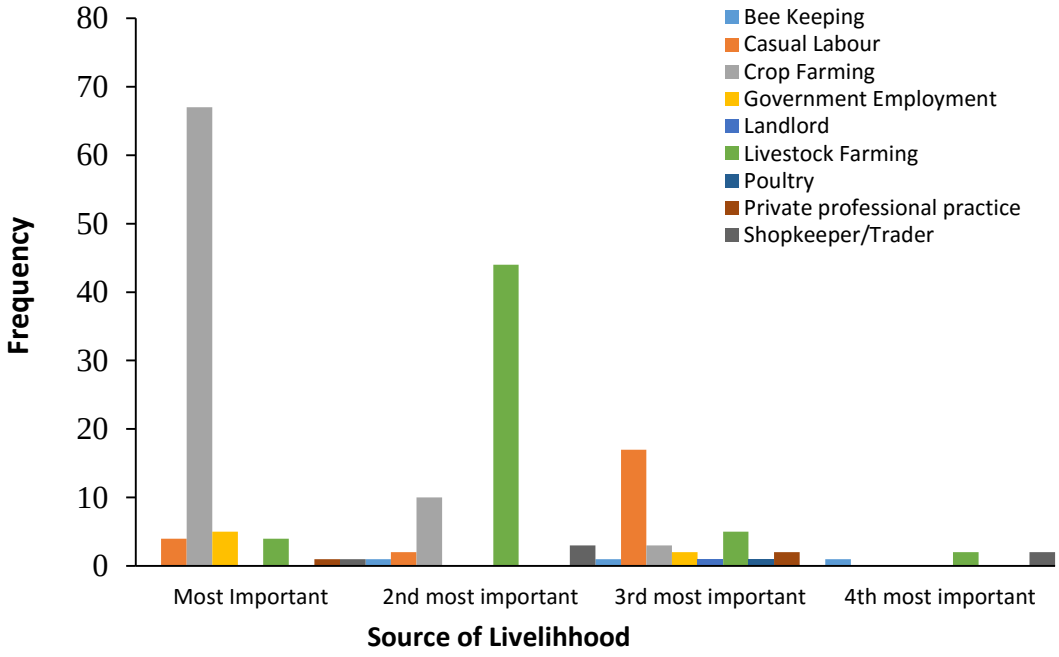

Figure 21: Main sources of livelihoods in Cherangany

6.4. Land tenure systems

Distribution of respondents according to the four main land tenure systems is shown in Figure 22 & 23). Majority of respondents at 55.6% and 74.6% were in possession of ancestral/inherited land in Mt. Elgon and Cherang'any, respectively. This was followed by acquired land at 33.1% in Mt. Elgon and 22.2% in Cherang'any. Land on lease/hire was at 9.0% in Mt. Elgon and 1.6% in Cherang'any. There were a few respondents estimated at 2.3% and 1.6% were squatters in Mt. Elgon and Cherang'any, respectively.

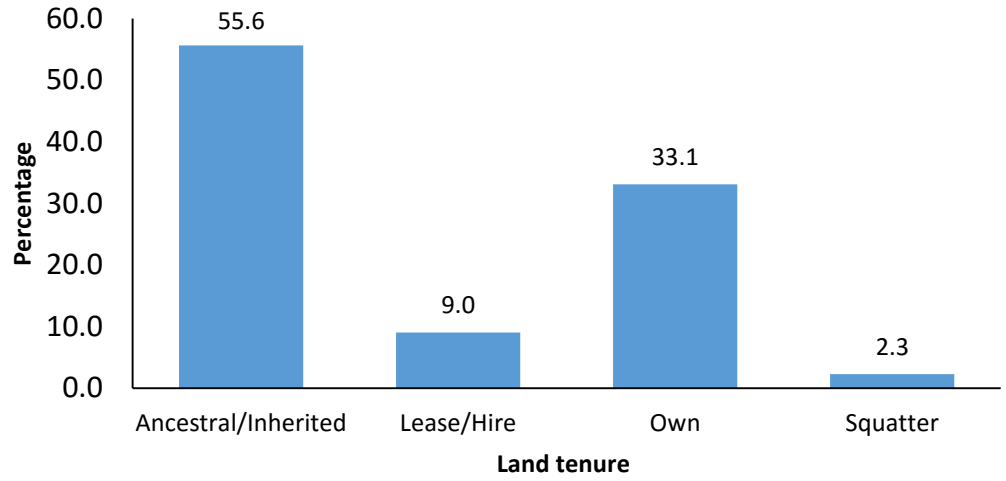

Figure 22: Distribution of respondents according to land tenure in Mt. Elgon

Figure 23: Distribution of respondents according to land tenure in Cherangany

Land tenure system specifies the extent of ownership and control of farmland, which can directly affect adoption of conservation practices. This analysis has identified four land tenure systems: ancestral/inherited, owner, lease/hire and squatter (Figure 3a & b). Security of tenure as expressed in ancestral/inherited and privately own land gives the farmer the authority and likelihood to implement soil conservation measures.

6.5. Farm sizes

The results of farm sizes are presented in Table 4. Majority of the respondents in Mt. Elgon had farm sizes ranging 1-2 acres (46.6%) and 3-4 (18.8%). While in Cherang'any majority of respondents had farm sizes ranging 3-4 acres (41.3%) and 1-2 acres (23.8%). A few respondents had large farms 11-12 acres at 1.5% in Mt. Elgon and 6.3% in Cherang'any.

Table 6: Percentage Distribution of Respondents by Farm Size in Mt. Elgon and Cherang'any

Farm Size	Mt. Elgon		Cherang'any	
	Frequency	Percentage	Frequency	Percentage
< 1 acre	27	20.3	4	6.3
1-2 acres	62	46.6	15	23.8
3-4 acres	25	18.8	26	41.3
5-6 acres	13	9.8	10	15.9
7-8 acres	1	0.8	1	1.6
9-10 acres	3	2.3	3	4.8
11-12 acres	2	1.5	4	6.3
Grand Total	133	100.0	63	100

6.6. Land use types

Distribution of respondents according to the four main land tenure systems is shown in (Figure 4a&b). According the respondents, crop production formed the larger part of land use pattern estimated at 56.9% in Mt. Elgon and 63.0% in Cherang'any (Fig. 24 & 25). This was followed by land use for buildings at 20.8% and 16.8% in Mt. Elgon and Cherang'any, respectively. Land use for pasture was 12.4% and 11.4% while land use for forest represented 6.9% and 6.5% in Mt.

Elgon and Cherang'any, respectively. The use of land for long fallow was estimated at 0.8% and 0.5 % in Mt. Elgon and Cherang'any,respectively while short fallow was 0.5% and 1.6%.

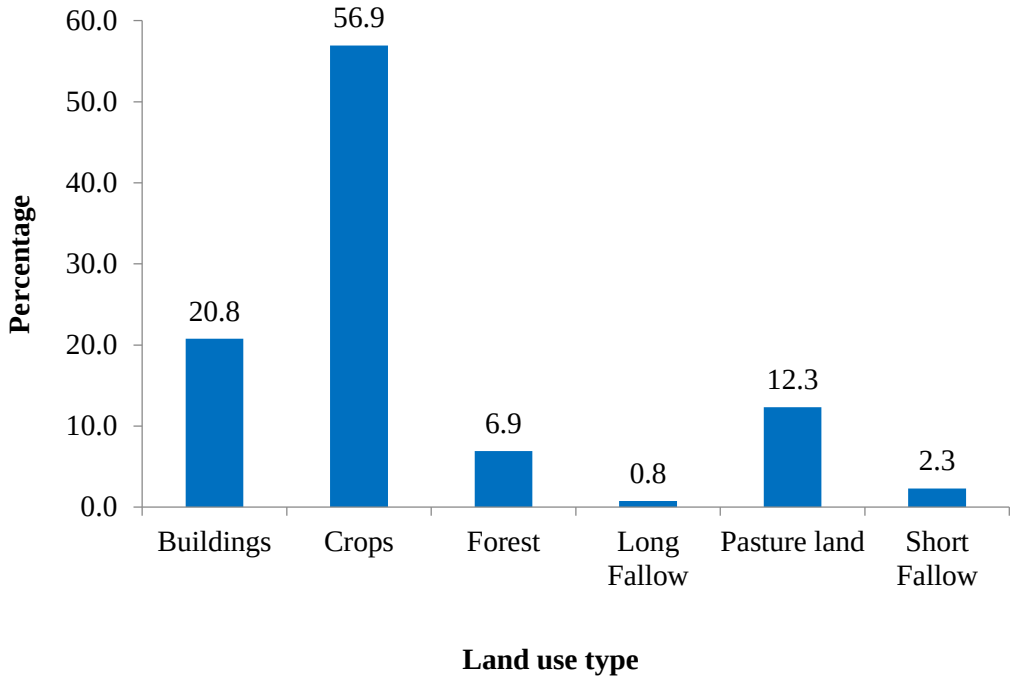

Figure 24: Land use patterns by responds in Mt. Elgon

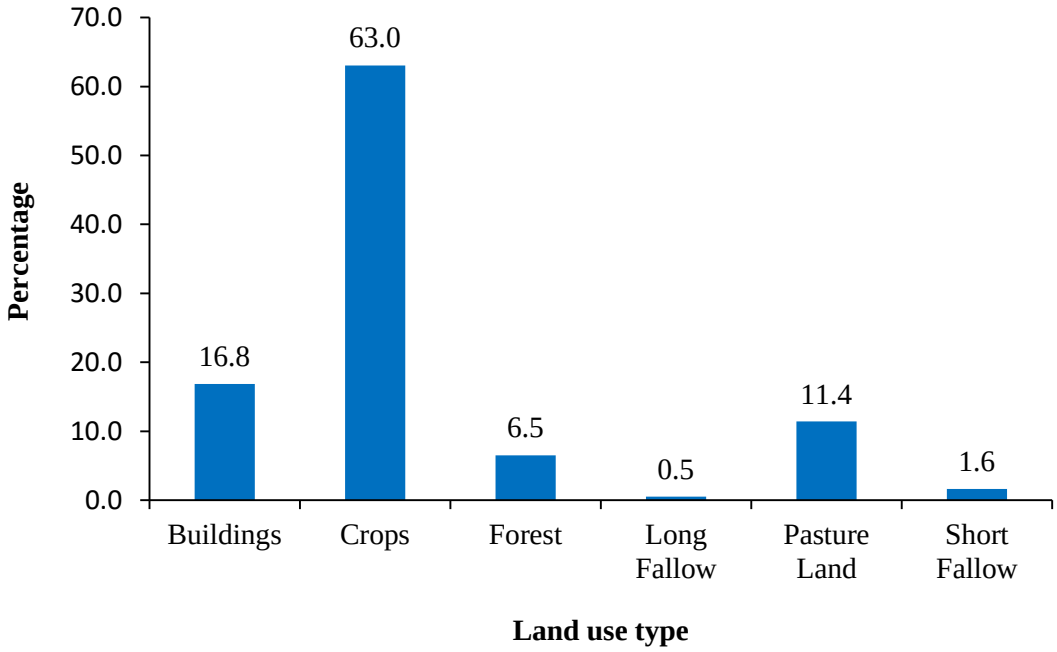

Figure 25: Land use patterns by respondents in Cherangany

6.7. Perception of land degradation problem

About 97.2% of respondents in Mt. Elgon and 95.1% of respondents in Cherang'any agreed that there was land degradation in their farms Figure 26a & b.The results of severity and extend of land degradation types are presented in Figure 27 & 28. Overall, water erosion was the most commonly mentioned type of land degradation at 57.7% and 62.7% in Mt. Elgon and Cherang'any, respectively. According to the respondents the extent of water erosion was severe in Mt. Elgon but moderate in Cherang'any. Fertility decline was the second most common land degradation type at 36.1% and 25.4% in Mt. Elgon and Cherang'any, respectively. The extent of soil fertility decline was perceived as moderate in the two study areas. About 10.2% of the respondents reported wind erosion in Cherang'any. Salinity degradation was the least estimated at less than 3% in the two study areas.

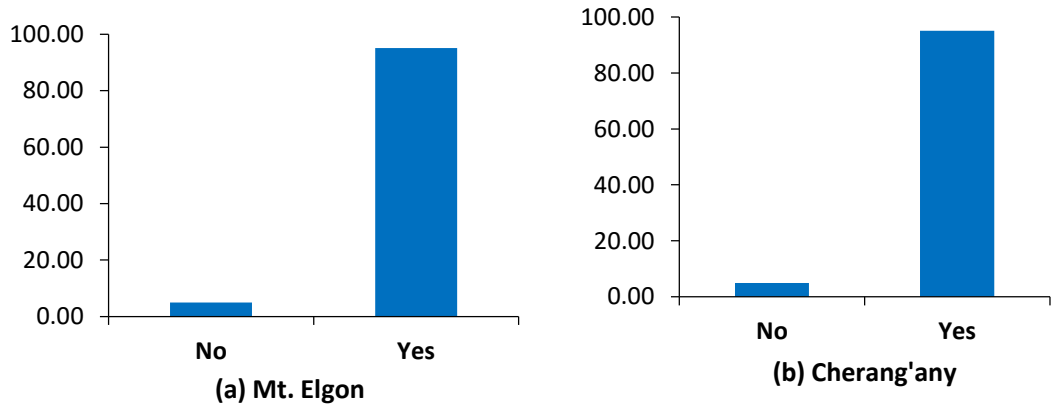

Figure 26: Respondents perception to land degradation in (a) Mt. Elgon and (b) Cherang'any.

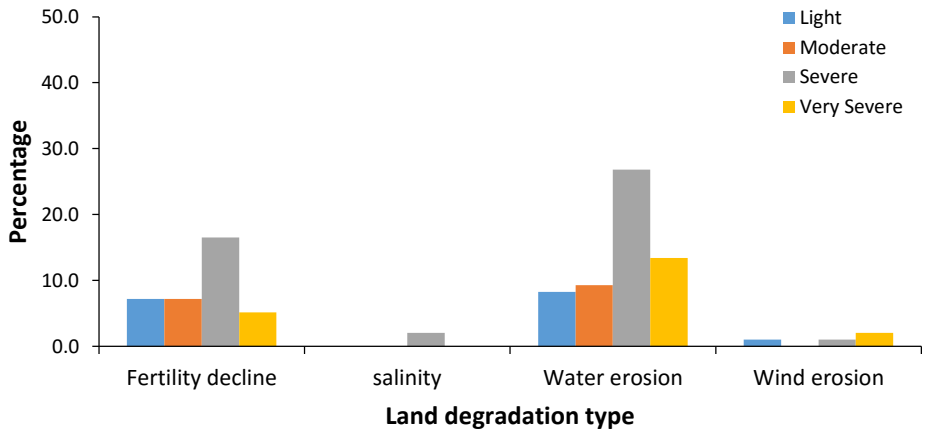

Figure 27: Land degradation types in Mt. Elgon

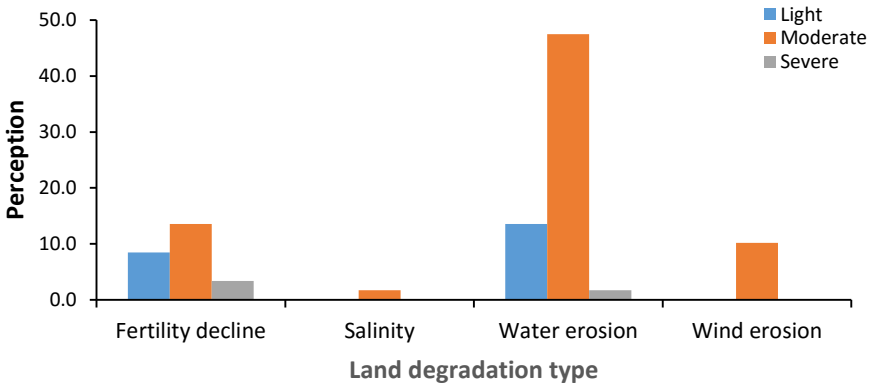

Figure 28: Land degradation types in Cherangany

6.8. Causes of land degradation

In Figure 7a, results obtained from Mt Elgon revealed that poverty and income inequality (41.2%), growing population (31.1%) and rapid immigration (17.6%) were the root causes of land degradation problem in Mt. Elgon. The other minor causes of land degradation were unemployment (5.9%), government policy and programs (1.7%), and political conflicts and warfare (0.8%). The results in Figure 7b, indicate that the growing population (40.6%), poverty and Income inequality (29.0%) and rapid migration and land clearance (23.2%) were the root causes of land degradation in Cherang'any. The least important causes of land degradation in this area was unemployment (7.2%).

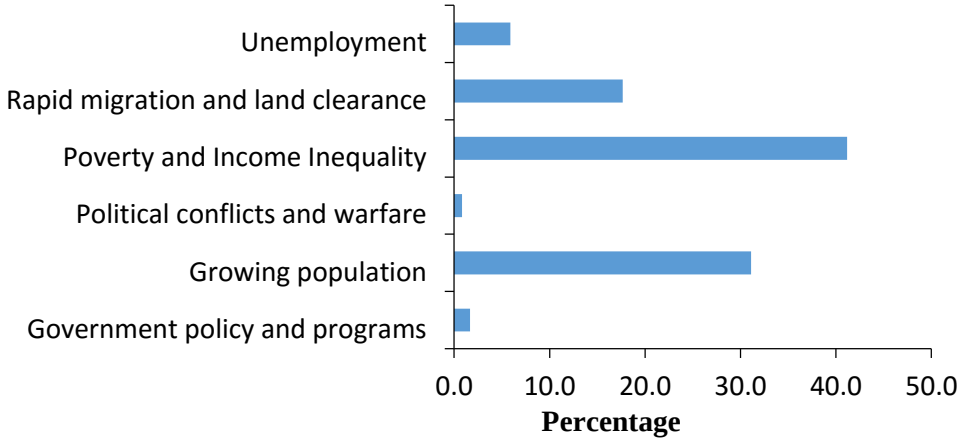

Figure 29: Perceived causes of land degradation in Mt. Elgon

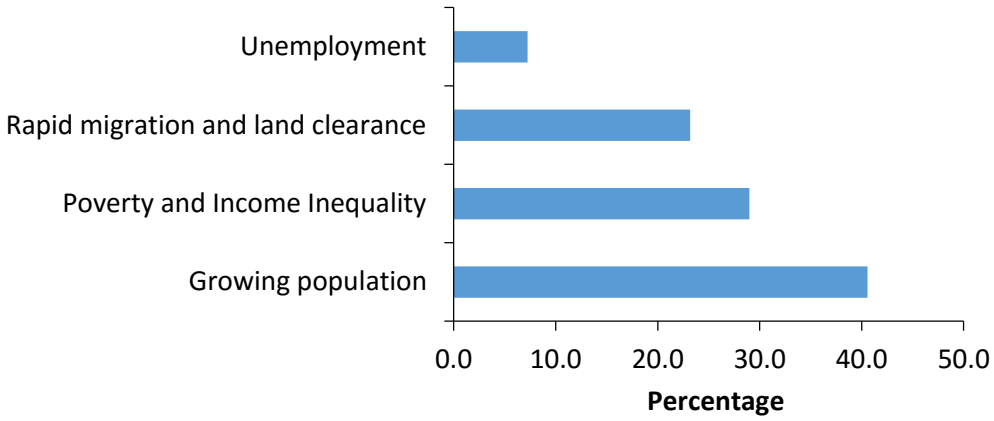

Figure 30: Perceived causes of land degradation in Cherang'any.

It is apparent from this survey that growing population, poverty and income inequality are the leading causes of land degradation in the study areas (Figure 29 & 30). Elderly respondents' intimated that large amount of indigenous forests existed in the study areas until the last two decades. This is evident from the forest fragments which are currently under strict government protection. Due to high demand for arable land by the growing population, the forested area were cleared and changed into settlements and farm lands. These expansions have contributed immensely to soil erosion particularly on steeper slopes causing soil fertility decline. This survey lends support to the fact that non-sustainable utilization of land resource such as vegetation clearing for fuel wood, expansion of cultivation and grazing on steep slopes contributes excessive soil (Woldeamlak, 2003).

6.9. Soil conservation methods and practices

In the two study areas, respondents practiced soil conservation methods which included: crop rotation, intercropping, organic fertilizer application and live fence hedgerows (Figure 8). In Mt. Elgon crop rotation was the most commonly practiced method (22.9%), followed by intercropping (22.4%), organic manure application (18.4%), and finally live fence hedgerows (11.4%). The lowest conservation methods practiced were fallow planting (0.5%), conservation tillage (1.0%) and mulching (4.5%). Similarly, in Cherang'any the commonest conservation methods were crop rotation (23.2%), intercropping (23.2%), and organic manure application (17.6%) and live fence hedgerows (12.0%). The lowest conservation methods practiced mulching (0.8%), conservation tillage (2.4%) and strip planting (2.4%). In contrasts cover cropping was slightly more practiced in Cherang'any (12%) than in Mt. Elgon (7.5%), while contour farming

practiced more in Mt. Elgon (11.4%) than in Cherang'any (3.2%). Strip farming was only practiced that was not reported by the respondents in Mt. Elgon.

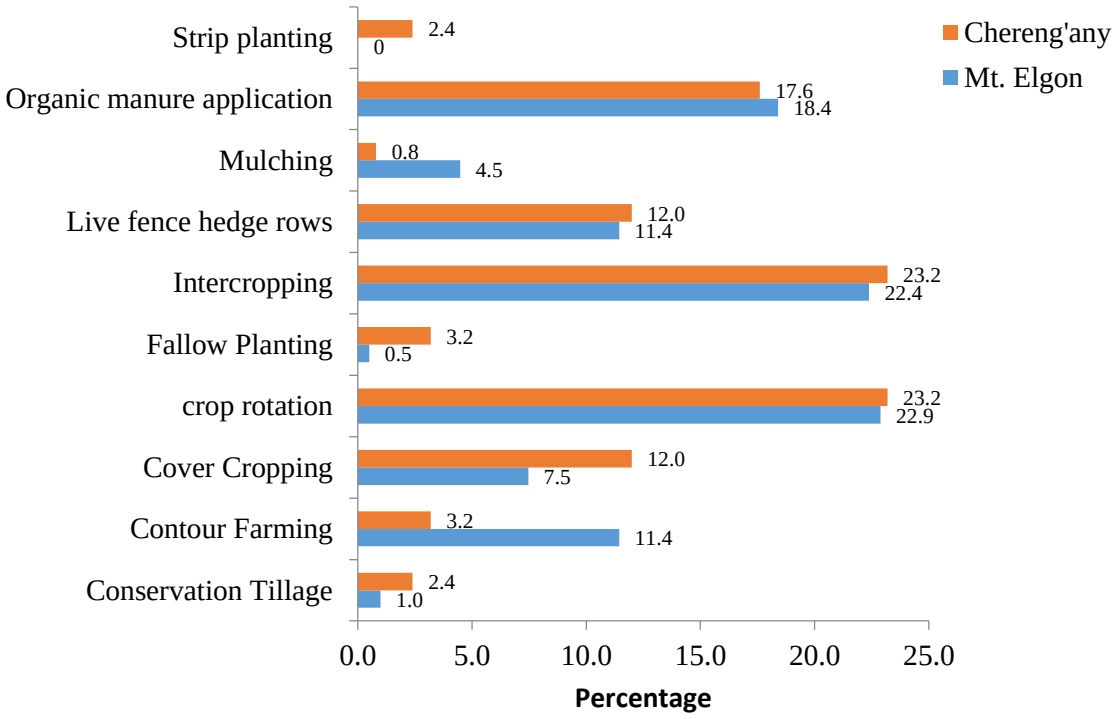

Figure 31: Land management strategies for soil conservation in the study areas

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATION

7.1. Conclusions

The survey indicates that:

- The respondents were dominated by males in all the study areas. There was fair age representation between youthful and old respondents.
- Majority of the respondents were literate.
- Marriage was highly prevalent, with large family households. The most common number of households was 5-8 members.
- The most important sources of livelihood are crop farming and small livestock keeping that is practiced on small farm sizes ranging 2-4 acres. Majority of respondents had secure land tenure of ancestral or privately owned land. Land cover was dominated by crops and settlements.
- Majority of the respondents farms experienced land degradation. The main types of land degradation are water erosion and fertility decline. Respondents perceived the extent of water erosion and fertility decline being moderate to severe.
- The main root causes of land degradation were poverty and income inequality, growing population and rapid immigration in Mt. Elgon, while growing population, poverty and Income inequality and rapid migration and land clearance considered main root causes of land degradation in Cherang'any.
- Respondents practiced soil conservation methods which included: crop rotation, intercropping, organic fertilizer application and live fence hedgerows

7.2. Recomendation

The present study recommends adaptation measures and strategies such as:

- Soil conservation practices such as agro forestry, composting, cover cropping, soil fertility management and erosion prevention measures.
- Farmer education and training of the development agents and resource user association officials to build the local understanding, management capabilities and community responsiveness to natural resource management;
- Extend the use of alternative livelihood sources such as bee keeping and intensify agro-forestry to decrease the deforestation.

- Further research on participatory land degradation assessments and quantification and matching with agricultural production.

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APPENDICES

APPENDIX I: Questionnaire on socio-economics status, livelihood sources, land tenure and land degradation

Questionnaire No: |__||__||__|

Name of Enumerator _____

Date _____ Start time_____ End time_____

Division _____Location_____ Sublocation_____

Village _____ Coordinates _____

SECTION A: Socio-Economic Characteristics Of The Household

Question	**Answer Choices**	**Code**
Q1. Name of respondent		
Q2.Respondent role in the household	**1** = household head; **2** = spouse; **3** = child; **4** = other (specify)_____	|__|
Q3. Approximate age	**1** = 18-25 years; **2** = 26-35 years; **3** = 36-50 years; **4** = 51-65 years; **5** = > 65 years	|__|
Q4. Gender	**0** = male; **1** = female	|__|
Q5. Marital status	**1**=married; **2**=single; **3**=widowed; **4**=divorced	|__|
Q6. Highest level of Education	**1** = no formal school education; **2** = primary level education; **3** =O-level secondary; **4**=A-level secondary education; **5**= college education; **6**=university education	|__|
Q7. Number of males in the household that are 15 years or more	*Total count*	|__|__|

Q8. Number of females in the household that are 15 years or more	*Total count*	|__|__|
Q9. Number of children in the household that are 14 years or less	*Total count*	|__|__|
Q10. Dwelling walls and floors	**1** = wood; **2** = mud; **3** = stone/cement blocks/brick; **4** = other (specify) _____	|__|
Q11. Dwelling roof	**1** = grass thatch; **2** = corrugated iron sheet; **3** =tiles; **4**= asbestos; **5** = other (specify) _____	|__|

Section B: Livelihood Sources

Question	**Answer Choices**	**Code**
Q12. Which are your sources of income? (please, rank in order of importance)		
a. Crop farming	**1**= Most important **2**=2nd most important **3**=3rd most important **4**=4th most important **5**=5th most important	|__|
b. Livestock farming		|__|
c. Bee keeping		|__|
d. Fish farming		|__|
e. Casual work		|__|
f. Shopkeeper/Trader		|__|
g. Government Employment		|__|
h. Private Professional Practice		|__|
i. Other (Specify)		|__|

(i) **Crop and Livestock Production**

Q13a. Which crops do you farm/produce? (please, rank in order of importance)		
a. Maize	**1**= Most important	
b. Wheat	**2**=2nd most important	
c. Millet	**3**=3rd most important	
d. Sorghum	**4**=4th most important	
e. Coffee	**5**=5th most important	
f. Tea		
g. Beans		
h. Sugarcane		
i. Ground nuts		
j. Pigeon peas		
k. Cow peas		
l. Butternuts		
m. Pumpkins		
n. Sweet potatoes		
o. Irish potatoes		
p. Vegetables (Specify)		
q. Other (Specify)		

Q13b. How much did you produce from your 5 most important crops in the last season, and how much did you consume or sell? (Give an estimate)

Crops	Amount Produced (Kg)	Amount Consumed (Kg)	Amount Sold (Kg)	Price (KES)
a. Most Important				
b. 2nd most important				
c. 3rd most important				

d. 4th most important				
e. 5th most important				

Q14a. Which livestock do you keep? (please, rank in order of importance)		
a. Cattle	**1**= Most important **2**=2nd most important **3**=3rd most important **4**=4th most important **5**=5th most important	|__|
b. Sheep		|__|
c. Goat		|__|
d. Pig		|__|
e. Poultry		|__|
f. Rabbit		|__|
g. Other (specify)		|__|

Q14b. How much do your animals produce, and how many did you consume or sell? (Give an estimate)

	Name of Product	Amount Produced (Kg)	Amount Consumed (Kg)	Amount Sold (Kg)	Price (KES)
a. Cattle					
b. Sheep					
c. Goat					
d. Pig					
e. Poultry					
f. Other (Specify)					

Q15a. How do you compare your income from farm products now and 4 years ago?		
i. Crops	**1**= increased; **2**=. decreased; **3**=same; **4**=don't know	|__|
ii. Livestock		|__|
iii. Other (Specify)		|__|

Q15b. What are the reasons for decreases?		
i. Crops	**1**=pest and diseases, **2**=drought; **3**=declining soil fertility; **4**=lack of pasture; **4**=theft; **5**=depredation	|_|
ii. Livestock		|_|
iii. Other (Specify)		|_|

(ii) Land Tenure And Land Use Intensification

Q16. Which of the following production assets do you have access to and use? (*choose more than one answer where relevant*)		
a. Land	**1**=accessed; **2**= not accessed	|_|
i. Ownership	**1**=own; **2**=ancestral/inherited **3**=lease/hire; **4**=squatter	|_|
ii. Size	**1**=less than 1 acre; **2**=1-2 acres; **3**= 3-4 acres; **4**= 5-6 acres; **5**= 7-8 acres; **6**= 9-10 acres; **7**= 11-12 acres or more	|_|
iii. Proportion cultivated	**1**=one eighth; **2**= quarter; **3**=half; **4**=three quarter	|_|
iv. Land use characteristics	**1**=forest, **2**= crops, **3**=pasture land, **4**=buildings, **5**= woodlot & bush grassland; **6**=long fallow (> 6 months), **7**=short fallow (< 6 months)	
b. Improved seeds/planting material/breeds	**1**=accessed; **2**= not accessed	|_|
Which ones?	**1**=maize; **2**=millet; **3**=bean; **4**=sweet potato; **5**= Irish potato; **6**=heifer **7**=other (specify) _____	|_|
c. Agro-chemicals	**1**=accessed; **2**= not accessed	|_|
Which ones?	**1**=fertilizers; **2**=Herbicides; **3**=Pesticides	|_|
d. Extension service	**1**=accessed; **2**= not accessed	|_|
Which ones?	**1** = planting timelines; **2** = planting methods; **3** = correct plant populations; **4** = weed control; **5** = pest control; **6** = poultry husbandry; **7** = small stock raising; **8** = food processing; **9** = beekeeping; **10** = micro-finance management	|_||_
_		_	
e. Credit	**1**=accessed; **2**= not accessed	|_|
i. Duration	**1**=seasonal; **2**=long-term; **3** = both	|_|

ii.Paid	**1**= yes (skip to Q16f); **2**=partly paid; **3**= no	|__|
iii. Reason not/partly paying?	**1**=high interest rate; **2**=low profits ; **3**=other (specify)	|__|
f. Irrigation facility/infrastructure	**1**=accessed; **2**= not accessed	|__|
Which ones?	**1** = dam; **2** = well; **3** = canal; **4**=terrace; **5**=other (specify)_____	|__|
g. Irrigation equipment	1=Accessed; 2= Not accessed	|__|
Which ones?	**1**=water pump; **2**= PVC pipes; **3**=bucket; **4**=other (specify)	|__|
h. Labour	1=accessed; 2= not accessed	|__|
i. For which operations did you need labour most in crop production (*choose more than one if relevant*)	**1** = land preparation; **2** = planting; **3** = weeding; **4** = harvesting; **5** = transport; **6** = other (specify) _____	|__||__| |__||__| |__|
ii. Is hired labour more or less than your unpaid family labour?	**1**=more; **2**= less; **3** = equal	|__|
iii. For which operations did you need it most in animal production (*choose more than one if relevant*)	**1** = herding; **2** = milking; **3** = feeding; **4** = spraying; **5** = transport; **6** = other (specify) _____	|__|
iv. Is hired labor more or less than your unpaid family labour?	**1**=more; **2**= less; **3** = equal	|__|

Section C: Soil Conservation Measures

Question	**Answer Choices**		**Code**
Q17a. Do you practice any of the following soil conservation methods in your farm? (*choose more than one option if relevant*)		**1** = yes **0** = no (skip to Q18a)	|__|
i. contour farming	|__|	ii. cover cropping	|__|
iii. mulching	|__|	iv. crop rotation	|__|
v. organic manure application	|__|	vi. live fence/hedge rows	|__|
vii. intercropping	|__|	viii. fallow planting	|__|
ix. conservation tillage	|__|	x. strip planting	|__|
Q17b. How did you learn about these methods?	**1** = ministry of agriculture extension staff; **2** = other farmers/friends; **3** = Ancestors; **4**=NGO/self-help group/community based organization;		|__| |__| |__| |__|

	5=other (specify)_____	
Q17c. How much of your farm do you put under soil conservation?	**1** = all; **2** = more than half **3** = less than half	|__|
Q17d. Have you experience any problem associated with these methods?	**1** = yes **0** = no (skip to Q18)	|__|
Q17e. If yes, which one(s)?	**1** = lack of funds; **2** = inadequate land **3** = workload **4** = other (specify) _____	|__| |__| |__| |__|

(III) Natural Resource Utilization

Q18a. Do you grow agroforestry trees in your farm?	**1** = yes **0** = no (skip to Q19)	|__|
Q18b. If answer above is **yes**, which ones? (take ***photographs of different trees in the farm if the farmer cannot identify them***)	*(Name the main agroforestry trees grown on the farm)* *1.*_____ *2.*_____ *3.*_____ *4.*_____ *5.*_____	
Q18c. What is main purpose for growing the trees? (***choose more than one option if relevant***)	**1**= wood fuel; **2**=timber; **3** = livestock forage; **4**=soil fertility maintenance; **5**=windbreakers; **6**=do not know; **7**=other (specify)_____	|__||__| |__||__|
Q18d. Where do get timber for construction? (*choose more than one option if relevant*)	**1**= own farm; **2**= forest; **3**= hardware: 4 =other (specify)_____	|__||__| |__||__|
Q18e. Where do get clean water from? (*choose more than one option if relevant*)	**1** = well; **2** =spring/steam/river; **3** = rainwater harvesting, 4=other (specify)_____	|__| |__| |__| |__|
Q19. Do you agree or disagree with the following statements		
Q19a. Soil fertility has declined over the last 5 or 10 years?	**1** = Yes, I agree **2**= No, I disagree **3** = Do not Know	|__|
Q19b. Biophysical factors such as poor soils, steep slopes, and uncertainty in the amount and distribution of rainfall are cause for land degradation?	**1** = Yes, I agree **2**= No, I disagree **3** = Do not Know	|__|

Q19c. Herbicides and pesticides are harmful to bees?	**1** = Yes, I agree **2**= No, I disagree **3** = Do not Know	|__|
Q19d. Forest and hedgerow clearing destroys forage for bees?	**1** = Yes, I agree **2**= No, I disagree **3** = Do not Know	|__|
Q193e. Repeated tillage and burning of crop residue after harvest destroys soil nutrients?	**1** = Yes, I agree **2**= No, I disagree **3** = Do not Know	|__|

(Iv) Production Constraints

Q20. What is the biggest constraint to crop production? (please, rank in order of importance)		
a. Unreliable rain/water	**1**= Most important **2**=2nd most important **3**=3rd most important **4**=4th most important **5**=5th most important	|__|
b. Pest and disease control		|__|
c. Soil nutrient enrichment		|__|
d. Lack of improved crop variety		|__|
e. Inadequate pollination		|__|
f. Low prices		|__|
g. Labour shortage/costs		|__|
h. Transportation		|__|
i. Lack of storage facilities		|__|
j. Lack of technical advice/skills		|__|
k. Other (specify)		|__|

(V) Land Degradation

Question	**Answer Choices**	**Code**
Q20a. Have you notice land degradation in your farm? (*choose more than one option if relevant*)	**1** = yes **0** = no (skip to Q23)	|__|
Q20b. If the answer is yes (in Q20a above), please state the main land degradation type?	**1**=water erosion, 2=wind erosion, 3=fertility decline, 4=salinity, 5=oil pollution, **5**=other(specify)_____	|__
__
__	

Q20c. What is the severity and extent water erosion?	**1**= none, 2= light, 3=moderate, 4=severe, 5=very severe	|__|
Q21d. What is the severity and extent wind erosion?	**1**=none, 2= light, 3=moderate, 4=severe, 5=very severe	|__|
Q22e. Severity and extent fertility decline?	**1**=none, 2= light, 3=moderate, 4=severe, 5=very severe	|__|
Q23. Name the root causes of land degradation	**1**=poverty and income inequality, **2**=unemployment, **3**=rapid migration and land clearance, 4=growing population, **5**=government policy and programs (e.g. shamba system), **6**=political conflicts and warfare **7**=other (specify)	|__| |__| |__| |__| |__|

APPENDIX II: Exercise Participants and role

Name	Sublocation	Mobile Phone	Ecosystem
Lydia Cheptoo	Endebess	0791425725	Mt. Elgon
Fredrick Matwoyi	kiboroa	0726514925	Mt. Elgon
Brian Musani	Kapkomon	0711611872	Mt. Elgon
Peter Kwalia Mara	Kaboywa	0716133460	Mt. Elgon
Kennedy Ndiema	Chesito	0702277571	Mt. Elgon
Alex Kibet Naibei	Kaptama	0715228418	Mt. Elgon
Kelvin Kibet Chebonya	Terem	0708775372	Mt. Elgon
Geofrey Kibet	Tywondet	0712563803	Mt. Elgon
Anita Jepkemoi Kiplagat	Kipsero	0797279917	Cherangany
Brian Kiplagat	Kapsowar		Cherangany
Kimutai Justine	Cheles	0700687208	Cherangany
Nicholas Kutto	Kapchemutwa	0722368686	Cherangany
Faith Kimaiyo	Singore	0741619236	Cherangany
Ruth Chelimo	Kipsero	0724791883	Cherangany
Edwin Kiptoo	Kapcherop	0711877255	Cherangany
Anthony Biwott	Kapcherop	0720254413	Cherangany

APPENDIX III: Fieldwork itinerary July, 2017

Date	Activity	Area
July 11th	Travelling from Nairobi to Kitale	
July 12th	Setting up field logistics and pre-testing questionnaire	
July 13th	Administering questionnaire	Endebes and Saboti, Trans Nzoia County
July 14th	Administering questionnaire	Kaptama, Chesito and Kaboywa,
July 15th	Administering questionnaire	Terem, Bungoma County
July 15th	Travelling From Kitale to Eldoret to Kapsowar	
July 16th	Administering questionnaire	Iten, Uashin Gishu
July 17th	Administering questionnaire	Kapsowar, Elgeyo Marakwet County
July 18th	Administering questionnaire	Kapcherop, Elgeyo Marakwet County
July 19th	Travelling from Eldoret to Nairobi	