

**RELATIONSHIP BETWEEN COMMUNITY LIVELIHOOD OPTIONS AND CLIMATE
CHANGE KNOWLEDGE AND PRACTICES: A CASE STUDY OF MAASAI MAU
FOREST, NAROK COUNTY, KENYA**

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A60/74990/2014

**A Thesis submitted to the University of Nairobi in partial fulfillment of the requirements
for the award Master of Science Degree in Environmental Governance.**

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November, 2016

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I, **Lilian Namuma Sarah Kong'ani**, declare that this thesis is my original work and has not been presented for award of a degree in any other university.

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DEDICATION

This thesis is dedicated to my dear son Eli M. Kaiga, brothers and sisters, niece Janet, late mom, Esther Masicha, and dad, Mr. Joshua K. Khaemba. Also dedicated to my colleague and friend the late Benard Claude Kamau Muthee.

ACKNOWLEDGEMENT

To God Almighty, I glorify you for your mercies that are new every day, and that enabled me to accomplish this work. My heartfelt gratitude to my supervisors, Dr. Thuita Thenya and Dr. Jane M. Mutune for your relentless mentorship, support, and supervision that facilitated the putting together of this work. I am so grateful for the patience and believing in me and for the continued guidance that inspired the success of this research. I wish to thank the current Director Prof. H. M. Mutembei, Prof. David N. Mungai, Deputy Director and the now College Principal and former Director, WMI, Prof. S.G. Kiama for your moral support. The entire Wangari Maathai Institute fraternity for any role played in accordance to the success of this work, thank you so much.

More so, I wish to thank DANIDA through STAKE project at the Institute which funded my research work, without supporting research, it would not be a success yet! Thank you so much.

My Research Assistants, Peter, Fred, Samuel, and Geoffrey thank you so much. Anthony my field contact, I sincerely appreciate your support too and to all the respondents thank you for enabling realize this research.

My son Eli, brothers and sisters and niece Janet, thank you for your prayers and moral support. My late mom, Esther Masicha, and dad, Mr. Joshua K. Khaemba, you will forever remain loved, appreciated and missed; may your souls rest in eternal peace.

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LIST OF ABBREVIATIONS

ASALs:	Arid and semi-arid lands
DfID:	Department for International Development
CFA:	Community Forest Associations
CO ₂ :	Carbon dioxide
CPA:	Charcoal Producer Associations
FACs:	Forest Adjacent Communities
FAO:	Food and Agriculture Organization of the United Nations
GHGs:	Green House Gases
GoK:	Government of Kenya
ICS:	Improved Cook Stoves
IKS:	Indigenous Knowledge Systems
IPCC:	Intergovernmental Panel on Climate Change
IPCC AR5:	Intergovernmental Panel on Climate Change's Fifth Assessment Report
KFS:	Kenya Forest Service
KWS:	Kenya Wildlife Service
MEWENR:	Ministry of Environment, Water, Energy and Natural Resources
MMF:	Maasai Mau Forest
NGOs:	Non-Governmental Organizations
NTFPs:	Non-Timber Forest Products
PFM:	Participatory Forest Management
SHGs:	Self Help Groups
UNDP:	United Nations Development Programme
UNFCCC:	United Nations Framework Convention on Climate Change

ABSTRACT

Rural households engage in a broad range of livelihoods including agriculture and non-agricultural activities. However, these livelihoods are being threatened by the changing climate that present increased potential for forest clearing to pave way for new farm lands as dependence on the forest resources for sustenance become inevitable. It is ironical that even though climate change continues to dominate on the world's front banner of environmental discourse, some studies established that some communities do not yet comprehend what climate change is. This study therefore assessed the relationship between community livelihood options and climate change knowledge and practices among communities adjacent to the Maasai Mau forest, Narok County, Kenya. Specifically, it investigated the livelihood activities, assessed the knowledge of climate and its implications on livelihood options and the climate change adaptation practices among households in Maasai Mau forest. Household surveys were conducted among 53 households that were systematically selected in the study area. The primary data was triangulated with focus group discussions, key informant interviews and participant's field observations. Secondary data included the review of published journals and grey literature. Quantitative data was subjected to in-depth analysis by use of means, percentages and cross-tabulations whereas qualitative data was organized, summarized and the coherence of responses observed. The main livelihood activities included crop production (85%) and livestock production (14%). There was found to be a high dependence on the forest resources (100%) although only 2% of the respondents ranked forest products as their major livelihood activity. Other livelihood activities included businesses and casual labour (8%). About 93% of the respondents were aware of climate change mainly through own experiences. This knowledge was attributed to increased pests and disease incidences, droughts, floods, drying up of streams, declined forest products and

crop yields. About 72% of the respondents cited natural causes as the primary cause for the changes in climate, 26% and 2% stated human activities and punishment from gods respectively. Participant observation however, evidenced anthropogenic activities undergoing in the study area as the probable cause of the climate change more than the purported natural causes. The communities practiced mixed farming, crop diversification, agro-forestry, improved livestock breeds and use of improved cookstoves in response to climate change. It is therefore, indisputable that the diverse rural livelihoods among FACs are affected by climate change. The communities are aware of the climate change mainly through own experience but their knowledge of its primary causes was inadequate thus informing their common adaptation practices. The study recommends designing of a policy on climate change awareness creation to enable better response practices. Further research is needed on the role and extent of alternative energy fuels in climate change adaptation among forest adjacent communities.

CHAPTER ONE: INTRODUCTION

1.0 Background

Livelihoods are means through which people eke a living. Rural livelihoods are varied, depending on capabilities and assets (Chambers & Conway, 1992). They are frequently faced with multiple stressors including population increase, poverty, political instability, over-exploitation, development and also poor governance (Onyekuru *et al.*, 2014). However, climate change is often recognized as the prime stressor on livelihoods and particularly in the 21st Century and in the developing countries where it can impact on what has been developed for a long time (Connolly-Boutin & Smit, 2015). The impacts of climate change are inevitable across the globe; the weather patterns are shifting, and sea levels are rising leading to increased flash floods and food insecurity.

Disappearance of natural habitats, flora and fauna has majorly been attributed to the changing climate while undermining livelihoods in many parts of the continent (Dube & Phiri, 2013). Forest ecosystems, in particular, support the livelihoods of more than two-thirds of the continent's six hundred million people (Olufunso, 2010). However, increased temperatures and changes in rainfall patterns have impinged on their composition and distribution thus incapacitating the availability of their goods and ecosystem services (Dube & Phiri, 2013). In some regions, soils are eroded, degraded and rendered unsustainable for agriculture aggravating deforestation to provide new farmlands. Decline in the pasture as a result of decreased precipitation heighten overgrazing in forests while on other hand, crop yields and livestock production have also declined as a result of climate change (Boon & Ahenkan, 2012; Aruwajoye *et al.*, 2013).

Some communities have since adopted commercial production of non-timber forest products (NTFPs) including mushroom and others to counter the impact of their decline (Foli *et al.*, 2011). Also, agro-forestry has been adopted to provide potential economic and environmental services capable of addressing communities household income while the use of clean cooking technologies enable reduce carbon emissions and conserve forests (Onyekuru & Marchant, 2014). In crop production, cultivation of drought-tolerant crops and fast maturing varieties have mostly been observed to cope with the changing and erratic rainfall patterns (Kuria, 2009; Boon & Ahenkan, 2012; Tambo & Abdoulaye, 2013). Crop diversification and mixed farming are practiced to counter risks of mono-cropping while others tend to engage more in timber extraction and charcoal burning particularly during dry seasons when agricultural production is not favorable to eke a living (Naituyupaki zonal management plan, 2012). The pastoral communities reduce their herd sizes in reaction to declined pasture and water while some opt to keep goats and sheep, which are more drought resistant (Kabubo-Mariara, 2008; Joto Afrika, 2013).

Climate change remains a global threat to many livelihoods. It either endangers forest ecosystems as there is significant potential for over-exploitation of the forests to meet the communities' demanding livelihoods. Little is, however, known and documented particularly on how the Maasai Mau forest adjacent communities' livelihood options relate with climate change knowledge and practices, a gap that this study sort to fill. The findings are expected not only to enrich our understanding of the existing climate change knowledge but also to help guide practical initiatives, such as policies, programs, and actions for climate change adaption to enable improve the management of the forest resources in the country.

1.1 Statement of the Problem

Most rural households rely on a wide range of activities and income bases where crop and livestock production are prominent. These livelihoods are however, threatened by the changing climate characterized by floods, prolonged drought spells, erratic rainfall patterns, disease and pest incidences and others. This presents increased significant potential for deforestation as high demand for new agricultural lands, overgrazing in the forests due to declined pasture, increased charcoal burning, illegal logging and over-exploitation of non-timber forest products for sustenance become inevitable (Naituyupaki zonal management plan, 2012). The escalation of unsustainable reliance on these livelihood options pose degradation and deforestation threats yet the country's forest cover still remains at 6%, (FAO, 2010; Kimutai & Watanabe, 2016) which is below the constitutional requirement of 10% and similar threshold endorsed by United Nations further aggravating global warming and climate change.

It is ironical that even though climate change has for a long time remained on the front banner of the world's environmental discourse, some studies, (Dube & Phiri, 2013) confirm that some communities in Zimbabwe do not comprehend it. Yet knowledge is critical in information communities' better adaption practices. Onyekuru *et al.* (2014) analyzed the effects of climate change on rural livelihoods, yet no similar study on Maasai Mau FACs had been documented. Boon & Ahenkan, (2012) and Tambo & Abdoulaye, (2013) on the other hand, evaluated how FACs adapt to climate change, but there is also no such study for the Maasai Mau FACs (MM FACs). Most of the studies (Macharia *et al.*, 2012) and Waithaka *et al.*, 2014) for instance are instead biased towards the arid and semi-arid lands (ASALs). This site-specific study sought to enrich our understanding of climate change knowledge among the MM FACs and their

livelihood response practices to generate pertinent information to inform climate change awareness creation policy and enable appropriate management adaptation.

1.2 Research questions

1. What are the livelihood activities pursued by the households adjacent to Maasai Mau forest ecosystem?
2. What is the knowledge of climate change among households and its implications on their livelihood options?
3. What livelihood options practices do the homes adjacent to Maasai Mau forest ecosystem undertake to adapt to climate change?

1.3 Research Objectives

1.3.1 Overall Objective

The overall objective was to assess the relationship between community livelihood options and climate change knowledge and practices among communities in Naituyupaki Location, Maasai Mau forest, Narok County, Kenya.

1.3.2 Specific Objectives

1. To investigate the livelihood activities among households in Naituyupaki location.
2. To assess the knowledge of climate change and its implications on livelihood options.
3. To assess the practices on livelihood options in response to climate change.

1.4 Justification

Climate change is among the biggest challenges to sustainable livelihoods in the 21st century across the globe (Kashaigili *et al.*, 2014; Balama *et al.*, 2016). The happenings have been confirmed by the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC

AR5). Climate change impacts on many livelihoods of the rural households thus resulting in increased overdependence on nature-based resources. Forest ecosystems, in particular, are facing possible degradation and deforestation as more demand for both timber and NTFPs to meet communities' livelihoods both during the wet and dry spells become inevitable. This is at the expense of the country's forest cover which remains below 10% Constitutional requirement.

No study had ever been conducted on the Maasai FACs' livelihood options and how they relate to the climate change knowledge and practices. Besides, some studies (Rwenzori Think Tank report, 2011; Dube & Phiri, 2013) confirmed that some communities do not yet understand climate change. Lack of information undeniably gags sustainable adaptation practices and in the process undermines effective management of the forest resources and sustained livelihoods. The study was therefore conducted to assess and document the relationship between community livelihood options and climate change knowledge and practices for the MM FACs in particular. The results aim to enable enhancing our understanding of climate change knowledge and improve the management of forest resources for sustained livelihoods through informed policies, programs, and actions to adapt to climate change.

1.5 Scope and Limitations

The extent of the study was to generate pertinent information on the relation between community livelihood options and climate change knowledge and practices among the Maasai Mau forest adjacent communities. This was gained through the collection of primary and review of secondary data. Also through identification and mapping of the Maasai Mau FACs' livelihood options, assessing the communities' knowledge of the climate change and how it influenced their livelihood options; and determining what practices they were undertaking in adaptation to the impacts of climate change.

The study encountered some challenges which included; unreceptive communities, scattered households, poor terrain, financial and time constraints. The study was, however, limited to four villages in Naituyupaki which were found to be non-unreceptive as guided by the four research assistants including the village elder who were well versed with the native languages and terrain. They helped in assuring the communities that the investigation was confidential and exclusively educational and hence enabled successful collection of data.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter gives a highlight of published and grey literature both local and global that is related to forest-based livelihoods, livelihoods and climate change, climate change and implications on livelihoods, knowledge of climate change and climate change adaptation practices in particular for the forest adjacent communities.

2.1 Forests based livelihoods

Livelihood refers to a way of making a living, and it comprises of capabilities, assets, and activities that enhance survival (Chambers & Conway, 1992). The contribution of tropical forests in particular to the livelihoods of the rural people has widely been acknowledged. According to World Bank, (2004) an estimated 1.6 billion people across the globe are dependent on forests for sustenance. While more than the continent's two-thirds of six hundred million people depend directly and indirectly on forests for survival (Olufunso, 2010). About three million people in Kenya living adjacent to forests depend on them for survival (Kimenyi, 2002).

The forest-adjacent households extract forests often to meet their subsistence needs for wood-fuel, herbs, fruits and other food stuff, forage, building materials among other products (Howell *et al.*, 2010; Kabubo-Mariara, 2013). The forest goods and services enable the rural households to diversify their livelihoods and also provide environmental functions that are crucial to the sustenance of rural economy (Mamo *et al.*, 2007). The forest products, as safety nets, are used to overcome unexpected circumstances and financial challenges. Besides, the forests maintain levels of consumption and prevent the forest-dependent rural households from being trapped by numerous pockets of poverty (Nkem *et al.*, 2010; Rayamajhi *et al.*, 2012; Aruwajoye *et al.*, 2013). According to Tieguhong & Nkamgnia, (2012), the role of forests in rural household's

poverty reduction is gained via the diversification and specific forest strategies adopted by households and via the provision of essential environmental services which benefit the local, regional, national and global stakeholders. The forest's role in air and water purification, production of healthy soils, cycling of nutrients, pollination, fodder, and regulation of erosion, pests and climate are of great essence for the FACs agricultural related livelihood activities (Kimenyi, 2002; Aruwajoye *et al.* 2013).

FACs are primarily known to be agrarian. Aruwajoye *et al.* (2013) for instance, assert that majority of the respondents (35%) in his study in Nigeria were farmers. The other livelihood options which included timber loggers, fuelwood sellers, beekeepers, petty traders, artisans, hunters, gathers, fish vendors, laborers and carpenters, palm wine tappers and farm produce processors were represented by small percentages. In Tanzania, Kilimanyika, (2006) indicates that 97% of his respondents stated that agriculture was of first importance to them while animal husbandry and small businesses were seen as regular secondary and tertiary activities and to a lesser degree artisanal work. The FACs also depend on the sale of the NTFPs for income generation on a small scale. In Ghana, the FACs rely on both forest ecosystem goods and services for the sustenance of their livelihoods (Boon & Ahenkan, 2012). However, the majority of the households (80%) in the study area were found to be involved in agriculture and particularly cocoa, maize, oil palm, cassava and plantain production as their main livelihood options. With the exception of cocoa, most farmers were found to grow crops primarily for home consumption. The communities also rely to a small degree on NTFPs for food sources and income generation.

According to Gross-Camp *et al.* (2015), all FACs in Cameroon, Equatorial Guinea, and Rwanda are characterized by agricultural production predominantly for subsistence with some cash crops including cocoa, mainly for Cameroon and Equatorial Guinea and pyrethrum for Rwanda. Many of the households also engage in secondary activities such as livestock rearing, fishing, wage labor, and small businesses. In the Rwanda sites, minimal use of products from non-plantation forests was observed, whereas in the Cameroon and Equatorial Guinea sites access to the forest remains relatively unconstrained, and there is widespread collection of meat, wood, fruits and other materials.

Ongugo *et al.* (2008)'s report confirmed that FACs in Kenya derive most of their primary income through agricultural activities at subsistence level. These communities cultivate crops as well as rear livestock. They also depend on forests for pasture, water sources, and energy, food and building materials. Similarly, Naituyupaki-Olokurto Management Plan, (2012) depicts that crop farming and livestock husbandry are important economic activities for the residents residing around a forest ecosystem. Also, these communities rely on NTFPs, including medicinal plants, wild honey, and wild fruits among others mainly for local consumption while they also use the forest as a source of pasture in the dry season.

2.2 Livelihoods and climate change

Sustainable livelihoods have the ability to cope with and recover from shocks and stresses while maintaining the livelihoods both now and in the future without undermining the natural resource base. According DfID (2000)'s livelihood framework, the communities ways of earning a living are supported by five types of capitals including natural, human, financial, physical and social capitals which communities use to cushion their livelihoods from stressors.

The livelihoods worldwide are frequently faced with multiple stressors or shocks including variability in climate, environmental, socio-economic and even political instability, over-exploitation, development and also poor governance which together have high potential to impact on livelihoods while reinforcing on each other negatively (IPCC, 2007). Climate change is however, often acknowledged as the primary threat to livelihoods in the 21st Century especially, where it can undo years of development. (Thompson & Scoones, 2009; Connolly-Boutin & Smit, 2015).

In the country's Climate Change Act, (2016), climate change is defined as a change in the climate system which is caused by significant changes in the concentration of greenhouse gases as a consequence of human activities and which is in addition to natural climate change that has been observed during a considerable period. The act provides for National Climate Change Council which is mandated to coordinate the country's climate change efforts. The IPCC, (2014) indicates that climate change has been established beyond reasonable doubt to be happening and even minor changes (Bryan *et al.*, 2013), in precipitation amount or temporal distribution, short periods of extreme temperatures, or localized high winds are harming livelihoods. Poor people's assets are eroded by extreme events undermining their livelihoods regarding labor productivity, housing, infrastructure, and social networks. Loss of farm income and jobs is a classic example of the loss of finances to climate change effects, which is compounded by increased cost of living, including higher expenses for food, health care, funerals and also over-dependence on nature based resources.

According Dube & Phiri, (2013)'s study in Zimbabwe, increased temperatures and decreased precipitation were confirmed to alter the natural environment thus leading to the extinction of

biodiversity that is depended upon by communities for sustenance. Also, climate change had adversely impacted on rural livelihoods in the country similarly to other parts of the sub-Saharan countries whose main livelihoods are largely confined to agricultural production and which is widely dependent on rainfall patterns. Dube & Phiri, (2013)'s results demonstrate that about 98% of the interviewees indicated that crop yields had declined due to low precipitation and rising temperatures while livestock had succumbed to droughts. Water availability, wild fruits, honey and Amacimbi-Mopane worm (ibid) and also tourism, forests, and wetlands (Nhemachena *et al.*, 2014) which are other critical livelihood options in Zimbabwe, were reported to have adversely declined because of the impacts of the changing climate.

In Nigeria, Onyekuru *et al.* (2014) cites weed infestation, increased diseases, reduced harmattan, floods and droughts, among others as the undeniable evidence of the changing climate. Idowu *et al.* (2011) cautioned that failure to control climate change, it would continue to impact on the country's livelihoods including; agricultural production, forestry and fisheries among others. The alterations in rainfall patterns, farmlands destruction by floods, increases in pest and diseases due to increased temperatures, humidity and natural disasters will affect livelihoods and also harm life and damage properties. Climate variability and change are also found to indirectly influence the biophysical environment, especially water availability and temperature regimes that are interacting to reduce agricultural production and forest resource availability. The impact is said to likely become extreme particularly when it triggers migration of people from areas of impact such as those associated with desertification and sea level rise to areas of more limited forest cover, leading to excessive forest exploitation and potential conflicts (ibid).

In Tanzania, agricultural sector remains the lifeblood for more than 75% of the population (Kangalawe & Lyimo, 2013). It accounts for 45% of the gross domestic profit and which is also critical for ensuring food security and alleviating rural poverty. The sector's productivity is, however, confirmed to have declined mainly because of natural factors such as drought, floods, and high winds among others. Crop yields were reported to be declining as species such as maize, finger millets, beans, cowpeas, and groundnuts were affected by droughts, incidences of insects and pests, diseases and vermin. Livestock production had declined regarding milk, meat, calves due to low rainfall conditions with decreased pastures. The other livelihood sectors mentioned having been impacted by climate change included, livestock, forestry, wildlife, wetlands and energy among others (Agrawala *et al.*, 2003).

In Kenya, just like in many parts of the world, temperatures have increased throughout the country with increased frequency of extreme weather events mainly droughts and floods while rainfall patterns have become irregular and unpredictable and declining livelihoods (Maitima *et al.*, 2009). Many socio-economic sectors including agriculture, water resources, forestry, fisheries, ecological systems, human settlements and health among others have been affected by climate change, which consequently impacts on the national food security (Brown, 2009; Thornton *et al.*, 2011). Agriculture remains the pillar of the country's livelihoods, yet it is the most prone to climate change. Most livelihoods, in particular in the rural settings have been affected by successive crop failure, water shortages, loss of livestock as a result of extreme weather events (Okoti *et al.*, 2014). Consequently, sudden floods triggered by the abnormal onset of the rainy seasons destroy infrastructure and hamper mobility, increase disease epidemics, damage crop fields, cause livestock deaths, cause soil erosion thus impacting on livelihoods. According to (Ojwang *et al.*, 2010) droughts degrade the environment increasing resource

conflicts and desertification in the country. The increase in droughts frequency and severity aggravates aridity of the drylands, making them drier which affects ecosystems balance and impacting on resultant livelihoods.

2.3 Climate change knowledge and livelihood dynamics

The changing climate scenario represents major threats to social and economic aspects of the environment that are now recognized as a matter of concern by the majority of the world's governments and scientists (Egbe *et al.*, 2014). It is a subject that is featuring prominently on the front banner of the world's environmental discourse; it is fundamentally discussed time to time both in the local and international forums such as the 2016 IPCC, held in Nairobi, 2016 UNFCCC, and the 2015 Conservation International forum. It has with no doubt been confirmed to be happening (IPCC, 2014) with visible impacts. Many questions, however, are unavoidable on whether climate change and its dynamics on livelihoods are well understood.

Boon & Ahenkan, (2012) demonstrate that most farmers surrounding the Sui forest reserve in Ghana did not understand the science of climate variability and change but they had observed that the rains had decreased, temperatures has increased, and also variations in rainfall patterns. About 78% of his respondents were aware of the changing climate. These respondents indicated that reduced crop yields was an evidence of climate change, which was related to increased temperatures and little precipitation, yet it supported livelihoods of the majority of the households rendering them more susceptible. Climate change was also blamed for the decline in NTFPs and fresh water sources.

The findings in Nigeria indicate that majority of the respondents in the communities sampled were already aware of climate change (Egbe *et al.*, 2014). This was attributed to the respondent's

ability to relate prolonged drought spells, low rainfall, increased temperatures, high winds, severe flooding, delayed onset of rains/early cessation and stormy weather to the changing climate and which were deteriorating the communities' livelihoods. Sources of a few households' awareness were attributed to extensive information from environmental education or sensitization by non-governmental organizations (NGOs) and extension workers as well as media. However, Ofuoku, (2011) had established that some households perceived nothing wrong with natural bush burning, since, for them, it was the quickest way for preparing the land for cultivation thus underscoring the need for awareness amongst them.

The Rwenzori Think Tank report, (2011) established that climate change, its causes, and effects among many households in Rwenzori region were relatively understood. However, the subject of climate change remained unknown to many and particularly to those with less exposure to external knowledge. A section of the respondents with some common knowledge of climate variability was said to have been obtained through indigenous knowledge system (IKS). Dube & Phiri, (2013) on the other hand, suggested that about 51% of his respondents had never heard about climate change, thus confirming a possibility of inadequate knowledge about climate change in Matobo's rural communities in Matobo and probably in other parts of Zimbabwe although these communities were aware of main changes in their environment. In Kenya, Kuria, (2009)'s report on local knowledge and perception of climate change among Kereita FACs suggest that majority of the respondents (87%) had a great degree of understanding of climate change. As such, their agricultural livelihoods and in particular, crop failure and loss of income were primarily ascribed to the changing climate.

2.4 Climate change adaption practices

The accumulation of greenhouse gasses (GHGs) for instance CO₂ in the atmosphere continues to promote global warming and consequently the variability in the climate, which impinges on livelihoods (IPCC, 2007). The rural people are however confirmed to develop adaptation practices based on their own local experiences, Trærup & Mertz *et al.* (2011). According to Onyekuru & Marchant, (2014), agro-forestry in Nigeria is one of the outstanding climate change impacts mitigation and adaptation practices for majority of the households in the country. It does not only meet their needs but also supplements main income activities, energy sources and also food in times of crop failure while mitigating GHGs. The households also adopted improved cookstoves, which they considered as a win-win option for the families since it does not only aid in abatement of climate change but is also considered as cost effective. In addition, the households increasingly make use of wetlands where they take advantage of areas often flooded to plant vegetables and crops that are tolerant to floods and also use autonomous traditional knowledge and practices to mitigate impacts of climate change.

In Ghana, the communities are said to adopt conservation of biodiversity and management of water resources so as to reduce the effects of the climate variability and change (Boon & Ahenkan, 2012). In agricultural coping practices, the communities cultivate shorter gestation period crops which are also drought resistant and grow a range of improved cocoa, maize and cassava hybrids to counter impacts of dry spells. Through capacity building and sensitization programmes, the Sui FACs appreciates the value of planting trees on their farms to provide shade for the crops and NTFPs (*ibid*). With the gradual decline in provision of valuable NTFPs including herbal plants, the communities have been said to turn to production of honey, snail farming, mushroom and rabbit keeping among others to supplement their income sources and

livelihoods (Foli *et al.*, 2011). Tambo & Abdoulaye, (2013) also found that some communities opted to borrow from banks, relatives, withdraw children from schools, kept off hospitals and diversified their activities to generate income in quest to manage the rising costs as a result of agricultural failures.

In South Africa, Thomas *et al.* (2007) suggested that increased rainfall uncertainty had enhanced communities' dependence on livestock and poultry besides crops in about 80% of homes interviewed. Besides, people often move to coastal areas while also abandoning the rain-fed agriculture for aquatic livelihoods. According to Kuria, (2009)'s study in Kenya, the Kereita FACs grew drought resistant crops, fast maturing crops to respond to dry spells in particular and also practiced petty trading. The FACs shift more to charcoal burning, firewood collection, honey gathering, extraction of medicinal plants and also businesses during dry seasons to raise income for their survival while they cultivate more during wet seasons (Naituyupaki zonal management plan, 2012). In ASALs parts of the country, communities opt to reduce their herd sizes while some abandon keeping dairy cattle and sheep and embrace keeping beef cattle and goats which are perceived to be more drought resistant (Kabubo-Mariara, 2008; Joto Afrika, 2013).

2.5 Research Gaps

Studies elsewhere were conducted to analyze the effects of climate change on rural livelihoods (Dube & Phiri, 2013; Onyekuru *et al.*, 2014) while others like (Boon & Ahenkan, 2012; Tambo & Abdoulaye, 2013) evaluated how the FACs adapted to climate change. However, no similar studies have been documented for the MM FACs and yet the findings elsewhere cannot be generalized to represent the local scenario. Majority of the existing studies (Macharia, *et al.*,

2012 and Waithaka *et al.*, 2014) for instance, are instead biased towards the arid and semi-arid lands (ASALs).

The Rwenzori Think Tank report, (2011) and Dube & Phiri, (2013) studies elsewhere indicate that climate change is little known among some communities. This is surprising considering that climate change is a global issue and continues to dominate on the front burner of the world's environmental discourse. This study seeks to determine whether such opinion also holds among the Maasai Mau FACs. Lack of information is a challenge to developing effective adaption practices, a gap that this study seeks to address.

While several literature (Kuria, 2009; Egbe *et al.*, 2014) demonstrate that climate change knowledge is fairly understood among majority of households in some parts of the continent, others like the Rwenzori Think Tank report, (2011) allude that the knowledge alone may not necessarily lead to better adaption practices since the latter is established to be hampered by other factors including lack of resources and capacity. As a result, the households continue to engage in activities that predispose their environment and livelihoods to climate change impacts including forest over exploitation and degradation and hence an interesting question for the study to review.

2.6 Theoretical Framework

This study adopted the livelihood framework as described by the UK Department for International Development (DfID); to analyze the livelihood activities and options of the rural households in the Maasai Mau forest ecosystem and how they related with climate change knowledge and practices. DfID, (2000) indicates that livelihood comprises the capabilities,

assets, and activities required for a means of living supported by the natural, human, financial, physical and social capitals.

The livelihoods of households in the study area were anticipated to include agricultural and non-agricultural activities. These were mainly expected to be influenced and supported by different assets primarily land which represented the core platform for the pursuit of crop production, the primary livelihood activity. The natural capitals included the forest, wildlife, wild fruits, herbal medicines, honey, water, and water as additional livelihood activities. The physical capitals mainly schools and health facilities would have been expected to play a critical role in enhancing communities' health and also household income to help reduce reliance on forests in particular. Financial assets particularly from the savings, remittances or pensions, wages would be pertinent in improving communities' livelihoods in the study area. The social assets such as networks, membership of groups, relationships of trust, access to wider institutions of society lays the foundation for the communities to pursue their livelihoods. The role of local resource managers would be important in building the knowledge of communities on their livelihoods and assets stressors, particularly climate change to inform better response practices.

2.7 Conceptual Framework

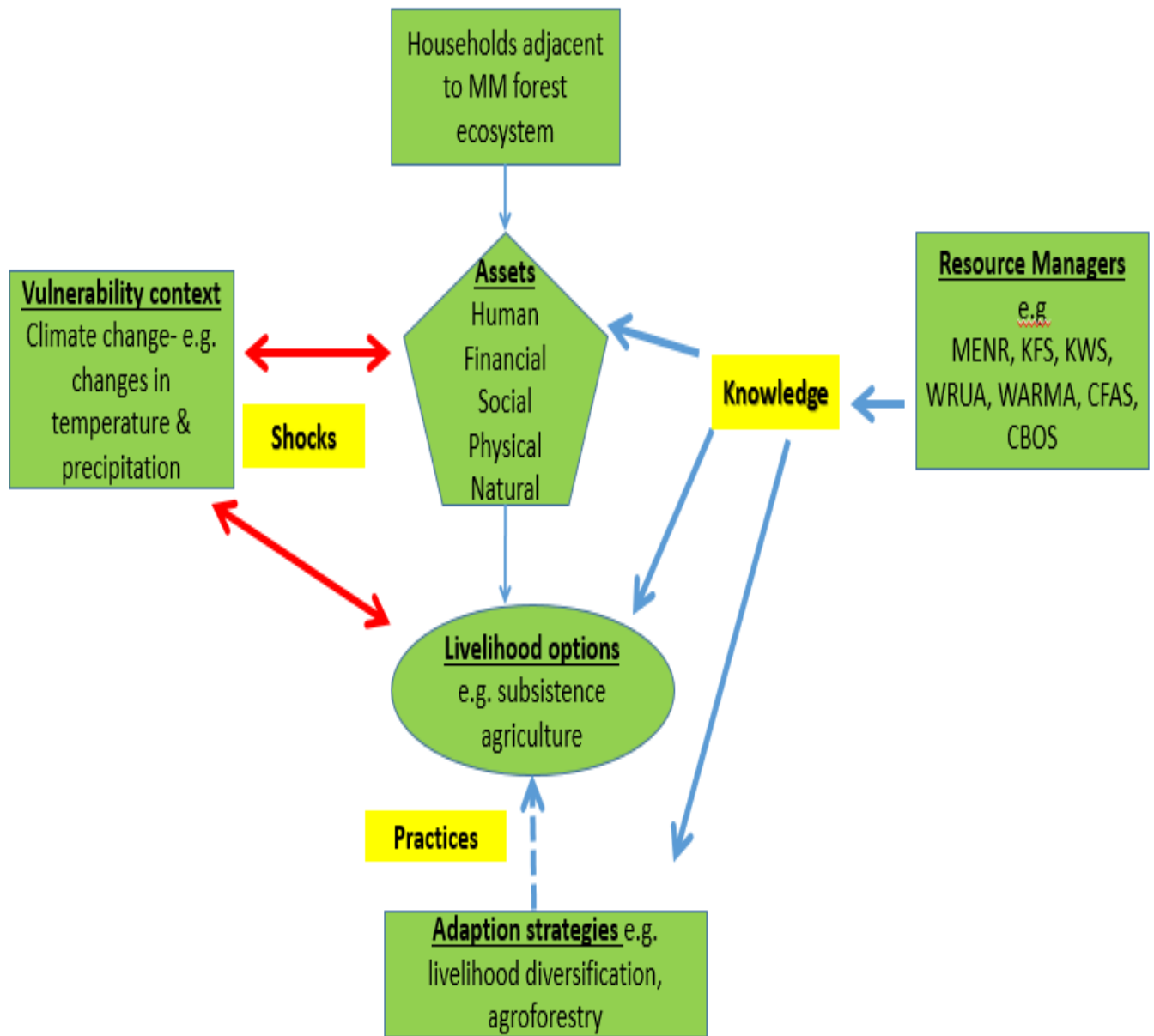


Figure 1: Elements of livelihoods framework modified from DfID, (2000)

CHAPTER THREE: METHODS AND MATERIALS

3.0 Introduction

This chapter provides information on the study area and methods used in the study. The survey enabled assess the relationship between community livelihood options and climate change knowledge and practices among the MM FACs.

3.1 Study Area

3.1.1 Geographical Location

This study was carried out among communities adjacent to the Maasai Mau Forest, Narok County. The Maasai Mau forest ecosystem forms the southern part of the Mau Forest Complex; Kenya's largest closed-canopy forest area which lies at approximately 0.0° to 0.91° South and 35.30° to 36.10° East in the South Rift region of the Rift Valley, Kenya at an altitude of 1,800 - 3,000m above sea level. The Maasai Mau forest is a Trust Land, managed by the Narok County. It covers 46,278 hectares; comprised exclusively of indigenous forest and is located in West Kenya, 17 kilometres northwest of Narok Town (Kipkoech *et al.*, 2011). The Ecosystem is surrounded by thirteen administrative locations including Ol Posimoru, Olokurto, Naisoya, Nkareta, Ereteti, Ololulunga, Ol Shapani, Melelo, Enabelibel, Sogoo, Sagamia, Tendwet and Naituyupaki. The study was specifically conducted in the Naituyupaki location, Narok North Sub-county which was readily accessible and also confined to financial and time constraints as shown in **figure 2**, although the results would not have been different if conducted in either of the other administrative locations considering they share similar geographical and also biodiversity attributes.

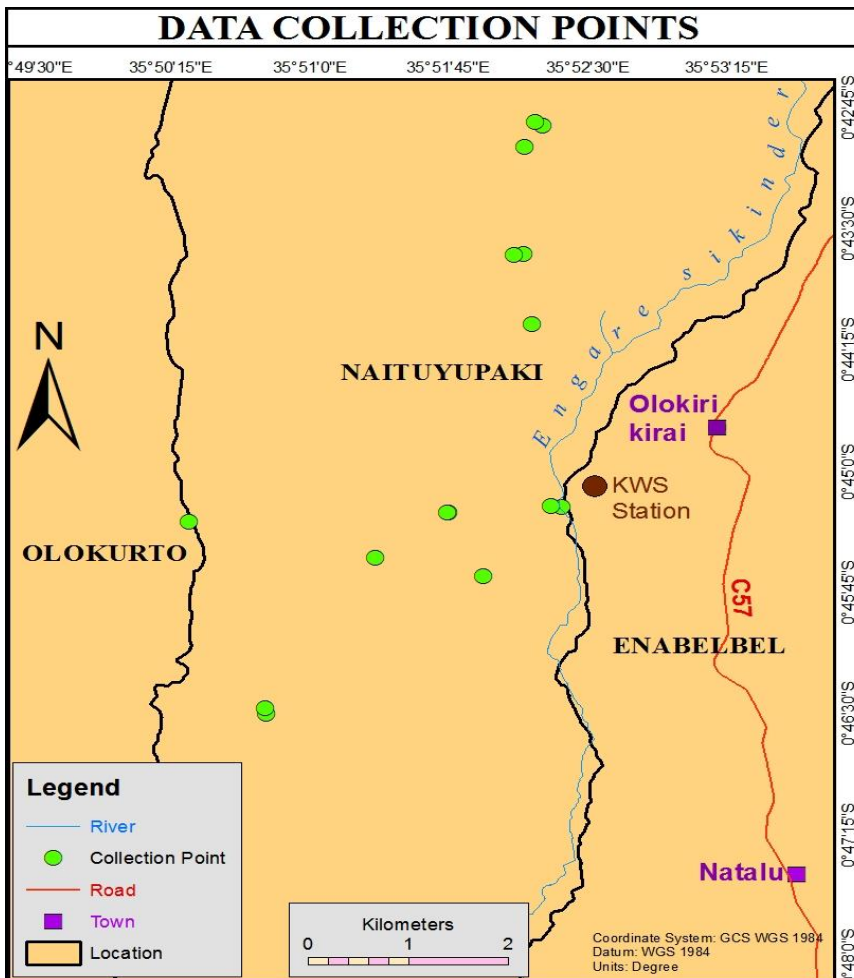


Figure 2: Data collection sites in the Naituyupaki

3.1.2 Climate and soil

Maasai Mau forest is characterized with bimodal rainfall pattern distribution, which peaks in April and August, and ranges from 1000 to 2000mm. The temperatures range from 16°C to 22°C with July being the coldest month. The potential evapo-transpiration is 1400mm to 1800mm per annum. The soil is deep, well drained, fine textured and of high agricultural potential (Kinyanjui, 2009). The main soil types in the Sub-County include; Mollic andosols, luvisols, chromic luvisols, luvic and ando-luvic, phaeozems, chromic vertisols and chromic aerosols which

determined by characteristics of the underlying basement rock and range from those developed on mountains to those developed on plains and swamps.

3.1.3 Biodiversity

The southern forests of the Mau Complex are rich in biological diversity in terms of fauna and flora. Maasai Mau forest in particular hosts wildlife such as the spectacular and rare Bongo, the yellow-backed Duiker; carnivores, including the Golden Cat and the Leopard; and the forest elephant. The forest also comprises of large stands of cedar and podocarpus forests with scattered natural glades (Thenya & Kiama, 2008).

3.1.4 Hydrology

The Maasai Mau forest is the main upper catchment of the Ewaso-Nyiro River, which provides the much needed water to pastoralist communities. The River is also the main tributary of Lake Natron, which is the breeding area for the flamingoes of the Rift Valley. To the west, the Maasai Mau forest is part of the upper catchment of the Mara River.

3.1.5 Socio-economic profile

Naituyupaki-Olokurto has a population of approximately 21,045 covering an area of about 527.60 Sq. Km with an estimated 3,811 households (KNBS, 2010). The area is inhabited by different ethnic groups including the Maasai, Kipsigis, Ogiek, Kisii, Kikuyus among others. The important economic activities among the residents residing in Naituyupaki include crop farming and livestock husbandry. Agricultural production benefits from the essential environmental services provided by the Maasai Mau Forest due to the favorable microclimatic conditions around the forest. The forest supports the local communities in terms of building materials, wood

fuel, charcoal, herbs, pasture, fruits, honey, water and also provides an important site for spiritual and cultural purposes (Thenya & Kiama, 2008; Naituyupaki Zonal Management plan, 2012).

3.2 Methodology

3.2.1 Reconnaissance

A reconnaissance was conducted to enable gain acquaintance with the study area. During this visit, a courtesy call was made to the local administration and sensitization of the village elders of the intention of research was conducted. Four enumerators were identified based on their education background, language and local knowledge. The enumerators were trained for two days to minimize measurement errors and with the aim to generate common understanding of the questions and approaches to interviewing and team interviews conducted for three days.

3.2.2 Study design

The study was conducted within three weeks in the month of June 2016 in Naituyupaki location, Narok County among communities adjacent to the Maasai Mau Forest. Naituyupaki location has a total of seven villages including Naituyupaki, Sauli, Ndete, Legen/Sasimueni, Nalengoi, Esoitit and Sagatia. The study however, was conducted in Legen/Sasimueni, Nalengoi, Esoitit and Sagatia villages which were approachable and readily accessible. The four villages were largely dominated by the Ogieks and a few Maasais and Kikuyus. Naituyupaki, Sauli and Ndete villages' access was constrained by distance, time, financial constraints and also communities' hostility which could be aligned to the fact that they stay on public/forest land without title deeds and therefore may be living in fear of being evicted. The study deployed a blended methodology where both quantitative and qualitative data were collected by use of different methods and techniques from both primary and secondary sources.

3.2.3 Data Sources

Secondary data were obtained from reviews of both published and unpublished literature from diverse local, national and international sources related to forest adjacent community livelihoods, their climate change knowledge and livelihoods dynamics and adaptation practices. The results from the reviews have been used to supplement primary data, which were collected via household survey, FGDs, key informant interviews, participants observations and also to support various aspects related to the study.

3.2.4 Sampling

The list of villages was derived by the help of four research assistants among whom one was a village elder. The research assistants who were well conversant with the study area recorded the names of each household head on the flip charts in each village resulting to a total of 183 households in the seven villages.

3.2.5 Sample size

Booth *et al.* (2008) study on the craft of research's rigorous scientific formulae, which provides for 95% confidence level below, was used to compute a sample size of 53 households from the recorded 183 households, equivalent to 29% of the total number of households (n=183).

$$n = \frac{(z^2 \times p \times q \times N)}{e^2}$$

$(N - 1) + (z^2 \times p \times q)$; where: n = Sample size (being determined), N = Population size (which is known), p = Sample proportion (assumed to be 0.05, if not given), q = 1 - p, e = 0.05 (since the acceptable error (level of significance) should be 5%) and z = Standard deviation at a given CI (z = 1.96 at 95% CI). Based on the available household data, the sample size was distributed as follows (Table 1).

Table 1: Sample size distribution

S/No.	Village	Total no. of Households	Computed Sample size
1	Legen/Sasimueni	38	11
2	Nalengoi	55	16
3	Esoitit	31	9
4	Sagatia	59	17
	Total	183	53

Source; KNBS, (2010)

3.3 Data collection

Household survey

The questionnaire was pre-tested among three households in Legen/Sasimueni but these households were not included in the actual survey. Pilot testing was meant to enable improve validity of the survey tool (Barribeau, *et al.*, 2015). This allowed final adjustments on the data collection tool. The semi-structured questionnaire was administered to 53 household heads. The information generated from the semi-structured questionnaire was complimented by information gathered from the two FGDs and three Key informant interviews.

The 53 households were proportionately distributed according to the respective village household data (**Table 1**). The respondents were systematically selected from a list of households picking every 4th household in each of the respective village to ensure equitable representation. To ensure equal representation of both male and female a list was drawn indicating male and female headed household and used for picking respondents systematically according to the proportionate villages sample.

Focus Group Discussion

The household survey was triangulated with participatory assessments and field observations. Participatory assessments included two FGDs conducted at the Village level. Each of the two FGDs comprised seven participants drawn from the four villages including Legen/Sasimueni, Nalengoi, Esoitit and Sagatia. The participants were randomly selected among the households giving an equal change for the participation of the respondents from the four villages. The FGDs were undertaken to allow develop deep insights on the communities' livelihood activities, climate change knowledge and practices. A checklist guide was prepared in advance and updated based on questionnaire survey was used in the FGDs.

Key Informant Interviews

Interviews were held with three key informants who were purposely selected for their ability to inform study objectives. The interviews were conducted at the informants' offices and village. These included, one from the Ministry of Environment, Water, Energy and Natural resources, (MEWENR), Department of Environment, one from the Kenya Forest Service (KFS)-Ecosystem Conservancy and one from Legen/Sasimueni village. A standard interview guide for the three key informants was prepared ahead of the interviews. This guide was designed to ascertain information on the informant's observation of communities' livelihood activities, climate change and communities could be contributing to the same, their knowledge of climate change, what the institution/leadership was doing to create awareness about climate change among the FACs, challenges experienced and how they were addressing the same to ensure communities sustained livelihoods and forest resource management. In the three cases, no consent was given to voice record the interviews and therefore meticulous notes were taken. Field observation was also made to capture and crosscheck issues raised in the FGDs and key

informant interviews such as livelihood activities, knowledge of climate change and adaptation practices. Informal talks with research assistants and field contact person were also executed as an additional method to triangulate information gathered.

3.4 Data analysis

The qualitative data on communities' livelihood activities, knowledge of climate change and response practices to climate change and variability gathered through interviews, focus group and informal discussions was transcribed, coded and interpreted based on identified thematic areas. The summaries of the narrations are used in the discussion in the subsequent section. Quantitative data from the household survey was organized, coded and entered in Statistical Package for Social Science (SPSS). The data was subsequently analyzed using a combination of descriptive statistics like, percentages, frequencies and cross tabulation. Data was displayed using charts and tables.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter presents and discusses the findings on household characteristics and assets, livelihood activities, climate change knowledge among the communities, sources of knowledge and communities practices in response to climate change.

4.1 Household Characteristics

70% of the respondents were male with 30% representation of women whose participation is well known to be reduced by their endowed domestic responsibilities. Most of the households were headed by male (83%) and (17%) by female, an observation that is consistent with the local peoples' customs in the country where males are anticipated to be the household heads and females attain this responsibility only upon death or migration of their spouses. In terms of marital status, 87% of the interviewees were married, 6% single, 6% widow/widower and 2% divorced. The average family size at household level consisted of 6 people, which is slightly higher than the national average of 5 persons per household (KNBS, 2010). Larger family sizes need more forest products for instance, more firewood collection in the MMF to cook a meal as compared to the quantity of firewood that would be collected to cook a meal of less persons as also observed by Chetri, (2005). The results demonstrate that most of the respondents were aged between 26-35 years followed by those whose age range was between 36-45 years, **Table 2**.

Table 2: Age of the Respondents

Age range	Frequency	Mean (n=53)	Percentage
17-25	3	22.3	5.6
26 -35	18	30.2	33.9
36 - 45	17	38.0	32.0
46 - 55	7	48.1	13.2
56 - 65	5	58.2	9.4
≥66	3	74.3	5.6

The average age for about 55% of the respondents was 44 years and hence this category is hypothesized to provide a good reflection of the respondents' responses due to their likely good comprehension of the changes that has happened in their environment besides those aged 66years and above.

On the literacy levels, the results demonstrated that the study area was largely dominated by primary school level as in **Table 3**.

Table 3: Education levels

Education levels	Frequency	Percentage
Primary	28	53
Secondary	6	11
Tertiary (College/University)	1	2
Never been to school	18	34
Total	53	100

A significant percentage of the respondents was also found to have never been to school. It is widely acknowledged that the more educated members of the communities in the country's rural areas often migrate to urban centers in search of jobs so they can improve their livelihood thus

sifting levels of literacy (Thenya, 2014). As a result, the communities including those in the study area are left with reduced capacity and hence continued reliance on the forest resources. Completed primary education however, provides a foundation for building able and better-educated community members (State of Education in Africa report, 2015) with better ability grasp the questions and respond to the same quickly and hence vital for successful research. The educated members of the communities, who secure formal employment on the other hand, play a critical role in contributing towards household's wellbeing through remittance of salary thus reducing reliance on forest products.

4.1.1 Household Assets

Physical assets

Although land is regarded as a natural capital by the livelihood framework as described by DfID, (2000), about 98% interviewees indicated that land was their most significant physical asset in pursuing their livelihoods. FACs are widely known to depend on crop production as their main livelihood strategy and hence it is undisputable that land is their foremost asset. According to the key informants, the households owned land communally in the study area, but each family produced the farm products independently. Land was purported to be a sensitive issue and majority of the community members did not have the title deeds. The respondents were hesitant to respond on matters relating to land ownership and hence the researcher opted to omit this question in the subsequent surveys. Communal land ownership, if not well managed, is assumed to pose the significant possibility of tragedy of the commons which is likely to enhance unsustainable farming practices and further forest destruction. Similarly, the forest is also said to be perceived as a God given resource to the FACs as revealed by the key informants. Communities believe that it belongs to each one of them and they have every right to utilize it

without any restrictions. This however, contributes to unsustainable exploitation of the same by the communities in their quest to make ends meet as also observed by Hardin, (1968). The respondents also cited tractor, posho mill, motorcycle, television, radio, vehicle, animal cart, and jembe as their other preferred assets demonstrating the value of physical assets in pursuant of communities' livelihood activities as demonstrated in **figure 3**.

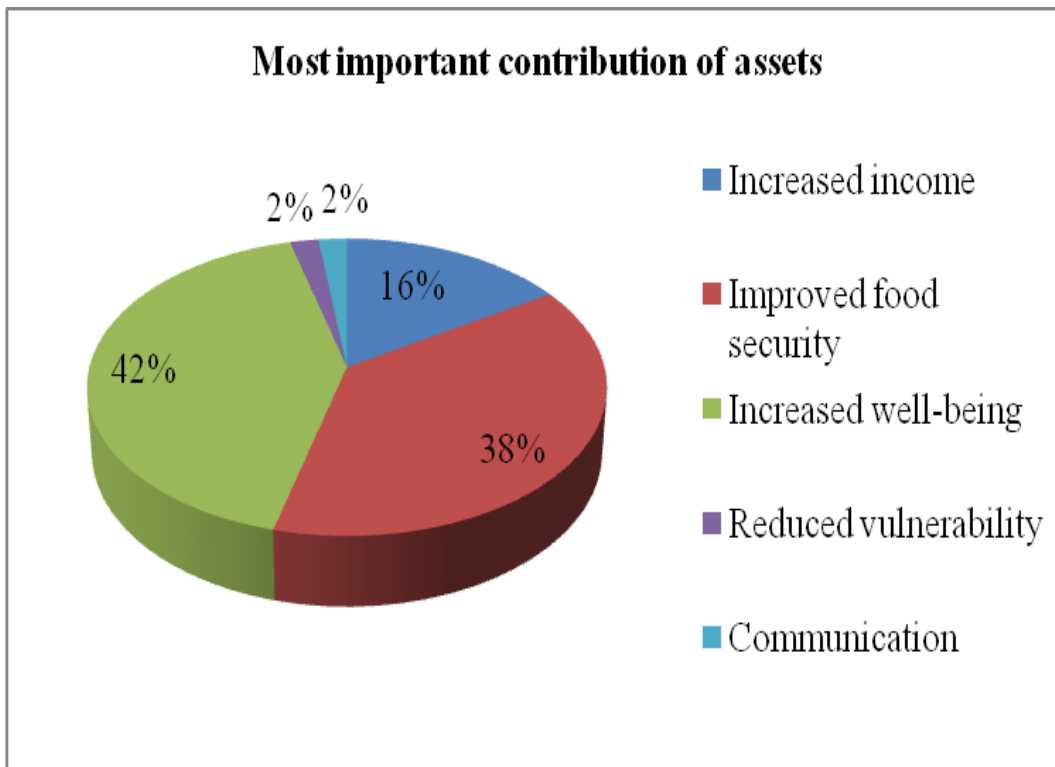


Figure 3: Most important contribution of assets

Source: Field survey (June, 2016)

4.1.2 Social capital

The result demonstrated that about 79% of the respondents were not in any social groups. The 21% in social groups indicated that these groups had been in existence for period between ≥ 6 months to ≤ 4 years. The identified social groups included the Kipakenge group, 4 family groups and the village peace committee each comprising a membership of between 11 and 30 with

almost equal representations for both men and women. The study noted that about 50% of those in social groups had joined them in January 2016. Formation and joining of social groups, in particular, self-help groups (SHGs) can be hypothesized to have been triggered by the communities urge to cushion their livelihoods against prolonged drought spells, flash floods and also increase disease and pest incidences that would otherwise render them more vulnerable to food insecurity. According to the household survey, majority of the respondents confirmed that the social groups were started to boost and empower team members economically, unite the community members, raise finances, as platforms for learning about livelihood activities and also enable solving and also fostering peace in the community. 38% of the respondents indicated that the groups helped to raise capital among other benefits as in **figure 4**:

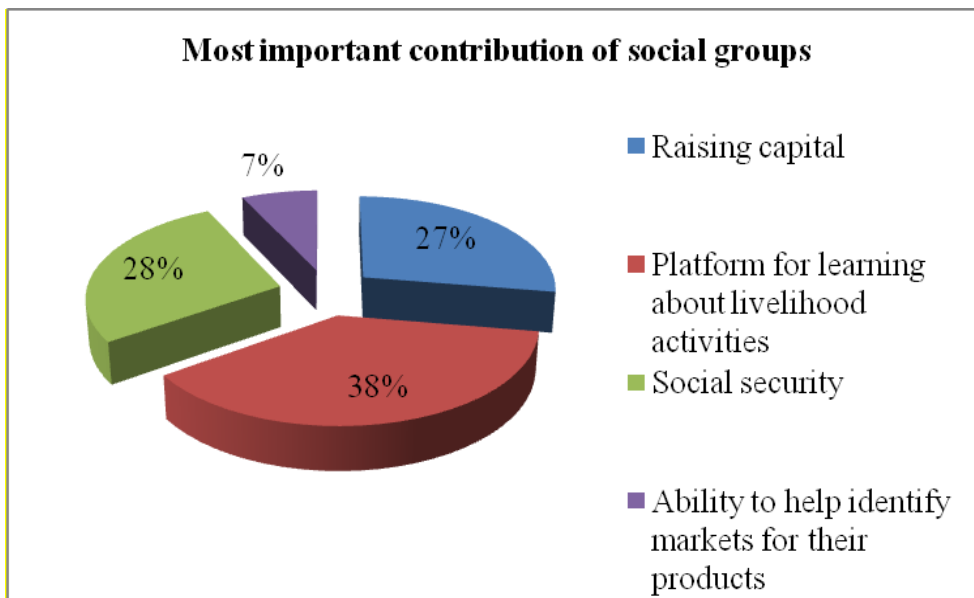


Figure 4: Most important contribution of social groups

Source: Field survey (June, 2016)

According to Basu, (2015), formation of SHGs has been confirmed as a vital contribution to the forest-dependent people in managing their livelihoods in the adverse climatic situation. The

SHGs are said to enable access to credit by the communities so they can be able to build up their assets, increase their wealth and enable starting small businesses to fight against risks and poverty similarly to the study area. These groups if well-established are therefore integral in the communities pursuant of livelihood activities.

4.2 Livelihood activities

Livelihood is a means of making a living. Most of rural households similarly to the FACs often diversify their livelihoods so as to spread the risks and reduce dependence on particular livelihood activity (Hussein *et al.*, 2016). The Respondents in the study area depend on a variety of livelihood activities. Their most important livelihood activities included crop production, livestock production and forest products, a reflection of the routine livelihood strategies. Other livelihood activities were petty trading and casual laborers as highlighted in **figure 5**.

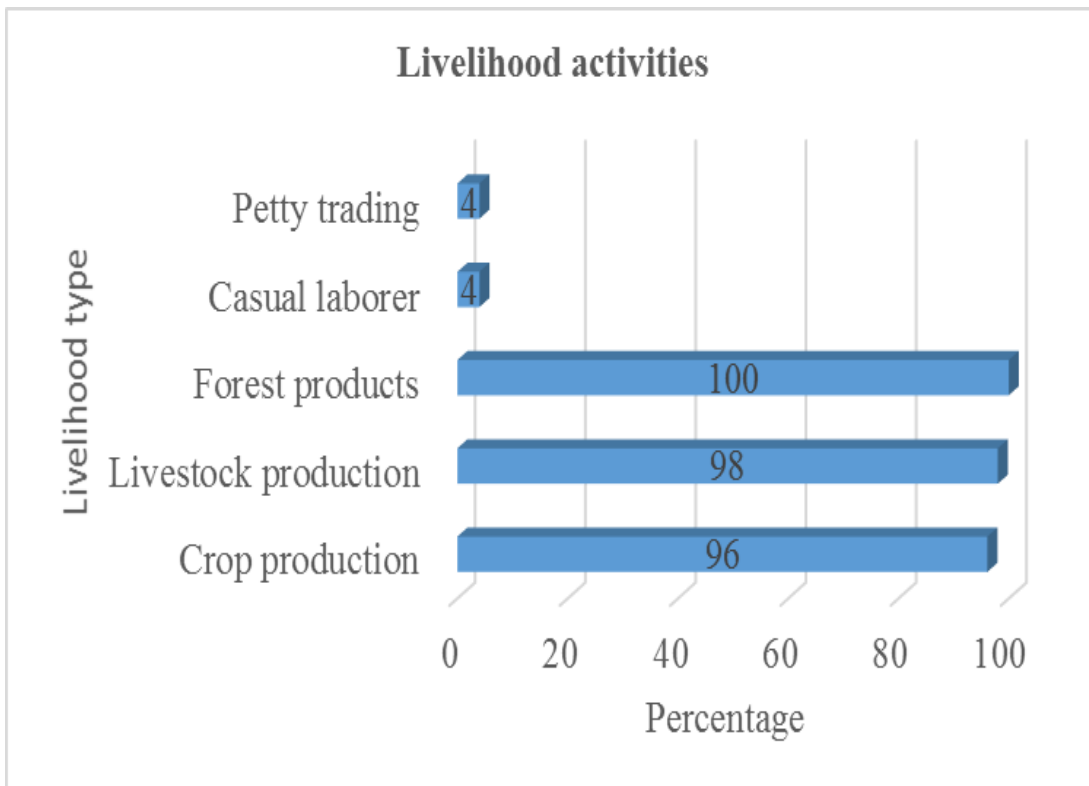


Figure 5: Livelihood activities in the study area

4.2.1 Crop Production

The results show that 85% of the households relied on crop production as their primary livelihood activity. In particular, 96% of the respondents were found to grow maize while other important crops cultivated included beans, peas, carrots, potatoes, cabbages and tree tomatoes. More than half of the households grew at least two types of these crops. Majority of the FGDs participants also considered crop production as their main livelihood activity. This plays a critical role in influencing the need to cultivate crops to continually meet the food needs of such populations alongside for about 3 million people living adjacent to forest resources including those in the study area thus heightening rate of deforestation for farmlands and continued trends of climate change. Crop demand was also confirmed through FGDs that revealed that in some incidences, lorries, find their ways to the forest to ferry potatoes and cabbages in particular for supply to the adjacent markets such as Olorkirikiria centre, Narok town, Nairobi, Nakuru and other parts of the country. Their cost of buying was however, cited to be way below market price, for instance, a 2kg tin of potatoes would cost Kshs. 20 by exploitative middlemen yet the same quantity would cost Kshs. 80 in Nairobi. They indicated that they however, usually have no choice other than disposing of their produce irrespective, aggravated by long distance, poor terrain and lack of transportation means that hinders them to reach competitive markets, a likely scenario for other FACs across the country.

These results is true for most of Africa as shown by Kilimanyika, (2006) in Tanzania, Gross-Camp *et al.* (2015) in Ghana, Cameroon, Equatorial Guinea, and Rwanda where the all FACs livelihoods were characterized by agricultural production primarily for sustenance. Similarly, Participant observation demonstrated that crop production was practiced on areas which formerly had trees confirming the integral role that trees play in agricultural production at their expense

though. Widespread tree stumps was a clear indication that the trees had been cut down to pave way for agricultural activities, in particular, cultivation of maize, potatoes, cabbages, beans, peas, carrots and tree tomatoes.

According to Barany *et al.* (2005), forests and trees outside of forests are integral components of agricultural production and the livelihoods of the adjacent communities. Besides contributing directly to food and nutritional security of rural households as food sources, they also contribute indirectly, in particular, farm inputs such as fertilizer, the likely scenario in the study area. The trees increase farming systems' resilience while forests and woodlands serve as safety nets during agricultural shortfalls. FAO, (2016) adds that forests contribute towards agricultural production by providing land and soils for small scale crop production while they also regulate weather patterns which are also the likely scenario for the study area.

Similarly to the MMF, Kilimanyika, (2006) alludes that the respondents indicated that crop production was their primary livelihood activity because of its ability to generate some real income, the availability of land resources, it was less complicated and also the respondents had skills required for crop production, even though more than 50% interviewed had only attained primary school education.

4.2.2 Livestock production

The results indicated that 14% of the respondents pursued livestock keeping either as their main livelihood activity. The households reared cattle, sheep, goats, donkeys and chicken as demonstrated in **figure 6**.

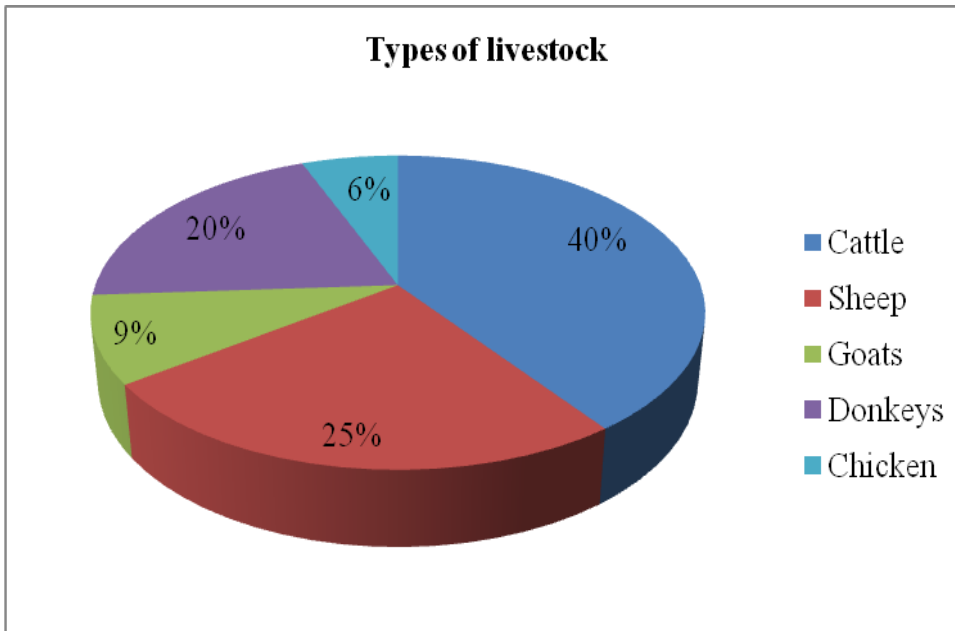


Figure 6: Types of livestock in the study area

Source: Field survey (June, 2016)

The communities relied on livestock for milk, meat, wool and also sold the whole animal especially so during drought spells to generate some income. Livestock keeping may have been influenced by the fact that pasture was readily available since respondents that kept livestock indicated to feed their livestock in the forest while only 3% of them also grow forage on their homestead as an alternative to the forest pasture. Poultry keeping in the study area was however, only practiced by 6% of the respondents. This is contrary to the Kilimanyika, (2006)'s findings in Tanzania, where 65% of the respondents kept poultry. Among these communities, poultry rearing was deemed relatively inexpensive to keep, in small areas, and the incidence of ticks coming from the forests affecting the poultry was minimal thus widely reared and hence this would have been expected of the MM FACs where most land is set aside for crop farming that

only aggravates deforestation and climate changes. About 8% of the respondents also pursued casual laborer and petty trading as alternative livelihood activities.

4.2.3 Forest products

According to the World Bank, (2004)'s forest strategy, more than 1.6 billion people depend on forests for their livelihood globally where in Kenya, an estimated 3 million people living within and adjacent to forests rely directly and indirectly on forests to eke a living (Olufunso, 2010). The MMF lies in the Mau Escarpment, one of the largest forest cover and also one of the country's major water catchment towers, alongside Cherangany Hills, Mt. Kenya and Aberdare Ranges and hence the likely high dependence on the forest as it provides micro-climate that favors agricultural activities. And although only 2% of the respondents ranked forest products as their main livelihood activity, it was established that 100% (n=53) of the respondents relied on the forests for either firewood, charcoal, building materials, herbs, honey, fruits, pasture, tree seedlings and wild game as discussed in the ensuing section. This finding concurs with numerous other studies such as Howell *et al.* (2010) in Malaysia and Kabubo-Mariara, (2013) in Kenya which demonstrates the contribution of forests to the adjacent communities' livelihoods and particularly in most parts of the less developed world including Kenya.

A cross tabulation of the results on level of education and most important livelihood activity as in **figure 7**, reflects that although all the respondents depended on forest products, a few of the (34%) of the respondents who had never been to school were the sole group dependent on forest products as their prime livelihood activity.

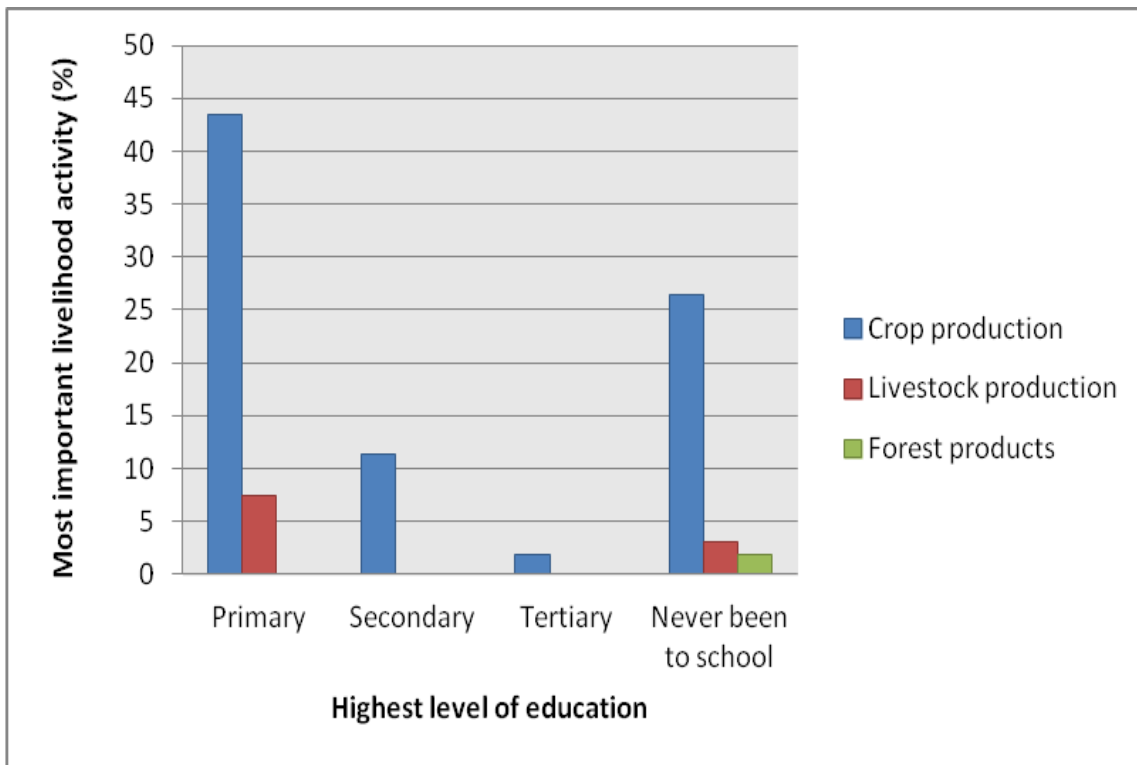


Figure 7: Highest level of education vs most important livelihood activity

Source: Field survey (June, 2016)

The result concurs with Mutune *et al.* (2015) study in Eastern Mau which observes that households with least levels of education are more dependent on forest resources; the least levels of education provide limited job options rendering forest-related activities such as wood collection and charcoal burning more dependable by the community members.

Firewood

All respondents (100%) collected firewood from the MMF. The collection of firewood was said to be the responsibility of adults, predominantly female as expressed by 96% of the respondents. This is a reflection of typical rural households where the communities are entirely dependent on fuelwood as the sole energy source of cooking fuel. About 51% of the respondents indicated that they fetched fuel wood on a daily basis while 47% weekly and only 2% on a monthly basis.

Majority of those who fetch fuelwood on a daily basis for home consumption often collect on back-loads (89%) while those who collected on donkey-loads (11%) often collect on a weekly or monthly basis. This is often influenced by factors such as the household sizes which dictates the consumption levels and income generation needs. The latter option was however disputed by FGDs participants who unanimously indicated that there was no market for fuelwood and therefore all wood collected was exclusively for household consumption.

Forest remains the major sources of energy for the FACs. Introduction of improved jikos and renewable energy fuels like briquettes in particular in the study area can contribute to less collection less firewood from the forests and also reduced emission of CO₂ via charcoal burning. This was confirmed to have been achieved in over 60% households in other areas in South Nandi (Gichuki *et al.*, 2014).

Charcoal

Only 6% of the respondents indicated to burn charcoal, a response that was replicated during the FGDs. These respondents indicated that charcoal was produced solely for home usage and therefore no direct economic value was related to the same. In contrarily, field observation confirmed that charcoal production was either a livelihood activity in the study area as one would come across charcoal pieces here and there on the roads, an evidence of it being ferried around. Also seen burning, several mounds of traditional charcoal kilns in hidden areas of the forest seemly to avoid any confrontation with the arm of the law. Commercial charcoal production and movement in Narok County had been banned since 2008 but it was found to thrive illegally still as observed by Tesot, (2014). According to the key informant from the MEWENRs, charcoal production was rampant in Narok County and its environments as also observed in Naituyupaki. Over 1,000 bags of charcoal from the forests in Narok County were

reportedly ferried to Nairobi and other towns of the country on a daily basis. He indicated that dishonest traders had resorted to using donkeys and motorbikes to ferry the charcoal from the endangered Mau, Olkurto, Olposomoru and Nyakweri forests to Narok town. Hundreds of donkeys and boda-bodas ferried charcoal at night, but it was indicated that the County Government was keen on crackdown and reprimanding of the culprits. Similar findings were recorded by Ongugo *et al.* (2008).

Charcoal production is widely known to involve tree felling which results to destruction of vegetation cover and hence loss of biodiversity. Mugo *et al.* (2007) suggested that if charcoal industry remains unsustainable which is likelihood of the study area, it may result in disruption of the rich biodiversity-ecosystem through deforestation and environmental degradation, disruption of livelihoods of millions of people across the globe who rely directly on forests and by extent continued trends of climate change similarly to the study area.

Illegal charcoal production is a menace and as also observed by the key informant interviews, it can hardly be entirely stamped out and therefore can only be restricted or rather promote its sustainable production via enforcement of the Forest (Charcoal) Act 2009 including in the study area. The Act provides for the Charcoal Producer Associations (CPAs) and gives the right to commercial charcoal producers to establish the CPAs. The community members are guided and bound to produce charcoal sustainably and ensure they implement reforestation and conservation plans for sustainable charcoal production. The CPAs members also develop codes and use them to regulate their activities and also help the forest department to enforce the Forest Act and that provides for sustainable charcoal production (Gathui *et al.* (2012) and hence viable efforts towards addressing this livelihood. It was however, established that the CPAs were introduced in Narok County in 2015 and community members had no knowledge about them also in

Naituyupaki. This therefore calls for the need to consider awareness creation for the CPAs and sustainable charcoal production across value chain among communities in the study area. Also, introduction and embracing of alternative energy fuels like briquettes among the FACs would help in reduction of reliance charcoal and hence minimize production of the carbon dioxide (CO₂) which causes global warming. Also enhancement of livelihood changes that enable communities to depend less on forest resources are adequate tool for sustainability.

Building materials

Only 6% of the respondents indicate to have assembled building materials from the forest. They said that the building materials were harvested merely for building their houses. It was however established during the FGDs and Key informant interviews that illegal cutting down of trees was still ongoing. Some of the communities also bribe the officers on patrol while the officers themselves also accept the bribes thus colluding and allowing cutting and ferrying of poles and timber out of the forests on donkeys for sale irrespective of the KWS office stationed adjacent to study area. It is worth noting that some efforts were however reported to been made to reduce on rampant illegal harvesting of trees by the KFS and KWS officers who make impromptu visits to the forest and reprimand culprits as revealed during the FGDs and key informant interviews. Building material remains an important livelihood and there is need to enhance enforcement of the forest regulations to curb rampant illegal tree cutting to safeguard the carbon sinks and abate climate change. There is also need to consider promoting agro-forestry activities and participatory forest management (PFM) which encompasses income and recreation issues to achieve sustainability.

Non-timber forest products

Herbs, pasture, honey and wild fruits were also acquired from the forest by the community members. 44% of the respondents' collected herbs, while 33% depended on pasture, 6% collected honey, and 2% depended on wild fruits for food. The herbs were collected primarily to treat the ailments of the community members and their livestock or for sale. The communities walked for more than 5km over poor terrain to access health services in the nearby Olorkirikiria health centre thus the importance of herbal medicine in study area. Neither community members nor KFS had a strategy for sustainable herbal remedy harvesting, studies on sustainable yield having never been conducted. No procedural means for documenting herbal remedy used for posterity's sake have been made too. On the other, the respondents indicated that honey harvesting and wild fruits collection was for both home consumption and commercial purposes. Honey harvesting was however conducted annually and therefore this enhances the dependence on other livelihood activities, in particular, crop production where fast maturing crops like potatoes, cabbages, maize are dependent upon for food. There is need to consider capacity building for the communities so to promote commercialized production of honey, at least twice or thrice in a year to make more viable to ease pressure on timber products. There is also need to consider developing grazing strategies for the communities to control overgrazing and forest destruction thus promoting conservation of important biodiversity areas.

Challenges in access to forest products

The household survey data revealed that 83% of the respondents (n=53) admitted facing various challenges in the collection of the wood products while only 17% perceived no problems. The respondents' most pressing problems included existing forest regulations, insecurity, reduced

availability of wood products, conflicts between the CFA and non-CFA members and increased distance covered in search of forest products as demonstrated in **Figure 8**.

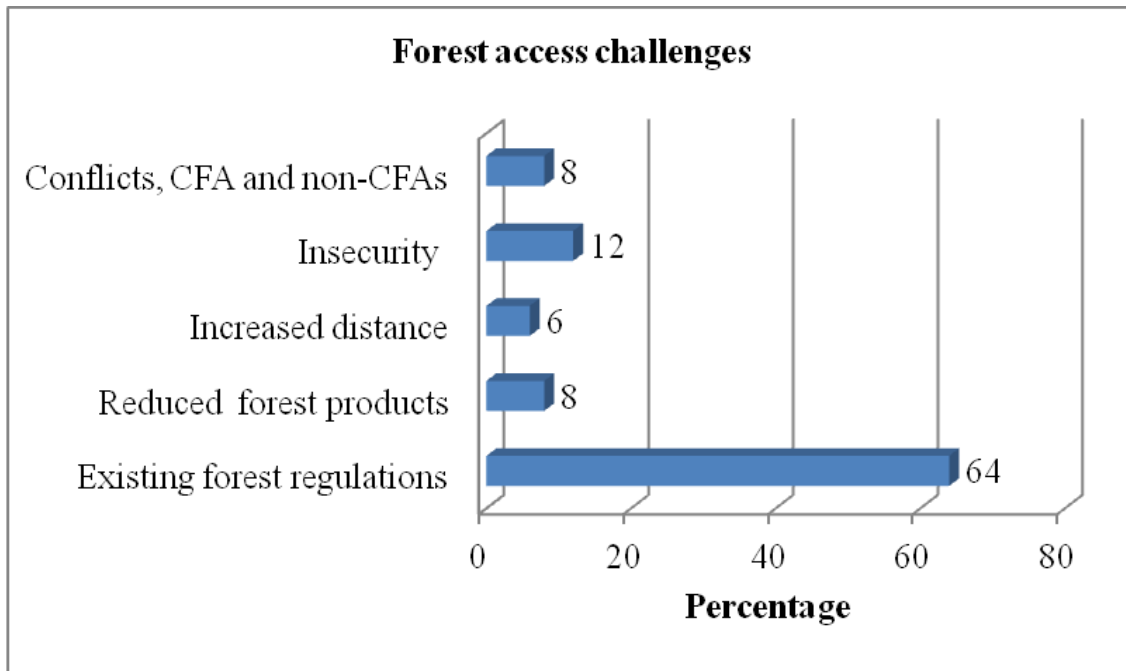


Figure 8: Most important forest access challenges

Source: Field survey (June, 2016)

The existing forest regulations was indicated to bar community members from freely accessing the forest to collect poles, timber and burn charcoal and therefore engaged in hide and seek with the local resource managers. Insecurity was mainly linked to attacks by wild animals including buffaloes, leopards and even elephants and hence restricting communities' frequent access to the forest. Climate change was not cited as a challenge to access to forest products as per se, however, the respondents reported reduced availability of forest products that was attributed to increased disease and pest incidences, increased temperature, low rainfall, increased precipitation and prolonged drought spells as observed by 94% of the interviewees confirming that climate change was also a challenge. This observation upholds the findings by Nhemachena *et al.* (2014)

and also Onyekuru *et al.* (2014) in Nigeria who found that climate change had contributed to reduced availability of forest products and in particular the NTFPs. It was said to have directly influenced the biophysical environment, particularly the availability of water and temperature regimes which interacted and reduced agricultural production and forest resource availability a likely scenario in the study area.

The results agrees with other studies for instance, conducted in Mt. Elgon by Ongugo *et al.* (2008), which pointed out existing forest regulations as provided by the Forest Act (2005) which provides for punishment to those who damage the forest in search of wood products such as logs for charcoal, firewood, and other commercial purposes thus regulating on the woods resource accessibility.

Similarly, Timko *et al.* (2010) studies in Sub-Saharan Africa cited increased distance to access forest products such as firewood and other forest resources as a critical challenge to the surrounding community which tremendously depended on them for survival. Also insecurity challenges were also presented since communities had to go further and deeper into forests to get the products risking wild animals attack same to the study area. Although 8% of the respondents cited conflicts between the CFAs and non-CFA members, the key informants at the county and village level revealed that the CFAs in the study area were quite dormant and therefore the conflicts between CFA and non-CFA members may not be such a challenge in access to forest products as purported by the respondents.

Responses to forest access challenges

About 75% of the respondents had increased on-farm activities as their strategy to address the challenges to access and usage of products from the forests. 11% use energy saving jikos, 5%

engage in petty trading and 9% plant forage in their homesteads and arm themselves particularly against wild animals while collecting the forest products. Replacing agriculture with fibers to reduce dependence on forest products. Use of alternative sources of energy and more efficient stoves and also increased agro-forestry activities to reduce pressure on forest products. The increased use of farm inputs such as fertilizers and pesticides was however reported to contribute to killing off bees and hence decline in honey production as established in the FGDs.

4.3 Knowledge of climate change

4.3.1 Understanding climate change

Results from the household survey indicate that 93% of the respondents had heard or knew about climate change as also confirmed in the FGDs where most of the participants held the same opinion. 8% of the respondents in the household surveys indicated that they had not heard or did not know about climate change. Similarly to the FGDs, 43% of the respondents in the household surveys were found to have understood climate change through own experiences. An average of 23% had heard via radio and others via Barazas, hear-say from other farmers, extension agents and also seminar as in **figure 9:**

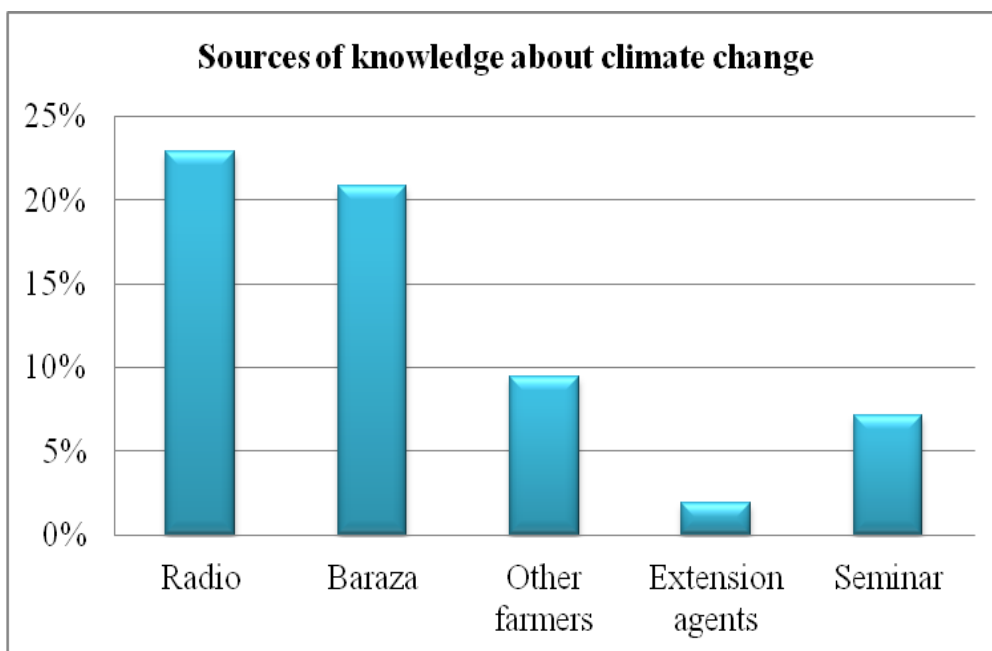


Figure 9: Knowledge about climate change

Source: Field survey (June, 2016)

The knowledge of climate change was acquired by the households between the years 2000 and 2015. The respondents stated varied accounts of their understanding of climate change as follows, “the mornings are nowadays freezing than in the earlier years, the sun has become too hot, there was a lot of rain in the past, however, this has changed, and hence we are forced to grow potatoes and maize but not without worrying about crop failure and losses due to the unpredictable rainfall patterns. The diseases have also increased, and they attack our plants leading to food insecurity. Flash floods and prolonged drought spells have also become inevitable and more severe. Seasons have changed from what we knew to news ones, pasture has also declined, and we have had occasions where livestock die during droughts and also when it floods.” The later was, in particular, a challenge to the Maasai households whose livestock

production was mostly considered as their most important livelihood activity while they also kept vast herds of livestock for prestige.

Similarly to Egbe *et al.* (2014) the study's findings indicated that majority of the respondents sampled were already aware of climate variability and change which they related to extended drought spells, low precipitation, increased temperatures, floods and unpredictable rainfall patterns among others. Similarly, Kuria, (2009)'s findings in Kenya on local knowledge and perception of climate change among the study communities suggested that 87% of the respondents had an impressive knowledge of climate change. Dube & Phiri, (2013), however, found that about 51% of their respondents had never heard about climate change, thus demonstrating the probability of inadequate information and knowledge among the communities in Matobo and in other parts of Zimbabwe although they were aware of the significant changes taking place in their environment contrarily to the findings in the MMF. Either, the report by the Rwenzori Think Tank, (2011) suggest that climate change subject was not well known to most of the respondents and particularly to those with less exposure to external knowledge unlike in the study area. Yet according to the Climate Change Act, (2016), climate change is defined as a change in the climate system which is caused by significant changes in the concentration of greenhouse gases as a consequence of human activities and which is in addition to natural climate change that has been observed during a considerable period.

4.3.2 Causes of climate change

About 72% cited natural causes, Supreme Being in particular, as the primary cause of climate change, while 26% and 2% cited human activities and punishment from gods respectively as highlighted in **figure 10**. This result agrees with Debela *et al.* (2015)'s which established that

78% of the respondents mentioned natural forces as the primary cause of climate change, 16% human activities while 6% were found to be unsure or rather could not explain as into what causes climate change.

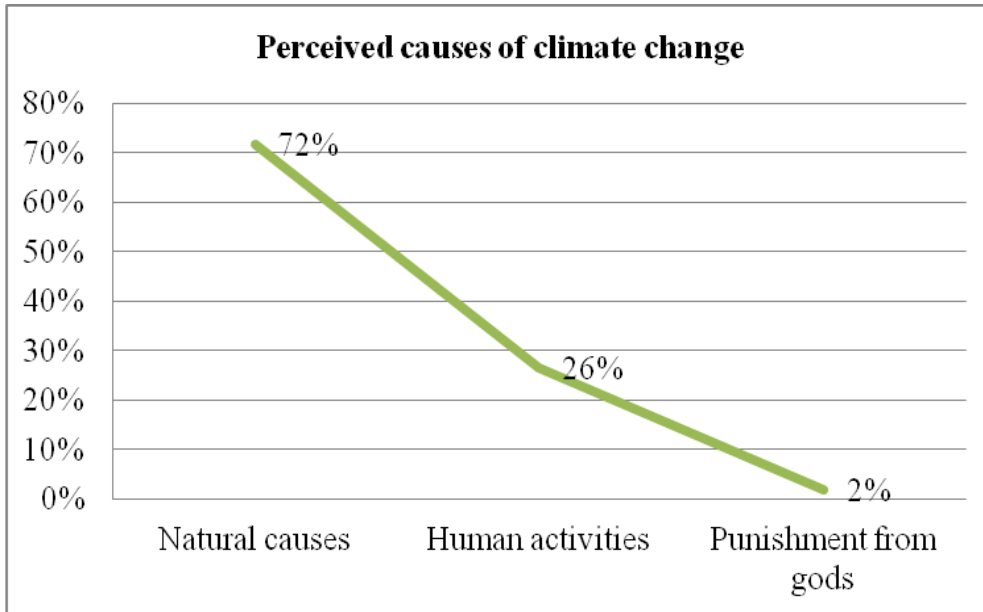


Figure 10: Causes of climate change

Source: Field data (June, 2016)

The results also corroborate the findings of Caribbean Institute of Media and Communication, (2012) report on climate change knowledge, attitude and behavioral practice survey which indicated that 43% of the respondents stated that they had contributed little to climate change causes and effects. Similarly to the finding of both Debela *et al.* (2015) & the Caribbean Institute of Media and Communication, (2012) report, the respondents' perception of natural causes as the primary cause of climate change may have been contributed by the communities' lack of adequate information and knowledge about the scientific understanding of what natural causes are. According to Nwankwoala, (2015), the natural causes of climate change include volcanic

eruptions, solar out radiations, biotic processes and even ocean currents, which is in contrary to how the FACs understands of natural causes.

Participant's observation on the hand, confirmed that anthropogenic activities could have contributed to the changing climate more than the natural phenomena at least in the study area.

Plates 1, on charcoal ferrying, **2** and **3** on clearance of forest to pave way for crop production are clear evidence on human activity in the forest.



Plate 1: Donkeys ferrying charcoal to Narok town. Photo taken in Narok, town, 2015



Plate 2: Section of the MMF converted to farm land

Sources: Field survey (June, 2016)



Plate 3: Production of tree tomatoes

Probably the communities who currently live in the forest, which is also a public land were concealing some information for fear of eviction. This observation is also supported by scientific findings by the IPCC, 5AR (2014) which demonstrate that human activities are the primary cause of climate change. Human activities, especially fossil fuels burning and land use changes, deforestation, land clearing and also agriculture as observed in the study area, are attributed as the major contributors of the GHGs emissions, which are responsible for more than three-quarters of the CO₂ (ibid).

The respondents' impressive knowledge of climate change alone is inadequate. The communities depend largely on their own observations and experiences as sources of information as noted by the 93% who had observed changes taking place in the environment similarly to the finding by Tessema *et al.* (2013). Either, the respondents' knowledge of the primary cause of climate change is still limited in that it is not founded on scientific information. This scenario upholds the GoZ-UNDP/GEF, (2010)'s report which suggest that most of the people in the less developed countries are not adequately informed of climate change. And by extent, climate

change information is limited to research institutions in these countries thus enabling little access to the same. Only 2% of the respondents reported to have received trainings related to climate change from the Government's extension officer, contravening the Constitution of Kenya, (2010), Article 35 & Climate Change Act, (2016), which provide for a right to get the climate change information in particular, by all citizens. According to Bryan *et al.* (2009) and Komba *et al.* (2012) the study suggests that the knowledge of climate change among FACs impacts significantly on how these communities deal with climate-induced risks and opportunities. It also determine their livelihood practices in adapting to climate change as also observed by Nzeadibe *et al.*, (2011) study in Niger Delta region of Nigeria. It is likely that the communities' knowledge of climate change as established will stagnate and or even be lost if it is not aligned to scientific knowledge thus increasing communities' vulnerability to climate change impacts.

Ozor *et al.* (2015) observed that punishment from gods as cause of climate change is common in most rural areas including the study area where communities attribute natural disasters to the anger of the gods. The communities believe that some evil deeds trigger gods' wrath that can alter the normal climatic patterns thus affecting livelihoods activities as observed by the 2% in the study area. It however, emerged during the FGDs that, "existence of gods is a no longer a thing of the present, it is overtaken by events," and the communities did not, therefore, believe in punishment of the gods as the cause for climate change, thus upholding majority's view.

4.3.3 Climate change implications on livelihood activities

All the respondents indicated that they had experienced climatic variations in the past ten years which had consequently affected their livelihoods. According to Hartter *et al.* (2012), for the local communities in most of the tropics, precipitation bears much significance regarding impacts as compared to temperature changes. The change in rainfall quantity and distribution

pattern affects agricultural production and forest conditions as also observed in the study area. The communities attributed the changing climate to increased drought incidences (15%), drying up of streams (8%), irregular rainfall patterns (6%) and increased pests and diseases occurrences (37%) that all resulted to poor crop yields (34%).

Notably pests and disease incidences caused crop failure rendering the communities more vulnerable to food insecurity in the study area. Similarly to Onyekuru *et al.* (2014)'s study in Nigeria, increased diseases incidences were linked to declined agricultural production particularly in crop production. Also, Agrawala *et al.* (2003) study's in Tanzania found that the growing of crops such as maize, finger millets, beans, cowpeas, and groundnuts was reported to have declined following the effects of increased incidences of insects and pests, diseases and vermin. According to the IPCC's Fifth Assessment Report, global agricultural production has already declined by 1-5% per decade. Also, agricultural productivity will be affected even by 2 degrees increase in global temperature, particularly in the tropics, an impact that will also see temperatures rise (ibid) as it is happening in the study area where it was cited as a sign of the changing climate. According to Dinesh *et al.* (2015), crop pests are already a major factor influencing farm productivity, and about 1/6th of the field, production is lost to pests globally with further losses to storage. Also, climate change is expected to increase the prevalence of crop pests, the frequency of new pest introductions will increase, the occurrence of the primary pest outbreaks will increase, and the risk of pesticide residues in food will increase similarly to the study area.

In contrary to Connolly-Boutin & Smit, (2015) which state that livelihood is faced with climate change as a major stressor particularly in the 21st century and in the developing countries, only 5% of the respondents in Nayituyupaki agreed with the finding. About 91% of the interviewees

cited other challenges that included poor leadership, poverty, and political instability. There is, however, need for the communities to understand that these problems are interconnected, and they reinforce each other as they impact on their livelihoods (ibid), hence need to be addressed holistically.

4.4 Climate change adaptation practices

Climate change is now a reality and adapting to the same is inevitable including for the MM FACs. According to the IPCC (2014) and Climate Change Act, (2016) adaptation refers to adjustment in natural or human activities' process in effort to respond to real and or anticipated climatic changes and its effects, which moderate harm or exploits beneficial opportunities. Moser (2010) observed that adaptation strategies could range from short-term to long-term and aim for more goals other than just climate change. According to Gbetibouo (2009), the FACs' knowledge of climate change and its effects is critical in informing their adaptation choices. These results demonstrate that the MM FACs understood that climate change is happening and were found to have adjusted their livelihood practices in response to the same as follows:

4.4.1 Crop farming

The results indicate that 63% of the respondents practiced mixed farming. Mixed farming is one of the biggest agricultural systems category in the world (Schiere *et al.*, 2006), and it involves crop farming alongside livestock keeping. The livestock kept included cattle, sheep, goats, donkeys and poultry purportedly to supplement income generated from crops as it has been the routine since time memorial. There is yet nothing much change in the adaptation practices and perhaps there is need to consider more sustainable farming activities. This result upholds practices in South Africa where Thomas, *et al.* (2007)'s study found that the unpredictability of

high rainfall had increased dependence on livestock and poultry besides crops in about 80% of the interviewed households.

The respondents also practiced crop diversification where they planted a variety of crops including maize, beans, peas, cabbages, potatoes and tree tomatoes. For the communities in the MMF, tree tomatoes, which were believed to respond better both during wet and dry seasons had been adopted in addition to their traditional crops as revealed during the FGDs. Moreover, household interviews revealed that communities had since adopted plantings of early maturing crops such as irish potatoes and cabbages, which are harvested after every three months similarly to other areas as also observed by Kuria (2009) and Boon & Ahenkan, (2012). The latter's study in Ghana found that households cultivated shorter gestation period crops which were also drought resistant like cassava to adapt to the changing climate. Crop diversification is one of the vital strategies in adapting to the effects of climate change (Ellis, 2000) and it's adopted mostly by rural communities, Balama *et al.* (2013) including in the study area.

Other practices included agro-forestry and adoption of other livelihoods such as petty trading and casual laborer similarly to the findings by Kuria (2009) and Tambo & Abdoulaye (2013). Agro-forestry was practiced to provide shade for the crops and livestock in particular during the dry seasons while some trees produced fruits that were consumed at household levels and also sold to generate some additional income. This finding agrees with other studies, for instance, Onyekuru & Marchant, (2014)'s results in Nigeria which indicated that agro-forestry did not only help communities meet their needs but also provide alternative income sources, energy and food in times of crop failure while it helped mitigate GHGs as it provided for more carbon sinks. And similarly to the findings by Balama *et al.* (2013), 33% of the respondents also mentioned that they had since adopted modern farming techniques where increased use of fertilizers,

pesticides, mist proof, besides farm manure were used to enhance the productivity of agricultural produce as part of their adaptation practices.

4.4.2 Livestock production

Traditionally, Maasai communities, keep large herds of livestock as a sign of wealth and as a status symbol. This guarantees a secured livelihood for the individual households particularly in times of crop failure due to unpredictable climate conditions and other factors. Large livestock herds are, however, associated with greater demand for pasture (Debela *et al.*, 2015). As a result, they trigger overgrazing in forests particularly for the FACs and subsequently contributing to the degradation of forests. Overgrazing in forests is also triggered by the decline of pasture and also water shortages among the FACs. In response to such challenges, this study found that 29% of the households reduce their herd sizes by selling them particularly during drought seasons to reduce losses of livestock succumbing to droughts. Also, 59% of the respondents kept improved livestock breeds such as Merino sheep and were adapted to cold seasons respectively. According to Lesnoff *et al.* (2012), cattle are known for slower biological turnover and are considered more vulnerable to shortages in feed during drought seasons, unlike small ruminants. The later are hypothesized to feed on lesser pasture and browse hence more manageable in times of scarce pasture. The households (12%) kept livestock besides cultivation of a variety of crops to counter the effects of single farming while multiplying sources of food to cushion against food insecurity (figure 11).

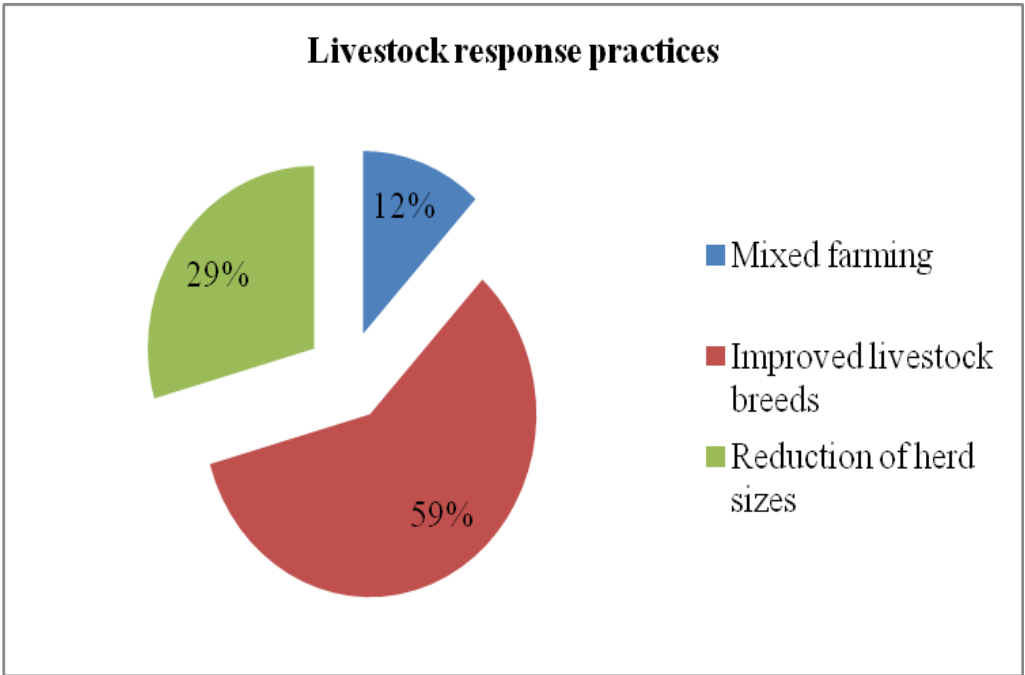


Figure 11: Livestock response practices

Source: Field survey (June, 2016)

4.4.3 Firewood and Charcoal

While all the respondents indicated that firewood was collected absolutely for home consumption, the households had adopted diverse ways in responding to reliance on the collection of the same from the forest. As such, 62% stated that they used improved cookstoves (**Plate 4**) for cooking.



Plate 4: Improved cook stove in study area

Source: Field survey (June, 2016)

These were majorly traditionally built cookstoves with only one side where firewood is placed through thus reducing the number of fuel wood pieces to cook a meal or heat the house space. This finding is similar to Onyekuru & Marchant, (2014)'s which established that some households had adopted improved cookstoves which were considered a win-win option for the families as it helped in abatement of climate change while also considered as cost effective. In

certain areas, local sources of firewood are completely depleted leading to travel especially for women to further into the forest and also dig tree roots, eliminating any chance for regeneration of trees. Use of more fuel-efficient woodstoves is widely being promoted by many agencies including the Global Alliance for Clean Cookstoves and Practical Action. These cookstoves help in cutting down on the amount of CO₂ and also reduce the number of times a household has to make to the forest in search of firewood allowing more trees the opportunity to grow to enhance the availability of carbon sinks that help in abatement of climate change.

Agro-forestry was also mentioned to have been adopted by 20% of the respondents who indicated to plant trees among other crops such as Irish potatoes, cabbages, beans and even maize on the same piece of land. These trees were harvested for firewood just as also established by Balama *et al.* (2013)'s study in Tanzania.

While only 6% had indicated charcoal as one of the benefits from the forests, they however, said that they had reduced reliance on the same by using improved cookstoves. Commercialized production of non-timber forest products and reduced reliance on wood products was also expressed by 9% of the respondents. This, however, was observed to be quite insignificant yet it would help in reduction of reliance on fuel wood and charcoal especially when other energy fuels like briquettes are embraced and enhanced. The key informant interviews revealed that the communities were being sensitized to register with the CPAs in order to produce charcoal sustainably. They were also planning to introduce technologies that would aid in the sustainable production of charcoal. However, the CPAs had only been introduced in 2015 and were yet to achieve results. In fact, none of the respondents mentioned CPAs during the household surveys and the FGDs. It was also suggested that communities had been encouraged to join the CFAs where they were sustainable livelihood activities in order to depend less on charcoal production.

It was noted during the key informant interviews that CFAs were particularly inactive in Naituyupaki due to poor terrains, engagement and followed up.

4.4.4 Building materials

The respondents (53.0%) mentioned collecting poles from the forest in the past twelve months solely for the building of their houses. They added that they had diversified their livelihood activities to enable eke a living as stated by 14% of the respondents. Key informant interview, however, revealed that the Government through KFS and the KWS stationed near the study area patrolled frequently and reprimanded any community members found cutting down trees illegally for poles and timber.

4.4.5 Non-timber forest products

Herbal medicine was harvested for home consumption as well as generate some income for the households. Although it emerged during the FGDs that medicinal trees were still intact, the respondents indicated that they had adopted other livelihood activities to supplement income from herbal medicines.

Honey production reportedly declined over the years to once a harvesting. Participants reported that use of fertilizers and chemicals to enhance crop production had negative effects on bees' populations consequently the respondents practiced mixed farming to diversify their livelihoods. It also emerged the participants were aware of need to intensify commercialized production of honey in their homesteads but lacked practical knowledge on how to go about it.

On the other hand, herders were said to rely on wild fruits for food while looking after their livestock in the forest. The availability of wild fruits was however on the decline with the shrinking of forests and prolonged dry spells. The communities had responded by adopting

planting of tree tomatoes which were used both for home consumption and commercial purposes as established during the FGDs, informal talks and participant's observation.

Edible wild animals found to inhabit in the Maasai Mau forest were determined to include buffaloes, dik-diks, wild pigs and others. The communities however, hunted less primarily as result of enforcement of its ban and thus restricting reliance on the same as established during the FGDs and informal talks. These animals also had become scarce with time. In response, the respondents said they had adopted other livelihood activities such as farming, livestock keeping, herbal medicine to reduce reliance on game meat while also avoiding the long arm of the law.

All respondents kept cattle, sheep, goats, donkeys or all and hence the need for pasture and water. Prolonged dry spells were in particular cited to lead to a decline in pasture and water shortages as further established in the FGDs. Some streams were said to dry or shrink during dry seasons. In response to this, 66% of the respondents indicated that they had to reduce their herd sizes in particular during dry seasons to minimize losses of livestock. Besides, 19% said they kept improved livestock breeds, 13% of the respondents diversified their livelihoods, but 3% stated that they grew fodder in their homesteads to supplement the forest pasture. The FGDs indicated some had drilled boreholes in their homes to counter water shortages particularly for home usage as expressed by 29% of the participants. Livestock keepers, especially the Maasai households were, however, forced to walk for long distances in search of water for their cattle and hence posing significant water resource use conflicts with other herders and also wild animals.

Studies elsewhere demonstrate a broad range of adaptation practices different from those established in the MMF. For instance, Boon & Ahenkan, (2012)'s study in Ghana found that the

FACs had adopted conservation of biodiversity and management of water resources to reduce and adapt to the impacts of climate variability and change. Such programs were, however, not mentioned in the study area yet are important in enhancing climate change adaptation practices. According to Foli *et al.* (2011), the respondents were found to have turned to the commercial production of honey, snail farming, mushroom, and rabbit keeping among others to supplement their income sources and livelihoods in response to declined NTFPs supplies in contrary to the study area. There is also need to consider building the capacity of the existing social groups to enable them pull together financial resources and access to credits to build their assets. Strong social groups would also allow startup of petty trading in the quest to increase households' food security and adapt to impacts of climate change as found to happen elsewhere by Tessema *et al.* (2013).

Sources of knowledge

The results indicate that the respondents knew or learned the adaptation practices for crop production, livestock production, and forest products in diverse ways. These were mentioned to include media, extension workers, own farmer's experience/indigenous knowledge, local resource managers, barazas, agro-vets and through other farmers as demonstrated in **figure 12:**

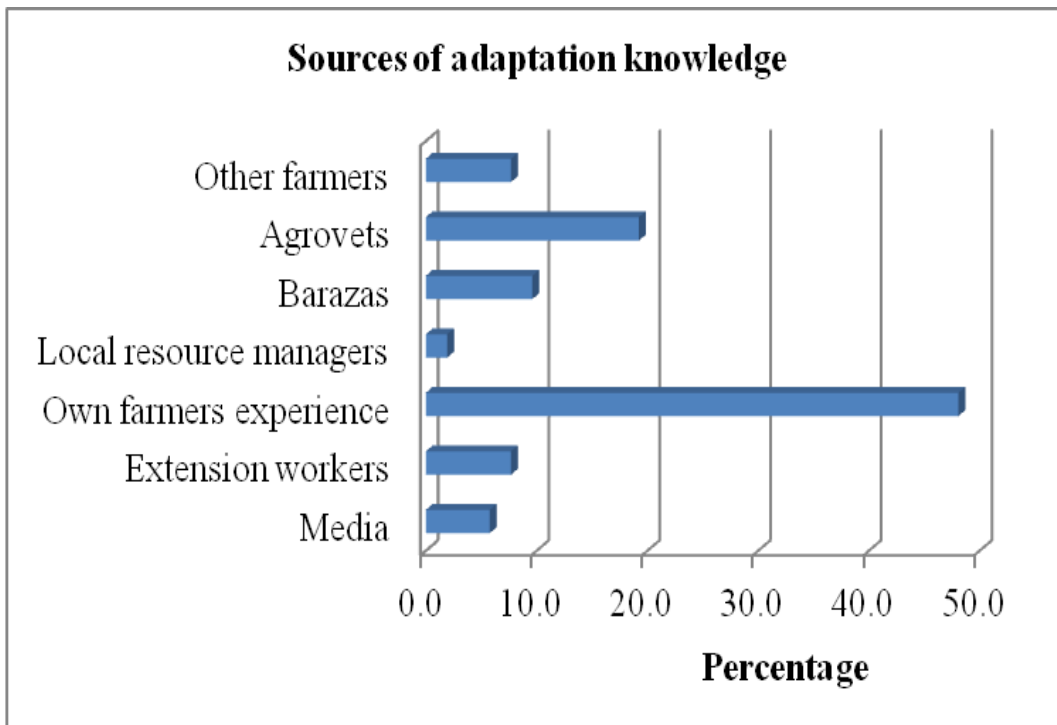


Figure 12: Sources of knowledge for adaptation practices

Source: Field survey (June, 2016)

The majority of the respondents (47%) however, cited own experience as their sources of knowledge for their adaptation practices for crop and livestock production in particular. The use of improved cookstoves was purported to have been learned via groups/alliances as expressed by only 4% of the respondents which provides limited knowledge of existence of variety of ICS. In contrary to this finding, Tessema *et al.* (2013) majority of the interviewees (58%) learned about their climate change adaptation strategies through the extension advice, 24% via own experimentation and 17% from their neighbors' testing and advise. This, therefore, demonstrates the importance of extension services and the role they play in influencing the communities' climate change adaptation practices which were mostly missing in the study area.

Climate change response challenges

This study established that the responses to climate change in Nayituyupaki were hindered by several challenges. The respondents (55%) cited lack of finances as their primary challenge. In contrary, Tessema *et al.* (2013) and Deressa *et al.* (2009) studies, attributed inadequate information to factors such as lack of the support of institutions to mainstream climate change issues into public extension systems. Lack of information was cited second place after financial constraints by 23% of the respondents in the study area while 17% stated lack of capacity. The results corroborate research by Mburu *et al.* (2015) where about 93% of the respondents cited financial constraints as the major limitation to climate change adaptation. Other challenges cited included irrelevant expertise, inadequate scientific and technological knowledge, inadequate information, infrastructure and inputs and others. Bryan *et al.* (2011)'s study in Kenya cited lack of money or access to credit as the most significant barrier to adaptation as expressed by (63%) of their respondents. 10% cited lack of inputs and 5% lack of information. According to Gbetibouo, (2009), 53% of the respondents in Limpopo River Basin, South Africa, cited lack of access to credit, poverty, and lack of savings as the primary barriers to adaptation. Inadequate knowledge on climate change was also perceived as the significant constraint by farmers in the Niger Delta (Nzeadibe *et al.*, 2011). In the three studies, financial difficulties, lack of information and capacity are notably cross-cutting challenges. The challenges are, indisputably an impediment to the communities' consciousness in using the forest resources sustainably and responding to climate change.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents a summary of findings, conclusion and recommendations based on the findings to inform further potential management practices, actions, programs, policy and research.

5.1 Summary

In summary, the Naituyupaki communities depend on agricultural production and forest products as major livelihood activities. Others included petty trading and casual laborer thus emphasizing common diverse livelihood approach among FACs in particular. The respondents were well aware about climate change as acknowledged by slightly more than half; however this knowledge was based on individual farmers' experience who observed changes taking place in their environment. More importantly, the communities' knowledge of primary causes of climate change is unfounded on scientific information as they purported that climate change is caused by natural causes. Participant's observation and key informant interviews attributed that human activities such as charcoal burning, deforestation and agricultural practices in the study area could be contributing to climate change more than the natural causes. The communities practiced crop diversification, mixed farming, agro-forestry, use of improved cookstoves and improved livestock breeding in response to climate change.

5.2 Conclusions

The main livelihood activities among the FACs included agricultural production and forest products. The aforementioned activities were negatively affected by the changing climate. Households were aware of climate change mainly through own experience attributed to increased crop and livestock disease incidences, floods and prolonged droughts but their climate change's

knowledge of primary causes was inadequate informing their common approach of practices to climate change adaptation.

5.3 Recommendations

Management

1. The government and non-governmental sectors and FACs should consider enhancing livelihood changes that make communities less reliable on forest resources as a critical tool for sustainability.
2. The relevant ministries for instance of Agriculture and Natural resources should capacity build communities on sustainable farming practices so as to reduce forest destruction.
3. As a strategy of reducing vulnerability of FACs to changing climate, the policy makers should align the local knowledge on climate change to scientific findings and vice versa.

Policy

1. The Ministry of Environment, Energy, Water and Natural Resources to design a policy on climate change awareness creation for the FACs in particular, to enable them adopt better mitigation practices.

Research

1. There is need for further research on the role, extent of alternative energy fuels in climate change mitigation and adaptation among FACs.

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7.0 APPENDICES

Appendix 1 Household Questionnaire No..... **Date:** ___/___/2015

My name is Lilian N. S. Kong'ani of the University of Nairobi. We are carrying out a research on the relationship between community livelihood options with climate change knowledge and practices. We are randomly selecting the households with the help of the village elder so we can ask you some questions on your livelihood activities, climate change knowledge and implications on your livelihoods and what you are doing to adapt to the same. Kindly allocate us some time and help respond to the questions. All the information that you provide is for the academic use only and will be treated with confidentiality. Your participation is voluntary and if it is okay with you could we proceed with the interview?

Note:

- *Household selection criteria- a household based in Naituyupaki for at least 10 years*
- *Definition of a household- people living together day in day out and cook and eat from the same pot and undertake joint or coordinated decision-making*
- *Do not ask questions that are obvious like the gender of the respondent?*
- *Make the interview interactive and incorporate probing skills*

Start time of interview:

End time of interview:

SECTION A:

1. Name of the Village _____

2. Name of the Respondent (*optional*) _____

3. Mobile number of the respondent _____

Table 1: Household (HH) Characteristics

3.1 Are you the head of the Household? <i>1 = Yes</i> <i>2 = No</i>	3.2 Gender of the respondent <i>1 = Male</i> <i>2 = Female</i>	3.3 Year of Birth?	3.4 Respondent's highest level of completed education <i>code</i> ⁴	3.5 How many people are members of your household?	3.6 How many years of farming experience do you have?	3.7 What is your marital status? <i>Code</i> ⁵

*code*⁴, 1 = Primary, 2 = Secondary, 3 = College, 4 = University, 5 = Never been to school
*code*⁵, 1 = Married, 2 = Divorced, 3 = Widow/widower, 4 = Single, 5 = Other (specify)

Table 2: livestock numbers

4. What livestock does your household has? (*circle appropriately*)

<i>Livestock</i>	<i>No.</i>
<i>1= cattle</i>	
<i>2= sheep</i>	
<i>3=goats</i>	
<i>4= donkey</i>	
<i>5= chicken</i>	
<i>6= Other (specify)</i>	

SECTION B:

Livelihood activities of households in Naituyupaki

5. What is your **most** important livelihood activity?

1 = Crop production, 2 = Livestock production, 3 = Forest products, 4 = Remittances 5= pension, 6 = Salaried employment, 7= Casual laborer, 8 = Business, 9 = Other (specify)

6. Why is it your **most** important livelihood activity?

1=I can pay children's fees, 2= we can access medical services, 3= improved food security, 4= improved social status, 5= Other (specify)

Table 3: Livelihood options and related incomes

<i>1 = Crop production</i>	<i>Crop type</i>	<i>Quantity in the past (12 months)</i>	<i>Usage</i>		<i>Selling price per unit</i>	<i>Cost of production/input/ per unit</i>
			<i>1=own</i>	<i>2=sold</i>		

	1=Maize					
	2=Beans					
	3=Peas					
	4=Millet					
	5=Sorghum					
	6=Carrots					
	7=Other (specify)					
2 = Livestock production	Livestock type	Did you sell any livestock/product in the last (12 months) 1=Yes, 2=No				
	1. Cattle					
	2. Milk					
	3. Sheep)					
	4. Wool					
	5. Goats					
	6. Donkey					
	7. Chicken					
	8. Eggs					
	9. Other (specify)					
3 = Forest products						
		How much received in the last 12 months				
4 = Remittances						
5= Pension						
6 = Salaried employment						
7 = Casual laborer						
8=Business						
9=Other (specify)						

7. What is the **most** important physical asset in pursuing your livelihoods?

1 = land, 2= Tractor, 3 = Posho Mill, 4 = Motorcycle, 5= Bicycle, 6 = Television, 7 = Radio, 8 = Mobile, 9 = Vehicle, 10=Animal cart, 11=Panga, 12= axe, 13=power saw, 14= Infrastructure, 15= Other (specify)

8. Do you own or have the above-mentioned asset? *1 = Yes, 2 = No*

9. What is the **most** important contribution of the physical asset as mentioned in no. 8 to your livelihood?

1= Increase income, 2=Improve food security, 3=Increased well-being, 4=Reduce vulnerability, 5=Communication, 6= Other (specify)_____

10. What other **most important** equipment would your household wish to have in support of your livelihood?

1 = land, 2= Tractor, 3 = Posho Mill, 4 = Motorcycle, 5= Bicycle, 6 = Television, 7 = Radio, 8 = Mobile, 9 = Vehicle, 10=Animal cart, 11=Panga, 12= axe, 13=power saw, 14= Other (specify)

11. a). Are there any agricultural extension officers in this area? *1=Yes, 2= No*

b). If yes, what kind of extension officers/workers?

1=Private Sector, 2=Government, 3=Civil Society

12. a). If yes, did you receive any extension services in agricultural production in the last 12 months? *1=Yes, 2=No*

b). If yes, what did you consider to be the **most** important extension service for your livelihood in the last 12 months?

1 = capacity building, 2= veterinary services, 3= crop husbandry, 4=farm inputs, 5= farm technologies, 6=linkage with markets for our products, 7= other (specify)

c). From whom did you receive the extension services?

1=local Government (KFS, KWS, MENR), 2= NGOs, 3=CFAs, 4=Social groups 5=local schools 6=churches, 7 = Other (specify)

13. a). Are you in any social group? *1 = Yes, 2 = No*

If yes,

b). What is the name of the social group that you belong to?

c) When was the social group started?

d) Why was the group started?

14. How many members does your social group has? Total_____ Female = _____ Male = _____

15. What do you consider as the **most** important contribution of the social group to the wellbeing of your household?

1 = help to raise capital, 2=platform for learning about livelihoods, 3=enable pooled resources, 4=social security, 5= help identify market for products, 6= other (specify)

16. Did your household benefit from the forest in last 12 months? 1 = Yes, 2 = No

If yes, kindly respond to the following questions:

Table 4: Forest Benefits

17. What products did you get from the forest? (start by ticking)	How often collected? <i>Code</i> ¹	Quantity collected <i>code</i> ²	Usage		If sold,		18. Who is responsible for collecting these products? <i>code</i> ³
			1=own	2=sold	Selling price per unit	Cost of production per unit	
1 = Firewood							
2 = Charcoal							
3= Tree seedlings							
4 = Building materials							
5= Herbs							
6 = Honey							
7= Fruits							
8 = Pasture							
9 = Hunting							
10 = Other (specify)							

*Code*¹, 1=daily, 2= weekly, 3= monthly, 4= yearly 5= other (specify)

*code*², 1=backload, 2= donkey load, 3=bags of 90kgs, 4= 25kgs, 5= 6kgs debe/ndoo, 6= seedlings, 7= other (specify)

*code*³ 1 = Self, 2 = Spouse, 3 = Children, 4= Other (specify)

Table 5: Forest use challenges

19. Have you faced any challenges in accessing the forest products? <i>1= Yes , 2 = No</i>	20. If yes, what is the most important challenge? <i>Code¹</i>	21. How have you responded to the challenge mentioned in no. 21? <i>Code²</i>	22. How do you compare the availability of the products now and 10 years ago? <i>Code³</i>	23. What is the most important reason for your response in no. 22? <i>Code⁴</i>

Code¹, 1 = insecurity 2 = reduced availability forest products, 3= increased distance covered in search of the products, 4 = Existing forest regulations, 4 = health issues, 6= conflicts between CFA members and non-CFA members, 7=other (specify)

Code², 1=increased borrowings, 2 = petty trading 3 = commercial production of forest products, 4=increased on-farm activities, 5= agro-forestry, 6=use of energy saving jikos, 7=other (specify)

Code³, 1 = Same, 2 = Decreased, 3 = Increased

Code⁴, 1 = Increased temperatures, 2 = Increased precipitation, 3 = Low rainfall, 4 = Increased diseases incidences, 5 =existing forest regulations, 6 =increased market demand 7= increased floods, 8= prolonged drought spells, 9=Other (specify)

SECTION C

Climate change knowledge and implication on livelihood activities

24. Have you heard about climate change? *1=Yes, 2= No*

25. How did you know or hear about climate change?

1 = Media (Radio/Television), 2 = Barazas, 3 = Extension agents, 4 = Workshops/conferences, 5 = Own farmer's experience, 6 = Self-groups/Alliances, 7 = Hear say from farmers/neighbours, 8 = Education from Schools/NGOs, 9 =Other (specify)

26. When did you hear about climate change?

27. What is your understanding of climate change?

28. How many members of your household do you think understand what climate change is?

29. Have you ever received any training in climate change? 1=Yes, 2= No

a) If yes, who trained you?

1= Local Government, 2=NGOs, 3=Community Forest Associations, 4=Extension Officers,
4 = Social Groups, 5= Other (specify)_____

b) What aspects of the climate change were you trained in?

1= Impacts of climate change, 2= Climate change mitigation, 3= Climate change adaptation,
4= Other (Specify)

30. Have you experienced climatic changes in the past 10 years? 1 = Yes, 2 = No	31. What do you consider as the signs of the changing weather patterns? (most important) Code ¹	32. What do you think is the cause of these changes? (most important) Code ²	33. Has any of these changes impacted on your daily livelihoods? 1 = Yes, 2 = No	34. If yes, what are these specific signs of the changing weather patterns that have affected your livelihoods? (most important) Code ³	35. How have the changes impacted on your livelihoods? (most important) Code ⁴

c) Who in your household attended the climate change training?

1 = Self, 2 = Spouse, 3 = Son, 4= Daughter, 5= Farm Manager, 6= Other (specify)_____

Table 6: knowledge of climate change

Codes^{1&3}, 1= High temperatures, 2 = increased flood incidences, 3 = increased drought incidences,
4 = Increased disease incidences, 5 = Pest infestation, 6 =Weed infestation,
7 = Crop failure, 8 = Irregular rainfall patterns, 9 =Uncertainties in the onset of farming season,
10 = Drying up of streams/rivers, 11 = Other (specify)

Code² 1 = Natural happenings, 2 = Human activities, 3 = Punishment from gods, 4 = Other (Specify)

Code⁴ 1 = Poor crop yields, 2 = Reduced soil fertility, 3 = Increased pest infestation,
4=Declined livestock production, 5=Declined forest products (pasture, timber, firewood,
charcoal, herbs, building materials, tree seedlings, etc), 6 = Declined business income,
7=food insecurity, 8 = Poverty, 9 = Other (specify)

36. Has your household changed your farming practices because of climate change?

1=Yes, 2=No

37. If yes,

a) When did you change the farming practices?

b) Why did you change the farming practices?

1=Poor crop yields, 2=Crop failure, 3=Increased pest and diseases, 4=Reduced soil fertility, 5=Increased drought incidences, 6=Lack of appropriate farming technology, 7=Lack of information, 8=Irregular rainfall patterns, 9=Insufficient rainfall, 10=Uncertainties in the onset of farming season, 11 = Other (Specify)

c) If yes, please indicate on how you have changed your farming practices.

1= Cultivation of drought tolerant crops, 2 = planting of early maturing crops, 3= crop diversification, 4=Agro-forestry, 5 = Mixed farming, 6 = Increased use of farm inputs such as fertilizers, pesticides, 7=Improved livestock breeds, 8= reduction of herd sizes, 9= Other (specify)

38. What is the **most** important reason for the change in your farming practices?

1=To improve food security, 2= Increase income, 3=Increased well-being, 4=Reduce vulnerability, 5= to counter the impact of droughts, 6= To counter crop failure, 7=To reduce pest & disease incidences, 8= Other (specify) _____

39. What do you think should be done to help curb the impact of the changing climate to your livelihoods?

1=Increased tree planting, 2=introduce energy saving solutions, 3=rain water harvesting, 4=increased awareness, 5=Other(specify)

40. Do you think that understanding climate change can help cushion your livelihoods from its impacts?

1 = Yes, 2 = No

41. If yes, why do you think so?

1= enable better adaptation, 2 = improved livelihoods, 3= increased natural resources, 4= reduce natural resource conflicts, 5= other (specify) _____

42. Is climate change the only challenge to your livelihoods?

1 = Yes , 2 = No

43. If no, what are the other challenges that impact on your livelihoods?

1 = poverty, 2 = population increase, 3 = political instability, 4 = poor leadership,

5 = other (specify) _____

SECTION D:

Practice on livelihood options in response to climate change

Table7: Responses

44. Livelihood activity	45. Responses Code ¹	46. How did you learn/know about the response stated in no. 46 Code ²
Crop farming		
Livestock Production		
Scarcity of forest products		
Firewood		
Charcoal		
Tree seedlings		
Building materials		
Herbs		
Honey		
Fruits		
Pasture		
Water		
Wild game/hunting		
Other (specify)		

Code¹, 1 = Cultivation of drought tolerant crops, 2 = Agro-forestry, 3 = Use of Improved cookstoves, 4 = Mixed farming, 5 = Commercialized production of non-timber forest products (NTFP), 6 = Table banking, 7 = improved livestock breeds, 8 = Diversification of livelihoods, 9 = adoption of other livelihoods, 10 = reduction of herd sizes, 11 = Reduced reliance on forest products, 12 = water harvesting, 13 = Other (specify)

Code² 1 = Media, 2 = Indigenous Knowledge systems, 3 = Extension workers, 4 = Barazas,

5 = Local Resource Managers, 6 = Alliances/Groups, 7 = own experience 8 = Other (specify)

47. What measures do you have in place to help reduce reliance on forest products?

1= use of energy saving jikos, 2= crop farming, 3= livestock production,
4= own farm forage production, 5= other (specify) _____

48. What is the **most** important contribution of the climate change response practices to the wellbeing of your household?

1= Improved food security, 2 = Children are schooling, 3 = We are able to buy medicine,
4 = We have been able to build/renovate our house,
5=We can afford access to modern lighting energy, 6 = Other (specify)

49. What is the **most** important challenge in your climate change response practices?

1 = Lack of finances, 2 = Lack of capacity, 3 = Unavailability of resources,
4 = Inadequate/small pieces of land, 5 = lack of information, 6 = natural resource conflicts
7=Other (specify)

50. If in a social group, what is the **most** important contribution of it to your climate change adaptation practices?

1 = Help to raise money to buy farm inputs, 2=learning platform, 3=facilitate commercial production of NTFPs, 4= help buy improved cookstoves/energy saving jikos, 5=Other (specify)

51. What do you think is the **most** important element to improving your climate change response practices?

1 = awareness creation, 2 = increased Capacity building, 3= enable access to subsidized loans,
4 = financial assistance, 5= Other (specify)

52. Whom do you think is the **most** critical in spearheading climate change adaptation practices?

1= Individuals, 2= Local Government/local resource managers, 3= NGOs, 4= CFAs,
5= CBOs, 6=Communities, 7 = Other (specify)

53. Give reasons for your response in question no. 53 above

1= has capacity, 2= individuals suffer most, 3= it's their mandate, 4= other specify

Thank the respondent for time and responding to the questions!

Appendix 2 FOCUS GROUP DISCUSSION- CHECKLIST

1. What are the livelihood activities pursued in Naituyupaki?
2. Rank the mentioned livelihood activities in order of importance
3. What benefits do you accrue from the forest?
4. Please explain what forest products do you accrue from the forest during
 - a) wet seasons
 - b) dry seasons

Please give reasons for the responses in 4a & b above

5. How many have heard about climate change?
6. How did you know or hear about climate change?
7. What indicators do you attribute to the changing climate change?
8. What do you think is the cause of the changing climate?
9. What effects does the changing climate have on the following livelihoods?
 - a) Crop production
 - b) Livestock production
 - c) Forest products
10. What livelihood practices do you practice to respond to the effects of the changing climate?
11. What measures do you recommend to enable all know and mitigate and adapt to the impacts of climate change?

Appendix 3 KEY INFORMANT INTERVIEW CHECK LIST

1. Name?
2. Your role?
3. For how long have you worked here?
4. What is your observation about climate change?
5. How do the forest adjacent communities contribute to issues of climate change?
6. What seasons do the coconcommunities tend to rely more on forests and why?
7. What is your opinion about the FACs and climate change knowledge?
8. What is the Department/Institution/Organization/leadership doing to ensure that the FACs are aware of climate change issues?
9. Are there any challenges? Please explain
10. What are you doing to address the challenges?
11. What is your opinion on the climate change budgetary allocation?
12. Why do you think the Forest Adjacent Communities are unreceptive to visitors?