CONTRIBUTION OF FOREST PROVISIONING ECOSYSTEM SERVICES TO LIVELIHOODS OF SMALLHOLDER FARMERS ADJACENT CHYULU HILLS FOREST

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DECLARATION

I understand that plagiarism is an offence and I therefore declare that this Thesis is my original work and has not been presented for any academic award in any institution of higher learning.

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This Thesis has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

I dedicate this work to the Almighty God for being my provider all through my study. To my daughter Cecilia Mwongeli when you read this thesis let it be an inspiration for your thirst of education.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

CIFOR:	Center for International Forestry Research
FAO:	Food and Agriculture Organization
FPES:	Forestry Provisioning Ecosystem Services
GDP:	Gross Domestic Product
GEF:	Global Environment Facility
GoK:	Government of Kenya
GTZ:	German Technical Cooperation
GRZ:	Government of the Republic of Zambia
IFAD:	International Fund for Agricultural Development
IUCN:	International Union for Nature Conservation
KFMP:	Kenya Forestry Master Plan
KFS:	Kenya Forest Service
KWS:	Kenya Wildlife Service
NEMA:	National Environment Management Authority
NTFPs:	Non Timber Forest Products
PFAP:	Provincial Forestry Action Program
RoK:	Republic of Kenya
TEEB:	The Economics of Ecosystems and Biodiversity
UNEP:	United Nations Environmental Programme
WCFSD:	World Commission on Forests and Sustainable Development

WCMC:	World Conservation Monitoring Centre
WHO:	World Health Organization
WRI:	World Resources Institute

DEFINATIONS OF TERMS

Forest Provisioning Ecosystem Services- Refers to services supplying tangible goods, finite though renewable, that can be appropriated by people, quantified and traded (Maass *et al*., 2005).

Smallholder farmers- They are those farmers who cultivate small areas of land usually less than 10 ha often less than 2 ha, use family labour, and depend on their farms as their main source of both food security and income generation (Nagayets, 2005).

Livelihoods -According to Sunderlin *et al*. (2005), Livelihoods represent the means of living.

Sustainable development-Implies development which while protecting the environment allows a type of economic activity that can be sustainable into the future with minimum damage to people or ecosystem (Goudie, 2000).

ABSTRACT

Forests are believed to play critical ecological, social, cultural, and economic role to the livelihoods of smallholder farmers in Kenya and even all over the world. Forestry Provisioning Ecosystem Services (FPES) contribute significantly to smallholder farmers' livelihoods though this contribution is sometimes not accounted for. Understanding the role played by FPES to the livelihood of smallscale farmers is crucial for sustainable management of the forest resources. This study therefore sought to investigate the contribution of FPES to the livelihoods of smallholder farmers adjacent Chyulu hills forest, Makueni County. The specific study objectives were to; (i) Identify the type of FPES provided by Chyulu hills forest to the adjacent communities (ii) Evaluate the contribution of FPES to the household income of smallholder farmers adjacent Chyulu hills forest and (iii) Assess factors influencing utilization of the Chyulu hills FPES. A survey research design was used. Stratified and purposive sampling methods were used to select the specific study Sub-locations. A sample size of 62 respondents was selected in the two Sub-locations using the coefficient of variation method (Nassiuma, 2000). Frequency distribution was used to determine the type of FPES extracted from Chyulu hills forest and the contribution of FPES to the household income of smallscale farmers. Logit regression model was used to analyze data on factors influencing utilization of the Chyulu hills forest. The results established that farmers in both Sub-locations extracted FPES with the 37.5% and 64.3% of the respondents in Mang'elete and Kiu Sub-locations, respectively extracting the services from the forest. The types of FPES extracted from Chyulu hills forest were mainly food and medicinal plants. In Mang'elete Sub-location, the most extracted food material was vegetables (44.4%) while in Kiu Sub-location honey was the most extracted at 87.5%. In Mang'elete the most extracted herbal was *Terminalia brownie* (52.4%) while in Kiu Sub-location the most extracted was *Grewia bicolor* (60.9%). Results further showed that FPES contributed a substantial amount of money to the income of the respondents with total mean income from FPES in the two Sub-locations being Ksh 811.36 (8.4%) while that from other sources such as farming being Ksh 8,907.53 (91.6%). There was a significant difference between the monthly mean incomes (Mang'elete (M= 355.56, SD= 1,252.04) and Kiu (M= 1,267.17, SD=3,085.60, $t(58) = -2.26$, $p<0.05$) accrued from the sale of forest products. Logit regression results showed that occupation of the household head, distance from Chyulu hills forest and presence of fence significantly ($p<0.05$) influenced utilization of Chyulu hills FPES in Kiu and Mang'elete Sub-locations. The study concluded that forest dependency is a reality irrespective of whether legal or illegal. It is recommended that conservation be enhanced by creating awareness of forest benefits to the community and training them on sustainable use of resources.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in Western, Central and Eastern Africa where there is considerable forest cover (UNEP, 2006). This, therefore, means that the percentage forest cover is directly proportional to the benefits derived from the forest considering all the other factors that might affect the use of forest products are held constant. According to FAO (2010), the livelihood of most rural people of developing countries is strongly linked to natural resources like forest. In Uganda, for example, forests and woodlands are now recognized as an important component of the nation's stock of economic assets and contribute in excess of US$ 546.6 million to the economy through forestry, tourism, agriculture and energy (NEMA UG, 2008). In Kenya too as noted by Mogaka *et al*. (2001), it is estimated that about 3 million forest adjacent dwellers depend on forests for provision of all households' wood and non-wood products needs and generally in the world 2.6 billion people are estimated to depend on fuelwood for cooking, charcoal making and for energy generation (FAO, 2013).

Forests are designated as protected areas which host game parks and forest reserves. They are also a source of fodder for livestock (Campbell and Luckert, 2002). In Kenya a good number of forest adjacent dwellers derive their income from the sale of forest provisioning ecosystem services such as fuelwood and charcoal, commercial hunting and handicraft, sale of forest fruits and vegetables and sale of fodder and medicinal plants. FAO (2012) estimates that forest industries contribute more than US$450 billion to national incomes contributing nearly one percent of the global GDP in 2008 and providing formal employment to 0.4% of the global labour force.

Local communities generally have scarce resources which lead to them using the forest as a source of livelihood either by extracting resources for subsistence use or for commercial purposes. The demand for the forest provisioning ecosystem services varies depending on the status of the socioeconomic development of the society. Communities with low income often give high priority to meeting basic needs from forest products such as wood fuel, medicinal plants and other forest derived foods (Kiplagat, 2008). Communities adjacent to the forests tend to supplement scarce resources with forest products. They tend to use the resources in combinations that offer the highest utilities.

The factors to determine decision of household to utilize forest resources include labour availability to gather the products, infrastructure, availability of alternatives on farms, other sources of income such as formal employment, wealth, household size, level of education, presence or absence of a fence and distance to the forest. Distance to the forest is a major determinant as it dictates time taken to reach the forest. Some research findings have shown that poorer households depend totally on forest products due to limited access to alternative sources of income, while the more wealthy households mainly use the forest for larger commercial activities (Wass, 1995).

Over the past two centuries the nationalization of much of the world's forests has eroded and alienated local community forest management systems in many nations. Forest departments, with limited financial and human resources, have experienced increasing problems in ensuring the sustainable use of millions of hectares of land under their sole jurisdiction (IUCN, 1996). It is now generally observed that involvement of community in forest management can contribute to reduce the unsustainable exploitation of resources which continues to be witnessed in most of the protected forests in the world. Lack of community involvement in forest protection may even worsen the degradation problem as these communities have over time come to view themselves as enemies of the forests rather than protectors and managers of this natural resource (Mbugua, 2007). As observed by Timko *et al*. (2010), if properly managed, these forest products can serve as incentive for forest communities to

protect the forest and to sustain their source of income. This study therefore explored the various types of FPES extracted from Chyulu hills forest by the adjacent households and assessed the contribution of these services to the households' income. It also examined the factors influencing households' utilization of the FPES and overall, the results of this study will give light to ways through which forest conservation can be achieved when at the same time community adjacent dwellers are able to pursue their livelihoods.

1.2 Statement of Research Problem

Chyulu hills forest is one of the most unique forests in Kenya. The forest is home to numerous plants and animal species. It is a dry land fragile ecosystem most vulnerable to climate change. Droughts impact negatively on water availability, agricultural production and rural livelihoods for the communities neighboring the forest. Communities living adjacent the hills heavily derive their livelihood from it and most of them practice smallscale rain-fed agriculture and thus the change in seasonality attributed to climate change leads to certain food products becoming scarce at certain times of the year.

In the recent past, the Chyulu hills forest has been subjected to rampant vegetation degradation through illegal logging, fire wood harvesting, charcoal burning and frequent fires (Pringle & Quayle, 2014). The problem is that the resultant increased extraction and intensity of use of tree products have complicated the conservation of the Chyulu hills forest. Despite of the essential products and services offered by Chyulu hills forest, its actual value in terms of contribution to the local and external community livelihoods has neither been synthesized nor economically quantified. FPES especially to the forest adjacent dwellers have long tended to be underestimated by economic planners and decision makers. The monetary value of natural ecosystems is extremely important because it enables policy makers and natural resource managers to make more informed decisions. De Groot *et al*. (2002) noted that the

level of familiarity with ecosystem capital and its role in conservation policy formulation is still low hence the continued degradation of fundamental natural assets such as forests.

The ability of forests to generate resources and other economic benefits to the local community users has been less recognized and emphasized by economic planners. The economic valuation of production and service functions of the ecosystem would be paramount in attempting to gauge the actual contributions of these production and service functions in the per capita income of the communities vis a vis the degradation trend of the forest. This study, therefore, attempts to bridge this gap by looking at the potential of forestry sector towards economic and social development more so to the forest adjacent dwellers as lack of awareness of the importance of forest ecosystems to the livelihoods of small scale farmers may hinder or bring challenges for its conservation especially when the communities around the forest are poor. According to FAO (2013), in order to reduce poverty especially in rural areas, the contribution made by forests and trees to food security and nutrition deserves urgent consideration.

Smallholder farmers adjacent Chyulu hills forest have for long relied on the forest for a number of resources which have had a great impact to their socio economic life unlike communities far from the forests. Specific forest provisioning ecosystem services as well as how Chyulu hill forest contributes to household income of the adjacent communities is not fully explored. Taking this into consideration, this study focused on understanding the actual forest provisioning ecosystem services and their contribution to the household income and also shed light on those factors influencing utilization of these resources.

Failure to understand factors influencing extraction of FPES from Chyulu hills forest may put the stakeholders on dilemma not knowing where to start when it comes to conservation and management hence leading to degradation and depletion of forest resources. However, economic valuation of forest ecosystems is important even beyond policy making because the general public are more likely to respect and protect their local ecosystems more vigilantly if they know their monetary value.

1.3 Objectives of the study

1.3.1 Main objective

To assess the contribution of forest provisioning ecosystem services to livelihoods of smallholder farmers adjacent Chyulu hills forest.

1.3.2 Specific objectives

1. To establish the type of forestry provisioning ecosystem services provided by Chyulu hills forest to the adjacent communities.
2. To evaluate contribution of forestry provisioning ecosystem services to the household income of smallholder farmers living adjacent to Chyulu hills forest.
3. To assess factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services by the adjacent communities.

1.4 Research questions

1. Which are the forestry provisioning ecosystem services extracted from Chyulu hills forest by the adjacent communities?

2. What is the contribution of forestry provisioning ecosystem services to the household income of communities living adjacent to Chyulu hills forest?

3. Which are the factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services by the adjacent communities?

1.5 Significance of the Study

Proper understanding of forest adjacent dwellers dependency on forest ecosystem services may provide insights on formulating policies related to utilization and conservation of those areas. The results of the study would shed more light on the economic value of Chyulu hills forest and therefore the need to conserve and protect it. It is also expected that communities living around the forested areas would use the findings to keep themselves informed on the forests contribution to the household income hence find it important to be involved in conservation measures. Further, the study will find out factors influencing utilization of forest provisioning ecosystem services and try to address some which can be controlled. Findings from this study will provide information to policy makers which may help in future policy formulation and improve the role of the local people in forest and natural resource management. It is also expected that the findings will add on to the existing literature on economic valuation of forest products.

1.6 Scope of the Study

The study focused on the community bordering Chyulu hills forest in the eastern side of the forest. It was limited to Mang'elete Sub-location of Mtito Andei Division and Kiu Sub-location of Makindu Division both of Makueni County. The respondents were purely drawn from smallholder farmers in Mang'elete and Kiu Sub-locations. The study focused on the contribution of forest provisioning ecosystem services to the smallholder farmers' livelihoods in Chyulu hills forest. It was limited in that accessing some households was difficult due to fear of wildlife especially in Kiu Sub-location which lied on the unfenced border.

1.7. Assumptions of the Study

The study assumed that:

1. Target respondents depended on the Chyulu hills forest for the forestry provisioning ecosystem services.
2. Forest extraction contributed to the smallholder farmers' household income in both Mang'elete and Kiu Sub-locations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section presents literature reviewed from previous studies, policies and legal framework relating to forest resource use. It shall enable further understanding of the contribution of forest provisioning ecosystem services to the livelihoods of communities living adjacent Chyulu hills forest in a global, regional and local context.

2.2 Economic, environmental and socio-cultural importance of protected forests

Protected areas are defined as areas of land or sea dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, managed through legal or other effective means (UNEP-WCMC, 2004). Protected areas in many countries were for the most part state-owned, with no-take policies, and provided little access other than for tourism (Naughton-Treves *et al.*, 2005). In the 1970s - 80s, the rights and needs of local communities in the development and management of protected areas began to be recognized.

The world's forests provide a range of ecosystem services. Forests serve as a vital safety net for millions of people around the world. Their role in eliminating poverty is not as well documented, but probably concerns a smaller number (Wunder, 2001). Forest provisioning ecosystem services (FPES) can be viewed as a safety net. They are a source of emergency sustenance in times of hardship like when crops fail, when economic crises hit, in times of conflict or war, or when floods wash away homes. FPES tend to be seasonal or to fill gaps, and are sometimes a form of savings, but are rarely the primary source of household income (FAO, 2001). Tropical forests mostly found in developing countries, are especially vital for safeguarding global environmental goods and services. Protected areas are considered one of the most

efficient and cost-effective options for conserving forests. Resource extraction from protected areas, including timber and non-timber forest products has been cited by local communities as one of the greatest available benefits (Bajracharya *et al.*, 2006).

Regionally, forests have immense value, and are essential for economic development, biodiversity conservation and equitable growth in the region. Forests also support most productive and service sectors in the Kenya, particularly agriculture, fisheries, livestock, energy, wildlife, water, tourism, trade and industry. It has been confirmed that the forests contributes between 33 to 39 % of the country's Gross domestic Product. Biomass comprises about 80% of all energy used in the country, while they also provide a variety of goods, which support subsistence (RoK, 2014). The forestry services provided by the water towers include local climate regulation, water regulation, water purification and waste treatment and water pollution sinks. Other services provided include erosion control, natural hazard and disease regulation. Forest adjacent communities benefit directly through subsistence utilization of the forests (GoK, 2009). Only 20 percent of the country's total area has high rain-fed agricultural potential and most farmers are dependent on smallscale commercial agriculture (WRI, 2007). Protected forests that are located in high potential areas are valued for their agricultural and human settlement potential.

Forests are major habitats for wildlife and are major contributors to the tourism sector's foreign exchange earnings. In addition, mountain forests supply water to biodiversity sanctuaries. Human dependence upon forests is a multifaceted phenomenon due to the fact that forests provide a diverse stream of benefits to humans (Beckley, 1998). Humans depend upon forests directly for timber, non-timber products, and recreational experience and indirectly for things such as air and water quality, biodiversity, carbon sequestration, and other ecological services. Studies by Redford *et al*. (2006) showed that man requires forest resources to maintain his way of life. Trees are used for fuel wood for heating and cooking, protected grasslands are coveted by herdsmen especially in times of drought and as pasture land becomes scarce (Neuman, 1998). According to Infield (2003), rural households depend on tropical forest for craft material, medicinal plants and places to put beehives for honey

production. In most cases, majority of people living adjacent to forests are poor and are mainly dependent on agriculture or on natural resources and ecosystem services (WRI, 2005). The utilization of natural resources as a livelihood strategy is important especially to the communities residing adjacent to these resources (Sumati, 2006). Such communities collect process and or market various kinds of natural resources either as a predominant activity or as part of a diversified portfolio of livelihood strategies designed to spread and minimize specific risks (Norfolk, 2004).

Forests, among the natural resources, have potentials and limitations for improving human welfare (Angelsen and Wunder, 2003). The Kenya's national accounting system fails to reflect the value of the goods and services that forestry provides to the wider economy, in particular to agriculture, tourism, energy and water which contribute above 40% of GDP (GoK, 2013).The contribution of forests to the national economy has been grossly undervalued, leading to low level of resource allocation to the sector.

There is need to promote appreciation of the value of forests to the economy, and the concomitant need for adequate resource allocation to the sector through public intervention and other innovative funding mechanisms. To leverage resources for forestry development, there is need for greater integration of forestry issues into other sectoral development programmes. Over dependency on wood products exerts considerable pressure on the tree and forest resources. In addition, the wood conversion technologies for timber manufacturing and charcoal production are obsolete and wasteful leading to overharvesting of trees to meet the demand. The key factors to accelerated loss of biodiversity are forest fires, deforestation and forest degradation, conversion of forests to other uses and game damage (Infield, 2003).

Soil erosion with consequent degradation of the fertility of the soil is a major challenge in the country. Further, siltation reduces water quality and the capacity of reservoirs particularly for hydroelectric power production. Forests guard against soil erosion, arrest it where it has started, and assists in creating conditions for restoring fertility to the soil where erosion has already caused a deterioration of fertility.

Globally and nationally the climate is changing, and this is having a direct impact on forest resources and ecosystems and on people and their livelihoods - through flooding, landslides, and drought. Forestry can play an important role in both mitigation and adaptation to climate change, and towards green growth (GoK, 2013).

Kenya is endowed with a wide range of forest ecosystems ranging from Mountain rainforests, savannah woodlands; dry forests and coastal forests and mangroves. In Kenya, gazetted forests cover a total area of 1.4 million hectares, representing about 1.7% of total land area. This does not meet the internationally recommended minimum of 10% of country forest cover. Forests outside gazetted forests are estimated to be 0.18 million hectares and are mainly situated in high and medium potential areas where the human population and agricultural production are concentrated (Pellikka *et al*., 2004). These forests have high species richness and endemism, which has made the country be classified as mega diverse. They rank high as the country's natural asset, due to their environmental, life supporting functions, and the provision of diverse good and services. With regards to level of economic benefit from forest, previous studies by Argawal & Chhatre (2006) have found that a higher level of economic benefits from forests encourage the community to participate in the management of forest resources.

Even though there is growing public recognition of the benefits of these ecosystems, they are increasingly under threat from deforestation and nearly 13 million ha are lost every year. Deforestation rates are particularly high in the tropical countries. It is estimated that some 1.8 billion M^3 of wood are harvested annually for wood fuel, with women typically doing most of the work (GEF, 2009). In spite of the importance of forests in Kenya, these forest ecosystems have continued to experience widespread land cover changes over the years due to rampant destruction, degradation and even excisions for human settlements (GoK, 2013). State forests are also subjected to illegal logging and cultivation by people seeking alternative means of livelihood. This demonstrates the need to upscale farm forestry across all the country's ecological zones (GoK, 2009a). This study therefore seeks to investigate the type and extend of

resource extraction from Chyulu hills forest and identify whether the extraction is sustainable and if not provide solutions to that.

2.3 Type of forestry provisioning ecosystem services provided by forests

It is without doubt that forests ecosystems provide human kind with a variety of services. Millions of people worldwide depend on the forest for their livelihoods through food consumption and sale, as well as employment from forestry enterprises, services from forest ecosystem, and forest biodiversity (FAO, 2013). For example, 2.6 billion People are estimated to depend on fuel wood for cooking, charcoal making and for energy generation (FAO, 2013). Yadav *et al*. (2003) state that, in Nepal forest, people rely on forests and trees for fodder and bedding materials, for timber and poles for houses and agricultural implements such as ploughs and for fuel wood, which is the most important, and often the only source of energy for cooking and heating for most rural households. Forests have been described by the World Bank as critical for the livelihoods of around 40 million people, or three-quarters of the national population, in the Democratic Republic of Congo (Debroux &Topa, 2007). Forestry provisioning ecosystem services (FPES) refers to the tangible goods extracted from the forest ecosystems such as food, fresh water and wood fuel (De Groot *et al*., 2002). Forests provide fodder, firewood, and subsistence timber-goods for which they are still the major source for most poor households in the developing countries.

Locally, those people living around the edges of the forests use the forests as a source of firewood, other wood products, medicinal purposes, honey, for hunting, and for livestock grazing. Some of these uses may be destructive to the forest while others may not. The Chyulu Hills is a critical dry land water catchment in Southern Kenya but its environmental integrity is increasingly threatened by inappropriate human activities like charcoal burning, logging and livestock incursion (Muriuki *et al*., 2011). In view of its role in sustaining the socio-economic welfare of many rural and urban populations and provision of water to large populations of wildlife species, it's imperative that its watershed ecosystem service is understood. Evidence from Bolivia

and Peru suggests that forest dependency increases when communities are located further away from urban centers (Stoian and Henkemans, 2000).

Local communities especially in the rural areas depend on forests for provision of wood, fuelwood, and non-timber forest products for their livelihoods. Over 530,000 households living at a distance of five kilometers depend directly on forest cultivation, collection of fuel wood, herbal medicine and other economic gains (KFMP, 1994). Development agencies have estimated that forests provide substantial livelihood benefits to more than half a billion people, many of them are very poor (Agrawal and Angelsen, 2009). These forests provide a wide range of goods and services that create opportunities for development, and support the livelihoods of millions of people living in and around the forest (FAO, 2005). Some of goods and services that are obtained from the forest resources are, wood for fuel and construction and these are quite evident while others, such as water sources, are less obvious. They supply timber, wood for energy, construction materials and food and medicines. Some of these life support systems of major economic and environmental importance are supply of timber, fuelwood, fodder and a wide range of non-wood products. For mountain people, this rich biodiversity provides a rich variety of FPES in the form of food, medicinal plants, genetic resources, and timber and non-timber products from mountain forests which constitute 28% of global forest area (Kapos *et al.*, 2000).

2.4 Contribution of forest ecosystems to peoples' livelihoods

The contribution of forestry to the Kenyan economy is currently undervalued in terms of GDP contribution (GoK, 2008). Consequently it is poorly mainstreamed into macro and sectoral plans and its budgetary allocation is low. The total value of the resource is not fully quantified either as inventory has only been carried out in the protected forest areas on an ad hoc basis. Moreover, resources falling outside these protected areas are not accounted for. It is, therefore, necessary to adopt an appropriate accounting and evaluation system for forests and woodlands that will reflect their true

value. Total environmental accounting for all goods and services provided by forest ecosystems continues to draw worldwide debate. The economic benefits contributed by the Mount Kenya forests, for example, are estimated at about Ksh. 2 billion per year (Emerton, 1997). The bulk of this value comprise watershed catchment protection and domestic use benefits but excludes ecological and existence values. Worriedly, however, the government and economic planners have failed to recognize the important role played by FPES in rural livelihood. This oversight has been primarily associated with lack of quantitative information to justify the role of forest resources in forestry sector development. If the total economic value of forests was really taken into account then people would recognize their importance and better protect and manage forest ecosystems.

Valuation results can also be used in determining or influencing pricing, land use and incentive policies (Munasinghe, 1993) or to influence or justify land-use and natural resource management decisions, including in terms of fiscal accountability and public support and internalization of costs. Forest valuation is, therefore, a tool that can provide society and decision-makers with information for deciding among alternatives or upon preferred combinations of possible interventions (Kengen, 1997).

Forests can be simultaneously recognized as a 'poverty trap' and a 'safety net' for the rural dwellers who use their resources (Angelsen & Wunder, 2003). In Africa, 600 million people have been estimated to rely on forests and woodlands for their livelihoods (Anderson *et al.*, 2006) while in India, 50 million people are estimated to directly depend on forests for subsistence alone. Historically, forests have played a major role to influence patterns of economic development, supporting livelihoods, helping structure economic change, and promoting sustainable growth. For millennia before the industrial revolution, forests, woodland, and trees were the source of land for cultivation and settlement, of construction materials, of fuel and energy, and indeed of food and nutrition as well (Williams, 2002).

Forest provide a greater share of income to these households than wage labour, livestock, self-owned businesses, or any other category aside from crop production.

The livelihoods of an estimated 300 million people worldwide living close to tropical forests depend on tree or forest products for daily subsistence (Calibre Consultants, 2000). In fact, 1.6 billion people worldwide, rely on forest resources for their livelihoods (FAO, 2012). This is a reality as nearly all the products used by humans for their survival are derived from tree. They contribute enormously to the global energy supply as well as providing food, fodder, Medicines, building materials and paper products. Globally about 70% of rural communities live in extreme poverty (World Bank, 2009). These people lack the Basic necessities to maintain a decent standard of living such as sufficient and nutritious food, adequate shelter, and access to health services, energy sources, safe drinking water, adequate education and a healthy environment. About half of this forest income is non-cash and includes food, fodder, energy, building materials, and medicine. In the economy of Ghana for example, Non- timber forest products have played an important role by way of supporting rural livelihoods. They contribute significantly to the income and food security of many rural households in Ghana (Ahenkan *et al*., 2011).

Forest ecosystems generally provide a wide range of goods and services such as; food, clean water, energy, climate regulation, biogeochemical and nutrient cycling, flood disaster mitigation, biodiversity support, spiritual and cultural benefits all which maintains life on earth (De Groot *et al*., 2002). Collectively, these benefits are commonly referred to as ecosystem services (MEA, 2005) and are usually grouped into four key categories. These categories include; provisioning services like food, fresh water and wood fuel, regulating services like water purification and climate moderation (De Groot *et al*., 2002). Others are nutrient balancing and maintenance of the hydrological cycle, cultural services like worship, recreation and ecotourism and supporting services like soil reconditioning and biodiversity support. This study only concentrated on forest provisioning ecosystem services which comprise of services supplying tangible goods, finite though renewable, that can be appropriated by people, quantified and traded' (Maass *et al*., 2005).

Since time immemorial, forests and their associated products have remained essential in sustaining livelihoods (Mamo *et al*., 2007). This is particularly for the people of

forest-dependent communities, who live in abject poverty (Shackleton *et al*., 2007). There is potential for economic activities to be derived from the forest if proper institutional arrangements which recognize the right of the communities to exploit the forest are put in place. According to a report of the World Bank (2006), approximately 1 billion extremely poor people depend on the forests for part of their livelihood, with 350 million heavily dependent on forests. Rural households throughout the developing world rely to varying degrees on a range of products and services collected from the surrounding ecosystems (Shackleton *et al*., 2002). These are used either for direct household consumption or sold in local, regional and national markets, when included into rural livelihood strategies, these help reduce people vulnerability to risks (Neumann and Hirsch, 2000).

Timko *et al*. (2010) noted that in Africa, over two-thirds of the continent's 600 million people are estimated to rely on forest products, either in the form of subsistence uses or as cash income derived from a wide range of timber and non-timber forest products. In rural areas of Sub-Saharan Africa, forest resources are amongst the most vital components of livelihoods and development opportunity (Cavendish, *2*003). Identifying ecosystem services and conducting valuation on ecosystem services and goods is becoming an effective tool to understand multiple benefits provided by the natural environment (Guo *et al*., 2001). In Africa, for example, bush meat provides 25% of protein requirements, and can be the principal source for some indigenous groups (Guo *et al*., 2001). Melaku *et al*. (2014) reported in their study in Southwestern Ethiopia that the contribution of NTFPs to annual household income is forty seven percent (47%), fifty percent (50%) of the income was from agriculture and remaining three (3%) was from off-farm. Dependency of local community on NTFPs was measured in Central Himalayan foot hills by Rijal *et al*. (2010) where in their study it was estimated that NTFPs provided poorer households with a cash income share of 44- 78%. Jagger (2012) in western Uganda estimated that households in rural Uganda derive 26% of total household income from forests and other wild areas including fallows, agricultural lands, wetlands, grasslands, and shrub lands.

Approximately 2.9 million people live adjacent to forests in Kenya. This is over a tenth of the total population (Wass, 1995). Forests provide the poor with quick cash or auto consumption goods especially in the event of unpredicted shortfalls, such as failure of agricultural crop or disasters (Angelsen and Wunder, 2003). The forest adjacent communities view the forest as a reservoir of goods and services and as a source of livelihoods to thousands of people living within kilometers of forest boundaries and benefit from a whole range of goods and services from the forest (Kamugisha *et al*., 1997). Kenya's indigenous forests are home to many communities whose livelihoods depend on the natural resource.

Forests comprise the country's water towers and catchments, where over 75% of the country's renewable surface water originate, and therefore serve critical water regulation roles which are important for human livelihoods, irrigated agriculture, and production of hydro-electric power. Watershed degradation is rampant in countries where livelihoods of rural people are heavily reliant on exploitation of forest resources (Wilkie *et al*., 2003). This calls for sustainable management of forests and harmonization of environmental conservation, livelihood needs and socio-economic development aspirations of such communities (IUCN, 1996).

Globally, empirical evidence has quantified and qualified the proportion of forest dependency from the entire household livelihood matrix. The seminal work by Vedeld *et al*. (2007) drawing upon 51 case studies across 17 developing countries revealed that the contribution of forests, mainly through forest income accounted for about 22% of the total household income. In North and South America, the contribution of forest income ranged between 14 and 20% of the total household income. In Asia, forest income varied from 10 to 20% of the total household income (Mukul *et al*., 2016). While in sub-Saharan Africa, forest income ranged from 30 to 45% of the total household income (Kalaba *et al*., 2013). These studies demonstrated the significant contribution of forests towards household economies. Some people depend solely on forests as their only source of subsistence, with its contribution sometimes being found to offset other household livelihood portfolios such as agriculture (Mcelwee, 2008).

It has been estimated that there are more than 60 million highly forest dependent people in Latin America, West Africa, and Southeast Asia, with an additional 400-500 million people directly dependent on these natural products (Riadh, 2007). Subsistence use of NTFP represents the greater part of its value to households. However, they are also source of cash income such income seldom appears to account for a large share of a households total income, but complements other livelihood activities (Shackleton and Shackleton, 2004). One particularly important aspect of non-market forest use is as an input into other household production processes. For instance, animal browse from trees and shrubs provide almost a third of the feed requirements of Sudan's livestock population (Mogaka, 2000).

Formally measuring and accounting for forest ecosystem services is a necessary first step toward properly valuing them, and various efforts toward this goal have been ongoing in recent decades at the global level. One of the earliest studies of ecosystem value at a global level estimated their total worth at $33 trillion per year, with forests making up a significant portion ($4.7 trillion) of this total (Costanza *et al*., 1997). Increased income can arise from the sale of many forest products such as bush meat and fuel wood. In Zambia, the major commercial forest produce from indigenous forests is charcoal, which is used by 83% of urban households (GRZ, 1997). Nationally, the present annual consumption of woodfuel is 7.2 million tons, of which two-thirds are used as fuelwood and charcoal in rural areas and one-third is used as charcoal in urban areas (FAO, 2007). Household food security improves from the collection of forest resources such as fruits, mushrooms, honey, roots and tubers, caterpillars, termites, grasshoppers, and other small-game animals (FAO, 2007). Forests serve as subsistence safety nets for the rural poor, essentially mitigating poverty for its users (Mayers, 2007). Forests can function as a source of permanent increases in income, assets, services and political rights particularly in well-functioning community-managed forests. Often, economic valuation of any goods and services is based on the concept of total economic value which is based on use values and non-use values. Use values can be further divided into direct use values, indirect use values and option values. Direct use values can be derived from the actual price

paid for an ecosystem goods or service, for instance paying for timber, firewood and others forest products. Economic valuation is very important to make vulnerability assessment of ecosystems (Hirsch *et al*., 2011). Thus this study might provide more insight while developing the national adaptation and mitigation strategies against the climate change. Market based approach can be applied for valuation of provisioning services such as timber or water. Individual products provide inputs and income to huge numbers of rural and urban households.

Although difficult to calculate systematically, forests play a significant economic role at the continental, regional, national and local levels in Africa. Previous studies have shown that the importance of natural capital in the total stock of capital tends to vary inversely with the level of income per head (Anderson *et al*., 2006). Globally, the forested area dedicated to the production of wood and non-wood products dropped from 1.16 billion hectares to 1.13 billion hectares over the 2000-2010 period (UNEP, 2012). This decline evident at the regional level is due largely to the deforestation associated with the expansion of the agricultural frontier, poor forest management practices, fire, excessive firewood extraction and illegal cutting. The land area covered by tree farms, however, grew more rapidly in Latin America between 2000 and 2010 (3.23% annually) than in any other region of the world (UNEP, 2010).

Forests continue today to provide the high levels of commercial benefits of households, companies, and governments that formed the initial impetus for protective statutes and policies. NTFPs indeed play a very significant role in the rural economy in terms of providing employment, income potential and life support sustenance (Nygren *et al.*, 2006). World Bank (2001) estimates that one out of four of the world‘s poor depend directly or indirectly on forests for their livelihood. It is estimated that 20–25% of rural peoples’ income is obtained from environmental resources in developing countries (Vedeld *et al.*,2007) and act as safety nets in periods of crisis or during seasonal food shortages (Shackleton and Shackleton, 2004). The FAO estimates that forest industries contribute more than US450 billion to national incomes, contributing nearly 1 percent of the global GDP in 2008 and providing formal employment to 0.4% of the global labor force (FAO, 2012).

Forests also provide other sources of incomes and subsistence benefits, generate informal work opportunities, and constitute reservoirs of economic values that help ameliorate shocks to household incomes - particularly in rural areas in poor countries (Chomitz and Kumari, 1998). In many areas, forest and trees and the related environmental services play a major role for household income and livelihood security. While forests and trees are widely important among smallholders, dependency on them varies substantially. In some cases, forest and tree products are the principal source of income for families, as shown by Padoch and de Jong (1991) for Peru, and Henkemans (2001) for Bolivia. Evidence from Bolivia and Peru suggests that forest dependency increases when communities are located further away from urban centers (Stoian and Henkemans, 2000). Forests contribute enormously to the global energy supply as well as providing food, fodder, medicines, building materials and paper products. In recent years, attention has also been focused on the importance of non-wood forest products which include plants for food and medicinal purposes, fibers, dyes, animal fodder and other necessities. Indonesia, for example, earns an estimated US$120 million a year from rattans, resins, sandalwood, honey, natural silk, pharmaceutical and cosmetic compounds (FAO,1995), while the local production of bidi cigarette from the tendu leaf *(Diospyros melanoxylon)* in India provides part-time employment for up to half a million women (FAO, 1993). In South Africa, according to valuations carried out by Dlamini and Geldenhuys (2011), the value of NTFPs is somewhere around $49.38 million. Medicinal plants are valued at $32.1 million and fuelwood at $13.5 million. Babulo *et al*. (2008) in Ethiopia noted that in a sample of 360 households from 12 villages forest environmental resources contribute the second largest share of income after crops ahead of livestock. An IIED/Forest Connect Report on Nepal (2012) found that one-third of rural people in Nepal collect and trade forest products, which generated US7.66 million in 2010 and benefitted 78,828 participants. In this connection, it has been estimated that more than 200 million people in the tropics live in the forests and in some parts of Africa as much as 70 per cent of animal protein comes from forest games such as birds and rodents (FAO, 2005). In the case of Uganda, forest-based cash is raised first and foremost from the sale of fuel wood and charcoal (36% of all sales), followed by the

sale of house-building materials (30%) and forest foods (21%). Money raised from the forest as well as from other sources is used to invest in livestock (a rapid multiplier of wealth if droughts and wars do not intervene) and school-fees (Shepherd *et al*., 2012*).* These investments increase shorter-term and longer-term resilience to shocks. It has been suggested that the average annual household income from NTFP trade in Central Africa ranges between 25 and 40% and goes up to 80%. For understorey lianas sold for food, women harvesters can earn $98-110 per month while wholesalers can make $429 in Brazzaville and retailers in Central African Republic make $132 on average per month (Ingram *et al*., 2005).

Income from forest resources is common strategy of the poor to complement agricultural income from small and marginal land holdings (Dasgupta and Maler, 1993). It is a coping strategy by the poor to mitigate the risk inherent in the subsistence agriculture. WCFSD (1999) noted that an estimated 350 million people depend almost entirely for their subsistence and survival needs on forests and that another 1 billion people depend on forests and trees for fuel wood, food and fodder. Estimated amount of 1.6 billion rural people are dependent on forests to some extent, 1 billion out of 1.2 billion extreme poor depend on forest resources for all or part of their livelihoods and 300 – 350 million people are highly dependent on forests and live within or adjacent to dense forests on which they depend for their subsistence and income (Chao, 2012). Billions more, including people in cities, depend on forest resources for food, traditional and modern medicines, construction materials, and energy sources. Studies suggest that ecosystem services and other non-marketed goods account for between 47% and 89% of the total source of livelihood for rural and forest-dwelling poor households (TEEB, 2010). Forest resources are crucial for rural livelihoods as well as for industrial income as a contributor to the national economic growth. Such industry is estimated to generate $40million annually and employs 80 000 people (Nield *et al.*, 1999). Money earned from the sale of forest products has been shown to complement agricultural income and provide financial cost of health, and house hold expenses (Arnold and Ruiz, 2001).

A study in Honduras shown that, although NTFP extraction has a low annual value it can provide insurance in the case of unexpected losses (Godoy *et al.*, 1997). Forest products are extracted in order to smooth the household‘s consumption in case of low crop returns (Shackleton and Shackleton, 2004). It is sometimes difficult to recognize ecosystem services and to quantify them accurately, partly because they often provide indirect benefits, meaning that they remain poorly understood in relation to their importance (Myers, 1996). Consequently, the World Bank (2004) declared that the continued inability to determine and clearly project the monetary value of ecosystem goods and services is likely to result in the continued loss of valued ecosystems which is detrimental for world societies and the economy.

2.5 Factors influencing utilization of forest provisioning ecosystem services

There must be a balance between resource restriction and resource use if provisioning services are to be exploited by local communities today. Brown *et al*. (2000) argue that the designation and sustainable use of protected areas can also lead to a more reliable resource base, whilst safeguarding the natural resources of a region for future use. The level of forest use and the degree of reliance on forest products differ across households. The factors that condition a household’s reliance on a particular economic activity and on forest products in particular may vary. Past studies by Volker and Waibel (2010) have pointed out that forest utilization is affected by factor resource endowment of the household, the household’s demographic and economic characteristics, and exogenous factors such groups who are economically and socially marginalized such as women, the very poor, ethnic minorities and those within lower socioeconomic classes or markets, commodity prices and technologies. Babulo *et al*. (2008) states that the level of use and degree of reliance on forests and its importance as a source of subsistence varies geographically, over time and across communities and hence since communities are not homogenous in nature, variation on household reliance on forests is inevitable.

Determining the attributes of a household that are related to dependence on the forest will help predict which households are likely targets for conservation. Income from forest resources is common strategy of the poor to complement agricultural income from small and marginal land holdings (Dasgupta and Maler, 1993). In an overview of case studies Vedeld *et al.* (2004) found out that forest products contribute between 20% and 40% of total income of households in forest areas, and that poor households tend to be disproportionately dependent on forest resources especially fuel wood and fodder. Within rural forest communities there are also often gender differences in forest use and political power. In the Jau National Park, Brazil, hunting and fishing is a predominantly male activity, whereas food preparation, collection of forest products to supplement diet, fuelwood gathering and agriculture is mainly women's work (Oliveira & Anderson, 1999). Similar differences in use have been shown in other forest communities (Ongugo, 2007). Despite this lack of tenure and control, women's work and incomes can have a greater contribution to household welfare and security (IFAD, 1999).

Other factors known to influence the extent to which a household depends on forest resources include distance, infrastructure and wealth. Distance from the forest will mainly dictate whether a household depend almost fully on the forest or not for its needs. Some research findings had shown that poorer households depend totally on forest products due to limited access to alternative sources of income, while the more wealthy households mainly use the forest for larger commercial activities (Wass, 1995). IUCN work has shown that, depending on location, at least twice as many species are gathered for home consumption as for sale (Shepherd, 2012). Forests and forest products also contribute to livelihoods by providing increased income, improved food security, reduced vulnerability, a more sustainable use of the natural resource base, and an increased well-being (Warner, 2000). This is critical for poor households as in Zambia for some of the poorest forest-adjacent families obtain up to 80% of their livelihoods from forests (PFAP II, 2005a). Wealthy households and individuals often have more political influence within the community, which means that they are more likely to gain the benefits provided by protected areas than are the poor. Differences in forest use, tenure and power can mean that protected area

designation has different impacts on men and women. Women often make more use of forest resources, but not necessarily the same resources that men use. Resource restrictions will therefore differentially affect the livelihoods of men and women: for instance, some protected areas allow NTFP and firewood collection, but ban hunting (Allendorf *et al.*, 2006). Age is directly related to livelihood activities and forest dependency, with the young and old being particularly dependent on forest resources. In the Ranomafana National Park, old men are more likely to pursue shifting cultivation than irrigated agriculture, because it requires less heavy labour. Similarly, households headed by young men were more dependent on shifting cultivation because they had not yet inherited land (Ferraro, 2002). Where standards of living are rising, younger people may have had more access to formal education than older people. Education can provide increased employment opportunities, and therefore alternative livelihood strategies (Kideghesho, 2007).

2.6 Regulatory framework governing access of forest provisioning ecosystem services

The history of control of forests by the government for conservation purposes in Kenya dates as far back as the colonial period. By 1908, the colonial government had put all the major forest areas in the country under the control of the government. The colonial government emphasized that "the public good was best served through the protection of forests and water resources, even if this meant the displacement of the local communities"(Kamugisha *et al.*, 1997). In the East African region, policy issues in management of mountain forests are deliberated upon under the umbrella of the East Africa Community which oversees the East African Treaty of 1999 (Better Globe, 2009).By 1990 the total forest areas gazetted was about 1 930 000ha and the process of gazettement still continues (Wass, 1995).

The management of forest resources in Kenya is guided by the National Forest Policy supported by the Forest Act (Wass, 1995). The Forest Department under the Ministry of Environment and Natural Resources is responsible for all the gazetted forests. The

main activities of the Forest Department include active management of plantations, law enforcement to control illegal extraction, licensing of extraction of forest products and fire protection. The Kenya Wildlife Service (KWS) was created as a parastatal in 1990 to control national parks countrywide. KWS works closely with the Forest Department and aims at conserving the natural environment and its flora and fauna for future generations. The organization also aims at using wildlife resources of Kenya sustainably for the economic development of the nation and for the benefit of the people living in wildlife areas.

Terefe (2003) on his side stated that community participation is very crucial to overcome the rate of deforestation. Historically, forests have played a major role to influence patterns of economic development, supporting livelihoods, helping structure economic change, and promoting sustainable growth. There are existing conflicts between the objectives of the conservation programmes and those of the local communities (Salafsky and Wollenberg, 2000). In Kenya, the conflict between the Kenya Forest Department and the forest dwellers has increased since the creation of the Forest Reserves, which began during the colonial periods. Recent conflicts have been recorded in Mau forests Mt. Elgon forest and Mt. Kenya forest. In the past, policy makers, forest economists and foresters have viewed forests primarily as a source of national revenue with timber as the dominant product (Tewari, 2004). However, in an era of fast-declining old-growth forests, great significance is attached nowadays to forest products besides timber, that is, non-timber forest products. Forest also help in maintaining livelihoods indirectly through watershed protection, grazing potential for livestock, live fences, windbreaks, and soil conservation (FAO, 2007).

The extended use and exploitation of forest resources even before the industrial revolution had led to efforts to conserve forested areas and plant new trees in specific regions of the world. In Europe, France and Germany were leaders in developing policies in the17th and 18th centuries to regulate the use of and to protect forests. The emergence of forestry as a science with its focus on sustainable timber production was also a hallmark of colonial forest departments founded all over the developing world by European colonizers (Barton, 2001). The introduction of a system of parks and

reserves was brought by the colonial government in the pretext of protecting resources and wildlife in them from Africans who were thought to have threatened their existence (Ogutu *et al*., 1997). This has been characterized by the government or local agencies identifying an area based on resource endowment, displacing the local people, outlawing human settlement and designating it as a protected area. Now, conservation in Kenya seems to be an increasing challenge (Mwale 2000) partly because of exclusion of local community interests and the unprecedented increase in world's population. The Kenya Wildlife Service advocates a total ban on use of the forest's products, and members of the community must walk long distances to collect firewood from unprotected forest blocks. This has led to tension between the community and the Service and disregard of the National Park's regulations. The Kenya Wildlife Service (KWS) was created by the Kenyan government to ensure the protection and conservation of the natural environment and its fauna and flora as a world heritage for the benefit of present and future generations (Okungu, 2005).

Mogoi *et al*. (2012) further recommended that taking into consideration the benefits and costs at the household level are crucial because this is the level where conservation management measures should be undertaken. Hence, this calls for thorough analysis of households' interaction with the forest ecosystems including the benefits they derive from the ecosystem as well as the costs they incur to ensure sustainable community involvement in the management of forests (Matiku *et al*., 2013). As Bruner *et al*. (2001) suggest, many governments contribute to forest resource protection problems by adopting policies and legislation that are in serious conflict with the fundamental social and physical setting.

2.8 Conceptual Framework

Livelihoods of smallholder farmers adjacent protected forests is dependent on

Extraction of forestry provisioning ecosystem services from the adjacent forest. Household income realized through sell of the forestry products such as firewood, charcoal and game meat also determines the condition of adjacent community

livelihoods. The increased income can cater for other needs such as food, educate children, and pay for drugs and hospital bills among others. These are notable indicators of improved living standards and hence livelihoods. Socioeconomic factors such as distance from the forest, gender, education level of household head, monthly income, size of land and age impact directly on dependency of the forestry provisioning ecosystem services from the hills.

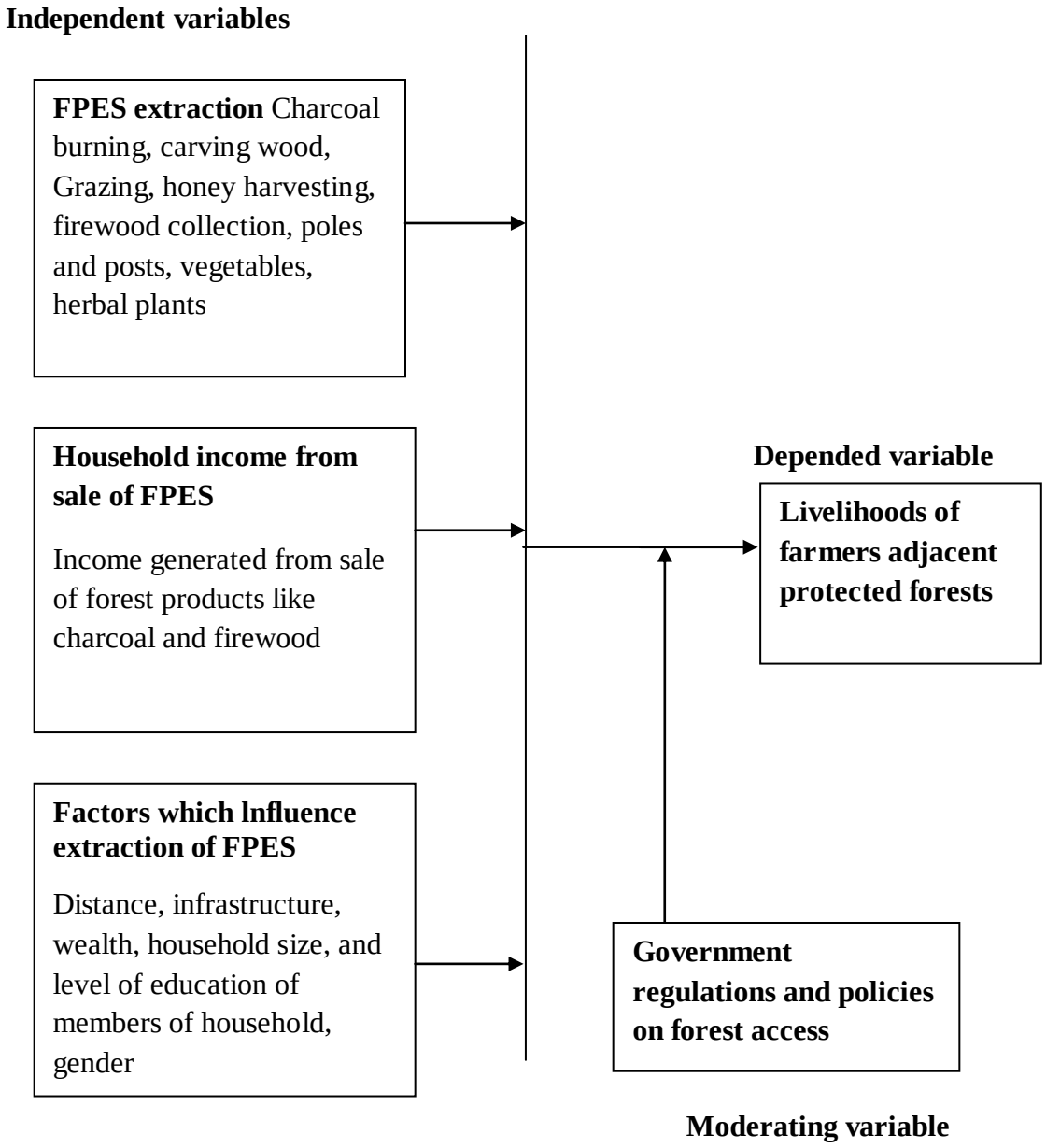

Figure 2.1 Conceptual Framework

Government policies and regulations are moderating variables. According to Pacheco *et al*. (2008a), Forestry regulatory frameworks influence how local communities access and manage forests, but also how they interact with markets. This is true because if the policies prohibit entry to the forests the communities adjacent to the forests will be restricted to resource extraction and entrance will only mean going against. Both independent and moderating variables determine the situation of livelihoods of small holder farmers, which is the dependent variable. Policy enforcement could be improved with the involvement of rural people in forest conservation by addressing the needs of the dependent communities and their livelihood (Illukpitiya & Yanagida, 2008).

The main indicators of appreciation of the role played by forests in improvement of livelihoods of smallholder farmers adjacent forests include increased flora and fauna, reduced extraction of the FPES, diversified means of livelihood and general improvement in forest conservation measures by forest bordering communities.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter first presents the background information of the study area. The second part is addressing research design used in the study. It also illustrates sampling procedures, data collection and analysis method.

3.2 Study area

3.2.1 General Location

The study area lies in Makueni County which covers an area of 8,034.7 Km^2. The County borders Kajiado to the West, Taita Taveta to the South, Kitui to the East and Machakos to the North (Figure 3.1). It lies between Latitude 1º 35´ and 30º 00´ South and Longitude 37º10´ and 38º 30´East. The average land holding in Makueni area is between 2-5 acres per household (Kenya National Bureau of Statistics, 2010). Most of the people live below poverty line, and as a result, they greatly rely on natural resources to improve their livelihood which affects their activities and conservation.

Makueni County lies in the arid and semi-arid zones of the eastern region of the country. Its major physical features include the volcanic Chyulu hills forest which lies along the Southwest border of the County in Kibwezi West Constituency. The Chyulu hills forest is made up of a series of hills of varying altitude, and form a narrow chain of quaternary volcanoes with a Northwest to Southeast elongation covering nearly 100 km long and up to 30 km wide, between Emali and Mtito Andei townships which lie along the Nairobi-Mombasa highway (Spath *et al*., 2000). The general landscape in the Chyulu Hills forest is characterized by an arid to semi-arid environment, with an annual rainfall of 500mm to 1200mm, and evaporation ranging between 1800mm and 2200mm (Muriuki *et al.*, 2011).

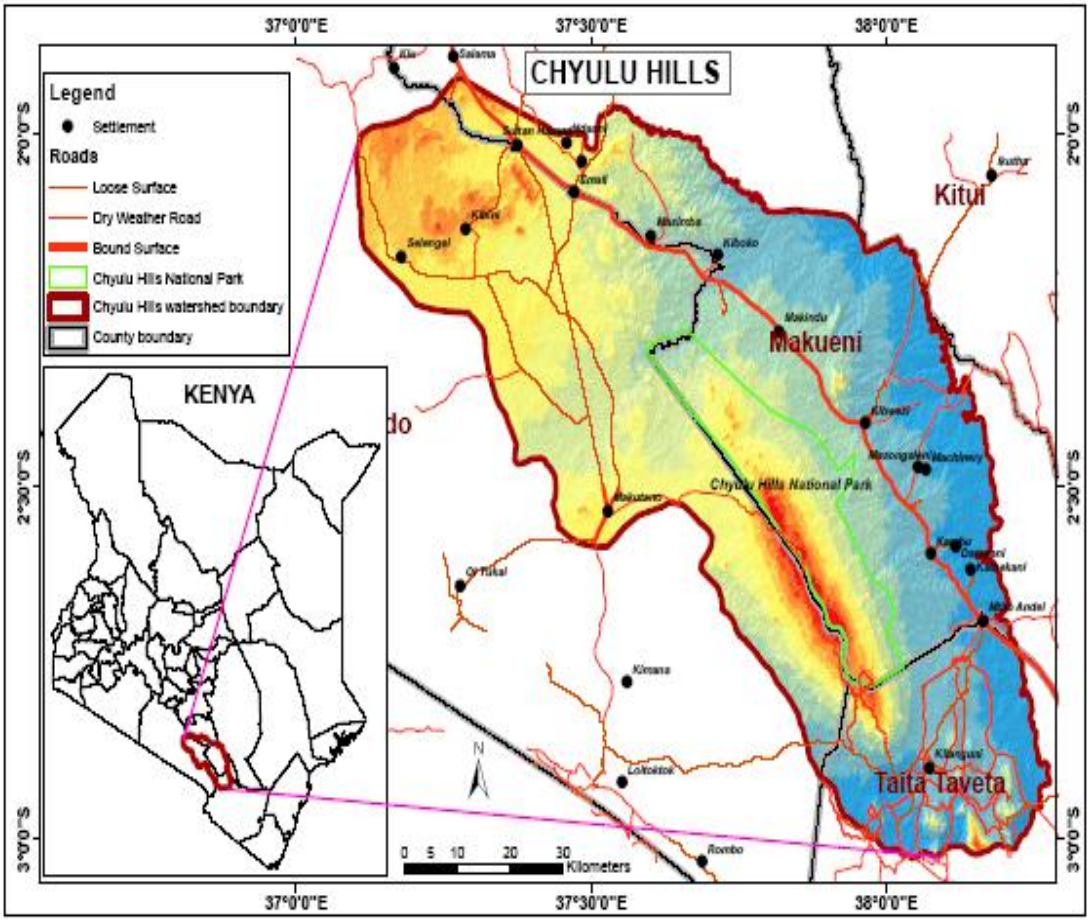

Figure 3.1 Spatial location of the Chyulu Hills in South Eastern Kenya

Source: Kiringe, J. W., Mwaura, F., Wandera, P., Kimeu, M. & Gachuga, F. (2015).

The forest provides most of the goods and services to majority which forms the basis of their subsistence. The forest adjacent communities view the forest as a reservoir of goods and services, and as a source of livelihoods to thousands of people living within kilometers of forest boundaries and benefit from a whole range of goods and services from the forest (Kamugisha *et al*., 1997). Chyulu hills forest has been a very important resource to the adjacent communities in terms of extraction of forest provisioning ecosystem services although to some level illegal logging and charcoal production are contributing immensely to the degradation of the forest. These

collection activities have led to the over exploitation of the forest resources without paying corresponding attention to the sustainability and continued supply of these resources. This of course has its own contribution to unpleasant environmental situations such as global warming and climate change, desertification, loss of species and habitat. The importance of these forest products makes it imperative to employ a sustainable management mechanism for the rapidly depleted forest resources so as to maintain an uninterrupted supply of these resources for the future generation. There is necessity of ensuring clear incentives for communities to limit local resource use to sustainable levels, including the provision of non-forest alternative sources of income and subsistence and of legitimate participation in forest management are cited as important components of sustainable natural resource management strategies across East Africa (Emerton and Mogaka, 1996).

The region however has a history of high-density squatter settlements, many of whom still lived in squatter camps in 2008/2009. Absorbing illegal settlers from all the major ethnic groups in Kenya, it has a track record of stark confrontations between land hungry peasants, the Kenya Wildlife Service, civil administration and local politicians (Freeman *et al*., 2004). Contestations over land use between squatters and the Kenya Wildlife Service became protracted after gazetting of Chyulu Hills National Park (Okello and Tome, 2007). This was done in two phases, with the lower Chyulu Hills being upgraded to national park status in 1983 (400 km^2), followed by the upper Chyulu Hills extension (380 km^2) in 1995. Both were done without adequate consultation with the surrounding community, and without providing for adequate compensation for displaced households. Between 1988 and 1990 many squatters were violently evicted from the Chyulu Hills National Park by the Kenya Wildlife Service and apprehended for illegal occupation and harvesting sandalwood (*Osyris lanceolata*), a protected herb.

3.2.2 Specific study sites

Specifically, the study was undertaken within approximately 0-12 Km distance from Chyulu hills forest. The study covered two Sub- locations, Mang'elete of Mtito Andei Division and Kiu of Makindu Division where both Divisions lie in Makueni County (Figure 3.2). The two Sub-locations were purposively selected as Mang'elete lies on the fenced border of the forest while Kiu lies on the side lacking electric fence to demarcate the hills forest from the rest of private land. A comparison on community-forest interactions was to be done between the two Sub-locations so as to determine whether the presence of electric fence on one of the Sub-location would restrict access to the forest resources or not. The study sites mainly comprised of smallscale subsistence agriculture with almost all the natural habitat having been cleared. The area surrounding the forest is densely populated and intensively used for farming with almost no permanent grassland or forest. There is widespread dependence on the forest by the local people who obtain fire wood, thatch grass, medicinal plants and also graze in the forest. There are incidences of illegal logging, charcoal burning and hunting of small animals in the forest. The forest has been subjected to over-exploitation of high value commercial tree species such as Elgon teak (*Olea welwitschii*) especially in the natural forest. Over the past 5 years, the forest cover and the tree density has decreased due to extensive clear felling of plantations without re-planting by large timber processing companies. There is also uncontrolled utilization of forest by residents such as illegal harvesting of high value trees and increase in number of forest users over time.

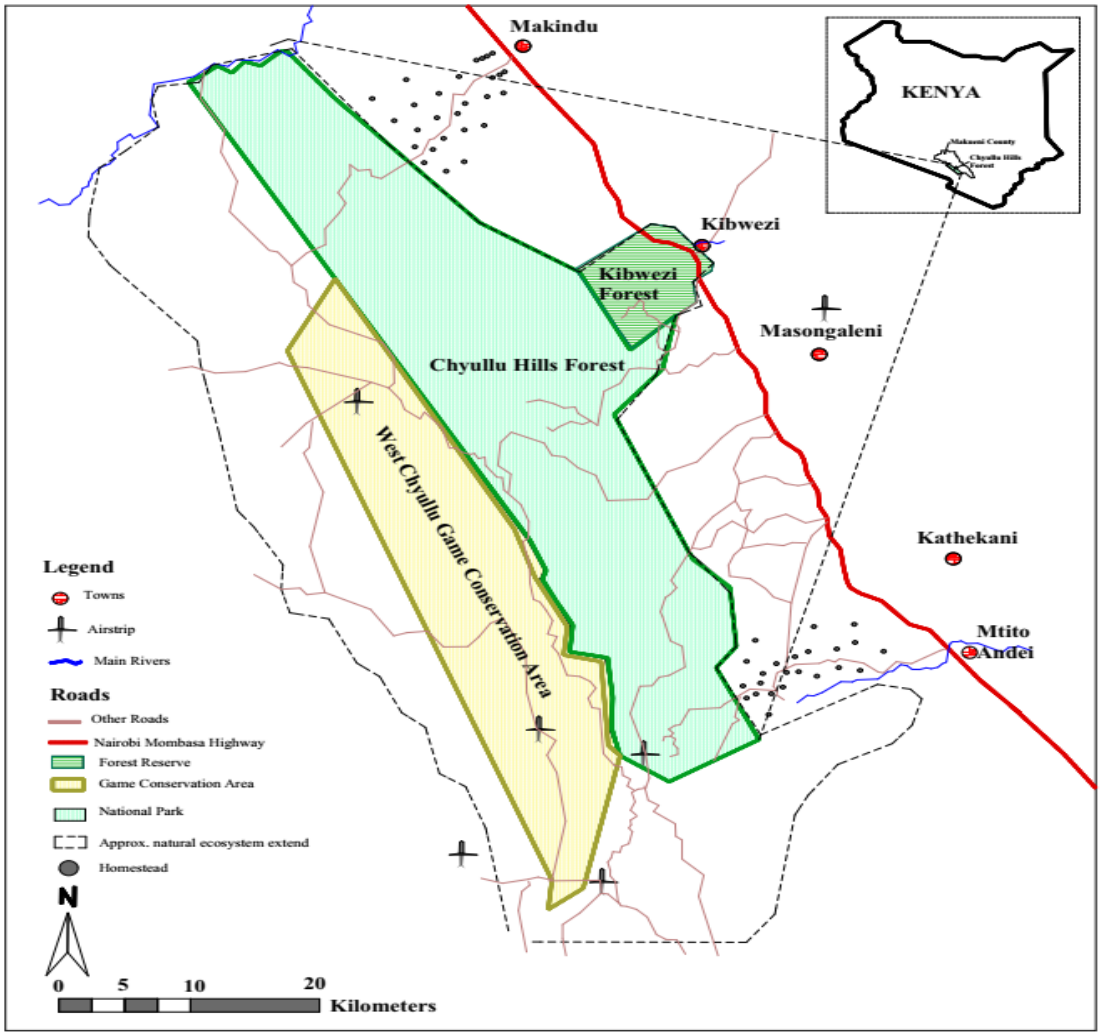

Figure 3.2 The specific study sites

Source: Adopted and Modified from Kenya Wildlife Services, 2014

3.2.3 Physical and agro-climatic conditions

The climate of the study area is influenced by altitude and physical features, that is, lakes, swamps, escarpments, hills and mountains in the neighborhood. Rainfall is normally received twice a year with short rains occurring between October and December while the long rains are generally received between March and May (Muriuki *et al*., 2011). May, June and July are normally the coldest months while the hottest months are between September and February (Kamau, 2013). The mean

annual rainfall in the study sites ranges from 300 to 800 mm. However, heavy rains occur around Chyulu hills, receiving 1,250 mm of rainfall per annum. The rainfall for the two wet seasons indicates that most areas receive 50 per cent of the annual rainfall during the March-May period and 30 per cent during the October-December period (Muriuki *et al*., 2011). The short rains (October-December) are more reliable compared to the long rains (March-May). Temperature ranges from 20 degrees to 30 degrees centigrade.

3.2.4 Geology and soil

The area is overlain by a strong rocky basement with isolated pockets of well drained clay soils which have quartz and feldspar grains and felsic gravel rock fragments. The soil depths (thickness) vary from between 1m (upslope) to nearly 2.0m the down slope sides of the Neighbourhood Rivers. Generally, soil types in the farms include nitisols which are well drained, porous, with high moisture and stablestructure, vertisols characterized by black cotton soil, poor drainage, high organic matter and antisols which are well drained, porous and contain high organic matter (Pringle & Quayle, 2014).

3.2.5 Vegetation

Chyulu hills have a rich heterogeneous vegetation community consisting of woodlands, bush land, grassland and forest patches which are scattered in different parts of the landscape depending on elevation, landform, rainfall, soils and prevalence of fire (Pringle & Quayle, 2014). The forest patches are common along the spines of the volcanic cinder cones with the largest patches located around the highest peaks in the central-southern sector of the hills, and are characterized as moist, dense cloud forest (Wildlife Works, 2014). Savannah woodland and riverine species dominate the villages under study. *Acacia eliator*; a key riverine species dominate the indigenous species at the study area and the banks of the neighbourhood seasonal rivers. Other

savannah woodland and riverine species in the study area and its neighbourhood include *Adansonia digitata, Vangueria apiculata, Phoenix reclinata, Ficus sycomorus, Grewia bicolour, Vangueria infausta, Garcinia livingstonei, Acacia tortilis, Acacia mellifera, Acacia seyal, Acacia senegal, Lannea alata, Vangueria madagascariensis, Balanites aegyptica, Acacia xanthophloea, Caesalpinia volkensii, Ficus sur, Acacia nilotica, Rubus pinnatus, Caesalpinia decapetala* among others. The indigenous species provide a range of benefits to the locals such as fuel wood, timber, poles, posts, fodder, shade and soil conservation among others.

3.2.6 Hydrology, drainage and water resources

The young nature of the volcanic lava fields in the area makes them very porous which enables them to intercept most of the rainwater in the Chyulu Hills more or less like a giant sponge such that there is almost no surface runoff. This process creates substantial subterranean water flow which works its way between the volcanic and basement rocks, and later emerges either as rivers, streams and springs in the foot slopes of the Chyulu hills. Because of this, the hills have been considered as a critical water recharge landscape in the region (Pringle & Quayle 2014). The percolating water specifically emerges at the Mzima springs some 20km south of Chyulu hills. The springs drain into Tsavo and Athi Rivers (Okello, 2005).

3.2.7 Agriculture and livestock

Mang'elete and Kiu Sub-locations are characterized by low and unreliable rainfall, marginal agricultural lands, dispersed populations and low fertility soils. The main crops produced in the area are maize, green grams, pigeon peas and sorghum. Mangoes, pawpaw and oranges are also being produced. Farmers in the area practice subsistence mixed farming, limited commercial farming, lumbering, beekeeping and smallscale trade in handicrafts. Wild khat (Miraa) grows on the hills and is picked by

local people. The study area falls in an agro pastoral region. Livestock production is a major economic activity in the area. Common livestock in the area include cattle, goats, sheep and poultry. Most farmers in the area keep livestock to supplement crops because the crop yields in the area are not reliable due to unreliable and poorly distributed rainfall and invasion by wildlife.

3.2.8 Wildlife

The Chyulu hills forest is home to a spectacular array of wildlife which stray from the neighbouring Tsavo West National Park. Most famously, the iconic 'big five', that is: the African elephant (*Loxodonta Africana*), Black rhinoceros (*Diceros bicornis*), African buffalo (*Syncerus caffer*), Leopard (*Panthera pardus*) and Lion (*Panthera leo*). In addition to these there is a diverse mammal community of predators such as jackal (Canis *spp.)*, wild dog (*Lycaon pictus*)**,** cheetah (*Acinonyx jubatus*), spotted and striped hyena (*Crocuta crocuta* and *Hyaena hyaena*), as well as large numbers of antelopes, including Thompson's (*Eudorcas thomsonii*) and Grant's gazelle (*Nanger granti*), eland (*Taurotragus oryx*), bushbuck (*Tragelaphus scriptus*), mountain reedbuck (*Redunca fulvorufula*), steinbok (*Rhapicerus campestris*), Coke's hartebeest (*Alcelaphus buselaphus cokii*), fringe-eared oryx (*Oryx beisa callotis*), gerenuk (*Litocranius walleri*), impala (*Aepyceros melampus*), lesser kudu (*Tragelaphus imberbis*), wildebeest (*Connochaetes taurinus*) and Kirk's Dikdik (*Madoqua kirkii*).

3.3 Research Design

The research design used in the study was descriptive survey. It aimed at collecting information from respondents on their interactions with the Chyulu hills forest reserve. Both primary and secondary data was used. Primary data was obtained using questionnaires while secondary data from internet, journals and books. The target population of this study was the smallholder farmers in the study area. The unit of study was the household and the head of the household was the respondent.

Table 3.1: Population Size of the two Sub locations

Sub-location	Households	Males	Females
Mang'elete	3,854	9,855	9,695
Kiu	1,307	3,044	2,913
Totals	**5,161**	**12,899**	**12,605**

Source: Kenya Population and Housing Census, 2009

A sample size of 62 respondents was selected from the total 5,161 households (Table 3.1) from the two sub-locations using the coefficient of variation method (Nassiuma, 2000). Nassiuma (2000) says for most surveys or experiments, a coefficient of variation in the range of 21% to 30% and a standard error ranging between 2% to 5% is acceptable. This study used a coefficient of variation of 30% and a standard error of 4%. The formula given by Nassiuma (2000) is:

$$n = \frac{NC^2}{C^2 + (N-1)\,e^2}$$

Where:

n = sample size

N= population

C= coefficient of variation

e = standard error

$$n = \frac{5161 \times (30\%)^2}{(30\%)^2 + (5161 - 1)\,(0.04)^2} = 55.65$$

Therefore, 56 respondents

To cater for attrition, respondent refusal to participate and other similar circumstances, Mugenda & Mugenda (1999), proposes that 10% of the calculated sample size be added. Thus 6 extra respondents were added to make a total sample size of 62. Thirty one (31) households were selected from each Sub-location as it was assumed that the study was purposive and majorly targeted those who would access the forest. The study also compared resource use from Chyulu hills forest between the two Sub-locations hence equal number of households from the Sub-locations was selected.

3.4 Sampling procedure and techniques

Multi stage sampling procedure which involved stratified sampling and random sampling techniques were used to select the respondents. The first stage involved stratified sampling of the Sub-locations in Mtito Andei Division and Makindu Division based on their proximity to Chyulu hills and picking those that had lied on the side of Chyulu hills using Nairobi-Mombasa highway as the reference point. The two Divisions were purposively selected because Makindu lied on the unfenced border of Chyulu hills forest while Mtito Andei lied on the border with electric fence hence the need to compare resource extraction of the two. Two roads leading to the Chyulu hills forest from the Nairobi – Mombasa highway were identified one in every selected Division. The choice of the roads was influenced by their proximity to two main markets in each Division that is Mtito Andei and Makindu markets. It was believed that the FPES find market in the two main markets centers. The selected road in Makindu Division lied in Kiu Sub-location while in Mtito Andei Division lied in Mang'elete Sub-location. The paths acted as reference points for the data collection as it is believed that forest adjacent dwellers use the paths leading to the forest when going for forest provisioning ecosystem services from the forest. Reconnaissance survey had showed that households are concentrated near defined roads in the two Divisions under study hence the roads acted as reference points in administering the questionnaires. All the households lying within the selected distance stood an equal chance of being interviewed regardless of distance from the forest. Heads of

households chosen for interviews in this study were in most cases male household heads or the oldest male (Kathuri and Pals, 1993). In households where there were no males, a wife to the head of the household or the oldest female was interviewed. The unit of analysis was the household head, and in exceptional circumstances, any household member who was 18 years and above was considered in lieu of the household head. A transect walk following the paths was done selecting the fifth household alternately on either side of the road. On the understanding that the forest adjacent populations in the area are similar in many aspects, the survey drew a sample size of 62 households from the two Sub-locations 31 from each Sub-location. The decision over the total number of respondents selected was guided by World Agroforestry Centre procedural guidelines (Nyariki *et al*. 2005) for characterization of studies at household level. They suggest that a sample size of 40 to 80 households spread over two or three communities which have populations with similar characteristics and attitudes is adequate to make inferences about a larger population. Approximately, the distance from Nairobi -Mombasa highway to Chyulu hills forest is 12 km on both Sub-locations therefore a comparison was to be made on contribution of Chyulu forest to the livelihoods of smallholder farmers close to the forest and those situated far away from the forest.

3.5 Data collection methods and instruments

Primary data was collected through interviews. Questionnaire was used as the guide of the interviews. Discussions and observations were also used. The questionnaires included fixed response questions on the resources they obtain from the forest, the measures they use in conserving the forest and open - ended questions were included to elicit more extensive discussions of some of the issues raised. These included perceptions and attitudes towards the conservation institutions involved level of community, involvement and relationship with all the stakeholders involved in the management of the forest. Secondary data was obtained through review of relevant literature from libraries and internet including resource materials such as relevant

policies and laws, journals, annual reports, books, workshop proceedings and periodicals.

3.6 Type of Data Collected

The required data in each objective are as shown in Table 3.2 below.

Table 3.2: Data requirements

Objective	Required data	Instrument
1. To identify the type of FPES provided by Chyulu hills forest to the adjacent communities.	Specific type of FPES; examples, Firewood, Charcoal Burning	Household survey questionnaire
2. To evaluate contribution of FPES to the house hold income of smallholder farmers in Chyulu hills forest.	Money got from sale of forest products, Value of the forest products	Household survey questionnaire
3. To assess factors influencing utilization of the Chyulu hills FPES	Factors influencing smallholder farmers' utilization of forest products	Household survey questionnaire

3.7 Methods of data analysis

Statistical Package for Social Sciences (SPSS) was used to analyze the data. The data was analyzed after error correction and data editing from each questionnaire. For economic valuation of forest resources, the data obtained was converted to monetary terms for all tangible goods by using market price. This was done through generalizing the sample results to the wider population in order to estimate the population characteristics. Descriptive statistics tools were employed to analyze the data collected from respondents (Table 3.3).

Table 3.3: Method of data analysis

SN	Objective	Statistical analysis
1.	To identify the type of forestry provisioning ecosystem services provided by Chyulu hills forest to the adjacent communities.	Frequency distribution
2.	To evaluate contribution of forestry provisioning ecosystem services to the house hold income of small holder farmers in Chyulu hills forest	Frequency distribution Chi-square test of independence
3.	To assess factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services.	Logistic regression

Analysis also incorporated the implications of various statistical findings as well as the perceptions of the respondents. Presentation was done in form of tables, percentages and bar graphs. Logistic regression model was used to assess the factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations, Makueni County.

The model specification as outlined by Gujarati (2004) and applied by Ndung'u and Bhardwaj (2015) is presented below, albeit in reduced form.

$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10}$..... (1)

Where Y_i is a dichotomous dependent variable (extraction of FPES or not, specified as yes=1, no = 2). α is the Y- intercept whereas β_1- β_{10} is a set of coefficients to be estimated. X_1-X_{10} are explanatory variables (factors) hypothesized (Table 3.2) based on theory and related empirical work, to influence extraction of FPES in Kiu and Mang'elete Sub-locations, Makueni County.

Equation (1) can be rewritten as;

Logit (p) = log (p / 1- p) = $\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10}$.....(2)

Where p is probability that Y= 1 i.e. p =probability (Y= 1). In terms of probability, equation (2) can be expressed as;

$p = \exp(\alpha + \beta_1 X_1 + ... + \beta_{10} X_{10}) / 1 + \exp \alpha + \beta_1 X_1 + ... + \beta_{10} X_{10}$.....(3)

Table 3.4 Description of explanatory variables to predict utilization of the Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations, Makueni County

Variable	Description	Expected sign
X_1	Occupation (1=skilled; 2=unskilled)	+
X_2	Gender of household head (1= male; 2= female)	+/-
X_3	Age (Age of household head in years)	+/-
X_4	Household size(number of family members in household)	+
X_5	Marital status (1= married; 2= otherwise)	+
X_6	Education level (1= educated; 2= no formal education)	+
X_7	Land size (in acres)	+
X_8	Distance to the forest(how far the farmer is from the forest in Km)	+
X_9	Average monthly income	+
X_{10}	Presence of fence (1= yes; 2= no)	+

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the findings of the study on the basis of data collected from the respondents and in relation to the objectives of the study. It first highlights the most salient socio-economic attributes of the respondents, the basis upon which other findings are anchored.

4.2 Response rate in Kiu and Mang'elete Sub-locations, Makueni County

In this study, a total number of 62 questionnaires were administered and a total number of 60 questionnaires were returned for analysis (Table 4.1). This represented 97% response rate. Therefore, the 97% response rate was sufficient for analysis as according to Mugenda and Mugenda (2003), a response rate of 50% is acceptable for analysis, 60% is good, and 70% is very good and beyond 80% is excellent. Therefore, the response rate in this study was excellent and sufficient for analysis.

Table 4.1: Response Rate in Kiu and Mang'elete Sub-locations

Response rate	**Sub-location**		**Totals**	**Percentage**
	Mang'elete	**Kiu**		
Returned questionnaires	30	30	60	97
Non returned questionnaires	1	1	2	3
Totals	**31**	**31**	**62**	**100**

4.3 Socio-economic characteristics of respondents

The socio-economic characteristics of the respondents presented in this section include gender, age, and marital status, occupation of the household head, education level of the household head, respondents' household size and monthly income. It was assumed that the selected socio economic characteristics influenced utilization of forestry provisioning ecosystem services from Chyulu hills forest.

4.3.1Gender of the household head

The results indicated that 86.7% and 76.7% of the households in Kiu and Mang'elete Sub-locations respectively were male-headed. (Figure 4.1).

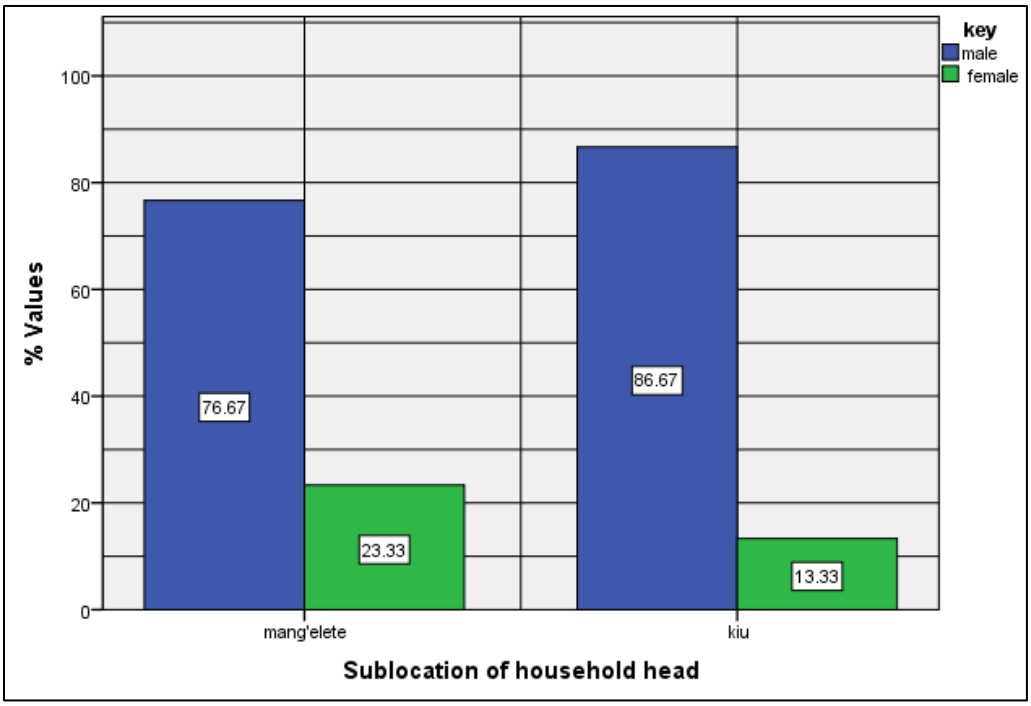

Figure 4.1: Percentage distributions of household heads by gender in Kiu and Mang'elete Sub-locations.

4.3.2 Age of the household head and household size

Table 4.2 reveals that the average household size is 6.1 and 6.4 persons in Kiu and Mang'elete Sub-locations, respectively and the mean age of the household head is 45.3 years and 47 years in Kiu and Mang'elete Sub-locations, respectively.

Table 4.2: Average household size of respondents and Mean age of household heads (years) in Mang'elete and Kiu Sub-locations

Sub- location	Mean household size (number)	Average age of household head (years)
Mang'elete	6.4	47
Kiu	6.1	45.3
Total	**6.3**	**46.1**

4.3.3 Education levels of the household head

A comparative analysis of education levels of the household heads (Figure 4.2) indicated that in Kiu Sub-location, 46.7% of the respondents had attained primary level education, 23.3% secondary level education, 16.7% college level education, 10.0% university level education and 3.3% did not go through any formal education. As for Mang'elete Sub-location 36.7% of the respondents had attained primary level education, 10.0% secondary level education, 26.7% college level education, 20.0% university level education and 6.7% did not go through any formal education.

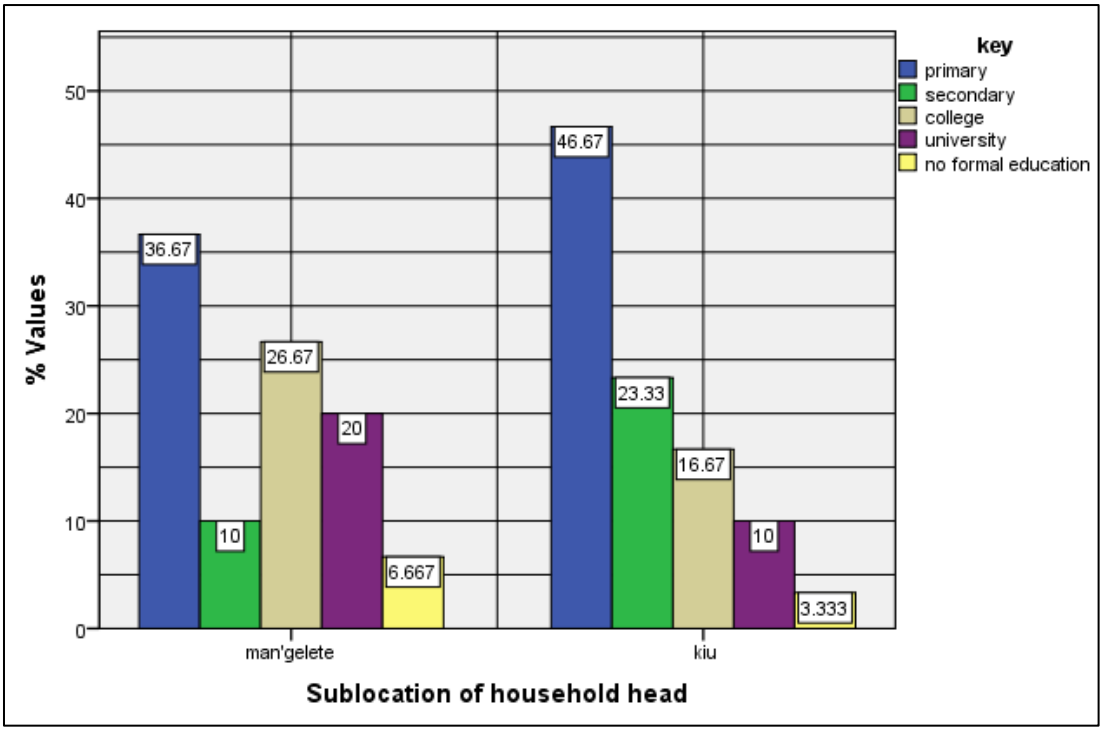

Figure 4.2: Percentage distribution of household heads by education levels in Kiu and Mang'elete Sub-locations

4.3.4 Marital status of respondents in Kiu and Mang'elete Sub-locations

The study revealed that, out of the total respondents in Kiu 73.3% were married, 13.3% single, 3.3% divorced and 10.0% widowed. This is compared with Mang'elete Sub-location whereby out of the total respondents 80.0% were married, 6.7% single, 3.3% divorced and 10.0% widowed.

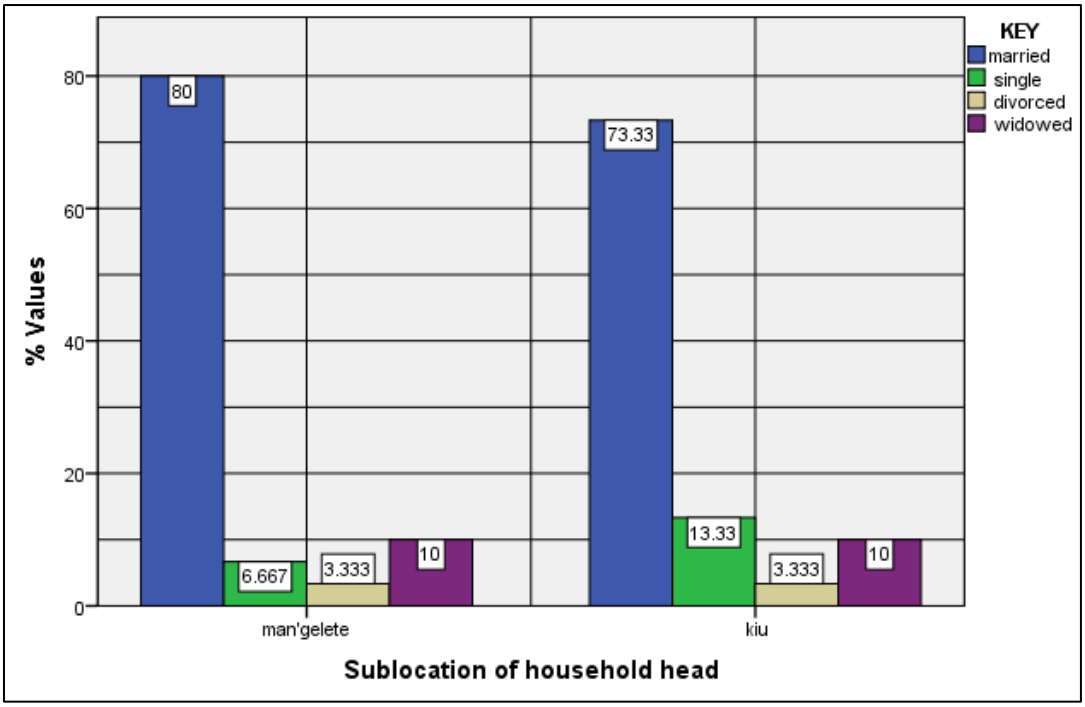

Figure 4.3: Percentage Marital status of respondents in Kiu and Mang'elete Sub-locations

4.3.5 Land size in Kiu and Mang'elete Sub-locations

The mean size of land in acres owned by each household was 4.6 and 5.1 acres in Kiu and Mang'elete Sub-locations, respectively. The results further indicate that the average size of land under cultivation in acres was 2.8 and 3.1 in Kiu and Mang'elete Sub-locations, respectively (Table 4.3).

Table 4.3: Mean land size and average size of cultivated land by respondents in Mang'elete and Kiu Sub-locations

Sub-location	House hold land size(acres)	Cultivated land(acres)
Mang'elete	5.1	3.1
Kiu	4.6	2.8
Total	**4.9**	**2.9**

4.4 Forestry provisioning ecosystem services extracted from Chyulu hills forest

4.4.1 Proportions of households extracting forest resources from Chyulu hills

Results presented in Table 4.4 showed that in Mang'elete Sub-location, 37.5% of the respondents extracted forest resources from Chyulu hills while 62.5% did not. In the case of Kiu Sub-location, 64.3% of the respondents extracted resources from Chyulu hills while 35.7 % did not.

Table 4.4: Proportions of households extracting FPES from Chyulu hills forest

Sub-location	Forest resource extraction		
	Those extracting (%)	Those not extracting (%)	Total
Mang'elete	37.5	62.5	100
Kiu	64.3	35.7	100

A chi-square test of independence was calculated comparing the frequency of forest resource extraction in Kiu and Mang'elete Sub-locations. A significant interaction was found ($X^2(11) = 22.17$, $p < 0.05$), indicating that the extraction was significantly influenced by the Sub-location of the respondent. More resources were extracted in Kiu sub-location compared to Mang'elete Sub-location**.**

4.4.2 FPES extracted from Chyulu hills forest by adjacent communities

Table 4.5 presents the different types of forest resources that were extracted from Chyulu hills. Out of the total respondents that extracted a particular resource from Mang'elete Sub-location, 31.6% extracted khat, 35.3% firewood, 31.2% charcoal, 16.7% medicinal plants, 35.7% poles and posts, 25.0% wild animals, 9.1% fruits, 17.6% timber, 21.4% fodder,11.1% wood for carving and 12.5% honey.

From Kiu Sub-location 68.4% extracted khat, 64.7% firewood, 68.8% charcoal, 83.3% medicinal plants, 64.3% poles and posts, 90.9% fruits, 82.4% timber, 78.6% fodder, 88.9% wood for carving and 87.5% honey. In addition, 75.0% hunted wild animals from the forest. Table 4.5 further shows the chi square test of independence values comparing the frequency of FPES extraction and Sub-location of the respondent. Results indicated that extraction of various FPES was significantly influenced by the Sub-location of the respondent. This included khat $X^2(1) = 4.16$, p-value=0.04), medicinal plants ($X^2(1) = 11.43$, p-value=0.00), fruits gathering ($X^2(1) = 9.02$, p-value=0.00), timber ($X^2(1) = 9.93$, p-value=0.00), fodder ($X^2(1) = 5.96$, p-value=0.01), carving wood ($X^2(1) = 6.41$, p-value=0.01), and honey ($X^2(1) = 5.19$, p-value=0.02). However, extraction of firewood ($X^2(1) = 2.05$, p-value=0.15), charcoal ($X^2(1) = 3.07$, p-value=0.08), poles and posts ($X^2(1) = 1.49$, p-value=0.22) and hunting for wild animals ($X^2(1) = 3.75$, p-value=0.05) was not significantly influenced by the Sub-location of the respondent.

Table 4.5: Forest provisioning ecosystem services extracted from Chyulu hills by the respondents

Forestry provisioning ecosystem services extracted from the forest	Sub-location		Chi square (X^2) value	p-value
	Mang'elete (%)	Kiu (%)		
1.Khat	31.6	68.4	4.16	0.041*
2.Firewood	35.3	64.7	2.05	0.152
3.Charcoal	31.2	68.8	3.07	0.080
4.Medicinal plants	16.7	83.3	11.43	0.001*
5.Poles and posts	35.7	64.3	1.49	0.222
6.Hunting for wild animals	25.0	75.0	3.75	0.053
7.Fruits gathering	9.1	90.9	9.02	0.003*
8.Timber	17.6	82.4	9.93	0.002*
9.Fodder	21.4	78.6	5.96	0.015*
10.Carving wood	11.1	88.9	6.41	0.011*
11.Honey	12.5	87.5	5.19	0.023*

Note:*Significance at 0.05 Significance level

4.5 Contribution of forestry provisioning ecosystem services to household income of smallholder farmers of Kiu and Mang'elete Sub-locations, Makueni County

4.5.1 Food resources extracted from Chyulu hills forest by adjacent communities

Food resources extracted from Chyulu hills forest were categorized into wild fruits, vegetables, game meat and honey. Table 4.6 shows proportions of respondents who extracted food resources from Chyulu hills. Results indicated that in Mang'elete Sub-location, 30.8% of the respondent's extracted wild fruits, 44.4% vegetables, 34.6% game meat and 12.5% honey. Similarly, in Kiu Sub-location, 69.2% of the respondents extracted wild fruits, 55.6% vegetables, 65.4% game meat and 87.5% honey. Table 4.6 further shows the chi square test of independence values comparing the frequency of food materials extraction with the Sub-location of the respondent. Results indicated that extraction of wild fruits ($X^2(1) = 6.79$, p-value=0.01), game meat ($X^2(1) = 4.34$, p-value=0.04) and honey ($X^2(1) = 5.19$, p-value=0.02) was significantly influenced by the Sub-location of the respondent. However, extraction of vegetables ($X^2(1) = 0.32$, p-value=0.57) was not significantly influenced by the Sub-location of the respondent.

Table 4.6: Food resources extracted from Chyulu hills forest by the respondents

Food resources extracted from the forest	Sub-location		Chi square(X^2) value	p-value
	Mang'elete N%	Kiu N%		
Wild fruits	30.8	69.2	6.79	0.01*
Vegetables	44.4	55.6	0.32	0.57
Game meat	34.6	65.4	4.34	0.04*
Honey	12.5	87.5	5.19	0.02*

Note:*Significance at 0.05 Significance level

4.5.2 Medicinal resources extracted from Chyulu hills forest by the respondents

Findings presented in Table 4.7 shows proportions of respondents who extracted medicinal resources from Chyulu hills. In Mang'elete Sub location, 45.0% extracted *Aloevera*, 47% *Azadirachta indica*, 39.1% *Grewia bicolor*, 50% *Solanum incanum*, 52.4% *Terminalia brownii*, 40% *Albizia anthelmintica* and 40% *Acacia nilotica*. This is compared with Kiu Sub location where 55% extracted *Azadirachta indica*, 52.6% *Azadirachta indica*, 60.9% *Grewia bicolor*, 50% *Solanum incanum*, 47.6% *Terminalia brownii*, 60.0% *Albizia anthelmintica* and 60% *Acacia nilotica*.

A chi square test of independence values comparing the frequency of medicinal plants extraction in Kiu and Mang'elete Sub-locations (Table 4.7) shows that all medicinal plants extraction ($p > 0.05$) was not influenced by the Sub-location of the respondent. However, the extraction of medicinal plants was generally higher in Kiu compared to Mang'elete Sub-location.

Table 4.7: Medicinal resources extracted from Chyulu hills forest by the respondents

Medicinal plants extracted from the forest	Sub-location		Chi square(X^2) value	P-value
	Mang'elete (N%)	Kiu (N%)		
1. *Aloe vera* (kiluma)	45.0	55.0	0.30	0.58
2.*Azadirachta indica* (Neem tree)	47.0	52.0	0.08	0.78
3. *Grewia bicolor* (Kilawa)	39.1	60.9	1.76	0.18
4. *Solanum incanum* (Mutongu)	50.0	50.0	0.00	1.00
5. *Terminalia brownie* (Muuku)	52.4	47.6	0.07	0.79
6. *Albizia anthelmintica* (Kyoa)	40.0	60.0	1.71	0.19
7. *Acacia nilotica* (Kisemei)	40.0	60.0	1.71	0.19

4.5.3 Monthly income accrued from sale of different forest resources

Results presented in Table 4.8 shows average monthly income obtained from sale of different forest resources. In Mang'elete Sub-location, respondents obtained an average of Kshs 366.67 from the sale of firewood, Kshs 366.67 from charcoal and Ksh 166.67 from poles and posts. Sale of Khat, wood carving and bush meat attracted Ksh 1,233.33, 0.00 and 0.00, respectively. However, in Kiu Sub-location, respondents obtained an average of Kshs 626.67 from the sale of firewood, Kshs 2,086.67 from charcoal, Kshs 673.33 from poles and posts, Kshs 2,833.33 from Khat, kshs 766.33 from woodcarving and Kshs 308.33 from bush meat. Table 4.8 further shows independent samples t-test p-values comparing the incomes accruing from the sale of each forest product between the two Sub-locations. Results indicated that mean values of poles and posts (p-value=0.02), wood calving (p-value=0.02), bush meat (p-value=0.04) and livestock products (p-value=0.02) were significantly different, with more of these provisioning services being extracted in Kiu compared to Mang'elete Sub-location. However, mean values of charcoal (p-value=0.06), firewood (p-value=0.57), khat (p-value=0.36), rent from land (p-value=0.15), crop sale (p-value=0.90), livestock sale (p-value=0.39) and regular employment (p-value=0.23) were not significantly different.

Table 4.8: Mean monthly income accrued by the respondents from sale of different FPES in Kiu and Mang'elete Sub-Locations (In Kshs)

Forestry provisioning ecosystem services extracted	**Sub-location of the household head**		**p-value**	**Totals**
	Mang'elete	**Kiu**		
Charcoal	366.67(1190.87)	2,086.67(5172.86)	0.06	1,226.67
Firewood	366.67(1188.55)	626.67(1256.14)	0.57	496.67
Poles and posts	166.67(647.72)	673.33(1256.14)	0.02*	420.00
Khat	1233.33(4485.10)	2833.33(7390.32)	0.36	2,033.33
Calving wood	0.00(0.00)	766.33(1568.04)	0.02*	383.17
Bush meat	0.00(0.00)	616.67(1633.71)	0.04*	308.33
Mean	**355.56(1,252.04)**	**1,267.17(3,085.60)**		**811.36(2,445.99)**
Income from other sources	**Mang'elete**	**Kiu**	**p-value**	**Totals**
Rent from land	933.33(3463.44)	0.00(0.00)	0.15	466.67
Crop sale	12,843.33(12242.)	12,450.00(11504.8)	0.90	12,646.67
Livestock sale	16,150.00(11575.20)	18,916.67(12990.77)	0.39	17,533.33
Livestock products	5,533.33(7793.60)	11,383.33(11124.44)	0.02*	8,458.33
Regular employment	6,066.67(17587.09)	1,946.67(6048.30)	0.23	4,006.67
Mean	**8,305.33(6106.85)**	**8,939.33(7852.61)**		**8,622.33(6772.13)**
GRAND TOTAL	**8660.89**	**10,216.62**		**9,889.50**

Note: 1.*Significant at 0.05 significance level 2. Figures in parenthesis shows standard deviate

It is further shown in Table 4.9 that the total income from FPES in Mang'elete Sub-location was Ksh 64,000.20 (4.9%) while that from Kiu Sub-location was Ksh 228,090 (14.5%). The FPES contributed a substantial percentage of income to the respondents. The total mean income from FPES in the two Sub-locations was Ksh 811.36 (8.35%) while that from other sources was Ksh 8,907.53 (91.65%). The FPES contributed a significant amount of income to the respondents.

Table 4.9: Proportion of monthly income (Kshs) accrued from FPES in Mang'elete and Kiu Sub-locations

Income Sources	**Sub-location**		**Total (Kshs)**
	Mang'elete	**Kiu**	
Income from FPES	64,000.20	228,090	**292,090.20**
Income from other sources	1,245,799.80	1,340,900.1	**2,586,699.90**
Total income	1,309,800	1,568,990.1	**2,878,790.10**
Proportion of income from FPES (%)	**4.9**	**14.5**	**19.4**

An independent samples t-test was conducted to compare the mean incomes accruing from the sale of forest products between the two Sub-locations. The two means were found to be significantly different, with Kiu Sub-location having a higher income (Mang'elete (M= 355.56, SD= 1,252.04) and Kiu (M= 1,267.17, SD=3,085.60, t (58) = -2.26, $p<0.05$).

4.6 Factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations, Makueni County

Results of Logistic regression analysis (Table 4.10) showed that occupation of the household head (coefficient=-3.316; p= 0.001; odds ratio=0.036), distance from Chyulu (coefficient=-0.427; p=0.013; odds ratio=0.653) and presence of fence (coefficient=-2.109; p=0.020; odds ratio=0.121) had a significant influence ($p<0.05$) on utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations. These variables have a negative coefficient meaning that they are negatively associated with utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations. However, the results showed that gender of the household head, (coefficient=0.790; p=0.451; odds ratio=2.203), age of the household head (coefficient=-0.013; p=0.730; odds ratio=0.987), household size (coefficient=-0.081; p=0.716; odds ratio=0.922), marital status (coefficient=0.020; p=0.964; odds ratio=1.020), education level (coefficient=-0.057; p=0.865; odds ratio=0.945), size of land (coefficient=-0.228; p=0.217; odds ratio=0.796), average income (coefficient=0.000; p=0.301; odds ratio=1.000) did not have a significant influence on utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations.

Table 4.10: Factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services by residents in Kiu and Mang'elete Sub-locations, Makueni County

Factor	Coefficient	P Value	Odds Ratio
Occupation	-3.316	0.001*	0.36
Gender	0.790	0.451	2.203
Age	-0.013	0.730	0.987
Household size	-0.081	0.716	0.922
Marital status	0.020	0.964	1.020
Education level	-0.057	0.865	0.945
Land size	-0.228	0.217	0.796
Distance to the forest	-0.427	0.013*	0.653
Average monthly income	0.000	0.301	1.000
Presence of fence	-2.109	0.020*	0.121
Constant	12.438	0.030	252165.393

Note: *Significant at 0.05 significance level

CHAPTER FIVE

DISCUSSION

5.1 Type of forestry provisioning ecosystem services provided by Chyulu Hills Forest to Kiu and Mang'elete Sub-locations, Makueni County

Results presented in Table 4.4 indicated that 37.5% and 64.3% of the respondents from Mang'elete and Kiu, respectfully extracted forestry provisioning services from Chyulu hills forest. The results are in agreement with National Forest Policy Green Paper (2000) in Swaziland, which stated that all rural people directly benefit from the forest as they depend on a range of forest products which are derived from their immediate environment. Ogutu *et al*. (1997) also noted that local communities have usually needed these protected forests for grazing, hunting, gathering food, wood and other useful products. Further scrutiny of results showed that those extracting FPES from Kiu were more compared to the ones from Mang'elete. It, therefore, means that respondents from Kiu benefit more from the forest compared to those in Mang'elete. This may be attributed to the absence of electric fence in Kiu side of the forest, enabling the residents to have free movements in and out of the forest. In Mang'elete side presence of the electric fence and the tight security inhibit people's movements in and out of the forest. The results are in consonance with findings of Mutune *et al*. (2015) who noted that the source of FPES depended on availability as well as ease of access.

Results presented in Table 4.4 further indicated that the types of forestry provisioning ecosystem services harvested from the forest by residents of the two Sub-locations are firewood, charcoal, carving wood, fodder, honey, poles and posts, khat, timber, fruits, medicinal plants and game meat. This is in conformity with study by Angelsen & Wunder (2003) who indicated that forest resources have traditionally supported the subsistence of indigenous people. Requirements for fuel wood, fodder and construction timber required by the people for their consumptive and productive purposes have been regarded as important benefits to communities (Fisher, 2004).

Food materials, charcoal, firewood, carving wood and medicinal plants were found to be the major types of forest provisioning ecosystem services extracted from Chyulu hills forest as shown in Table 4.5. In Mang'elete Sub-location, most extracted food material was vegetables at 44.4% and the least was honey at 12.5%. On the other hand, in Kiu Sub-location the most extracted was honey at 87.5% while the least extracted was vegetables at 55.6%. Analysis of these results showed that the percentage of food resources extraction in Kiu Sub-location was higher compared to Mang'elete. In Kiu Sub-location, access to the forest was easier due to absence of electric fence compared to Mang'elete where the electric fence is acting as a physical barrier to the forest access.

Households in both Sub-locations use a number of different tree species for the treatment of various ailments. Medicinal plants extracted were majorly for subsistence use. A few sold the medicinal plants. This could be attributed to the fact that in the nearest market centres there are quality health services and therefore few people depend on herbal medicine. In Mang'elete the most extracted herbal was *Terminalia brownie* at 52.4% while in Kiu Sub location the most extracted was *Grewia bicolor* at 60.9%. The use of the forest for medicinal purposes was more prominent in Kiu than in Mang'elete Sub-location. This difference may have been caused by easiness in the access of the forest due to lack of fence in Kiu. Results of the current study contradicted the fact that Kiu Sub-location is near quality health services in Makindu level four hospital unlike Mang'elete which is abit far and one would expect use of medicinal plants to be prominent in Mang'elete. The results on the use of herbs are in agreement with WHO (2002) findings that indicated that more than 80% of the world's population uses natural plant remedies and other related forms of traditional healing as their primary mode of healthcare. In Kenya, traditional medicines play a major role in primary healthcare and upkeep of rural communities (Kisangau and Kokwaro, 2004). Hamilton (2004) further argues that medicinal plants can be key to including local people in forest conservation strategies. The advantages of such medicines according to Miller (1980) include the low cost, and an element of self-reliance and non-dependency on health institutions. Natural remedies are not only

cheaper than modern medicines but are often the only medicines available in remote rural regions (GTZ, 2001). There are many possible reasons for preferring natural medicines, one being dissatisfaction with one's experience of physicians, with the relative ineffectiveness of previous medical treatment, with the perception of being offered no choice in a doctor's office, and, importantly, with the many adverse effects of conventional drugs. Nevertheless, many reports highlight dissatisfaction with modern medicine's hurried consultations, over-emphasis on laboratory tests, and drug side effects that many find difficult to tolerate (Dinges, 2017).

Additionally, it was established that products that were most extracted such as charcoal and honey were not available in the farmlands as most of trees have been cleared to pave way for farms. The community obtained these products from the forest ecosystem illegally. The results are in agreement with findings of Hersi and Kangalawe (2016) who noted that communities living adjacent to the forest invariably extract commodities from it against the law. Results of chi square test of independence values comparing the frequency of FPES extraction and sub-location of the respondent (Table 4.5) indicated that extraction of several FPES was significantly influenced by the Sub-location of the respondent. This included khat $X^2(1) = 4.16$, p-value=0.04), medicinal plants ($X^2(1) = 11.43$, p-value=0.00), fruits gathering ($X^2(1) = 9.02$, p-value=0.00), timber ($X^2(1) = 9.93$, p-value=0.00), fodder ($X^2(1) = 5.96$, p-value=0.01), carving wood ($X^2(1) = 6.41$, p-value=0.01), and honey ($X^2(1) = 5.19$, p-value=0.02). The findings were attributed to the fact that the Sub-locations did not have similar characteristics which influenced extraction of a particular resource such as easiness to access of the forest. More and different types of FPES were extracted by communities living in Kiu Sub-location side of the forest compared to Mang'elete side of the forest. In Mang'elete Sub-location, a number of the residents view the forest as their only source of livelihood, not even the electric fence can deter them. They dig under it and sometime cut wires to gain access to the forest or are forced to wait for power to go off so as to enter the forest. These results are in agreement with findings of similar studies in Eastern Kenya, Southern Rift and Mt. Kenya which revealed that local utilization of local forest resources by the forest adjacent

communities is imperative and any action to deny the households from forest utilization limits their livelihood opportunities (Emerton, 2001).

From the present study, it can therefore be deduced that smallholder farmers bordering protected forests depend on the forest for a number of forest provisioning ecosystem services. To the local people, Chyulu hills forest is a pharmacy, a supermarket, a building supply store and a grazing resource. The present trend of the results is in agreement with findings of CIA (2012) who reported that about 70% of the Cameroonian population depends on forestry provisioning services for their livelihoods. Restrictions in access can also cause significant changes in the diets of rural communities. Leaves, fruits and vegetables collected in the forest provide many people with vitamins and minerals (Foppes and Ketphanh, 2004), and bush-meat provides from 30 to 80% of the daily protein requirements of rural communities in the Congo Basin (Wilkie & Carpenter, 1999). Results of chi square test of independence (Table 4.6) indicated that extraction of wild fruits ($X^2(1) = 6.79$, p-value=0.01), game meat ($X^2(1) = 4.34$, p-value=0.04) and honey ($X^2(1) = 5.19$, p-value=0.02) was significantly influenced by the sub-location of the respondent.

5.2 Contribution of forestry provisioning ecosystem services to household income in Kiu and Mang'elete Sub-locations, Makueni

Results presented in Table 4.8 indicated that the average monthly income obtained from sale of different forest resources showed that in both Mang'elete and Kiu sub-locations khat sale accrued the highest average monthly income with ksh 1,233.33 in Mang'elete and Ksh 2,833.33 in Kiu giving a mean total of Ksh 2,033.33.Overall, firewood sale comes second with a total of Ksh 1,226.67 followed by charcoal sale with Ksh 496.67. Sale of Khat attracted highest income due to the fact that it is majorly extracted for sale but the rest of products are mainly for subsistence use. This is in line with existing literature that rural livelihoods income from the sale of FPES is an important contributor to overall household income for rural residents (Fisher, 2004). In Mang'elete, bush meat and calving wood is purely for subsistence use. This

is likely due to the challenges experienced in accessing the forest hence one will only collect resources enough for use without any surplus for sale, therefore, saving money that would have been used to buy the same from the market. This supports previous research done by Shackleton and Shackleton (2004) that those households that employ FPES for direct household consumption save cash resources, which would have otherwise been used to purchase the products.

It is further shown that the total mean income from FPES in the two sub-locations was Ksh 811.36 (8.60%) while that from other sources was Ksh 8,907.53 (94.42%). The FPES contributed a significant amount of income to the respondents. This result was similar to what one would expect that free forest utilization by households are additional sources of income in rural areas and fuel woods as they are the main source of energy (Kaale *et al*., 2002). In Central Africa, forest communities generate 67% of their total income from hunting and gathering, and only 33% from agriculture, labor and employment; which illustrates how vulnerable forest communities can be to changes in forest access (Cernea & Schmidt-Soltau, 2006) hence the findings of this study are in agreement with similar findings elsewhere and corroborate the importance of forest resources to households. It is estimated that 90% of the world's poor depend on forests for at least a portion of their income (World Bank, 2000).

Forest foods, charcoal, firewood, poles and posts, khat and medicinal plants were the most important contributors to both cash and non-cash income, but in terms of relative importance to the household other items such as calving wood and bush meat also score high in Kiu Sub-location for cash income. The food materials extracted from the forest are honey, bush meat, vegetables and wild fruits with honey being the most extracted in Kiu and vegetables in Mang'elete. Kiu has the highest number of households extracting all food materials as compared to Mang'elete and, therefore, evident that lack of electric fence contributes to more forest utilization.

Results presented in Table 4.9 Indicated that the total monthly income from FPES in Mang'elete Sub-location was Ksh 64,000.20 (4.9%) while that from Kiu sub-location was Ksh 228,090 (14.5%). The FPES contributed to the income of respondents. This is a clear indication that the forest resources obtained from Chyulu is a major boost to

the livelihoods of farmers and more so to their non-cash income and so they rely on the hills forest for their survival regardless of whether the extraction is illegal or not the reason being attributed to the fact that forest-adjacent communities operate behind a background of limited economic opportunities (Hauck *et al*., 2015). Also Yemiru (2011) noted that most of the poor people in rural areas maintain diversified livelihood strategies because they cannot obtain sufficient income from any single strategy and also to reduce risks. Many small-scale farmers are, therefore, not solely small agriculturists but they include forest products in their livelihood systems. The results of this study, however, does not agree with findings by Fisher (2004) that forest income contributed about 39% of the household income in Ethiopia highlands and nearly equaled combined livestock and agricultural incomes as in this present case forest cash income is too low compared to other farm sources of income.

Contribution made by forestry provisioning ecosystem services obtained from the Chyulu forest can be categorized into household cash income and non cash household income. Non-cash income refers to the income which could have been got from sale of those products utilized for subsistence use. Non-cash uses of forests continue even where there are no cash sales of forest products at all. From this study it is deduced that non-cash values make a larger contribution to overall household income than do cash values in the two sub-locations. The findings are in agreement with similar study done in Ethiopia where considerable portion of forest income benefits were found to be in-kind benefits associated with the subsistence use of forest goods and services, for example the value added of wood fuel production provided very large in-kind income benefits because many households collected wood fuel and fodder themselves rather than purchasing it in the market (UNEP, 2016).

5.3 Factors influencing utilization of the Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations, Makueni County

Results of Logistic regression analysis (Table 4.10) showed that occupation of the household head (coefficient=-3.316; p= 0.001; odds ratio=0.036) distance from Chyulu (coefficient=-0.427; p=0.013; odds ratio=0.653) and presence of fence (coefficient=-2.109; p=0.020; odds ratio=0.121) had a significant influence ($p<0.05$) on utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations. These variables have a negative coefficient meaning that they are negatively associated with utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations.

Occupation correlates negatively to forest utilization implying that those employed extract fewer resources as they do not have time for going to the forest and again they already have a source of income hence are able to provide for their needs. The results are supported by findings by Illukpitiya and Yanagida (2008) who stated that forest dependency decreased for households with more diversified income sources. Distance is also negatively correlated in the current study. Respondents living within a short distance from the forest edge collect more FPES than those living far from the forest. This agrees with the findings of a similar study carried out in Sri Lanka (Brockhus, 1996). Presence of electric fence also correlated negatively with extraction of resources. Those on the fenced border were found to extract fewer resources due to the fence barrier as access to the forest means they have to improvise ways of accessing the forest. Other studies by Mungai *et al*. (2011) in Arabuko sokoke forest found out that fencing of the forest has limited access of the humans into the forest however; they sneak through informal inlets in search of livelihood. This is mainly done by men because they sometimes decide to jump over and women are not able to jump high.

The results however showed that gender of the household head, (coefficient=0.790; p=0.451; odds ratio=2.203), age of the household head (coefficient=-0.013; p=0.730;

odds ratio=0.987), household size (coefficient=-0.081; p=0.716; odds ratio=0.922), marital status (coefficient=0.020; p=0.964; odds ratio=1.020), education level (coefficient=-0.057; p=0.865; odds ratio=0.945), size of land (coefficient=-0.228; p=0.217; odds ratio=0.796), average income (coefficient=0.000; p=0.301; odds ratio=1.000) did not have a significant influence on utilization of Chyulu hills forestry provisioning ecosystem services in Kiu and Mang'elete Sub-locations.

Education is negatively correlated to extraction of resources. Hence the higher the level of education the fewer the resources extracted. This agrees with findings by Parry *et al*. (2009) who stated that higher education attainment is associated with less reliance on forest resources. This is because a higher level of education provides a wider range of job options hence making fuel wood collection unprofitable due to greater opportunity costs of collection (Dolisca *et al.,* 2006). The results however contradict the findings of another similar study which indicated that education was positively correlated with forest resources extraction (Masozera, 2002).

Further scrutiny of the results indicated that the size of land was negatively related with forest resources extraction. Respondents with large plots of land depended less on the forest for FPES. The results are in concurrence with findings of Babulo *et al*. (2008) who found that households with large plots of land were less likely to engage in forest extraction as their dominant livelihood strategy.

Average income in this study includes the monthly earnings from sale of agricultural produce and monthly salary for those employed. Average income (coefficient=0.000; p=0.301; odds ratio=1.000) had a negative relationship with forest resources extraction and utilization and, therefore, households with higher income depended less on the forest resources. This implies that poor households engage more extraction of forest resources compared to well off ones. The results contradict the findings of Kamanga *et al*. (2008) who found that households with lower agricultural income engage less in communal forest income generation. In Ranomafana National Park, Madagascar, wild sources of food and income accounted for a larger share of household incomes among the poor, so restriction to access of the park was likely to

affect these households the most, possibly increasing the size of loans during times of food deficit (Ferraro, 2002).

Household size and forest resources extraction and utilization had a negative relationship. The result contradicts what one would expect because as the number of family members' increases, the demand for more food to be cooked and more houses to be built also increases. The bigger the family size, the more labor is available to gather forest products. It also contradicted findings by Mamo *et al*. (2007) who found out household size to be positively associated with forest dependency. Larger families have higher subsistence needs which necessitate them to depend more on forest resources. The contradiction was likely because demand for a particular resource from the forest did not necessarily lead to extraction of that resource from the forest since extraction of all the resources was illegal. Age is positively correlated with the FPES extraction from the forest implying that the skills and knowledge of forest resources extraction and utilization increased with age. The results agree with findings by Godoy *et al*. (1997) who states that age of household head is positively related with forest dependency, albeit with diminishing effect after reaching a peak of physical growth. However, older people might possess strong ecological knowledge about their proximate environment, a phenomenon which might increase their likelihood of being more dependent on forest resources.

The study findings do, however, contradict those of Kideghesho and Msuya (2010) in Tanzania who reported that labor-demanding activities, such as charcoal production, are more common among young men. Gender and marital status had a positive relationship with forest resources extraction. Male headed households depended more on the forest as men find it easier to enter the forest even at night because they do it illegally hence they have to hide themselves. The results do not concur with research findings of similar studies. Households headed by females have been reported to rely more on forest products in Cameroon (Fonjong, 2008) and southern Ethiopia (Yemiru *et al*., 2010), while in South Africa, studies have indicated a negligible gender effect (Cocks *et al*., 2008).

Other studies suggest that women are the primary users of forests; for example, in a study in Uttar Pradesh, India, women derived 33 to 45% of their income from forests and common land, whilst men derived only 13% (FAO, 2006). Whilst women have access to and substantial labor and management responsibilities for forest resources, they are much less likely to own land than men, and it is often men who control the use and marketing of the products and incomes (Lastarria-Comhiel, 1995).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

From the study, the categories of FPES that are extracted from Chyulu hills forest by the households include food materials, wood fuel, medicinal plants, khat, building materials, animal fodder, carving wood, and building materials. The food materials extracted are fruits, honey, vegetables and bush meat. Woodfuel include firewood and charcoal burning. Medicinal plants extracted are *Aloevera*, *Azadirachta indica*, *Grewia bicolor*, *Solanum incanum*, *Terminalia brownii*, *Albizia anthelmintica* and *Acacia nilotica*.

It was established that access to forest in Mang'elete Sub-location was hindered by presence of electric fence. In Kiu Sub-location, access to the forest is easier as there is no electric fence therefore; residents in Kiu are reported to benefit more on FPES extraction compared to Mang'elete which is bordered by an electric fence. Further, it can be concluded that communities near the forest generally rely on FPES to support their livelihoods.

This study indicated that Chyulu hills forest plays a significant role in contributing to rural household incomes. Most of the communities in the study area, however, derive a greater proportion of their livelihood from agriculture but also depend on the forest for certain products aiming at supplementing what they earn from other livelihood means. The present study has revealed that the principle sources of income for the majority of households were from farming. Forest utilization is a supplementary source of income to farming.

The current study has indicated that community utilization of FPES is influenced by a number of factors. Chief among them and which were found to have a statistical significant influence include occupation of household head, distance to Chyulu hills forest and presence or absence of fence. Other factors such as gender of the household head, education level of the household head, age of the household head, family size, monthly income and land size also influenced community utilization of FPES although the influence was statistically insignificant.

6.2 Recommendations

From the above findings, the present study makes the following recommendations:

1. As the results show forest dependency is a reality irrespective of whether legal or illegal, conservation can therefore be enhanced by creating awareness of forest benefits, exploring opportunities to generate more benefits from forest resources to the community and training them on sustainable use of the resource.

2. The forests managers must support adjacent community activities geared towards forest conservation in order to maximize the opportunities for limited livelihood opportunities in rural areas through FPES utilization in the view of the fact that forests are of great importance to the livelihoods of forest adjacent communities in regard to providing their household products and incomes.

3. For future study, research can be carried out to assess the contribution made by medicinal plants to livelihoods and their impact to the community adjacent protected forests. Findings from such a research will be useful in solving the problem of unsustainable forest resource extraction.

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APPENDICES

APPENDIX I: HOUSEHOLD QUESTIONNAIRE

AN ASSESSMENT OF CONTRIBUTION OF FOREST PROVISIONING ECOSYSTEM SERVICES TO SMALL HOLDER FARMERS' LIVELIHOODS IN CHYULU HILLS FOREST

The Information Collected from this Survey is strictly Confidential and is to be used for Academic Purposes Only.

Informed Consent Form

A research is being undertaken to assess contribution of forest provisioning ecosystem services to small holder farmers' livelihoods in Chyulu hills forest by a student from South Eastern Kenya University, Mtito-Andei Campus. You have been identified as a key stakeholder in this research and therefore a respondent to a few questions. The information you provide will be treated with confidentiality and will be used for academic purposes only.

MODULE A: HOUSEHOLD IDENTIFICATION AND SOCIO-ECONOMIC DATA

A1. Date …….

A2. Sub-location……..……...…… Village……

A3. Name ……. (If not household head)

A4. Occupation [1] Farmer [2] Casual labour [3] Other (specify)_____

A5. Gender [1] Male [2] Female

A6. Age of the household head _____years

A7. How many members are there in your household including yourself?

[1] Children below 5 years [ ] [3] Members between 18 -35 ye[ ]

[2] Members between 6 - 18 years [ ] [4] Members over 35 years [ ]

A8. Marital status_____ [1] Single [2] Married [3] Others (specify)

A9. Education level _____

[1] Primary school (Standard [ ] [3] Diploma [ ] [5] Others specify

[2] Secondary school (Form [ ] [4] Degree [ ]

A10. Number of years spent in formal education _____years

A11. Do you own land in which your household lives? [Yes] [No]

A12. [a] Does your plot border the forest reserve? [Yes] [No]

[b] What is the Size of your land in acres _____

[c] What is the total land size under cultivation in acres? _____

A13. [a] Which year did u settle in this area? _____

[b] What is the distance from here to Chyulu forest _____

[c] How long does it take to walk from here to Chyulu forest……(hrs or min)

[d] Is the forest boundary fenced? [Yes] [No]

[f] If yes what type of fence? ……..

MODULE B: LIVELIHOOD RELATED ACTIVITIES

B1. What are the main economic uses that you have put on your land?

(Rank from the one occupying large acreage)

[1] Crop farming [ ]

[2] Livestock farming [ ]

[3] Tree planting [ ]

[4] Grass growing [ ]

[5] Others specify_____ [ ]

B2. Which types of crops and/or livestock are raised on your farm?_____

[1] Crops_____

[b] Livestock_____

B3. [a] What was the household head and spouse doing during the last 7 days preceding the interview?(tick where appropriate)

Activity	**Household head**	**Spouse**
1.Worked for pay		
2.On leave/Sick leave		
3.Worked on own family business		
4.Worked on own family agricultural holding		
5.Seeking work		
6.No work available		
7.Full time student		
8.Retired		
9.Incapacitated		
10.Homemaker		
11.Others (Specify)		

B4. How much income, did your household receive from the following livelihood activities in the last one year?

Sources	**Amount in Kshs**	**Earning member** **1-head 2-spouse** **3-child 4-relative**
1.Rented out land		
2.Sales of crops (harvested)		
3.Sale of livestock products		
4.Sale of livestock		
5.Sale of trees from the forest		
6.Quarrying(sand or stone) from the forest		
7.Casual village labour		
8.Regular employment		
9.Business income		
10.Remittances		
11.Honey sale		
12.Wood carving		
13.Charcoal sale		
14.Firewood sale		
15.Other specify_____		

B5**.** What is your average level of income (per Month).

B6. What is your level of spending per month on the following items:

[1] Food KSh……. [2] Clothing KSh…… [3] Education KSh…..

[4] Medical KSh……..

MODULE C: THE TYPE OF FORESTRY PROVISIONING ECOSYSTEM SERVICES.

C1 [a] Do you extract anything from the forest? [YES] [NO]

[b] If yes, tick the resources extracted and rank them in order of importance

Extracted ecosystem services	**Tick if Extracted**	**Rank by importance 1=Not important 2=Neutral 3=Very important**
1.Firewood		
2.Charcoal		
3.Medicinal plants		
4.Poles and posts		
5.Hunting animals		
6.Gathering fruits		
7.Timber		
8.Fodder		
9.Wood for carving		
10.Grazing Livestock		
11.Honey production		

[c]What are some of the herbal plants obtained from the forest?

Local name	**Tick if extracted**	**Rank from the most extracted**	**Part used**	**Ailment treated**	**In human or livestock or both**
Kiluma(aloe vera)					
Mwarobaini (neem tree)					
Kilawa					

Mutongu					
Muuku					
Kyongoa					
Kisemei					
Others (specify)					

C2. [a] Do you graze in the forest? (Yes) (No)

[b] If yes, how often do you graze in the forest? (How many times in a week)

[c] How many heads of livestock do you take to the forest?

[d] How long do you take to reach the grazing sites in the forest?

[e] What types of animal are taken to the forest?

[f] How often do you cut and carry fodder from the forest?

[g] How many head loads of fodder do you cut? ……When?

At night or during the day ?.....

[h] How much money would you be willing to pay to graze in the forest?(ksh)

[i] Is the fodder supply from the forest enough for your livestock**?**

[1] Enough for wet season [2] supplement from other farmers plot

[3] Enough throughout the year [4] others (specify)

[j] Do you get permit to graze or cut fodder from the forest? [Yes] [No]

[k] If yes, How much do you pay for the permit? Daily /Weekly/ Monthly/Annual?

[l] If no permit ,what happens if forest wardens catch you?.....

C3. [a] Does the produce from your farm satisfy the food requirement? 1 [Yes]

2 [No]

[b] If no state how you supplement the family needs.

[1] Cultivate in the forest [2] Buy from market

[3] Lease land [4] Get relief food [5] Others….

[c] Fill the table below to show the types of food materials you obtain from the forest.

SN	**Type of Food material**	**Varieties**	**Which month of year**	**Frequency of harvesting**	**For sale or subsistence use**	**Market price**
1	Wild fruits	1. 2. 3. 4.				
2	Vegetables	1. 2. 3. 4.				
3	Game Meat	1. 2. 3. 4.				

4	Others……..	1. 2				

C4. [a] What do you use for cooking? (Tick and then rank them in the order of most used)

[1] Fire wood [ ] [2] Charcoal [ ]

[3] Electricity [ ] [4] Gas (LPG) [ ]

[5] Others (specify)

[b] In case your answers above is firewood, Where do you obtain your fire wood?

(Tick all appropriate answers**)**

[1] Own Farm [2] Locally purchased [3] Adjacent Forest

[4] Other source……

[c] If the adjacent forest is one of the answers above, how often do you

Obtain the resource from the forest?

[1] Daily [2] Weekly [3] Monthly [4] Annually

[d] Which month of the year do you access/obtain the resource above from the forest

[e] Is it easy to access/obtain the resource given above from the forest?

[Yes] [No]

If yes, how?

_____

_____

If No, why?

_____

C5. [a] Where do you obtain your timber requirements?

[1] Own farm [2] Locally purchased [3] Adjacent forest

[4] Neighbours farm [5] Others

[b] Are there trees within your farm, of the same form and quality as those found in the adjacent forest? [Yes] [No].

[c] What do you use for fencing? …… Source **…….**

MODULE D: CONTRIBUTION OF FORESTRY PROVISIONING ECOSYSTEM SERVICES TO HOUSEHOLD INCOME.

D1. [a] Do you generate income from the forest Resources? [Yes] [No]

[b] If Yes, fill in the table below amount got for sale of the resources accessed

[c] Have you paid for extracting resources from the forest? [Yes] [No]

[d] If yes, fill in the table the amount paid for each of the resource obtained

Forest resource	**Frequency of access per week**	**Number harvested in a month**	**For subsistence use or commercial**	**Amont sold in Ksh**	**Distance to the market sold**	**Estimate of amount accrued monthly**
Firewood(head loads)						
Bush meat						
grazing						
Charcoal burning(sacks)						
Herbal plants						
Building poles and posts(number of pieces)						
Cutting grass for fodder						
Wood for carving						
Wild fruits						
Others specify						

D2. [a] Do you cultivate from the forest? [Yes] [No]

[b] If yes, indicate the much you harvested per crop and the much you sold in the table below

Crops	This season				last season			
	Area planted	**Harvest in 90kg bag/kg**	**%sold**	**Amount accrued**	**Area planted**	**Harvest in 90kg bag /kg**	**%sold**	**Amount accrued**
Millet								
Green grams								
Maize								
Cotton								
Sorghum								
Beans								
Cow peas								
Peas								
Others specify								

MODULE E: FACTORS INFLUENCING UTILIZATION OF THE CHYULU HILLS FORESTRY PROVISIONING ECOSYSTEM SERVICES.

E1. Which members of the household are involved in collection of forestry products?

[1] Adult male [2] Adult female

[3] Female children [4] Male children

E2.The villages surrounding Chyulu Forest do not benefit as much as they

Should from the Forest

[1] Strongly disagree [2] Disagree [3] No opinion [4] Agree [5] Strongly agree

E3.Give reasons for your answer above……

E4. In your own opinion, do you find Chyulu hills to be of any use to you as an individual?

[Yes] [No]

E5. How would u feel if the hills were fenced? (For those on unfenced part)

[1] Bad [2] very bad [3] good [4] very good

E6.Explain your answer in the question above……

E7.Do you face any challenges in conserving Chyulu hills? [Yes] [No]

E8. If yes, which among the following challenges is/are applicable to your case? (Please identify and rank them in decreasing order of importance, where 1is the biggest constraint and 5 the least)

		Tick	Rank
[1]	Lack of information on how to conserve	[ ]	
[2]	Distance from the hills	[ ]	
[3]	Lack of alternative livelihood	[ ]	
[4]	Lack of money to facilitate conservation	[ ]	
[5]	Lack of motivation	[ ]	
[6]	You are not aware whether it's your responsibility	[ ]	

E9. In your own opinion who should conserve forest reserves?

[1]All stakeholders [4] Community

[2] Government [5] Other (Specify)

……

[3] Immediate users at local level

E10.Are you in any way involved in the conservation groups or associations?

[Yes] [No]

E11.If yes indicate how? (Tick where appropriate)

[1]Community forest associations

[2]Through village conservation committee

[3]Through village advisory committee

[4]Through any other group or activity (please specify)

E12.How many members does the group comprise?

1. Males……..2. Females……..

E13.What are the activities carried out by your group towards forest conservation?

[1]

[2]

[3]

[4]

E14.How much money do you contribute per month? …… (Ksh)

E15.How frequently does the group meet? (Please tick where appropriate)

[1]Weekly

[2]Twice weekly

[3]Monthly

[4]Twice in a month

[5]Others…..

E16.What can you say about the availability of the following forest products over the last 2 years?

(1.Increasing 2.Decreasing 3.Constant 4. don't know)

[1]Firewood [ ]

[2]Pasture and fodder [ ]

[3]Vegetables [ ]

[4]Fruits [ ]

[5]Timber [ ]

[6]Wood for charcoal burning [ ]

[7]Medicinal plants [ ]

[8]Wood for carving [ ]

[9]Bush meat [ ]

[10]Poles and posts [ ]

E17. What factors in your own view have contributed to the general (most mentioned) trend above?

[1]Education and training by Organizations [2] Awareness campaigns by different ministries

[3]Lack of adequate land for cultivation [4] Population increase

[5] Better price [6] Traditional norms

[7]Government protection [8] Community protection

[9] Individual's resolution to abide by rules [10] other (specify) _____

End.

God's blessings.

APPENDIX 2: PLATES

Plate 1: Electric fence demarcating community land and Chyulu hills forest
Source: Student Field photography: Date taken 12.06.2018

Plate 2: Electric fence bordering the Mang'elete community and Chyulu hills forest

Source: Student Field photography: Date taken 12.06.2018.

Plate 3: Community bordering Chyulu hills forest at Kiu Sub-location

Source: Student Field photography: Date taken 12.06.2018.

Plate 4: Kiu Sub-location border with Chyulu hills forest.

Source: Student Field photography: Date taken 12.06.2018