



UNIVERSITY OF NAIROBI

**CLIMATE CHANGE IMPACTS AND ADAPTIVE MECHANISMS OF PASTORAL
COMMUNITIES IN MUKOGODO FORESTED AREAS OF LAIKIPIA COUNTY IN
KENYA**

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THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN CLIMATE
CHANGE AND ADAPTATION OF THE UNIVERSITY OF NAIROBI**

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DECLARATION

This thesis was written by me and in my own words, except quotations from published and unpublished sources which are clearly indicated and acknowledged. I am conscious that the incorporation of material from other works or a paraphrase of such material without acknowledgement will be treated as plagiarism, subject to the custom and usage of the subject, according to the University Regulations on Conduct of Examinations. The source of any picture, map or other illustration is also indicated, as is the source, published or unpublished, of any material not resulting from my own experimentation, observation or specimen collecting.

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DEDICATION

This Thesis is dedicated to my wife Jennifer Wanja Kiambi for her encouragement and support both financial and moral and my children Antony Kiriimi and Royford Mutembei as an example to them.

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ABSTRACT

In the forested pastoral ecosystems of Kenya, as elsewhere in Africa, traditional pastoralists' social, political and ecological systems are undergoing profound transformation due to climate variability and subsequent adaptive measures. This study was undertaken in Mukogodo forested ecosystem of Laikipia County among the Yaaku community. The general objective of the study was to understand and document the courses of resilience of the pastoral communities to the impacts of climate change and how the community used local adaptive responses. The Yaaku community in Mukogodo forested ecosystem of Laikipia County was studied to appreciate and document the climate change and adaptation measures. They were studied by collecting climate data at county and national meteorological stations. Additionally, the researcher conducted surveys to characterize household assets which gave the effects of climate variability as manifested by land use change and quantified by coping strategies. A simple random sampling method was used where 30 percent of the households in each of the nine villages were selected. The selection of households was by stratified random method of odd numbers from a list of Yaaku households guided by the initial participatory community managed disaster and risk reduction (CMDRR) activity done within the study community. A structured questionnaire was administered to 240 household heads or their representatives within the nine villages. The study also used Focus Group Discussions (FGD), and Key Informants (KI) interviews to help in the triangulation of the data. The study applied a combination of qualitative and quantitative approaches and analysed the data gathered, of which climate variability data were analysed by trend analysis. Land use and management data gathered by remote sensing were analysed by computer software (Erdas Imagine 2014) and classified images were keyed into maps composition by ArGIS to give the land use trends from 1984 to 2014. The study site was visualised by Google Earth and ground visits. Household survey data were analysed by use of Statistical Package for Social Sciences (IBM SPSS statistic 20). The FGD, ocular (photos) and KIs were analysed by context. The CMDRR data were analysed by pair-wise ranking and percentages. From the data it was evident that there was a decreased rainfall, while the temperatures increased over the period. However the variability in climate (rainfall and temperatures) had contributed to the change in land use and management of the pastoral forested ecosystem of Mukogodo in which there were decrease of grassland, forest, and increase in bare land and increase of shrub land, riverbed vegetation and agriculture cover in the last three decades. This change has affected Mukogodo forested ecosystem which became bush land instead of a forest. The main five hazards which contributed to vulnerability to climate change were drought, human conflict, human diseases, human wildlife conflict, and livestock diseases. These hazards were quantified and adaptation responses documented in form of disaster risk reduction plan for preparedness and among these are contingency plans for emergency. Therefore in order for the community to implement the plans two committees, one per location with representation of members from the nine villages were formed. The study found that political will coupled with community traditional adaptation strategies (social capital) addressed most of the impacts of climate change. It was therefore concluded that in order to have climate change adaptation measures in pastoral community in forested ecosystem in African or developing world, consideration of political influence is paramount. This is because the political sphere seemed to be the main delivery of adaptation.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS-	Acquired Immune Deficiency Syndrome
ASALs-	Arid and Semi-Arid Lands
CARE-	Cooperative for Assistance and Relief Everywhere
CIDP-	County Integrated Development Plan
CMDRR-	Community Managed Disaster Risk Reduction
COP-	Conference of Parties to the convention
DFID-	Department for International Development
ESP-	Economic Stimulus Project
FAO-	Food and Agriculture Organisation
FGD-	Focus Group Discussion
GoK-	Government of Kenya
GDP-	Gross Domestic Product
GHGs-	Green House Gases
HIV-	Human Immunodeficiency Virus
HOMECE-	Home Economics
ICT-	Information Communication Technology
IFAD-	International Fund for Agricultural Development
IIRR-	International Institute of Rural Reconstruction
ILCR-	International Land Coalition Rangelands Initiative
ILRI-	International Livestock Research Institute
IPCC-	Intergovernmental Panel on Climate Change
IWGIA-	International Work Group for Indigenous Affairs
KI-	Key Informant
KNBS-	Kenya National Bureau of Statistics
KWS-	Kenya Wildlife Service
KFS-	Kenya Forest Service
LCG-	Laikipia County Government
LCIDP-	Laikipia County Integrated Development Plan
LRRD-	Livestock Research for Rural Development
MAM-	March April May rains

NASA-	National Aeronautics and Space Administration
NDMA-	National Drought Management Authority
NOAA-	National Oceanic and Atmospheric Administration
OOP-	Office of the President
OND-	October November December rains
PDRA&A-	Participatory Disaster Risk Assessment and Analysis
PLUP-	Participatory Land Use Planning
PPME&L-	Participatory Planning, Monitoring, Evaluation & Learning
RCMRD-	Regional Centre for Mapping of Resources for Development
RPLRP-	Regional Pastoral Livelihood Resilience Project
SDGs-	Sustainable Development Goals
SLM-	Sustainable Land Management
SPSS-	Statistical Package for Social Sciences
SSA-	Sub-Saharan Africa
SYR-	Synthesis Report
UNESCO-	United Nations Education Scientific and Cultural Organisation
UN-	United Nations
UNFCCC-	United Nation Framework Convention on Climate Change
UNISDR-	United Nations International Strategy for Disaster Reduction
URTI-	Upper Respiratory Tract Infection
VIP-	Ventilated Improved Pit

DEFINITIONS OF TERMS

The definition of terms was based on context meaning as used in this thesis with modification.

Sensitivity: Degree to which a system is affected by, or responsive to, climate stimuli (IPCC, 2001).

Vulnerability: Degree to which a system is susceptible to injury, damage or harm (IPCC, 2001).

Potential: Degree to which a system is susceptible to climate stimuli (IPCC, 2001).

Resilience: Degree to which a system rebounds, recoups or recovers from a stimulus (IPCC, 2001).

Responsiveness: Degree to which a system reacts to stimulus (IPCC, 2001).

Adaptive capacity: The potential or capability of a system to adapt to (to alter to better suit) climatic stimuli (IPCC, 2001).

Adaptability: The ability, competency or capacity of a system to adapt to (to alter to better suit) climatic stimuli (IPCC, 2001).

Climate change: Refers to a change in the state of the climate that persists for an extended period, typically decades or longer. Climate change may be due to natural and anthropogenic processes (IPCC, 2001).

Climate variability: Is the year to year fluctuation or the variation in mean state of climate on all spatial and temporal scales (IPCC, 2001).

Livelihood: It comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living (Robert and Gordon, 1992).

Sustainable livelihood: Livelihood that can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the long and short term (Robert and Gordon, 1992).

Epoch: A period of time in history marked by notable events or particular characteristics

Risk: The possibility of adverse effects in the future (UNISDR 2015):

Exposure: The inventory of elements in an area in which hazard (climate change impact) may occur. (UNISDR, 2015):

Disaster: This is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material economic or environmental losses that exceed the community or society ability to cope using own resources (UNISDR, 2015)

CHAPTER ONE: INTRODUCTION

1.0: Introduction

In this chapter, the background information either historical in nature or previous research done in the study area is given. The information includes but not limited to physical and biophysical setting, problem statement and general scope of the study, which includes objectives and justification, significance of research.

1.1: Background

Climate change is presumably an intricate and challenging environmental problem facing the world in recent time. However presently, the questions of interest include continuous aberration of climate; weather uncertainties and food insecurity which are caused by unchecked environmental degeneracy. The rise in human population and demand for more agricultural land for food production or livestock keeping has greatly led to some of the issues, which in other hand has resulted in destruction of the vegetation cover and afterwards degraded environment (Food and Agriculture Organization- FAO 2010). The need for fuel wood (charcoal and firewood), food and forest products for various uses (including poles and timber for building and construction, fodder in forested semi-arid and arid lands and medicinal values) has exacerbated the problem and the results have had negative effects that include climate change, environmental degradation, droughts, food insecurity for wildlife, domestic animals and human beings (FAO 2010).

Laikipia County Government (LCG), (2013-2017) indicate that most vulnerable areas to climate change phenomenon are forested dry lands of Kenya including the Laikipia County. This is brought about by the fragile nature of the environment that has been caused by encroachment by agricultural activities linked to increased human population and followed by unsustainable land use activities. In this regard the frequency and severity of both droughts and floods is already high and is expected to increase in the coming years (LCG, 2013-2017). Availability of rainfall determines the smallholder farming and livestock production though the latter is dominant in the region. Major impacts of droughts on smallholder activities have increased food insecurity (food shortage and poverty) and loss of livelihoods (LCG, 2013-2017).

Smallholder farmers in Laikipia have similar climate change impacts and concerns with other forested dry lands of Kenya, although, means to food security of communities varied from place to place as do the adaptation strategies to environmental hazards such as drought and floods, of which Laikipia County is no exception. Therefore, each agro-ecological zone has distinct challenges in maintaining food security, which often cut across all the sectors. Thus, the forested dry lands of Laikipia County have different and distinct challenges from other agro ecological zones, in which there are evidences of forest degradation, drying of streams, soil erosion and loss of biodiversity.

The County mainly consists of a plateau bordered by the Aberdares to the south, Great Rift Valley to the west, Mt. Kenya ridges to the south east and all of which impacts on the climate of the county in one way or the other. Ewaso Nyiro North Basin with its tributaries which have their sources in the slopes of the Aberdares and Mt. Kenya and flow from south to north, taking over the level plateau and the entire county. The tributaries as illustrated in Figure 1.1 include Timau, Nanyuki, Rongai, Moyak Segera, Naromoru, Burguret, Engare, Ewaso Narok, Pesi and Ngobit rivers. These streams flow in a way that goes in hand with the County's terrain which slopes gently from the highlands in the south to the lowlands in the north. The patterns in which the people have occupied or settled in these regions is in a big way determined by these rivers, as they provide water for their domestic use and both livestock and irrigation purposes. However, other areas like those in the south western part of the region have a much high potential in terms of forestry and mixed farming because of their favourable climatic conditions. These variability in climatic conditions have largely led to some areas like Marmanet being densely populated and other areas such as eastern and northern parts of the County suitable for grazing livestock, while the plateau lying in the central and the northern parts of the county is suitable for ranching as illustrated in Figure 1.1.

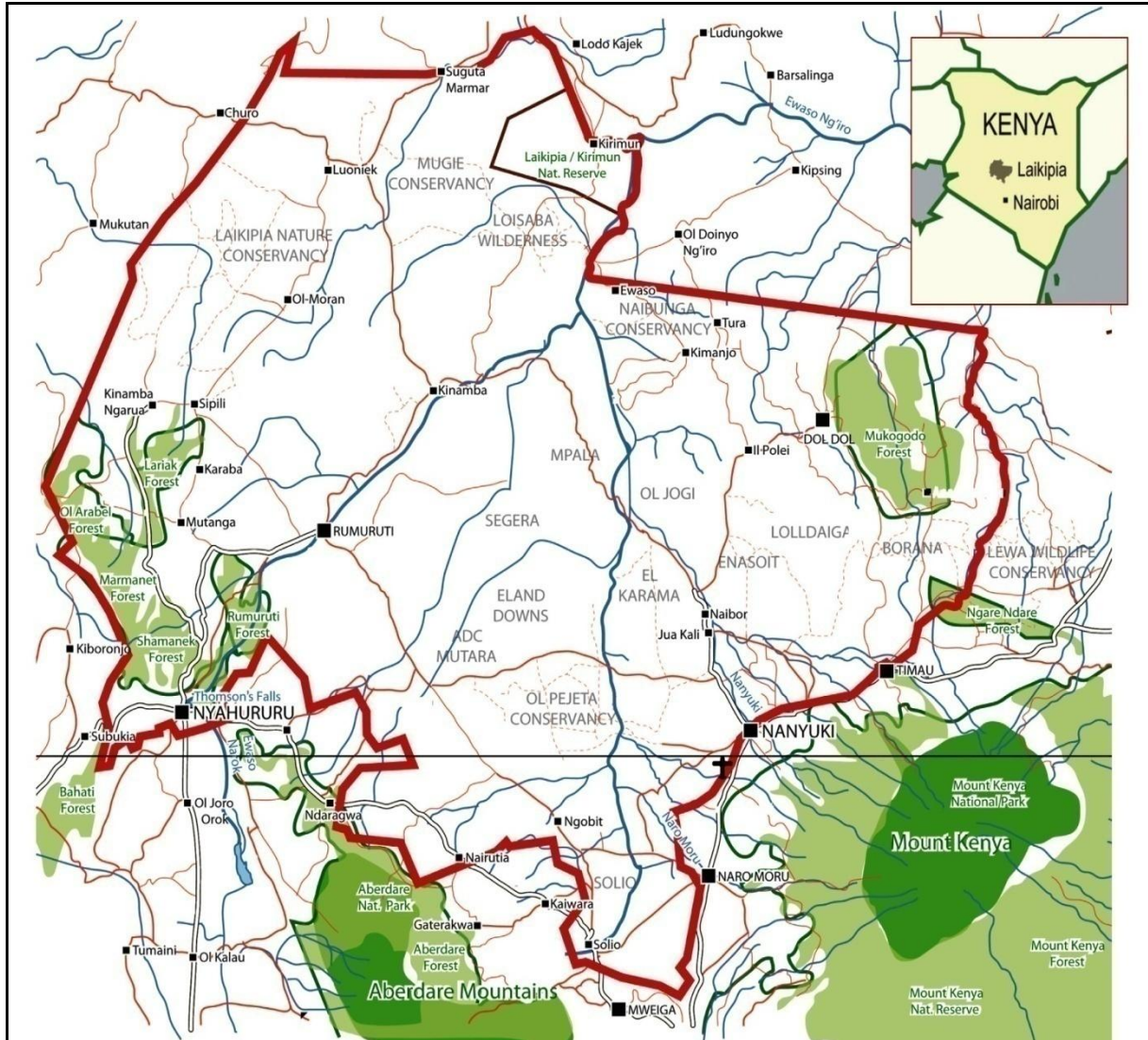


Figure 1.1: A topographic map of Laikipia County showing the natural resource (LCG, 2013-2017)

Key

Broad red line is the county boundary

Green patches are forested areas.

Red continuous lines are main earth roads

Red dotted lines are small track roads

Blue lines are rivers



1.1.1: Biophysical setting

In this section issues on climate, vegetation, land use resources, water, physiographic and drainage and biophysical vulnerabilities are outlined for Laikipia County and focused on the study location.

1.1.2 Climate

The location at which the county is placed and altitude at which it lies attracts a relief type of rainfall. This rainfall averages between 400mm and 750mm annually despite higher annual rainfall records being observed in areas along slopes of Mt. Kenya and the Aberdare Ranges. For instance 900mm of rainfall annually is received in areas of North Marmanet as compared to slightly over 400mm annual rainfall in drier parts of Mukogodo and Rumuruti. On the other hand, annual estimate of 500mm is experienced in the plateau while the forested Mukogodo region receives 706mm of rainfall annually. Table 1.1 indicates a reduction trend of rainfall in 2009 and 2011 in Doldol. In addition it shows that Doldol region which is in the northern part received much lower rainfall compared to Nyahururu in the south (LCG, 2013-2017). Doldol is the Laikipia North Sub County Headquarters and is located at the periphery of the Mukogodo forest which was the study area. Therefore, Doldol Market and Kalalu Weather Recording Station were the focal areas for the study as far as biophysical data was concerned.

North East and southEast trade winds and subsequent Inter-Tropical Convergence largely influence the seasonal distribution of rainfall in Laikipia County. The months of March and May have long rains while October and November have short rains. Contrastingly, there are some parts of the regions that receive conventional rainfall between the months of June and August as a result of trade winds. These areas are inclusive of parts bordering Aberdare Ranges and Mt. Kenya. Areas in the north of the County are much hotter in terms of temperatures as compared with those in the eastern side which are near Mt Kenya. These temperatures range at a mean of between 16° C and 26° C annually. Cooler temperatures are also experienced in the County especially in the western and southern parts of the County in the months of April while the hottest month is February. The daily average sunshine hour is between 10 and 12. Table 1.1 below presents the mean annual rainfall in millimetre between 2008 and 2012.

Table 1.1: Mean Annual Rainfall in Millimetres 2008-2012

Station	2008	2009	2010	2011	2012
Doldol	256.25	298.3	560.8	169	545
Rumuruti	741.4	535.1	1069.1	1342	822
Nyuhururu	812.2	635.8	1375.3	1201.2	1500
Nanyuki	726.7	292.1	1411.2	896.9	857.1

Source: Laikipia Meteorological Stations (LCG, 2013-2017).

1.1.3: Vegetation

A total area of 580 square kilometres of land is covered by six gazetted and one non gazetted forest. The county still harbours natural and artificial forests, for instance Mukogodo is one of natural forests; and the artificial ones include Ng'arua, Lariak, Rumuruti, Marmanet and Shamaneik forests (LCG, 2013-2017). However some parts of forest, for instance in Ng'arua and publications fires, deforestation and grazing have largely led to depletion of the forest cover over the years. Poles, pastures, wood fuel and timber are the forest main products. The provision of setting of bee hives, research ground on flora, natural herbs and wildlife habitat for instance for elephants and birds have all been provided by these forests. Nevertheless, farm woodlots are a common feature in the Counties southern part. In Mukogodo, ecotourism is a dominant activity through conservation of natural forests particularly at Iligwesi. Practice of bee keeping is done by individual farmers around Rumuruti and Mukogodo forests. Poles and timber production is done using woodlots by farmers (LCG, 2013-2017). Laikipia is dominantly a pasture land with 43 private conservancies or ranches of which 30 ranches are owned by companies and 13 as group ranches by community as indicated in Figure 1.1

1.1.4: Land use and resources

In Laikipia County 1,984 square kilometres of the entire land in the county is arable land. Non arable land covers 7,456 square kilometres. 243.3 square kilometres is covered by urban areas. Gazetted forest land stood at 580 square kilometres. Land use patterns are much influenced by the climatic conditions and the ecological zones. Some of those were pastoralist, mixed farming, ranching, agro pastoral, marginal mixed farming, formal employment and trade or business. Laikipia County is predominantly a livestock rearing county with ranches occupying over 50 per cent of the entire land (LCG, 2013-2017).

Private ranches are involved in conservancy for wildlife and beef cattle farming. The average size of the ranches measures 10,000 acres. Ranches owned by multiple individuals are mainly in the northern part stretching to about 72,544 hectares. The Yaaku community reside in the group ranches which include the forested ecosystem of Mukogodo. South western part of the County offer favourable weather conditions hence suitable for crop farming. The County in 2012 had 471 fish ponds and four natural fish dams, three fingerling multiplication farms of which majority were initiated under the Economic Stimulus Project (ESP) in 2009; forestry and agro forestry within Mukogodo was one of the natural forests. Red sand harvesting along river beds in Laikipia North is one of the mining activities in the County, tourism of which is the major attractions includes;- the wildlife, the unique Maasai cultural practices, the Thomson falls and urban development are the main land uses in the county(LCG, 2013-2017).

1.1.5: Physiographic and drainage

Mt. Kenya slopes in the neighbouring Nyeri, and the Aberdare's Ranges, bordering Nyandarua is the predominant source of water in the region. There are initiatives put in place to restore the two catchment areas after they had faced encroachments (LCG, 2013-2017).These initiatives included the riparian areas marking, tree planting along the river banks especially the indigenous species and creating awareness among the community on conservation. Tributaries that come from Mt. Kenya, the Aberdares and Ewaso Nyiro are ones that drain Laikipia. The rivers are as indicated in section 2.1 and illustrated in Figure 1.1. Other common features in the County for domestic and irrigation purposes include boreholes, pans and dams. Nevertheless, in the northern part of Laikipia rock catchments are yet to be fully exploited. Some of the small streams originate from Mukogodo Forest.

1.1.6: Water resources

The main water resources in the County include the six main tributaries of Ewaso Nyiro as mentioned in section 1.1. Bigger proportion of households in the region access water from permanent rivers, wells, springs, and roof catchment while around 30 percent of the population in 2009 accessed piped water (LCG, 2013-2017).Water pollution due to anthropogenic wastes was minimum in urban centres and also in rural settlement as per 2009 population and household

census report which indicate that approximately 78,390 homes have latrines in the County (GoK, 2010b).

The main toilet facility distribution indicate that 3.7 percent used Ventilated Improved Pit (VIP) latrines, 11.8 percent used flash toilets, 0.7 percent used buckets and 72.8 percent used ordinary pit latrines, whereas 11 percent used other ways of disposal such like natural bushes. On garbage disposal, 61 percent of the homes had their garbage collected by the local authorities garbage pits were used by 15 percent used public garbage heaps were used by 10 percent and only one percent of the households used neighbouring community groups (GoK, 2010b). The studies were undertaken in rural and forested ecosystem and thus human waste disposal was by pit latrines, natural and garbage disposed by burning.

1.1.7: Biophysical vulnerabilities

The growth of towns like Nyahururu, Nanyuki, Wiyumiririe, Rumuruti, and other shopping centres together with population pressure on limited land resources have largely affected the supply of social amenities. Settlements [informal] around Nanyuki and Nyahururu towns especially Likii, Manguu and Maina villages had resulted to great levels of pollution, poor disposal of waste and sanitation. In addition to sand harvesting, farming in riparian areas and other quarrying activities in Matanya area in Laikipia Central, Kimugandura in Laikipia East, and Kimanju in Laikipia North had increased the instances of land degradation leading to lot of poverty in the County (LCG, 2013-2017).

Farming along the river banks, overgrazing, deforestation for charcoal burning were factors that contributed to environmental degradation hence led to reduced quality and quantity of water sources, productivity of land, high levels of pollution for both water and air, constraining existing effluent and solid waste disposal facilities especially in the urban areas. A lot of farming activities in forests also was a threat to the county's rich biodiversity. The results of these negative patterns of climate in the county include reduced land productivity, decrease in level and volume of ground water and surface water leading to loss of pasture and famine especially in areas within the vicinity of Matanya, Daiga, Ol Moran, Pesi, Kimanju, Doldol and Kirimon increased human-wildlife, and human-human conflicts, resulting from the competition for the insufficient resources e.g. foliage and water leading to loss of life and livelihoods, insecurity and

loss of forest cover, importantly blending the issue of frequent temperature fluctuations, increase in humidity, wind speeds, loss of employment opportunities in, fishing, tourism, livestock sector, agriculture and reduce surface run offs (LCG, 2013-2017). For the study of the Yaaku community living in Mukogodo forest, their vulnerabilities are due to climate change, frequent droughts, livestock diseases, human-human conflict and degradation of forested ecosystem.

1.1.8: Social economic setting

This section includes physical and administrative contexts, local economic settings, social setting, health setting, regulatory framework and social economic vulnerability of Laikipia County.

1.1.9: Physical and administrative context

Laikipia County is comprised of three administrative sub-counties: Laikipia North Laikipia East and Laikipia West. Nanyuki, Rumuruti and Doldol, respectively, are the Sub County headquarters.

Laikipia is further sub-divided into 15 wards 51 locations and 96 sub-locations, as shown in following order. It has 15 electoral wards, six in Laikipia West, five in Laikipia East, and four in Laikipia North constituencies. The Yaaku community reside in Mukogodo East ward of Laikipia North Sub County in Laikipia County. Table 1.2 below presents Laikipia constituencies and the electoral wards.

Table 1.2: The county constituency and electoral wards

Name of constituency	Name of ward	Number of ward
Laikipia North	Mukogodo West, Mukogodo East, Sosian & Segera	4
Laikipia East	Nanyuki, Ngobit, Umande, Thingithu & Tigithi	5
Laikipia West	Mithiga Olmoran, Rumuruti township, Igwamiti Marmanet & Salama	6
Total		15

Source: (LCG, 2013-2017)

1.1.10: National or regional local economic setting

The sources of revenue for Laikipia County are both internal and external sources. Entertainment taxes, property taxes and rates, user fees and charges, licences and permits are internal sources of revenue. In the 2012/13 financial year, the internal revenue base stood at Kshs. 600 Million. The external sources were transfers in accordance with Article 203 (2) of the Kenya constitution from national government, and any unconditional or conditional grants emerging from development partners and national government. The direct transfer from national government under Article 203 (2) in the financial year 2013/14 was Kshs. 2.7 billion. These transfer financial resources are increasing year after year, of which very few are distributed to the marginalised Yaaku community living in Mukogodo forest.

1.1.11: Social setting

The Housing and Population Census a report of 2009, Kenya National Bureau of Statistics (KNBS) states that the county population stands at 399,227 of which 200,602 are females and 198,625 are males. 427, 173 was the projected number of people in the year 2012 of which there was an expectation of a rise to 457,514 and 479,072 in 2015 and 2017, respectively. A comparison between men and women is not even; hence the proportion of women is way above that of men in all the ages with an exception of age bracket 5 - 19 years. It is therefore suggested that the region will require addressing of the needs of women for huge proportion of the population consisted of the latter (LCG, 2013-2017).

The youth aged 35 and below take over half of the County's population with the trend expected to go on up by the year 2018. As at 2009, a total of 22% of the county comprised of primary school going children. All this totalled to 88,023 persons (comprising of 44,727 males and 43,296 females). On the other hand in 2009 there was a total of 34,569 persons (comprising 16,788 females and 17,781 males) representing 9% of the total population of secondary school going age. The study has targeted a small pastoralist community of about 4,000 inhabitants "not certain" for they were included in category of "others" in 2009 population census (International Fund for Agriculture Development (IFAD, 2012), called the Yaaku.

1.1.12: Health setting

Rumuruti, Doldol, Nanyuki and Nyahururu are the four sub county hospitals in the area. The county has 34 public dispensaries and eight public health centres. Still, there is one nursing home, one private health centre, three private hospitals, 33 private clinics and six private dispensaries. HIV and AIDS, diarrhoea, pneumonia, typhoid and upper respiratory tract infections (URTI) are the five most prevalent diseases in the county. The HIV prevalence rate stands at 6.1% (LCG, 2013-2017).

The mean distance to health centres is six kilometres. 10 percent of the households lay in the range of zero to one kilometre (0-1) from the nearest health facility while 40 per cent lay within the range of 1.1 to 4.9 Km. The nurse-population ratio stands at 1:1,000 while doctor-population ratio stands at 1:12,500. The locations of Mukogodo and Sieku which are home of the Yaaku are in short of these facilities in exception of one situated in the nearby Doldol market (LCG, 2013-2017).

1.1.13: Regulatory framework

To ensure the smooth implementation of the Laikipia County activities, the County Executive and County Assembly prepare and approve the various policies and legislations respectively. Such frameworks ensure that the County has enough ways for the influence in performance of its development functions. Governance of the local communities and public participation are the frameworks that cut across. Demarcation of villages as service delivery units for purposes of budgeting and planning is another key legislation. This is the reason of ranking Yaaku villages on vulnerability levels. The County also has in place the County Monitoring and Evaluation System to compliment the National Monitoring and Evaluation System and serve the County Government needs (LCG, 2013-2017).

The system covers the projects and programmes operating in the county. The County Planning Coordination, Monitoring and Evaluation Unit provide the required leadership in the process. Laikipia County has established ways for participation by the people in part VIII of the County Government Act which is a critical avenue for response and feedback. They consist of ward hall meetings, ICT based platforms, validation for a notice boards development project, budget preparation and Sites Avenue for participation of people's representatives including members of

National Assembly, Senate, citizen forum and county decentralized unit. The Yaaku community is not having any of their own in County Assembly, Executive, Parliament Senate or other mention for a to help in policy implementation of the County(LCG, 2013-2017).

1.1.14: Socio- economic vulnerabilities

The growth of towns and the population pressure on limited land resources as shown in section 2.2.6 above and other shopping centres, has reduced the provision of social amenities. The emergence of informal settlements around Nanyuki and Nyahururu towns especially Likii, Manguu and Maina villages, has led to high levels of poor sanitation, pollution and disposal of waste. In addition forested areas farming in riparian areas, sand harvesting and other quarrying activities in Laikipia East at Kimugandura, Kimanju in Laikipia North and Matanya area in Laikipia central has aggravated the process of land degradation leading to high instances of poverty within the county (LCG, 2013-2017). Farming along the river banks, overgrazing, deforestation for charcoal burning are factors that contributed to environmental degradation hence lead to reduced quality and quantity of water sources, productivity of land, high levels of pollution for both water and air, constraining existing effluent and solid waste disposal facilities especially in the urban areas. A lot of farming activities in forests also is a threat to the county's rich biodiversity (LCG, 2013-2017). The country's economy is highly dependent on climate sensitive sectors such as agriculture, energy, tourism, water and health. Frequent floods and droughts have led to loss of life and damaged property, and rising temperatures have impacted agricultural production, which sustained up to 75 percent of Kenya's population (GoK, 2015a). In addressing those complexes of climate change phenomenon, the communities livelihood assessment was based on sustainable livelihood frame work of which would determine which of the capitals could influence climate change adaptations than others (LCG, 2013-2017).

1.2: Statement of the problem

The climatic condition in a given area has a direct bearing on the level of economic development and way of life. Laikipia County being a pastoral or agricultural rural based economy, life is determined by the amount and distribution of annual rainfall and temperature variations from time to time. Therefore different counties have experienced various impacts of climate change, which sometimes manifests itself in increased intensity and frequency of erratic weather patterns

like floods and droughts, of which Laikipia County is not exceptional. While Laikipia County has contributed little if any to climate change, its impacts are devastating to the county (LCG, 2013-2017).

Since studies undertaken on climate change in Laikipia County are in other areas of the county and focused on other issues, for example Ogalleh et al., (2012) focus on suitability and variability of climate change in sub-locations of Umande and Muhonia, while Gitau (2013) studied impacts of drought in primary schools in Laikipia West. The other researchers whose study covered the whole county were FAO (2010). They only mentioned the study area as a pastoral livelihood zone. The area which has not been covered is the Yaaku Community in forested ecosystem of Mukogodo East, which over the last decades, has witnessed a remarkable degradation of the forest. This was attributed to negative climate variability effects, coupled with land use changes among which are malpractices such as forest destruction. What remain unclear are the impacts of climate change on the forested areas and the adaptive responses to cope with these changes by communities inhabiting these ecosystems. This study addressed these issues by identifying the changing trends of climate in Laikipia County for the last three decades, determining the changes in land use and management for the last three decades, quantifying the levels of vulnerability of the Yaaku community and their impacts due to climate change; and developing the strategies to be used by the Yaaku community to respond to the changing climatic and land use management.

1.3: Objectives of the study

The broad objective to provide the direction of study and specific objectives to address the specific areas of broad objective are outlined below.

1.3.1: Broad objective

The study sought to address the following broad objective: To understand through targeted studies the courses of resilience of the pastoral communities in Laikipia to the impacts of climate change and how they used local adaptive responses for sustainable livelihoods.

1.3.2: Specific objectives

The study sought to address the following specific objectives

- I. To identify the climate trend of Laikipia county for the last three decades.
- II. To determine the changes in land use and management by the Yaaku Community for the last three decades.
- III. To quantify the vulnerability and impacts to climate change of the Yaaku community.
- IV. To work with the community to develop suitable response strategy for the Yaaku community to reduce climate change impacts and livelihood sustainability

1.4: Justification and significance of research

Vulnerability and adaptation to climate change are urgent issues among many developing countries, Kenya being one of them and Laikipia County being no exception. However, climate change impacts and subsequent adaptive strategies varies from one country, county, ecological zone, ecosystem, community, and livelihood due to social, economic, and political factors of the area. Therefore the Yaaku community residing in Mukogodo forest has unique and different way of addressing climate change and adaptation issues which need investigation. Developing countries have low capacity to adapt and are more vulnerable to climate change damages, just as they are to other stresses. This condition is more extreme among the poorest people (IPCC 2001). The Yaaku community are marginalised, which make them susceptible to climate change. In context of the IPCC (2001) about vulnerabilities to climate change damage, the poorest people are in developing countries, and it is necessary to develop adaptation measures in order to stimulate their implementation by decision makers. This study sought to contribute to science by providing information on adaptive strategies used by communities in forested pastoral areas. The information documented and provided to the community as a way forward and accompanied projects put in by different stakeholder will be helpful in improving the pastoral livelihood resilience.

CHAPTER TWO: LITERATURE REVIEW

2.0: Introduction

In this chapter the work reviewed were mainly in relation to climate change and adaptations in forested ecosystems which were mostly inhabited by indigenous communities as per the Kenyan case (GoK, 2010b). And also the sustainability of resource use of forested pastoral community and the participatory methodology for adaptability to climate change based on livelihood capitals. The work reviewed includes climate change institutional governance, protocols and agreements of climate change and adaptations meetings (Conference of Parties - COP). The other works reviewed include land use management and planning, disaster risk reduction, and how it influences management for forested pastoral ecosystem while addressing sustainable development goals. The importance of adaptive measures to pastoralist indigenous communities is also reviewed.

2.1: Climate Change Challenge

The earth's climate has always changed and evolved, whereby some of these changes have been due to natural causes but others can be attributed to human activities such as deforestation and atmospheric emissions from, for example, industry and transport, which have led to gases and aerosols being stored in the atmosphere. They are known as greenhouse gases (GHGs) because they trap heat and raise air temperatures near the ground, acting like a greenhouse on the surface of the planet (UNFCCC, 2006).

As noted by the Intergovernmental Panel on Climate Change (IPCC, 2001) chapter 4 in its Third Assessment report on the state of the global climate that an increasing body of observations gave a collective picture of a warming world and other changes in the climate system, Africa in that case Kenya is not exceptional. The fourth Assessment report noted that it was very likely that the 1990s had been the warmest decade worldwide, and 1998 the warmest year since instrumental records had begun in 1861, although a few areas had not been warmed in recent decades. According to the report, human influence will continue to change atmospheric composition throughout the twenty first century (UNFCCC, 2006). The observation in Laikipia indicated that the trend is increasing in that 2000s were warmer than 1990s and according to the analyses by National Aeronautics and Space Administration (NASA) and the National Oceanic and

Atmospheric Administration (NOAA), 2016 is the warmest year since the modern record started being kept in 1880 and that the same year was third in row to set a new record for global average in surface temperatures (NASA & NOAA 2017)

Later in the Intergovernmental Panel on Climate Change (IPCC, 2007) in its Fourth Assessment report stated that Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of ‘multiple stresses’, occurring at various levels, and low adaptive capacity. Africa’s major economic sectors are exposed to huge economic impacts, current climate sensitivity, and this vulnerability is caused by existing developmental challenges such as complex governance, endemic poverty and institutional dimensions; limited access to capital, including, infrastructure, markets and technology; complex disasters and conflicts and ecosystem degradation. The continent’s vulnerability to projected climate change and weak adaptive capacity has been contributed by these factors or conflicts (Boko *et al.*, 2007). According to Boko *et al.*, (2007), Africa’s forests’ threats are inclusive of interacting with human drivers such as deforestation and forest fires.

The fourth IPCC report states that climate change is occurring and mostly as a result of human activities. It also illustrates that the impacts of global warming are already under way and expected in future, and describes the potential for adaptation of society in reduction of its vulnerability. Finally it presented an analysis of costs, policies and technologies intended to limit the extent of future changes in the climate system (IPCC, 2007).

The fifth IPCC confirms that human influence on the climate system is clear and growing, with impacts observed across all continents and oceans. However, many of the observed changes since the 1950s are unprecedented over decades to millennia. And that the IPCC is 95 percent certain that humans are the main cause of global warming. In addition, the synthesis report (SYR) found that the more human activities disrupted the climate, the greater the risks of severe, pervasive and irreversible impacts for people and ecosystems, and long-lasting changes in all components of the climate system. The SYR highlighted that there are means to limit climate change and its risks, with many solutions that allowed for continued economic and below 2°C relative to pre-industrial levels will require an urgent and fundamental departure from business

as usual. Moreover, the longer the world waited to take action, the more it would cost and the greater the technological, economic, social and institutional challenges would be faced (IPCC, 2014)

Climate change is happening now and is projected to worsen in the future (GoK, 2015a). Kenya is extremely susceptible to the impacts of a changing climate because most livelihoods and economic activities are reliant on climate sensitive natural resources. Droughts, floods and rising temperatures in particular have devastating consequences for the environment, society and economy. Climate change is affecting various sectors of the economy such as manufacturing and trade which rely on infrastructure and services such as water, energy and transport are also vulnerable to disruptions caused by droughts and heavy rains. Tourism is an important source of foreign exchange earnings which depends on a wide range of environmental resources, such as the abundance and diversity of wildlife, which could be impacted by climate change.

The agriculture and livestock sector, which accounts for 25 per cent of Gross Domestic Product (GDP) and another 27 per cent indirectly through links to agro-based industries, is very sensitive to climate change. Research by the International Livestock Research Institute (ILRI) indicates that increases in temperature can negatively impact agricultural productivity, resulting in a decrease in the production of major staple crops (GoK, 2015a). For example, incidences of severe and damaging frost that are attributed to climate change are becoming more common in Kenya. Drought is especially a problem in the Arid and Semi-Arid Lands (ASALs) leading to loss of animals.

Agricultural and pastoralist systems will need to adapt to ensure provision of adequate food for a growing population and improve production and conservation of the ecosystem (GoK, 2015a).

The Yaaku community have been adapting and conserving the forested ecosystem despite of climate changes in their environment. This is evidenced by IFAD (2012) that the hunters and gatherers community like the Yaaku of Mukogodo Forest noted that the droughts of 2009 and 2010 has a number of climate change impacts including the drying up of rivers, lack of snow on Mount Kenya, scarcity of food, and changes in rainfall patterns and harvesting seasons. In order to address the impacts of climate change and apply the adaptation strategies as detected by the

community, various methodologies or techniques are employed to address the forest degradation issues among them participatory land use planning and management.

2.2: Participatory Land use Planning

As indicated by the International Land Coalition's Rangelands initiative (ILCR) (2015a), Land-use planning is the systematic assessment and planning of land and land based resources and their potential, together with the design of alternatives for economic and social development in a manner that achieves welfare and sustainable livelihoods while safeguarding resources for the future. Therefore participatory land use planning is an interactive planning process based on a dialogue among all stakeholders, for negotiation, consensus building and decision making regarding the sustainable use and management of private, communal and public land. In the case of Yaaku the land is communal and a consensus building needed is among all stake holders including the administrator's, political leadership and conservationist. Participatory land use planning provides an opportunity for otherwise marginalised groups such as women, youth, pastoralists, fishers, hunter and gatherers to take part in planning. The following stages in a participatory land use planning process which included stakeholder mapping, community mapping of forest land management, land capability assessments, analysis of problems or solutions for the Yaaku was undertaken during the CMDRR exercise. The Yaaku community was one of the most marginalised community in the county among others in Kenya in line with chapter four part (1)21(3) (GoK, 2010a).

Participatory land use planning was important for a number of reasons among others: Community 'ownership' led to strong commitments to invest in and implement land use plan, community development needed to be demand-driven by community member's themselves, community participation helped resolve conflicts, as through the planning process where different stakeholders agreed on how land was used and managed, land pressure needed more intensive management if it was not to degrade or be over-exploited and participatory planning increased the incentives for community land users to invest in that management.

Therefore Participatory Land Use Planning (PLUP) provides information and direction to the relevant community of users and decision makers to enable them: optimise the productivity of

the land and resources; develop infrastructure and services; protect the environment and biodiversity and establish appropriate governance and administration systems as indicated by international land coalition's rangelands initiative (2015). In order to get entry to the community and have a participatory land use planning and management methodology practiced, Community Managed Disaster Risk Reduction (CMDRR) approach was applied.

2.3: Disaster Risk Reduction (DRR)

The vulnerability of Laikipia County to a variety of disasters is mainly caused by its geographical location. The characteristics of low rainfall and frequent dry spells of the county is mainly caused by it being on the leeward side of Mt Kenya (LCG, 2013-2017). Major disaster that affects the county from time to time is drought. Massive loss of crop yield and livestock is usually caused by such spells. This has led to overreliance on relief food. During the dry periods, conflicts over pastures and watering points have been experienced. Fire outbreaks within conservancies (wildlife) and also within the informal settlements in the urban areas are some of the other frequent disasters experienced. The disasters normally have negative impacts on the community due to property loss and livelihoods following raising the levels of poverty in the county. As reported in the Laikipia County Integrated Development Plan (LCIDP) 2013-2017, the occurrence of heavy rains and floods have been known to destroy farms, livestock, roads and shelters (LCG, 2013-2017). To help the community understand and have bottom up approach in addressing risks and subsequent adaptive strategies, a participatory methodology was essential such as risk reduction managed by the community which was undertaken in the two locations of Yaaku community.

2.3.1: Community Managed Disaster Risk Reduction (CMDRR)

Community Managed Disaster Risk Reduction (CMDRR) is “a process of bringing people together within the same community to enable them to collectively address common disaster risks, and pursue common disaster risk reduction measures. It is a process that mobilises a group of people in a systematic way towards achieving a safe and resilient community. It envisions a dynamic community that is cohesive in making decisions, deals with conflicts, resolves issues, manages collective and individual tasks, respects the rights of each individual, demands their rights and addresses and bounces back from hazard events” (Binas, 2010). It also refers to a process whereby there is active engagement of the community in the identification, analysis,

monitoring and evaluating the risks with intention of reducing people's disaster risk and enhancing their capacities. It makes the communities sole decision-makers in the process and in the management of disaster risk reduction measures (IIRR & Cordaid, 2013).

2.3.2: The Disaster Risk Reduction Formula

The framework that guides disaster risk reduction is a relationship has indicated by equation 2.1 below. :

$$DR = \frac{H \times V}{C}$$

Equation 2.1

Disaster Risk = Hazard x Vulnerability divided by Capacity.

This is a qualitative framework that can be used to assess disaster risk levels and guide risk reduction planning measures. It shows that the risk of suffering consequences of a disaster is determined by the presence of the hazard event and vulnerability conditions in combination with inadequate coping capacity (IIRR & Cordaid, 2013).

The CMDRR methodology enables the trans-disciplinary processes at the community level. The methodology initiates the research and also helps in the exit after completion due to its four essential parts (the basic minimums) of facilitating CMDRR as outlined by Abdi & Cordaid, 2011). These are reports of Participatory Disaster Risk Assessment and Analysis (PDRA&A), development of disaster risk reduction measures (a development plan and a contingency plan), building strong community organizations-structures and Participatory Planning, Monitoring, Evaluation and Learning (PPME&L).

2.4: Sustainable Land Management and Climate Change

Sustainable land management is the adoption of land use systems that, through appropriate management practices, enables land users to maximise the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (TerrAfrica, 2009). SLM includes management of soil, water, vegetation and animal resources which also includes ecological, economic and socio-cultural dimensions (Hurni, 1997). The ecological, economic and socio-cultural dimensions are referred to as the '3 Es' of sustainable development; Equality, Economy, and Ecology (UNESCO, 2006).

Socially thus equality, Sustainable Land Management (SLM) helps secure sustainable livelihoods by maintaining or increasing soil productivity, thus improving food security and reducing poverty, both at household and national levels.

Economically, SLM pays back investments made by land users, communities or governments.

Ecologically, SLM technologies; in all their diversity, effectively combats land degradation

In the case of Yaaku community the social aspect of SLM was of importance because the practices and experiences were inherent in the community and not with other communities and had faded away.

As indicated by Nkomo *et al.*, (2006), land degradation is exacerbated by climate change and climate variability. Also, Africa's climate has long been recognised as both varied and varying whereby it vary because it ranges from humid equatorial regimes, through seasonally-arid tropical and hyper-arid regimes, to sub-tropical Mediterranean-type climates; and vary because all those climates exhibited differing degrees of temporal variability, particularly with regard to precipitation (FAO, 2011). Climate change was a major concern for Sub-Saharan Africa (SSA) bringing new challenges. However, there is huge potential for Sustainable Land Management (SLM) in climate change mitigation and adaption. SLM best practices and their up scaling in sub-Saharan Africa is essential for a variety of reasons, but the most basic is to sustain and improve livelihoods while protecting the land's resources and ecosystem functions. SLM thus seeks to increase production including traditional and innovative systems and to improve resilience to food insecurity, land degradation, loss of biodiversity, drought and climate change. These factors are not unique in Laikipia and Mukogodo forest ecosystem and the inhabiting community the Yaaku, which was investigated and addressed by the study.

2.4.1: Sustainable Development Goals

Transforming our world is the title of 2030 development agenda adopted by the 193 countries of the UN General Assembly on 25 September 2015. It include 2030 agenda for sustainable Development which has 92 paragraphs with main 51 paragraphs outlining the 17 Sustainable Development Goals (SDGs) and their associated 169 targets. These 17 SDGs are as listed below.

- i. *Poverty*: End poverty in all its forms everywhere

- ii. *Food*: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- iii. *Health*: Ensure healthy lives and promote well-being for all at all ages
- iv. *Education*: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- v. *Women*: Achieve gender equality and empower all women and girls
- vi. *Water*: Ensure availability and sustainable management of water and sanitation for all
- vii. *Energy*: Ensure access to affordable, reliable, sustainable and modern energy for all
- viii. *Economy*: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- ix. *Infrastructure*: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- x. *Inequality*: Reduce inequality within and among countries
- xi. *Habitation*: Make cities and human settlements inclusive, safe, resilient and sustainable
- xii. *Consumption*: Ensure sustainable consumption and production patterns
- xiii. *Climate*: Take urgent action to combat climate change and its impacts
- xiv. *Marine systems*: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- xv. *Ecosystems*: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- xvi. *Institutions*: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- xvii. *Sustainability*: Strengthen the means of implementation and revitalize the global partnership for sustainable development'

Among the seventeen sustainable development goals, the study focused on five goals directly numbered 1, 2, 13, 15, 16 and many others indirectly. At Paris climate deal (conference of parties COP 21 December 2015),it was said that handling climate change would only be

effective if the SDGs were met; and that climate and development are properly linked, particularly around gender equality, poverty and energy.

2.5: Importance of Pastoral Economy

The pastoral economy in Africa is wholly centred on livestock. The importance of livestock and their contribution to human welfare and improved agriculture is recognized (LRRD, 2004). They contribute about 25% of the agricultural gross domestic product in sub-Saharan Africa, and even exceed this value in some West African countries (LRRD, 2004). They provide income, which is vital to household food security. Thus, livestock is their insurance to survival (Aboud, 1982). For the Karamojong, cattle play a major role in, personal aspirations, political inclination, dancing, and songs (Hudson, 1970). The indication is that almost all activities be they economic, social, or cultural are centered on livestock. In case of the Yaaku who are in between pure pastoralism and hunters and gatherers in the Mukogodo Forest has not benefited in pastoral classification due to impacts of climate changes in their environment, nor are they the original hunters and gatherers thus has not maintained their natural, human, physical, financial, political and social capitals/assets environments.

2.5.1: Adaptive Measures to Pastoralism

Pastoralism as an adaptive strategy is based upon the three main resources of animal herds, pasturelands and water (Negi, 1995). The pastoral and agro-pastoral economy is subsistence oriented. It aims at providing a regular supply of food for the extended families and the communities for physical and social well-being. They protect their herds against natural risks through strategic methods, such as sharing and loaning stock to others. They tend to keep a variety of livestock, to meet the different ecological situations and exchange requirements.

The pastoral communities have developed different safety net mechanisms for their poor clan members. However mobility of livestock is a necessity in the pastoral areas for the best economic use of range resources coping with the ecosystem variability (Emana *et al.*, 2006). Of which population, adaptations and movements have forged links between groups: peaceful ones such as marriages, violent ones such as cattle rustling and raids, collaborative ones such as creating labour network and reciprocal relationships built on sharing of animal (Ahmed and Abdel, 1996). Coping strategies during drought such as, species diversification, mobility, stock

lending or stratification have enabled the herders to return to herding even after a severe drought (Ahmed and Abdel, 1996).

Kaye-zwiebel *et al.*, (2014) indicate that pastoralists typically utilize extensive rangelands as common pool resources and manage them through customary, polycentric governance systems and social networks (Runge 1986, Ostrom 1990, Niamir 1998, Agrawal 2007). Mobility is a hallmark adaptation that allows pastoralists to buffer themselves against temporally variable environmental conditions and to access key resources that are heterogeneously distributed across large spatial scales (McCabe, 1994). All these adaptive measures are common and practical in pure pastoral ecosystem but not in forested pastoral communities like the Yaaku. Therefore this study has addressed these issues in forested ecosystem on basis of political influence to climate change impacts and adaptations.

2.6: Climate Change Adaptation at Community Level

Vulnerable communities initially try to cope with climate change by applying traditional coping mechanisms and adaptation strategies. Some of these coping mechanisms only prepare people to survive a disaster (instead of preventing it from occurring). In other cases these responses are not sustainable in the long term. For more and more communities the growing magnitude of the problem means local knowledge is no longer sufficient for them to autonomously adapt to climate change (Binas, 2012). Empowering and supporting those that suffer the most from hazards is crucial in tackling climate change.

The mechanisms that communities used to cope with disasters had provided the basis for further adaptation and were linked with new knowledge and accessible technologies. Experiences from (CMDRR) showed that grassroots and autonomous adaptation were the most sustainable approach, was cost-effective and easily replicated (Binas, 2012). Thus building the capacity of different stakeholders, particularly communities, local organisations and local government, to cope with climate change and disasters was central to this as it strengthened local expertise, experience and initiatives. Empowering people had raised awareness on climate change and its adaptations. The Yaaku community started to see the changing weather has, due to climate change and its causes such as anthropogenic activities in the Mukogodo forested ecosystem.

2.7: Constitution of Kenya on marginalized groups

In line with the recognition of marginalized groups by the Constitution of Kenya, 2010, Article 260 of the Constitution defines a “marginalized community” as: (a) a community that, because of its relatively small population or for any other reason, has been unable to fully participate in the integrated social and economic life of Kenya as a whole;(b) a traditional community that, out of a need or desire to preserve its unique culture and identity from assimilation, has remained outside the integrated social and economic life of Kenya as a whole;(c) an indigenous community that has retained and maintained a traditional lifestyle and livelihood based on a hunter or gatherer economy; or (d) pastoral persons and communities, whether they are (i) nomadic; or (ii) a settled community that, because of its relative geographic isolation, has experienced only marginal participation in the integrated social and economic life of Kenya as a whole (GoK, 2015b).

Similarly, the Constitution of Kenya, 2010, defines ‘marginalized group’ as: a group of people who, because of laws or practices, on, or after the effective date, were or are disadvantaged by discrimination on one or more of the grounds in Article 27 (4) which prohibits discrimination on the basis of ethnic or social origin, religion, conscience, belief, culture, dress or language. In addition, article 27(6) calls on the state to undertake, ‘legislative and other measures, including affirmative action programs and policies designed to redress any disadvantage suffered by individuals or groups because of past discrimination’. This article prohibits both direct and indirect discrimination (GoK, 2015b).

Articles 56 and 260 of the Constitution are a clear demonstration of the intentions of the country to deal with the concerns of minority and marginalized groups: The definition of marginalized communities and groups by the COK, 2010, and the provisions for affirmative action programmes for minority and marginalized groups are efforts to clearly provide a legal framework for the inclusion of minority and marginalized groups into mainstream development of the country. These articles present the minority and marginalized groups including groups that fit the OP 4.10 criteria as a unique category of certain segments of the Kenyan population that deserve special attention in order to bring them to par with the rest of the country(GoK, 2015b).

The Constitution of Kenya requires the State to address the needs of vulnerable groups, including “minority or marginalized” and “particular ethnic, religious or cultural communities” (Article 21.3):The Specific provisions of the Constitution include: affirmative action programs and policies for minorities and marginalized groups (Articles 27.6 and 56); rights of “cultural or linguistic” communities to maintain their culture and language (Articles 7, 44.2 and 56); protection of community land, including land that is “lawfully held, managed or used by specific communities as community forests, grazing areas or shrines,” and “ancestral lands and lands traditionally occupied by hunter-gatherer communities” (Article 63); promotion of representation in Parliament (d) ethnic and other minorities; and (e) marginalized communities” (Article 100); and an equalization fund to provide basic services to marginalized areas (Article 204)(GoK 2015b).

The factors which contributes and affect the marginalization of whole communities or segments of a community are; (i) historical injustices especially over land rights; (ii) ethno-cultural factors; (iii) livelihood strategies; (iv) minority status of a community; (v) socio-political factors; and, (vi) exclusion from development activities due to poverty e.g. a community of households who may be unable to make contributions towards a development activity(GoK, 2015b) .These factors are the same for the Yaaku community.

2.8: Indigenous Peoples of Kenya

The Republic of Kenya has a multi-ethnic population, among which more than 25 communities identify as indigenous. The concept of indigenous peoples is not recognized in Kenya but the government acknowledges the existence of marginalized communities (GoK, 2010a). These communities include hunter, gatherers and pastoralists. Most hunter and gatherer communities live in the forested areas of the highlands and the coast or near rivers and lakes. This is where they used to hunt, fish, gathers honey and other forest products (IFAD, 2012). The pastoralist groups are found on the arid and semi-arid lands (ASALs), which constitute 84% of the country’s area unlike the hunters and gatherers whose ecosystem is not well defined. As reported by IFAD (2012), the difference between hunter, gatherers and pastoralists is not clear-cut since some hunters and gatherers keep cattle and many pastoralists mix livestock herding with other subsistence strategies (cultivation, hunting, gathering).

Traditional hunter-gatherers live in the forests, hunt for meat and gather honey as well as other non-timber forest products. Included in this category are also small fishing communities living near rivers and lakes. Because these peoples differ from the pastoralists by not keeping cattle, they are often called Torobbo, Dorobo, Ndorobo or Wandorobo, all Swahili terms deriving from "*Il Torobbo*", the Maasai term for poor or, by inference those without cattle. Dorobo is therefore considered a derogatory term. In the coastal areas, hunter-gatherers are mostly addressed by the Somali terms Boni, which also refers to someone without any possessions, or Sanye, which means; to gather together to use for a general purpose. Waata, a term of Cushitic origin, is also used. Today, hunter-gatherer groups are increasingly known by their own names. Although the 2009 census still lists a group called Dorobo, it also lists seven hunter-gatherer groups, including two groups of fishers, by their own names; the Aweer, Dahalo, Waata, Ogiek, Sengwer, El Molo and Munyoyaya and as members of some of the large ethnic groupings such as the Kalenjin, the Mijikenda and the Swahili. The Walwana (Ilwana, Malakote) are listed as an independent group. These eight groups do not constitute an exhaustive list, and communities such as the Yaaku (Yiaku) and the Omotik definitely belong to Kenya's hunter-gatherers (IFAD, 2012).

The Yaaku are among the old Cushitic groups in the Rift Valley of Tanzania and Kenya that became associated with various Nilotic tribes like clients, mostly as self-defence for their own preservation under the various waves of Nilotic migration into their ancestral area (Orville, 1996). The Yaaku are associated with the Maasai of Kenya and majority speak Maa language and are referred to as the *Mukogodo* Maasai. *Athii* or *Mwokore* are names given to the Yaaku in the traditions by highland Bantus like Kikuyu and Meru. The Maasai called these early Cushitic peoples by the name Dorobo. The "*Dorobo*" are not one tribe but referred to various original forest-dwelling hunters-gatherers (Southern or Eastern Cushites). One connotation of "*Dorobo*" is poor people who don't own cattle (Orville, 1996). The Yaaku consider themselves Maasai and speak the maa language because they have gotten completely into Maasai culture and language. Between 1925 and 1936 they left their Cushitic language Yaaku for the Eastern Nilotic Maasai language (Yaaku dice database-internet). The hunters and gatherers have 'knowledge of the forests natural resources its animals and its trees, the individual properties and use of thousands of plants, where to find and gather honey and how to use them in a sustainable way, has not only sustained the hunters and gatherers themselves but has benefited their neighbours, with whom

exchange networks have been established and functioned for centuries. This information collected was vital to help manage the forest due to climate variability and various political influences in the Yaaku community.

2.9: Conceptual frame work

This model was adapted from sustainable livelihood framework with modification (DFID, 1999).

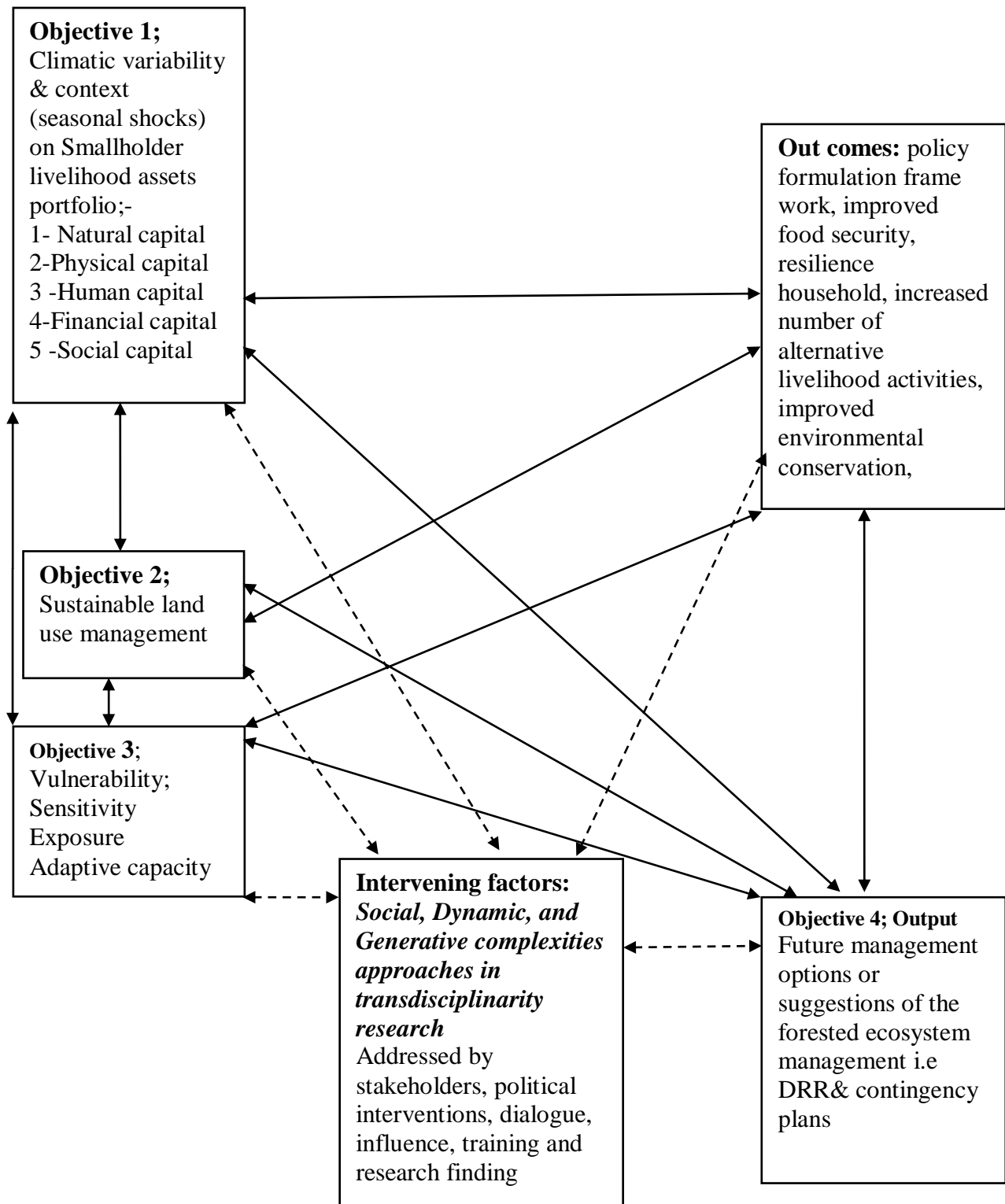


Figure 2.1: Conceptual frame work

2.9.1: Overview of the methodological approach

The conceptual framework was developed to demonstrate how climatic variability and change, context (seasonal shocks) and sustainable land use management influences smallholder livelihood assets portfolio: such as natural, physical, human, financial and social capitals of the Yaaku community. The livelihood portfolios were affected by climatic variability's thus making the community vulnerable, and through the intervening factors of social dynamic and generative nature, the outcomes and outputs were experienced. None of these variables was independent or dependent of one another but were all interrelated and web twined. McLeod (2001) suggested modifications to the assets categories that supported sustainable livelihood theory, and she still gave insight to addition of two new assets: political capital and institutional knowledge. This study indicated that political influence/capital cuts across all other capitals and thus an intervening factor and important in climate change and adaptation issues, which was addressed through social, dynamic, and generative complexities approaches in trans-disciplinary research. Thus, the researcher suggested a modification of DFID sustainable livelihood model to include political capital or guidance as an asset or capital in the model.

2.9.2: Livelihood assets or capitals

Livelihood approach seeks to gain correct and realistic understanding of people's potency (here called "assets" or "capitals"). It is important to resolve how people are determined to convert these strengths into positive livelihood outcomes. The approach is based on a belief that to achieve a positive livelihood people need to acquire a range of assets. Hence the sustainable livelihood framework identifies five types of capital or assets upon which livelihoods are built which includes; *social capital*, *human capital*, *natural capital*, *financial capital* and *physical capital*. McLeod (2001) summarised these assets or capital as follows: first "*natural (environmental) capital*: which is natural resources (land, water, wildlife, biodiversity, environmental resources). Second *physical capital*: which is basic infrastructure (water, sanitation, energy, transport, and communications), housing and the means and equipment of production. Third is the *human capital*, which includes health, knowledge, skills, information and ability to labour. Fourth is the *social capital*, which is social resource (relationships of trust, membership of groups, networks, access to wider institutions). And lastly is the *financial capital*,

which includes the financial resources available (regular remittances or pensions, savings, supplies of credit)” McLeod (2001).

The essence of policies processes and institutions cannot be overemphasized, because they engage at all levels, from the family to the international arena, and in all spheres, from the most public to the most private. They in a big way determine access (to various types of capital, to decision-making bodies to source of influence and livelihood strategies), returns to any given livelihood strategy and terms of exchange between different types of capitals (DFID, 2000). Whether people are able to achieve a feeling of inclusion and well-being, there is a direct impact on policies, institutions and processes. Because culture is inclusive in this area they also account for other ‘unexplained’ variability in the ‘way things are done’ in different societies (DFID, 2000). Decision making processes and access to assets can be greatly determined by policies, institutions and processes. For the study they were referred to as political influence/ capital for most of the climate change adaptation issues in communities were addressed by or in political statements.

2.9.3: Climate variability

Climate data was collected at county meteorological offices for the last 30 years. Also a tool was employed known as Community Managed Disaster Risk Reduction (CMDRR) “a process of bringing people together within the same community to enable them to collectively address common disaster risks, and pursue common disaster risk reduction measures” as used by Abdi and Cordaid (2011) and CARE International (2015) .

2.9.4: Vulnerability context

This frames the external environment in which people exist. People’s livelihoods and availability of assets are greatly influenced by critical trends and shocks of which people have no control over. Though not all of seasonality and trends were considered as negative, vulnerability emerged when human beings faced harmful threat or shock with inadequate capacity to respond effectively. Vulnerability is the degree of exposure to risk (hazard, shock) and uncertainty, and the capacity of households or individuals to prevent, mitigate or cope with risk. The risks in the study were the climate change impacts (Abdi and Cordaid (2011).

2.9.5: Livelihood Outcomes

These were the outputs of livelihood strategies for example increased well-being, more income, reduced vulnerability, a more sustainable use of natural resources and improved food security. When thinking about livelihood outcomes, the aims of the study was to get the extent to which these were being achieved and implemented.

2.9.6: Social, Dynamic, and Generative complexities approaches

Trans-disciplinarity is an approach of conducting research that involves synergistic collaboration between all disciplines with high levels of integration between the disciplinary sets of knowledge. Trans-disciplinary research practices are issue or problem centred and prioritizes the problem at the centre of research over discipline. Trans-disciplinarity is not a single form of knowledge. It is a dialogue of forms. Different disciplines and systems were part of the dialogue, as well as the multiple epistemic of cognition understanding, conceptualizing, and causal explaining (Klein, 2007). Trans-disciplinary research solves complex problems and also requires combining three forms of knowledge such as scientific systems knowledge, societal target knowledge, and political transformation knowledge. Transdisciplinary research is conceived as a practice oriented approach, because it is not confined to a closed circle of academic expertise. It broadens to incorporate stakeholders in the public and private domains and the intervening factors in the model are the social, dynamic, and generative complexities approaches which involve everybody and at all research stages up to and including result dissemination thus put in broken or dotted arrows. The other components of this model are discussed and explained in section 2.9.1 above on overview of methodological approach.

CHAPTER THREE: DATA AND METHODOLOGY

3.0: Introduction

Methodology is discussed in this chapter including the study area and population, the research design; sampling procedures, sample size, data collection methods as well as processing and analyses procedures.

3.1: Characteristics of the study area

The characteristics of the study area involve the location, topography and population as outlined in the sub-sections below.

3.1.1: Location of study area

The study was conducted in Mukogodo East Ward, which is in Laikipia North Sub County of Laikipia County of Kenya. Laikipia County lies between latitude 0°18" and 0 °51" north and between longitude 36°11" and 37°24' east. It occupies an area of 9,462 km² (2,338,111 acres) (LCG, 2013-2017).

As indicated in the map in Figure 3.1, Mukogodo East is comprised of four locations, namely Makurian, Sieku, Mukogodo (Mumonyot) and Iipolei Locations. Mukogodo East Ward borders Mukogodo west to the west, Umande Ward to the south, Meru County to the east and Isiolo County to the north. The study site and the hazard (climate change) were identified by community participatory methodology known as community managed disaster and risk reduction (CMDRR) Appendix 3.

3.1.2: Topography

At Ewaso Nyiro Basin in the north the County altitude lies between 1,500 metres above sea level and 2,611 metres in the south. Marmanet Forest is found at a height of 2,611 metres above sea level. Mukogodo and Loldaiga forests are other areas of high altitude in the eastern part of the County. These areas lie at 2,200 metres above sea level (LCG, 2013-2017). As illustrated in Figure 3.1 below, the Mokogondo Forest is the home of Yaaku community who occupy Mukogodo and Sieku locations of Mokogondo East Ward of Laikipia North Sub County of

Laikipia County. Figure 3.1 shows the Mukogodo East ward which is the home of the Yaaku, community.

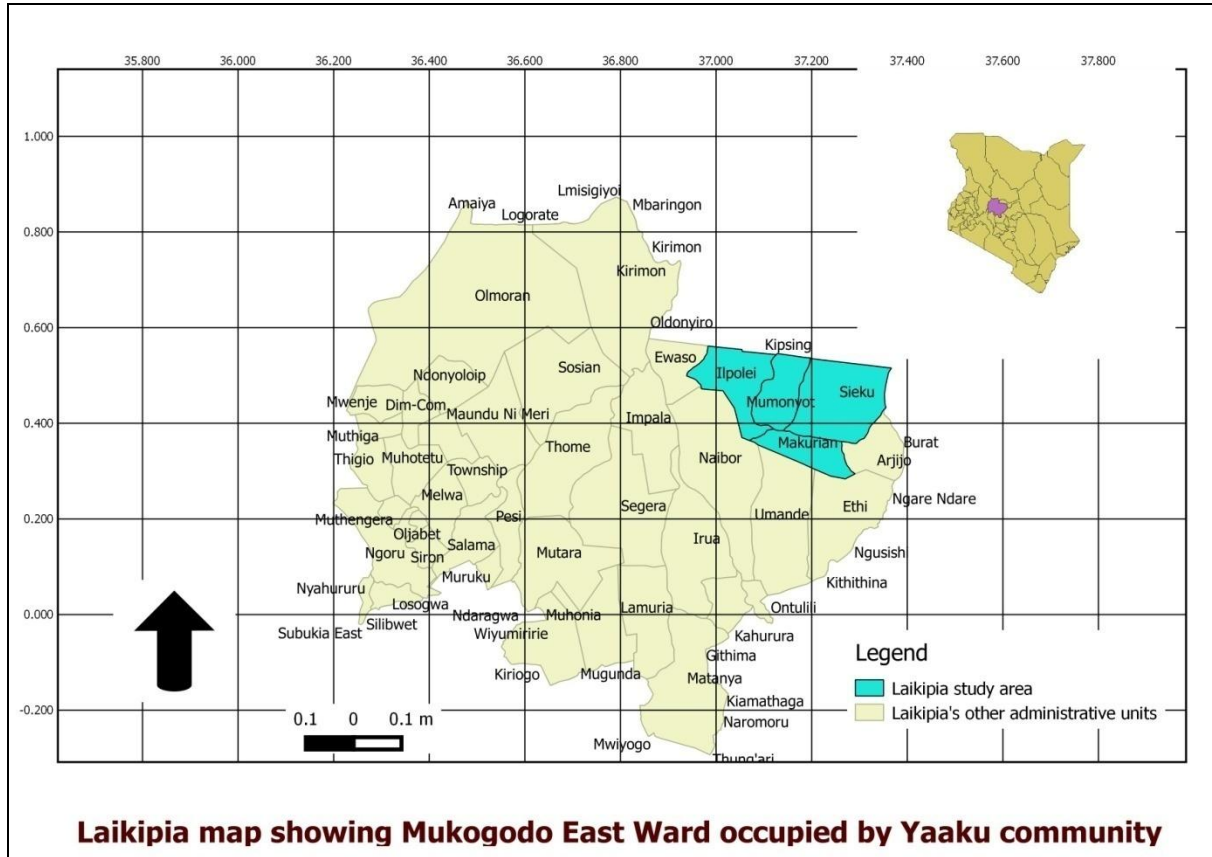


Figure 3.1: A map of Laikipia County showing the study site

3.1.3: Population

According to the 2009 Kenya National Bureau of Statistics (KNBS), the total population for the Laikipia stands at 399,227 people; of these 200,602 are females and 198,625 males. The population projection for year 2017 is 479,072 persons. The study targeted a small pastoralist community of about 4,000 inhabitants “not certain” for they were included in category of “others” in 2009 population census (IFAD, 2012), called the Yaaku living in Mukogodo and Sieku locations of Mugogodo East Ward of Laikipia County.

community of about 4,000 inhabitants “not certain” for they were included in category of “others” in 2009 population census (IFAD, 2012), called the Yaaku living in Mukogodo and Sieku locations of Mugogodo East Ward of Laikipia County.

3.2: Research design

The study utilised a socio-economic survey using a structured questionnaire with initial entry to community by community managed disaster risk reduction (CMDRR), and supported by key informant interview and focus group discussions methods. The research also made use of secondary data from University libraries, public offices including meteorological offices, regional centre for mapping of resources for development (RCMRD) and other relevant sources which help to address the objectives.

3.3: Sampling procedure

The study population comprised of 800 households in Mukogodo and Sieku locations in Mukogodo East ward (Appendix 7), while the sampling frame, from which the study sample was drawn constituted all the households living in the nine villages of these two locations. The unit of analysis was the household and the subject of analysis (the respondent) was the head of the household or their representative.

In each of the nine villages, a list of the households was compiled during the process of CMDRR, and systematic sampling was used to pick numbers of households (actually about 30 percent of households) from each village (Borg and Gall, (2003). Then random sampling was undertaken among the systematically selected households in each village, to constitute a study sample of 240 households.

Two formulae (from Mugenda and Mugenda, 1999, and Kathuri and Pals, 1993) were used for computing the study sample size, but yielded rather large sample sizes that could not be sustained by the available resources for the study. According to Kathuri and Pals (1993), a minimum of 100 is recommended for a survey research and gives a reasonable unit for analysis.

(Borg and Gall, (2003) indicated that at least 30% of the total population is representative. Thus, 30% of the accessible population is enough for the sample size. Thus in this study 30% of 800 households was 240 respondents.

Hence resorting to the provisions of the Statistical Package for the Social Sciences (SPSS) programme, which suggest that any sample size of 200 and above will allow perfect functioning of all the analytical procedures provided by the programme

3.4: Type of data collected and collection methods

The subsections below details the methods and tools that were used in data collection based on objectives. Every objective is outlined separately and the methods or tools used to get the results. A standard, structured questionnaire with open and closed-ended questions that addressed the study objectives was used to collect primary data from the respondents. It was administered in the form of an interview schedule in local language and Kiswahili and translated and recorded in English since some of the agro-pastoralists were illiterate. In way of pretesting it, the principal researcher administered the questionnaire with help of translator to confirm reliability and validity of information provided.

3.4.1: Climate trend of Laikipia County for the last three decades

The data on average annual rainfall and daily maximum and minimum temperatures from 1986 to 2015 was collected from Laikipia Meteorological Station in Kalalu of Mukogodo East Ward (Laikipia North) which is within the study area and Rumuruti (Laikipia West) and Laikipia air base (Laikipia East) for county situation comparison.

A socio-economic survey using a structured questionnaire was used to collect respondent's opinions on climate changes and adaptations on rainfall and temperature characteristics for last three decades from 1986 to 2015.

3.4.2: Changes in land use and management for the last three decades

The remote sensed data from land-sat images of the area for last three decades was collected from regional centre for mapping of resources for development (RCMRD) to determine land use changes. In the classification, maps were generated using specialist software (IMPACT Toolbox “ offers a combination of element of remote sensing, photo interpretation and processing technology in a portable and stand -alone GIS environment”), Erdas and ArcGIS). The maps show the land cover status of the four Epochs, 1984, 1995, 2004 and 2014 changes between each

of the epoch; i.e. 1984-1995, 1995-2004 and 2004-2014 which show the statistics of change. Field validation was done to improve the classification and to come up with class cover validation and errors of classification computed. A socio-economic survey using a structured questionnaire was used to collect respondent's opinion on climate changes and adaptation on land use and management in specific based on livelihood capitals for last three decades as from 1986 to 2015.

3.4.3: Vulnerability and impacts to climate change of the Yaaku Community.

The methodology used by Abdi & Cordaid (2011), IIRR & Cordaid (2013), CARE international (2015) of assessing vulnerability was applied. In this methodology, vulnerability, is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes, and also is a function of the character, magnitude and rate of climate variation to which a system is exposed and its adaptive capacity (IPCC, 2001).

3.4.3.1: Exposure

Degree of exposure varied for the different elements at risk of climate change impacts (Human and non-human economic assets, institutions, and critical service which provide facilities (IIRR & CordAid, 2013). That is

- Human disaggregated by gender, age, special conditions
- Productive assets e.g. livestock, farmland/crops, shops
- Critical service providing facilities e.g. schools, health units, markets, roads, bridges
- The tools used are vulnerability mapping and vulnerable village ranking, livelihoods strategies and wealth ranking.

3.4.3.2: Adaptive capacity

Capacity: Referred to individual and collective strengths and resources that can be enhanced, mobilized and accessed to allow individuals and communities to shape their future by reducing climate change risk. The aim of capacity assessment was to identify the existing capacities, the required capacities to cope in the face of the climate change impact and the gaps. Capacity was classified into the following categories;

- Human capabilities (knowledge, skills, attitudes)

- Economic (assets e.g. livestock, farm land money)
- Natural (forests, rivers, waters sources)
- Physical (roads, bridges, hospitals)
- Social (institutional, cultural, political, and ideological)

The tools used were social or resource map, livelihood strategies and wealth ranking.(Plate 3.2).

A socio-ecological survey using a structured questionnaire was used to collect respondent's opinion on climate changes and adaptation on vulnerability of household of Yaaku community for last three decades as from 1986 to 2015.

3.4.4: Response strategies of the Yaaku community to reduce climate change impacts

A tool employed was community managed disaster risk reduction (CMDRR) as used by Abdi & Cordaid, (2011) and CARE International (2015) to help community to participate in development of response strategies to reduce climate change impacts.

Data was used to draw community disaster risk reduction plans and community contingency plans. With help of area administration and the extension workers, the key informant (KI) interview consisted of eight participants purposively sampled within various social economic groups of Yaaku pastoralists which helped to develop preparedness and response strategies.

A socio-ecological survey using a structured questionnaire was used to collect respondent's opinion on climate changes and response strategies to climate change impacts of household of Yaaku community for last three decades as from 1986 to 2015.

Plate 3.1 below shows a local leader conducting a CMDRR exercise in Mukogodo community.



Plate 3.1: A local leader addressing the Mukogodo community

As shown in plate 3.1, community members are having a consultative session where climate change was identified as a main hazard and responses strategies to reduce climate change impacts were being sought from the community members. This was the time of mapping where research was to be undertaken

Plate 3.2: below shows Yaaku community leaders conducting a CMDRR exercise in Mukogodo community.



Plate 3.2: Yaaku community leaders participating in CMDRR drawing of resource map

As shown in plate 3.2 this resource map is used as tool to identify capacities of the community and also helps the researcher and other stake holders understand the area of study.

3.5: Data analysis

The sub section below details how data were analysed by combination of qualitative and quantitative approaches.

3.5.1: Climate trend of Laikipia County for the last three decades

The data on average annual rainfall and average annual minimum and maximum temperatures as from 1986 to 2015 was analysed to get climate variability within the period by trend analysis and measure of central tendency. Microsoft excel was used to plot the trend charts number of years with minimum and maximum temperature.

Data from social economic survey (from household interviews) was analysed after entry in to computer software package (SPSS) to get the respondents' opinions of rain fall and temperatures variability within the three decades (last thirty years ago, twenty years ago and ten years ago) and charts were drawn using Microsoft excel to which indicated the trend or variability of the respondents opinion.

3.5.2: Changes in land use and management for the last three decades

The area was delimited by the Mukodogo East Ward within Laikipia County and which enclosed the Mukodogo Forest which was the home of the Yaaku community. Landsat imageries from regional centre for mapping of resources for development (RCMRD) were analysed by use of remote sensing computer software Erdas imagine (2014) and classified images were input into maps composition by ArGIS to give the land use trends as from 1984 to 2014. The study site was visualised by Google Earth for comparison with present situation as form of ground check, accompanied by ground visits to some of the areas. The changes were obtained by classifying Land sat images for four epochs: 1984, 1995, 2004 and 2014. The epochs were at a period of 10 years to allow clear and notable change detection. Data from social economic survey was analysed after entry in to computer software package (SPSS) to get the respondents' views of land use and management within the three decades.

3.5.3: Vulnerability and impacts to climate change of the Yaaku community.

The vulnerability was analysed by percentages and contextual analysis of every factor that was exposure and adaptive capacity for every threat identified. That is for exposure; location of element, level of vulnerability, why the element was at that location while capacity was analysed by percentage existing, required and gaps. The required capacities which were not sourced locally became gaps to be addressed to mitigate issues of climate change and adaptation at community level. Plate 3.3 below shows Yaaku community members deliberating on vulnerability issues.



Plate 3.3: Yaaku community leaders participating in CMDRR by identifying hazards

AS Indicated in Plate 3.3, representation of the community is balance on gender and age. Therefore the data was representative because of well-balanced gender representation in the exercises to minimise bias.

3.5.4: Response strategies for the Yaaku community to reduce climate change impacts

Participants identified the climate variability and extremes experienced by the local Yaaku community and their suggestions of future management. Data from social economic survey was analysed by cumulative frequencies and contextual analysis.

Working committees on climate change issues were formed during CMDRR where data were analysed by pair-wise ranking and percentages.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0: Introduction

This chapter presents the findings and their respective discussions. The presentation is captured by five sections, namely: land use and management changes in the last three decades, climate change trends on weather elements i.e. rainfall and temperatures, climate change trends on livelihood capitals for last three decades, climate change vulnerability on Yaaku community for last three decades and the four study objectives.

4.1: Land use and management changes in the last three decades

In this section what is discussed is the respondents' distribution by locations and villages, respondents' gender, respondents' age, respondents' educational levels; the respondents opinion on who they think address the issues of climate change and adaptation in their community.

4.1.1: Distribution of Respondents by locations and villages

The study sought to establish the distribution of respondents by location and villages. This was necessary because it helped to provide a fair representation of the communities involved in the study. Table 4.1 below presents the findings

Table 4.1: Distribution of Respondents by locations and villages

WARD	LOCATION	VILLAGE	FREQUENCY	PERCENT
Mukogodo East	Mukogodo	Bokish/Katana	40	16.7
		Kurikuri/Imukongo	26	10.8
		Loirepirepi/Maraimbe	18	7.5
		Lorien/Tool	27	11.3
		Seek	27	11.3
		Toirai/Pisho	23	9.6
	Sieku	Nadungoro	25	10.4
		Naimaral	27	11.3
		Sieku	27	11.3
		Total	240	100.0

As indicated in the table 4.1 above the population distribution in Mukogodo East Ward of Laikipia County is in four locations, namely Ipolei, Mumonyot (Mukogodo), Makurian, and Sieku. The Yaaku community are distributed in the locations of Mukogodo and Sieku thus the study covered two locations of Mukogodo East Ward which comprised of nine villages of which six were in Mukogodo and three in Sieku. The questionnaires were distributed according to household population as follow: Bokish & Katana 40, Kurikuri & Imukongo 26, Loirepirepi & Maraimbe 18, Lorien & Tool 27, Nadungoro 25, Naimaral 27, Seek 27, Sieku 27, and Toirai & Pisho 23, totalling to a study sample of 240 respondent households. The Bokish & Katana and Loirepirepi & Maraimbe villages in Mukogodo location had the highest and lowest household population and thus highest and lowest samples taken from these villages respectively. As indicated in Table 4.1 the 240 respondents were spread in nine villages of the two locations of Mukogodo ward. Thus the results given by the study is representative of the community.

4.1.2: Distribution of Respondents by gender

Table 4.2 below shows the distribution of respondents by gender.

Table 4.2: Distribution of respondents by gender

Gender	Frequency	Percent
Male	152	63.3
Female	88	36.7
Total	240	100.0

There were 152 males interviewed representing 63.3% of the respondents, while females were 88, representing 36.7 % of the total respondents. Both genders were well represented at least over 30% in each case as per Kenya constitution (Gok, 2010a). Thus the data collected was a representation of the opinion of all gender in the sampled area. This gives right information on climate change impacts and adaptive responses in the sample area in that gender biasness was minimised. In this community which is relatively male dominated (63.3%), major decisions on climate change adaptations and strategies helps in climate change mitigations in the community.

4.1.3: Distribution of respondents by age

Figure 4.1 below shows distribution of respondents by age.

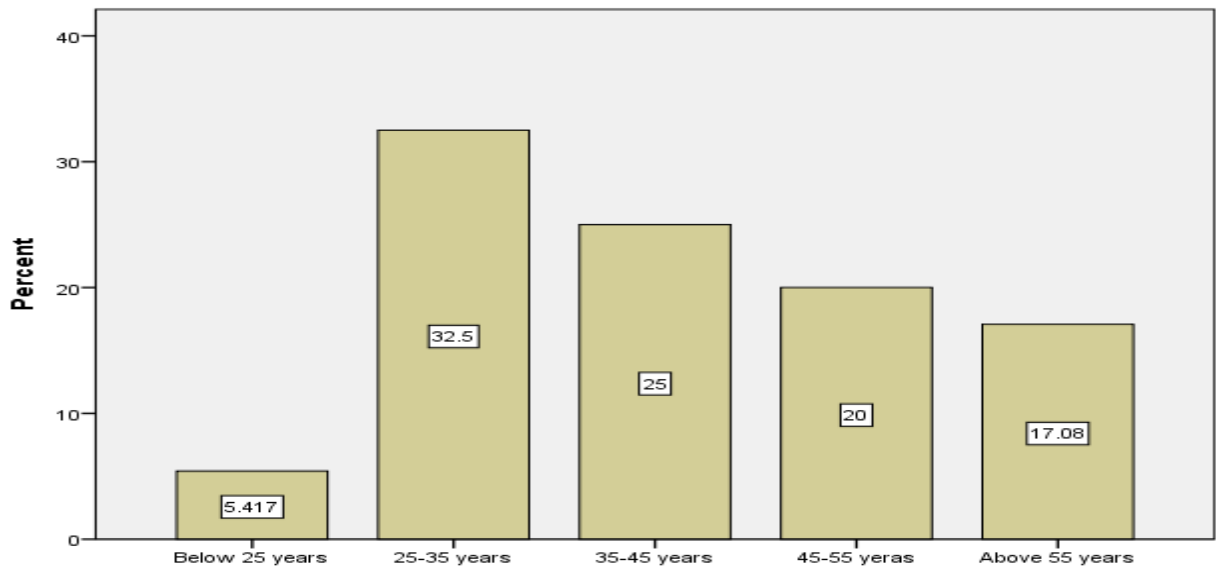


Figure 4.1: Distribution of respondents by age

Figure 4.1 above indicates the various age brackets of the respondents in Yaaku community. The majority of the respondents (72.5%) were between 25 -55 years of age thus a good indication of maturity and reliability of the information provided. The 5.4% of respondents are either children or grandchildren who represented the household head. Over 55 years of age bracket (17.1%) are an important group of respondent in that they form the elders whom advise on historical events on climate change and adaptations are shorted from. Therefore the age of head of household has a relation with the kind of information got on the trend of weather and other climatic elements for the last three decades being studied.

4.1.4: Distribution of respondents by educational level

Figure 4.2 below shows the distribution of respondents by education level.

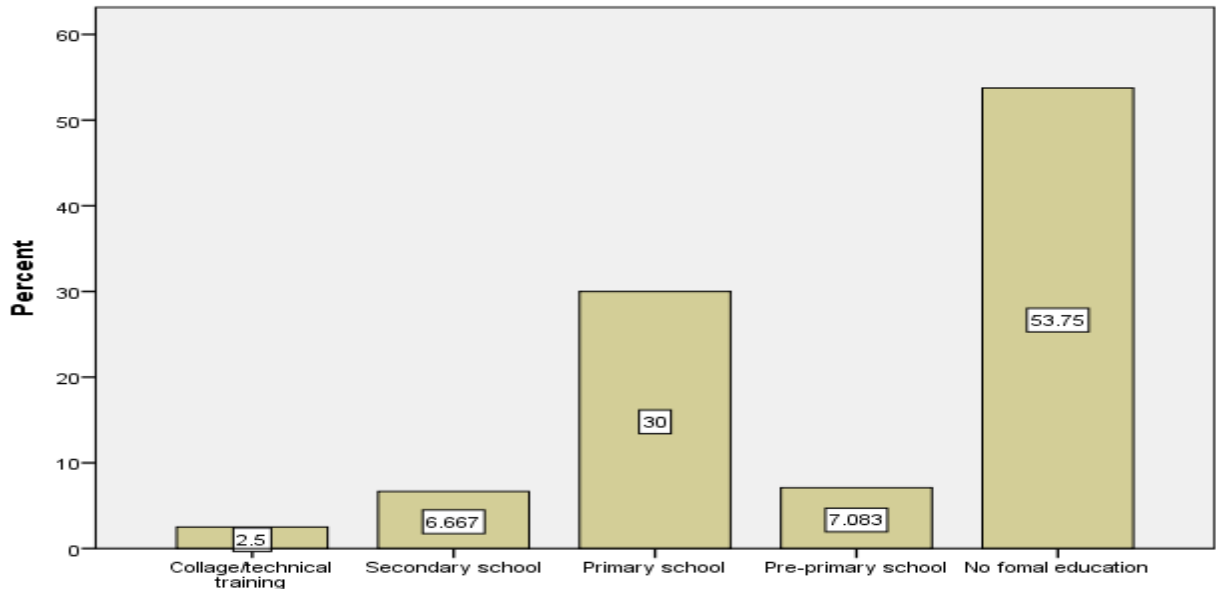


Figure 4.2: Distribution of respondents by educational level

The majority of the Yaaku community are lowly educated, with only 9.2% of them having secondary school education and above as indicated in Figure 4.2. A small minority 37.1% are of primary school education and lower levels, with 53.8% of them having no formal education. The majority of the respondents had no basic primary education and above thus verbal communication and data collection in their households was done through enumerators from the community who had at least four level of education. This contributed to increase of primary data collection time to six months

4.2: Changes in distribution patterns on weather elements; rainfall and temperatures

The sub section details what the distribution pattern in rainfall amounts, their intensity, and distribution of rainfall seasonality reliability in the last three decades in the Mukogodo forested ecosystem. Annual and seasonal temperatures are also taken into consideration and discussed.

4.2.1: Distribution pattern in rainfall amounts

Figure 4.3 below shows the trend in rainfall amounts in Mukogodo forested ecosystem

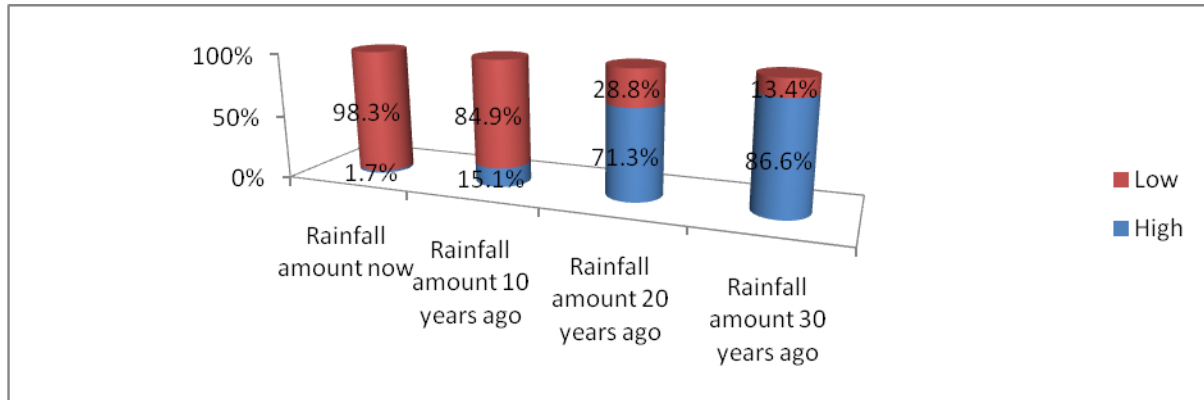


Figure 4.3: Distribution pattern in rainfall amounts

In this study the opinion of the respondents on the distribution pattern of rainfall amounts were sought. As indicated in Figure 4.3, a larger proportion (98.3%) of Yaaku community felt that the rainfall amounts are in fact on the decrease, while a smaller proportion (1.7%) believes that it is on the increase now. The Larger proportion thought the rainfall amounts was decreasing (98.3%) due to climate change and associate impacts, the adaptive strategies to these climate change impacts were not clear to the respondents as indicated during the focus group discussion. As indicated by key informants the decline of rainfall amounts in the Yaaku forested ecosystem has contributed to changes in livelihood strategies and adaptations. They indicated that forest or vegetation change in the area is determined by the rainfall amounts. As indicated by *Kang-Tsung et al* (2009) that main purposes of determining rainfall amounts in an area are for hydrological uses such as river flood control, sewer management and dam construction where planners use rainfall accumulation information, the purpose for amounts in Yaaku community is mainly for human drinking, regeneration of vegetation as livestock feed and bees forage

4.2.2: Distribution pattern in rainfall intensity

Figure 4.4 below shows the trend in rain fall intensity

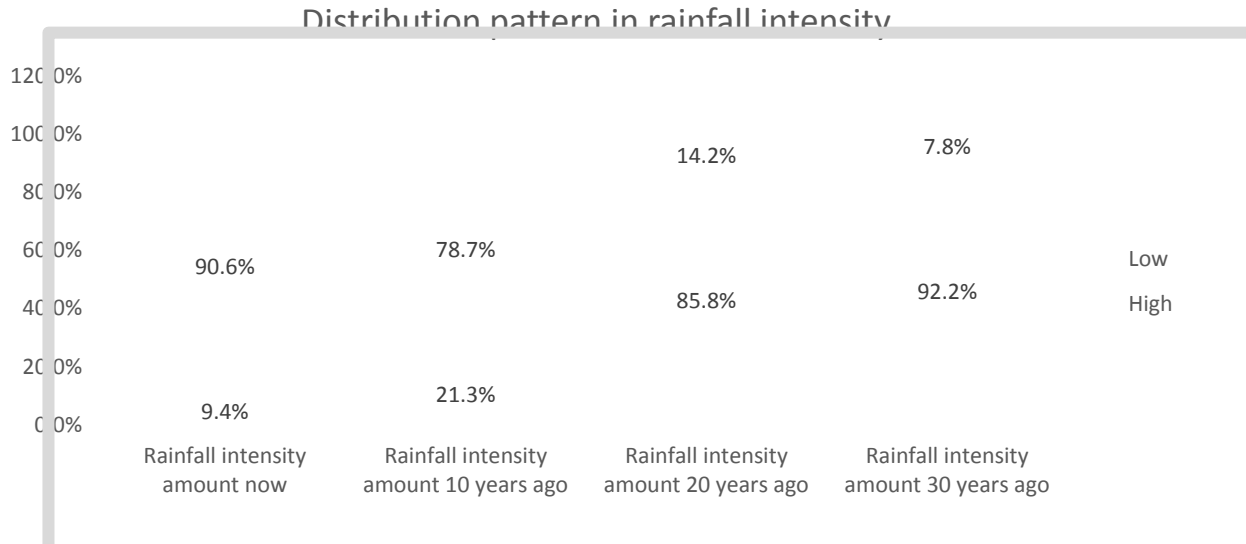


Figure 4.4: Distribution pattern in rainfall intensity

The intensity of rainfall is a measure of the amount of rain that falls over time. The opinion of the respondents were sought to indicate the distribution pattern of rainfall intensity for the last three decades. As shown in Figure 4.4, the majority (92.2%) of the respondents gave their opinion that rainfall intensity was high in last thirty years than now and that the distribution pattern is decreasing. However a high or low intensity is hard to say. It depends on the local circumstances depending on the areas normal standards. Generally speaking a relatively low intensity is for instance 2 millimetre of rain a day and relatively high may be 30 millimetres an hour. High intensity of rainfall on steep slopes, may lead to flash floods. On flat areas it may lead to ponding, or urban floods when the drainage capacity is insufficient for the intensity of the falling rain (Gabaldo, 2008). At Mukogodo forested ecosystem with steep valleys flash floods can be predictive and an area of climate change adaptation strategy. This can give opinion of the return period of a rainfall or drought event that is likelihood or probability of an event with a specified intensity and duration (Glossary of Meteorology, 2009)

4.2.3: Change in pattern in rainfall distribution

Figure 4.5 below shows trend in rainfall distribution

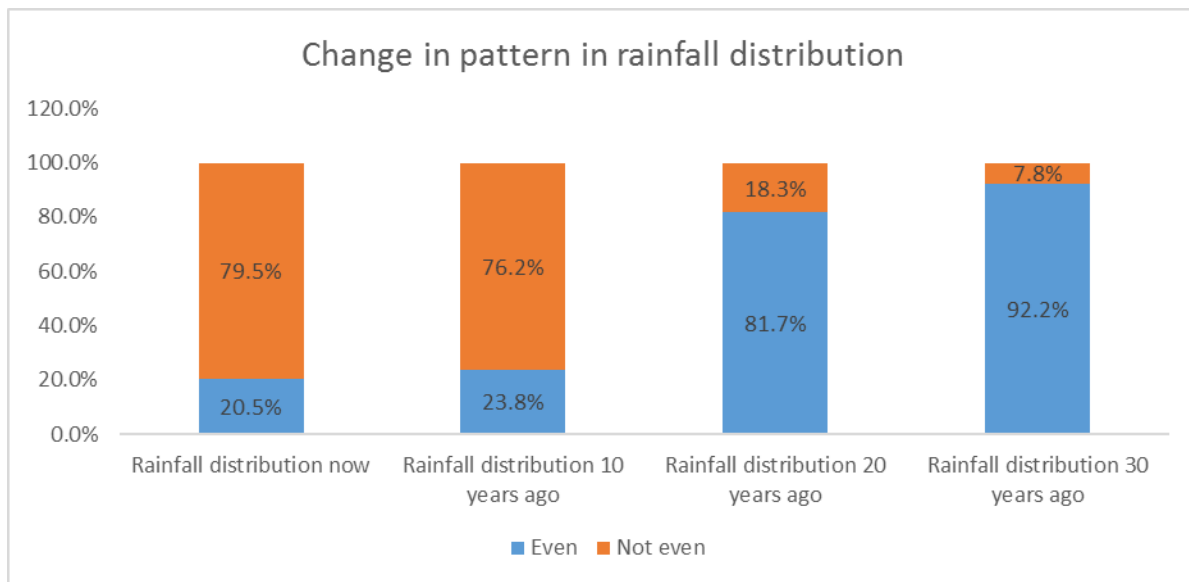


Figure 4.5: change in pattern in rainfall distribution

Rainfall distribution is the variability of the intensity throughout a storm, although the overall depth for a storm may be the same for a given duration no matter which distribution is chosen (Stephen and Tobi (2014)). There are four (4) different types of rainfall distributions throughout the Laikipia County which determined the eco-climatic or livelihood zones:

(1) Pastoral, (2) ranching, (3) marginal mixed farming and (4) mixed farming. As shown in Figure 4.5, the majority (92.2%) of the respondents gave their opinion that rainfall distribution was even in last thirty years than now and that the change in pattern is decreasing. The implication in the pastoral forested ecosystem of the Mukogodo is that climate change impacts were severe due to fragility of the ecosystem in form of fauna and flora in the period under study

4.2.4: Distribution pattern in rainfall seasonality

Figure 4.6 below shows trends in rainfall seasonality

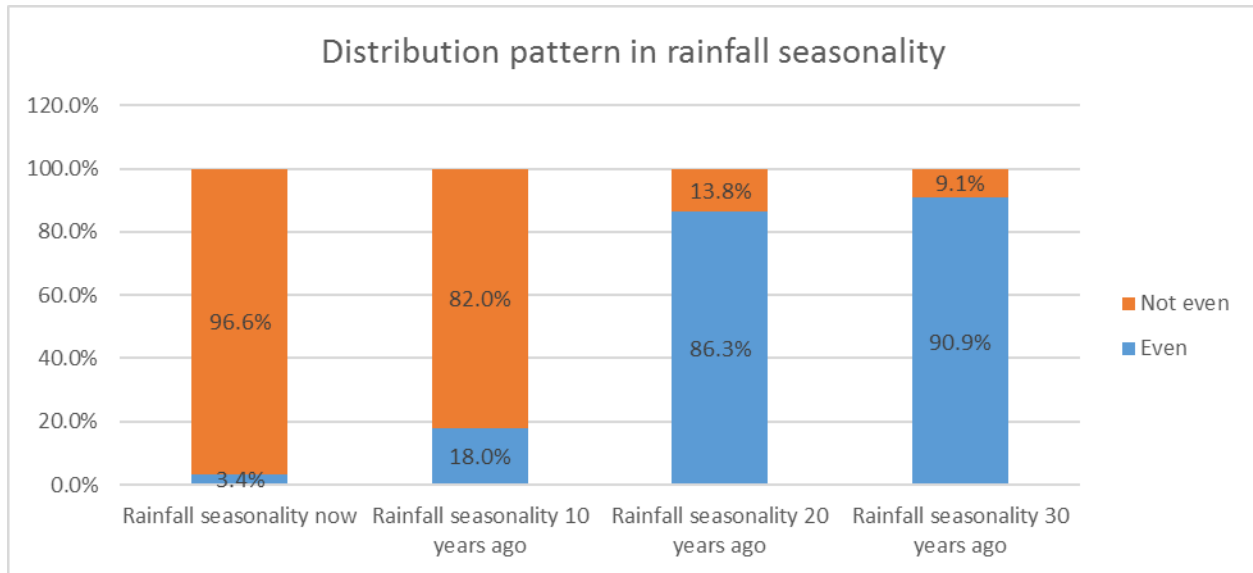


Figure 4.6: Distribution pattern in rainfall seasonality

Rainfall seasonality is an important agro-hydrological consideration, particularly when viewed in the light of runoff generation and also in determination of number and reliability of rainy seasons. Rainfall seasonality is related to the temporal distribution of rainfall on a monthly basis. It is estimated by the Walsh and Lawler Seasonality Index (Walsh and Lawler, 1981). The opinions of the respondents were also sought to indicate the distribution pattern of rainfall seasonality for the last three decades.

As shown in Figure 4.6, the majority (90.9%) of the respondents gave their opinion that rainfall seasonality was good in last thirty years than now and that the distribution pattern is decreasing. The rainfall seasonality which is related to temporal distribution of rainfall had implications of climate change adaptations in the pastoral forested ecosystem of the Mukogodo so severely due to fragility of the ecosystem in form of fauna and flora in the last three decade

4.2.5: Distribution pattern in rainfall reliability

Figure 4.7: Below shows the trend in rainfall reliability.

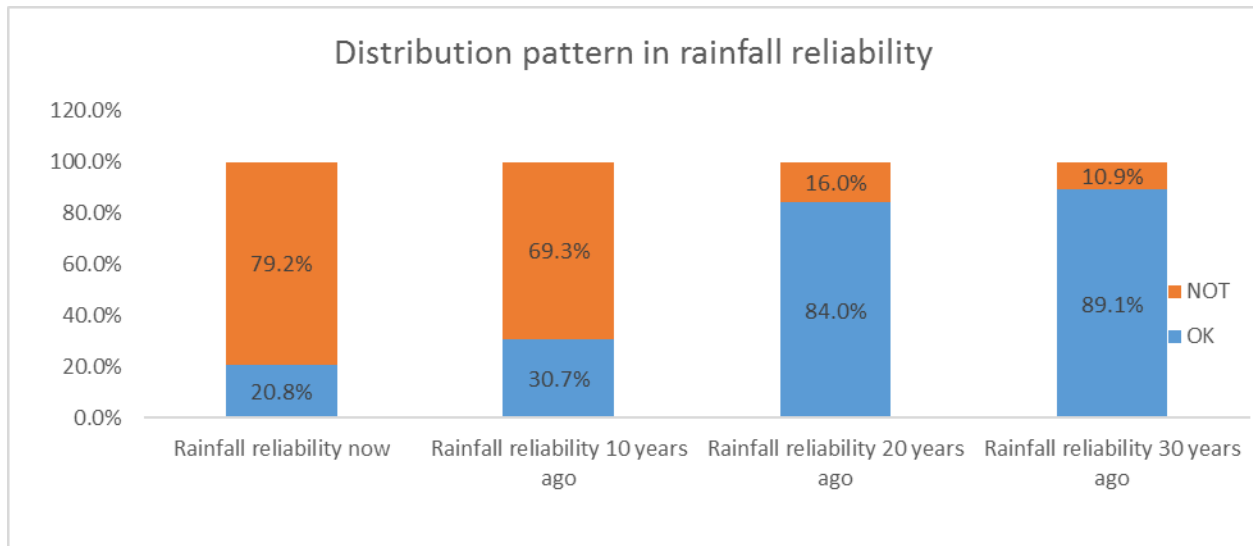


Figure 4.7: Distribution pattern in rainfall reliability

Rainfall reliability is the amount of precipitation and pattern as it relates to normal level of rainfall. The opinions of the respondents were sorted to indicate the distribution pattern of rainfall reliability for the last three decades. As shown in Figure 4.7, the majority (89.1%) of the respondents gave their opinion that rainfall reliability was good in last thirty years than now and that the distribution pattern is decreasing. According to Rowntree (2012), the meteorological criteria for drought and for reliable rainfall were found to differ between the upland cultivators and the lowland pastoralists, the latter experiencing a higher frequency of drought. Therefore the Yaaku pastoralist of Mukogodo stands a bigger charge to experience drought due to non-reliability of rainfall. It was demonstrated that the occurrence of drought was related to both the annual rainfall total and to the seasonal distribution (Rowntree, 2012).

4.2.6: Distribution pattern in Annual temperature

Figure 4.8 below shows the trend in annual temperature.

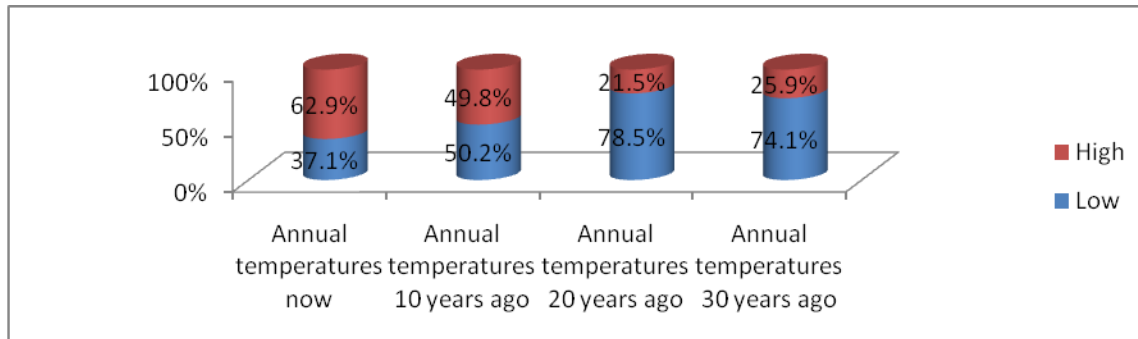


Figure 4.8: Distribution pattern in Annual temperature

As indicated by Figure 4.8, the majority (74.1%) of the respondents gave their opinion that annual temperatures were low in last thirty years than now and that the distribution pattern is decreasing. What was noticed was that the opinions of the respondent and community members on the last 20 years period (78.5%) the annual temperature were better than the 30 years (74.1%). In further discussion at focus group the indication was that the period from 1997 to 1999 the temperature effects were over-shadowed by earlier El Niño phenomenon. Thus even now a big minority (37.7%) had the opinion that the temperature is low which is attributed to the forested ecosystem which is relatively cool even during the hotter months of the year.

4.2.7: Distribution pattern in seasonal temperatures

Figure 4.9 below shows the trend in seasonal temperature.

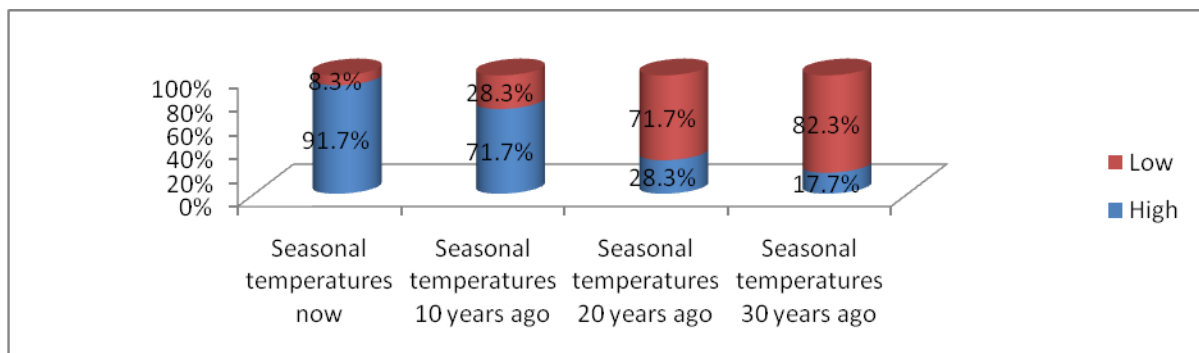


Figure 4.9: Distribution pattern in seasonal temperatures

As indicated by Figure 4.9, the majority (82.3%) of the respondents gave their opinion that seasonal temperatures were low in last thirty years than now and that the distribution pattern is decreasing. Unlike the annual temperatures distribution pattern, the seasonal temperatures opinion was clear the majority (71.7%) indicated that the seasonal temperature distribution pattern at 20 years was increasing.

4.3: Climate change trends on livelihood capitals for last three decades.

Access to livelihood *assets* (natural, financial, social, physical, and human capitals) is shaped by characteristics of the community and by the multiple and interacting biophysical and socioeconomic drivers. The assets are the livelihood resources that people used in varying combinations to build their livelihood adaptation strategies (Scoones 1998). These are changes in natural, physical, human, financial and social factors which are assessed to determine their changes due to climate change in the last three decade. This was researched because livelihoods interact to heighten the susceptibility and constraint to climate change adaptability (Reid and Vogel 2006; IPCC 2007), indicated that Sub-Saharan Africa was vulnerable to climate change, as multiple biophysical, political, and socioeconomic stresses interacted to heighten the region's susceptibility and constrain its adaptive capacity.

4.3.1: Changes in natural capital for the last three decades

The opinion of the respondents were sought to indicate the trends of harvesting of forest products, species biodiversity (trees, shrubs, herbs, pastures), forest water resources (rivers, springs), wildlife numbers, land use (degradation), livestock keeping (cattle/goats) and bee keeping for the last three decades

4.3.1.1: Changes in harvesting of forest products

Figure 4.10 below shows changes in harvesting of forest product

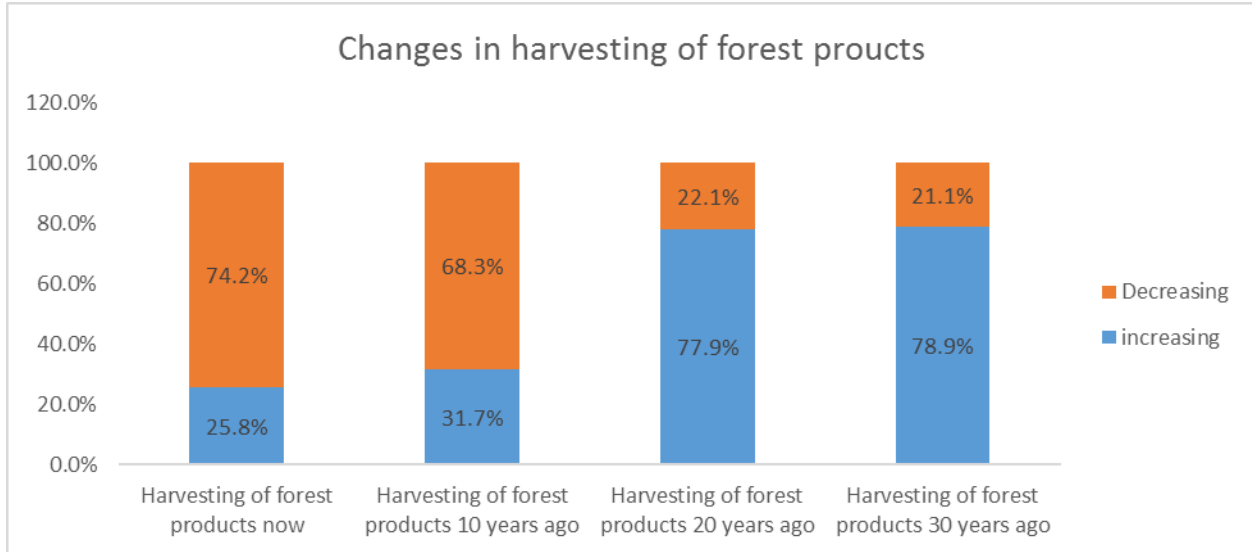


Figure 4.10: Respondents opinion on changes in harvesting of forest products

Unlike the common understanding that forest resources utilisation increases with increasing human population, the Mukogodo case is different in that the majority of the respondents (78.9%) reported that the forest resource use was more in last three decades than now as indicated by Figure 4.10. In deep discussions with focus group and key informant's interviews, this phenomenon which is contrary to the norm was explained by the community having strong adaptation structure and strategies to impacts of climate change thus forest conservation measures were enforced. Kenya forest service (KFS) which manages gazetted forest were not managing Mukogodo forest apart from small portion managed by Lekuruki conservancy and proposed Kurikuri conservancy which are community based, but the bigger forested area of the Yaaku community was generally community managed. The same results of increase of forest and shrubby cover are evidenced by remote sensed information as discussed in section 4.5.2.

4.3.1.2: Changes in species biodiversity (Trees shrubs, herbs, pastures).

Figure 4.11 below shows the changes in species biodiversity

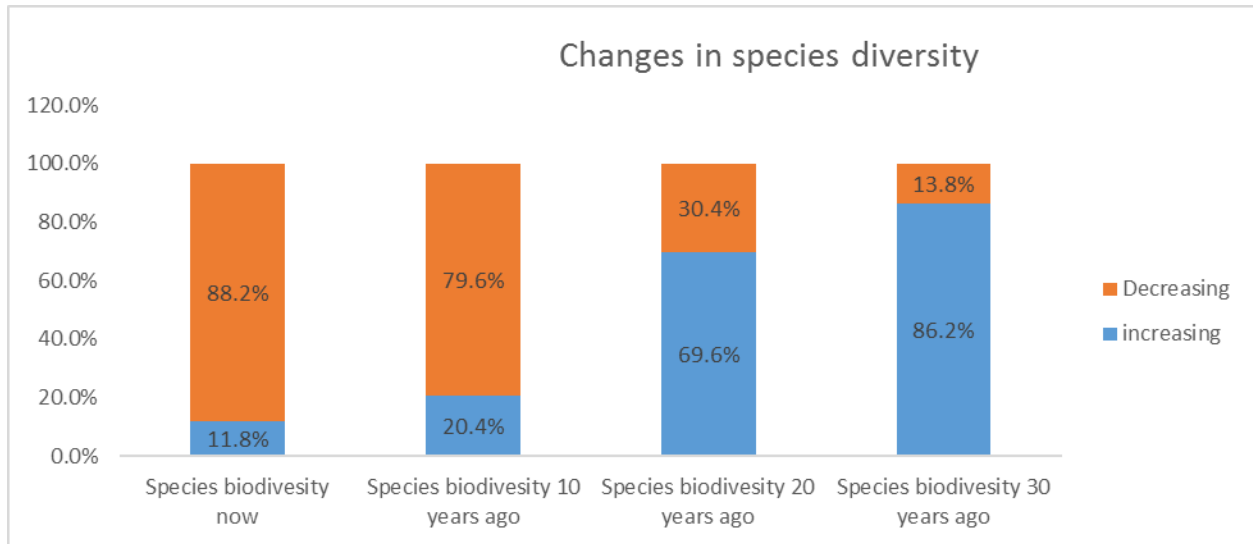


Figure 4.11: Changes in Species biodiversity

Like in the case of forest resource utilization section 4.3.1.2, where the trend of resources utilization was more in last three decades than now, the majority of the respondents(86.2%) also indicted that species biodiversity were more in the thirty years ago and decreased progressively to present date as indicated in Figure 4.11. The indication was that although there was increase of forest cover due to reduced use of forest resources, the biodiversity of the vegetation species reduced progressively probably due to effects of climate change. There is a need to have ecological research to document the species composition of the Mukogodo ecosystem and their change over the period. The change of species diversity and degradation of scenery site of caves due to climate change has reduced tourism activity around Mukogodo forest.

4.3.1.3: Changes in forest water resources (rivers, springs,)

Figure 4.12 below shows changes in forest water resources.

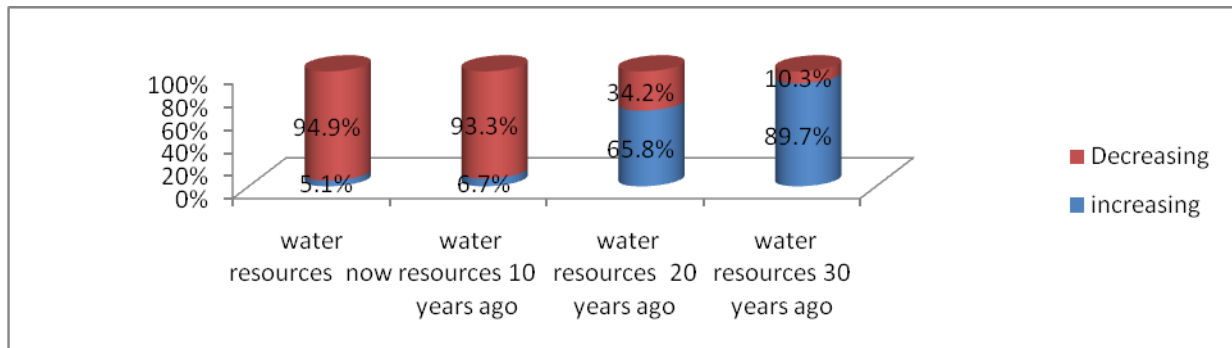


Figure 4.12: Changes in forest water resources

The majority of the respondents (89.7%) reported that the water resource was more in last three decades than now as indicated by Figure 4.12. In deep discussions with focus group and key informant’s interviews, the rivers and springs have dried in the extent that river were covering shorter distance now than it was last three decades. Information from elders in focus group discussion confirmed that some springs dried up 20 years ago. This explains the distinct big difference in opinion of respondent (65.8%) to (5.1%) about last 20 years and now. This sharp decline may be attributed to climate change impacts among other factors. As indicated by (Kebede et al, 2011; Songok et al, 2011b). That in sub-Saharan Africa, extreme droughts impeded people’s ability to grow food and rear livestock, and pastoralists and agro-pastoralists needed adaptations to changes in water regimes in order to maintain their food security and wellbeing, Yaaku community had no exception.

4.3.1.4: Changes in Wildlife numbers

Figure 4.13 below shows wildlife numbers.

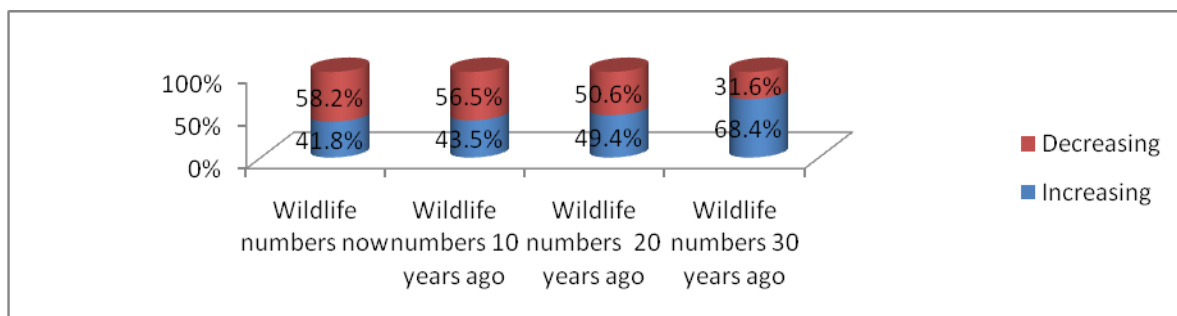


Figure 4.13: Changes in wildlife numbers

The majority of the respondents (68.4%) reported that the wildlife numbers was more in last three decades than now as indicated by Figure 4.13. The opinion change between last twenty years and now was almost constant. In deep discussions with focus group and key informant’s interviews, this was attributed to the fact that the Yaaku community was moving from hunters and gatherers to another livelihood sector for example to pastoral system. It was also indicated that Yaaku are not hunters but pastoralist and do not reduce wildlife number because they have livestock to depend on.

4.3.1.5: Changes in land use (degradation)

Figure 4.14 below shows changes in land use (degradation)

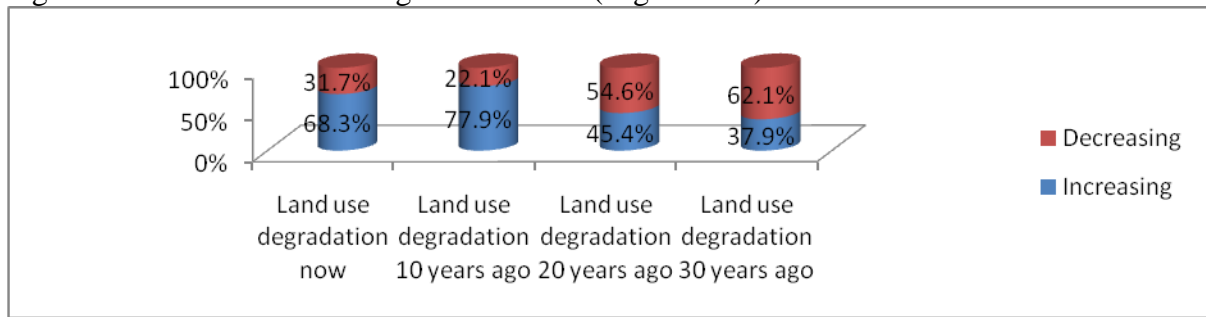


Figure 4.14: Changes in Land use (degradation)

The majority of the respondents (62.1%) reported that the changes in Land use (degradation) had decreased in last three decades than now as indicated by Figure 4.14. As indicate in section 4.3.1.4, changes in livelihood system from hunters and gatherers to pastoral livelihood, came in with grazing and browsing which lead to ecosystem degradation. In deep discussions with focus group and key informant’s interviews, the degradation was attributed to increase of livestock being grazed in the forested ecosystem.

4.3.1.6: Changes in Livestock keeping (cattle or goats)

Figure 4.15 below shows changes in livestock keeping (cattle or goats)

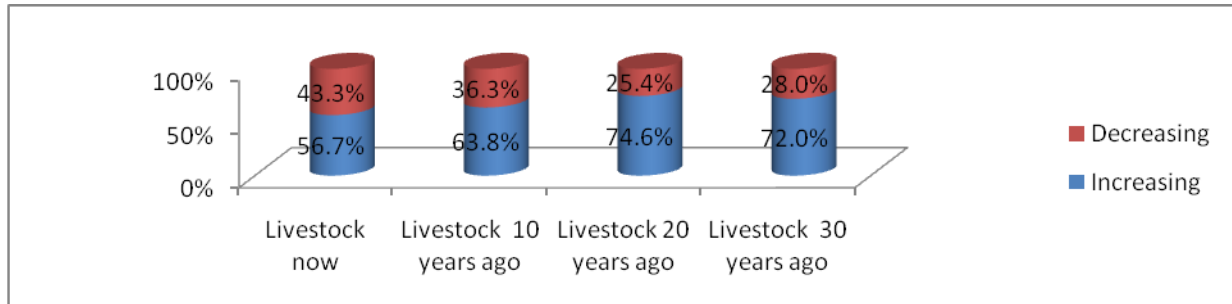


Figure 4.15: Changes in Livestock keeping (cattle or goats)

The majority of the respondents (72.0%) reported that the Livestock keeping (cattle or goats) had increased from the last three decades than now as indicated by Figure 4.15. As indicated in section 4.3.1.4, changes in livelihood system from hunters and gatherers to pastoral livelihood which contributed to the increase of opinion (74.6%) on livestock number last twenty years, came in with slight increase of livestock numbers. In deep discussions with focus group and key informant’s interviews, the progressive decrease in livestock keeping opinion was attributed to increase in degradation of grazing and browsing resources (section 4.3.1.5), livestock related conflict with neighbours and due to climate change impacts in the forested ecosystem

4.3.1.7: Changes in Bee keeping

Figure 4.16 below shows changes in bee keeping

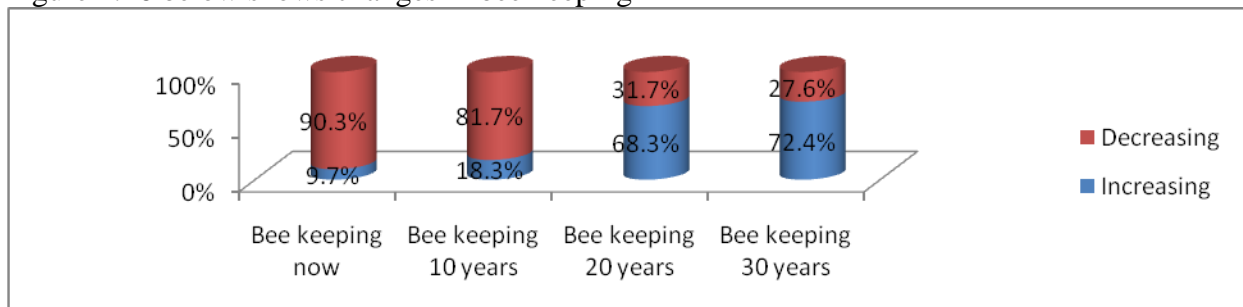


Figure 4.16: Changes in changes in Bee keeping

The majority of the respondents (72.4%) reported that the bee keeping had increased in last three decades than now as indicated by Figure 4.16. As indicated in section (4.3.1.4) changes in

livelihood system from hunters and gatherers to pastoral livelihood contributed to the decrease of opinion (9.7%) on bee keeping by now. However the confirmation came out in deep discussions with focus group and key informant’s interviews, that progressive decrease in bee keeping was attributed to change of livelihood system from hunter-gatherers to pastoralism which was associated with climate change impacts in forested ecosystem.

4.3.2: Changes in trends of social capital for the last three decades

This subsection details the results of trends of social capitals. Therefore the opinion of the respondents were sought to indicate the trends of family cohesion (divorce or separation rate), number of community groups, community leadership, network without and within the community, conservation groups and stock friendship (livestock and Bees).

4.3.2.1: Changes in trends on family cohesion (divorce or separation) for the last three decades

Figure 4.17 below shows changes in trend on family cohesion

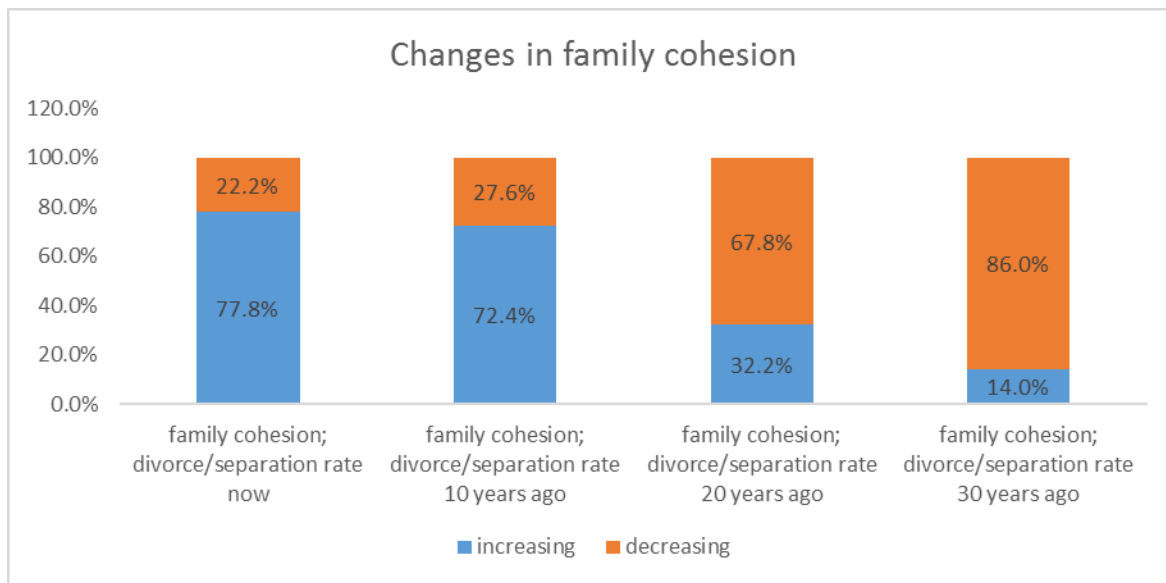


Figure4.17: Changes in trends family cohesion (divorce or separation rate) for the last three decades

As indicated by Figure 4.17, the majority (86.0%) of the respondents gave their opinion that or separation rate) was low in last thirty years than now and that the trend is increasing. In depth discussion at focus group, many issues were associated to this change ranging from change in

education levels of female gender, lack of property by the male gender, coming of communication system, example, mobile phones, and interaction with other people and migration to market centres, example Doldol. None of the reasons given had direct attribute to climate change and future investigation was needed to ascertain if there was any link to climate change or if they are adaptation to climate change impacts issues.

4.3.2.2: Changes in trends of number of community groups for the last three decades

Figure 4.18 below shows changes in trend of numbers of groups

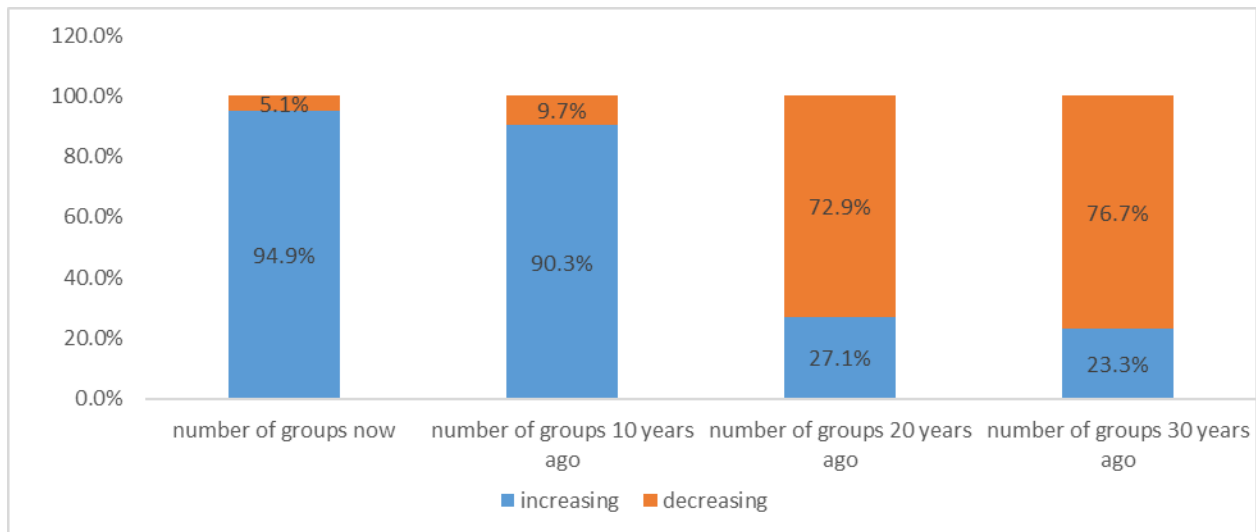


Figure 4.18: Changes in trends in number of community groups for the last three decades

As indicated by Figure 4.18, the majority (76.7%) of the respondents gave their opinion that the number of groups was low in last thirty years than now and that the trend was increasing. In depth discussion at focus group, many issues were associated to this change ranged from encouragement by development partners, nongovernmental and governmental agents to form groups. The group formation attribute was used to form and organise sustainable land management and climate change and adaptations management address groups in the two Yaaku communities

4.3.2.3: Changes in trends of community leadership for the last three decades

Figure 4.19 below shows change in trend of community leadership

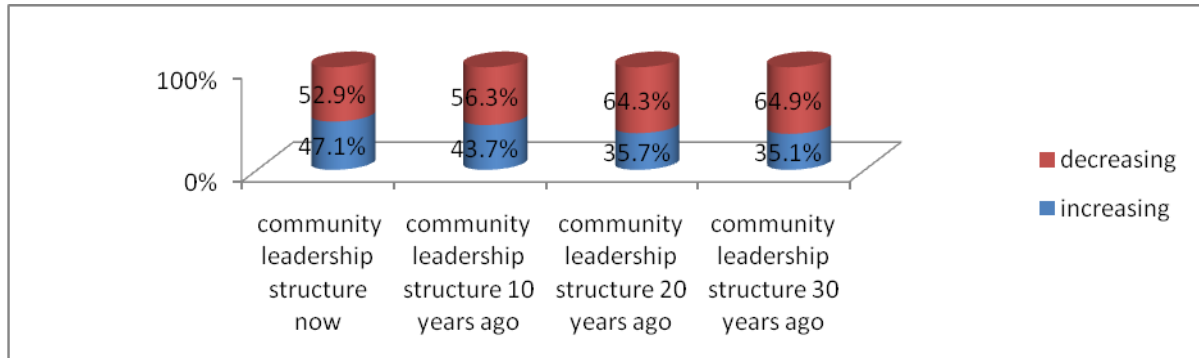


Figure 4.19: Changes in trends of community leadership for the last three decades

As indicated by Figure 4.19, the respondents gave their opinion that the community leadership had slightly changed as from last thirty years to now and that the trend was almost constant whereby the opinion ranged from 35.1% in last thirty years to 47.1% now. In depth discussion at focus group, the main issue associated to this was maintenance of traditional eldership (Moran leadership). In deep discussion at focus group and key informant interviews, it come out clearly that community leadership was the guide or implementers of various climate change adaptation strategies at the community level and thus mitigate impacts of climate change at the forested ecosystem, example, as discussed in section 4.3.1.1 .

4.3.2.4: Changes in trends of networks without and within the community for the last three decades

Figure 4.20 below shows changes in trends of networks within the community.

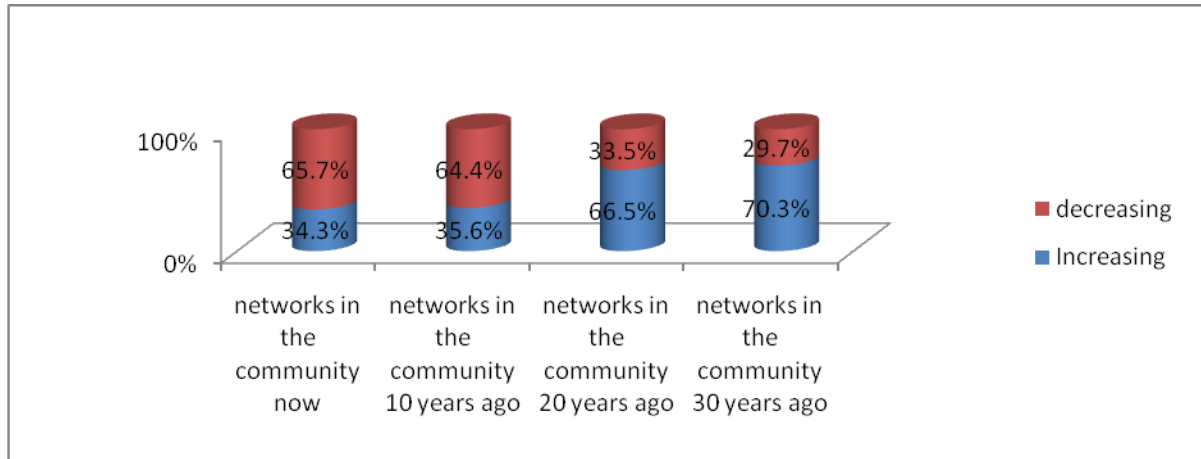


Figure 4.20: Changes in trends of network without and within the community for the last three decades

The majority of the respondents (70.3%) reported that the networks without and within the community had increased in last three decades than now as indicated by Figure 4.20. In deep discussion at focus group and key informant interviews, it come out clearly that networks without and within the community encouraged interactions between the Yaaku and the Maasai which resulted to intermarriages and concurrent absorption of Yaaku culture by Maasai culture which was presumed superior. This coupled with the changing ecosystem due to climate change made the Yaaku community in earlier years move from hunters and gatherers to become pastoralists.

4.3.2.5: Changes in trends of conservation groups for the last three decades

Figure 4.21 below shows changes in trend of conservation groups.

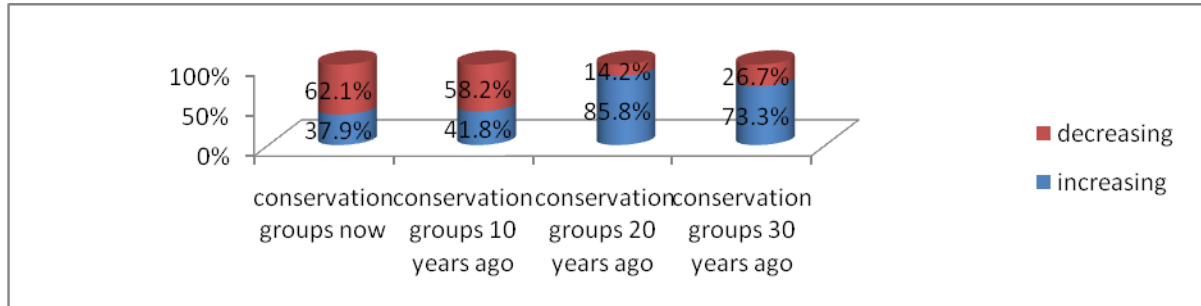


Figure 4.21: Changes in trends of conservation groups

The majority of the respondents (73.3%) reported that the conservation groups were more in last three decades than now as indicated by Figure 4.21. In deep discussion at focus group and key informant interviews, it come out clearly that conservation groups numbers in the period of twenty years were higher than in thirty years due to influx of nongovernmental organisations before formation of conservancies in the forested ecosystem and the neighbouring environs. By now the opinion indicated that the conservation groups were in decreasing trend and would continue because of operational Lekuruki conservancy and proposed Kurikuri conservancy which do conservation work and that after fully operation of Kurikuri conservancy, the conservancy groups would be minimal. All the conservation and climate change mitigation issues of the forested ecosystem and its environs were addressed by conservancies groups, the two all guided by the community.

4.3.2.6: Changes in trends of stock friendship (livestock and Bees) for the last three decades

Figure 4.22 below shows changes in trend of stock friendship.

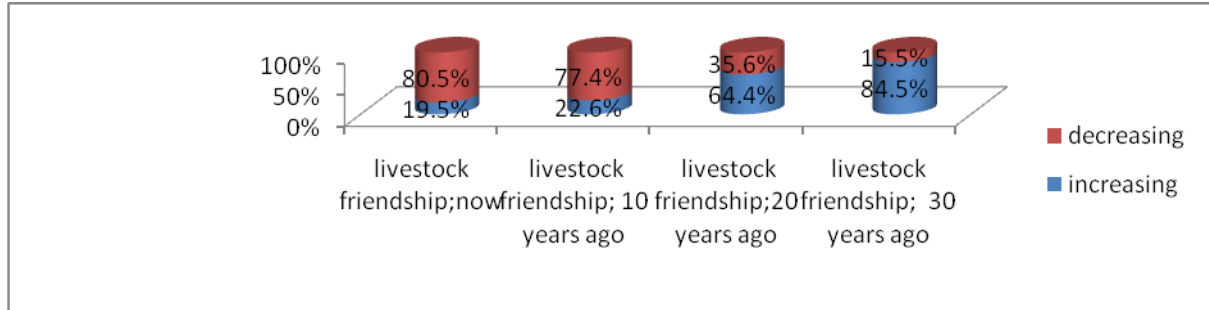


Figure 4.22: Changes in trends of stock friendship (livestock and Bees) for the last three decades

The majority of the respondents (84.5%) reported that the stock friendship had increased from the last three decades than now as indicated by Figure 4.22. In deep discussions with focus group and key informant's interviews, the progressive decrease in stock friendship opinion was attributed to increase in migration to towns or change of culture, degradation of grazing and browsing resources (section 4.3.1.5) and due to climate change impacts in the forested ecosystem

4.3.3: Changes in trends of physical capital for the last three decades

The opinion of the respondents were sought to indicate the trends of water structures availability, sanitation, energy (electricity supply), roads network, farming equipment's and housing structures.

4.3.3.1: Changes in trends of Water structures availability for the last three decades

Figure 4.23 below shows changes in trend of availability in water structures.

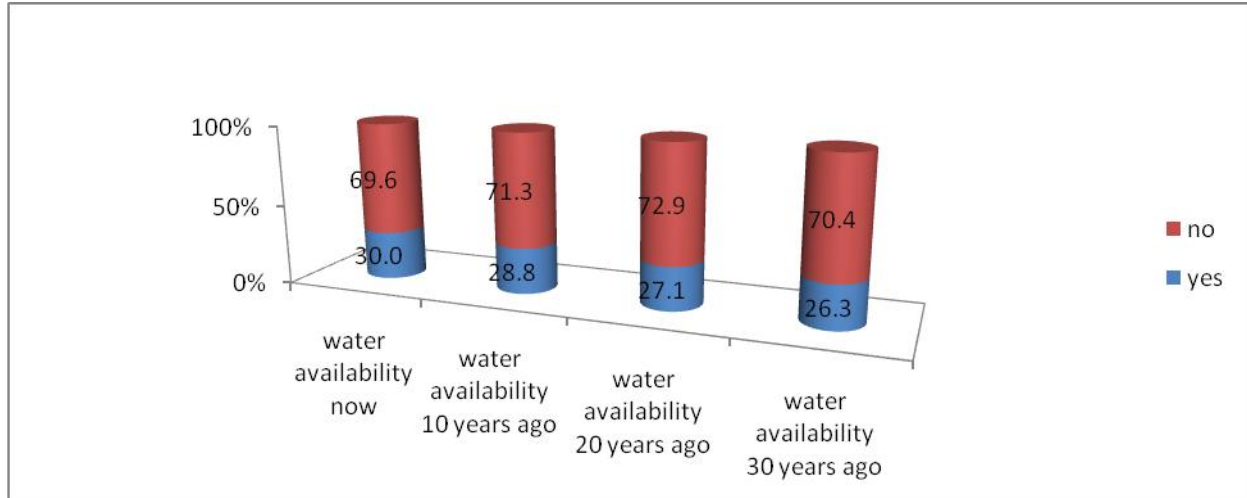


Figure 4.23: Changes in trends of Water structures availability for the last three decades

As indicated by Figure 4.23, the respondents gave their opinion that the water structures had slightly changed as from last thirty years to now and that the trend was almost constant whereby the opinion ranged from 26.3% in last thirty years to 30.0% now whom opinion was yes. In depth discussion at focus group, the main issue associated to this was that there was no water structure development during the study period. The implication is that the source of water had been from the rivers and springs which had progressively dried up as discussed in section 4.3.1.4 due to impacts of climate change over the three decades.

4.3.3.2: changes in trends of Sanitation for the last three decades

Figure 4.24 below shows changes in trend of sanitation

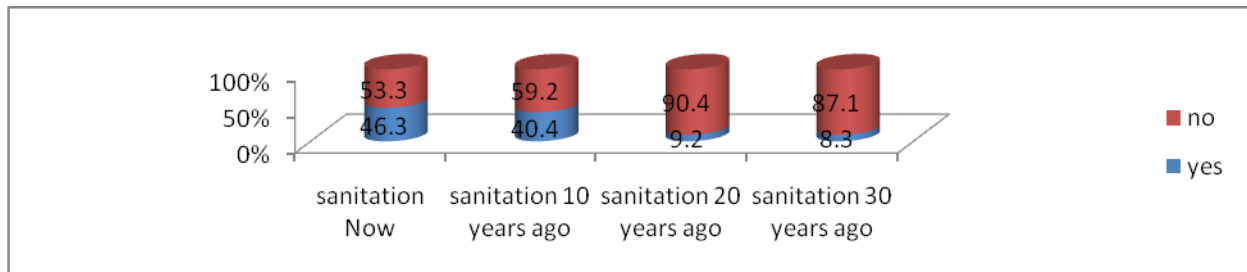


Figure 4.24: Changes in trends of Sanitation for the last three decades

As indicated by Figure 4.24, the majority (87.1%) of the respondents gave their opinion that the sanitation was low in last thirty years than now and that the availability was increasing. In depth discussion at focus group, the issue was associated with availability of pit latrines at schools and few at community homes by now

4.3.3.3: Changes in trends of energy (electricity supply), for the last three decades

Figure 4.25 below shows changes in trends of energy

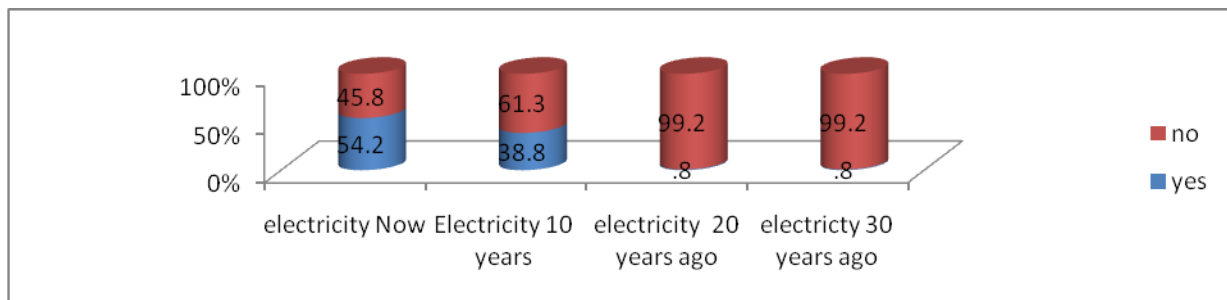


Figure 4.25: Changes in trends of energy (electricity supply), for the last three decades

As indicated by Figure 4.25, the majority (99.2%) of the respondents gave their opinion that the trend of energy (electricity supply) was low in last thirty years than now and that the supply was increasing and that average majority (54,2%) had the same opinion that the trend in electricity supply had increased by now as compared to last three decades. In depth discussion at focus group, the issue was associated with solar lighting in schools and chiefs camp

4.3.3.4: Changes in trends of roads network for the last three decades

Figure 4.26 below shows changes in trends of roads network

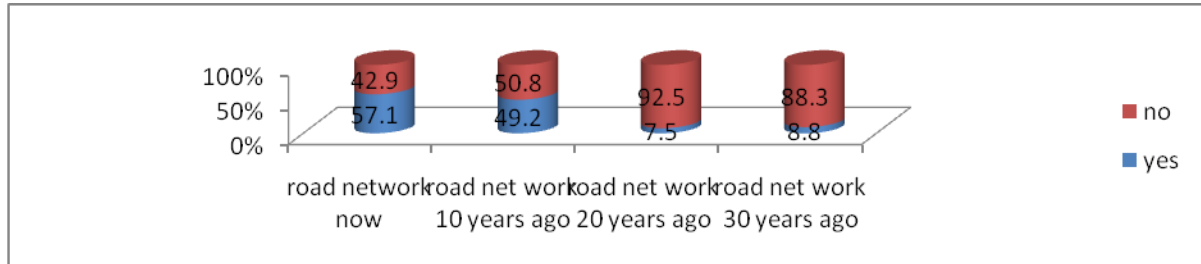


Figure 4.26: Changes in trends of roads network for the last three decades

As indicated by Figure 4.26, the majority (88.3%) of the respondents gave their opinion that the trend of roads network was low in last thirty years than now and that the roads network was increasing. In depth discussion at focus group, the issue was associated with opening of feeder roads to reach the schools, and lack of political representation.

4.3.3.5: Changes in trends of farming equipment for the last three decades

Figure 4.27 below shows changes in trend of farming equipment

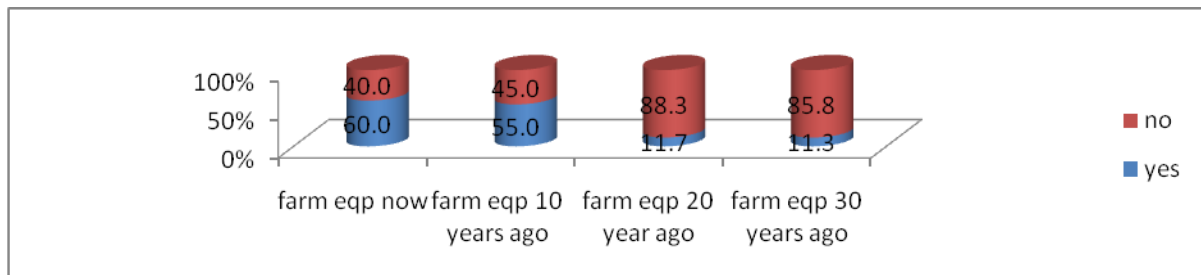


Figure 4.27: Changes in trends of farming equipment's for the last three decades

As indicated by Figure 4.27, the majority (85.8%) of the respondents gave their opinion that the trend of farming equipment was low in last thirty years than now and that the farming equipment's were increasing. In depth discussion at focus group, the issue was associated with some of the community member practicing crop farming near their sheltered home stead's, lank of political representation.

4.3.3.6: Changes in trends of housing structures for the last three decades

Figure 4.28 below shows change in trend of housing structures.

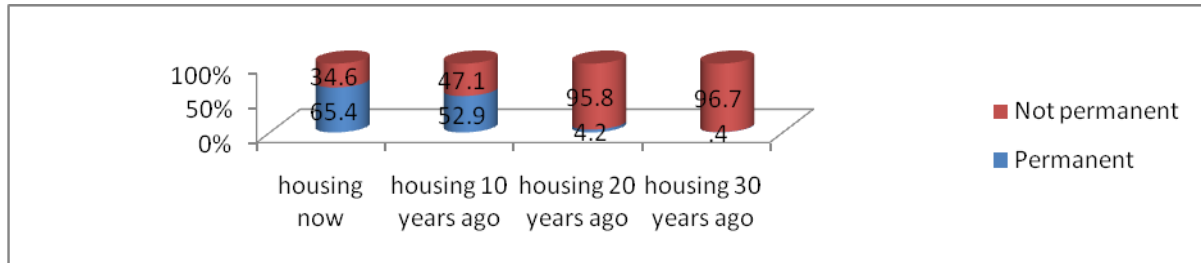


Figure 4.28: Changes in trends of Housing structures for the last three decades

As indicated by Figure 4.28, the majority (96.7%) of the respondents gave their opinion that the trend of housing structures was temporary in last thirty years than now and that the housing structure had increasingly changed. In depth discussion at focus group, the issue was associated with some of the community members being employed and get money to fund permanent house construction. It was also attributed to the number of community who had gone to school.

4.3.4: Changes in trends of human capital for the last three decades

The opinion of the respondents were sought to indicate the trends primary schools number, secondary schools number, health facilities numbers ,malaria occurrence, use of radios and mobile phones.

4.3.4.1: Changes in trends number of primary schools for the last three decades

Figure 4.29 below shows changes in trend numbers of primary schools

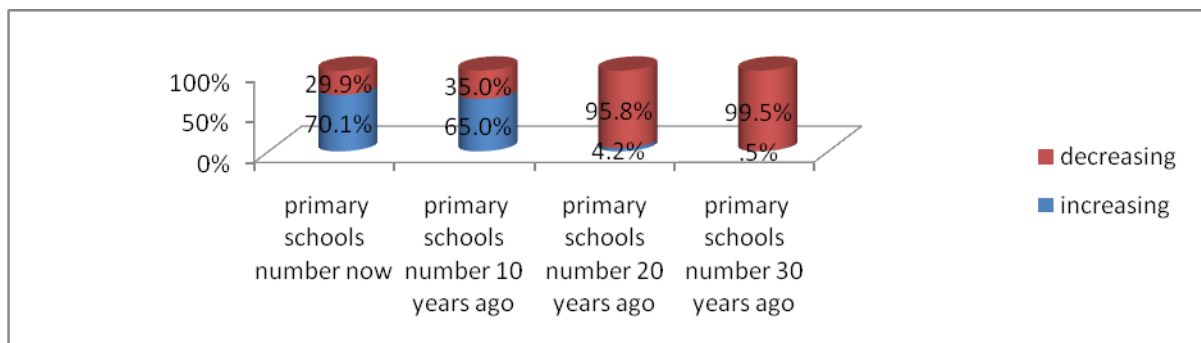


Figure 4.29: Changes in trends of number of primary schools for the last three decades

As indicated by Figure 4.29, the majority (99.5%) of the respondents gave their opinion that the trend of primary schools was low in last thirty years than now and that the primary schools was increased. In depth discussion at focus group, the issue was associated with opening of the first two primary schools, Kurikuri Primary School in Mukogodo location and Sieku Primary School in Sieku location in the last 10 years.

4.3.4.2: Changes in trends of number of secondary schools for the last three decades

Figure 4.30 below shows changes in trend of numbers of secondary schools

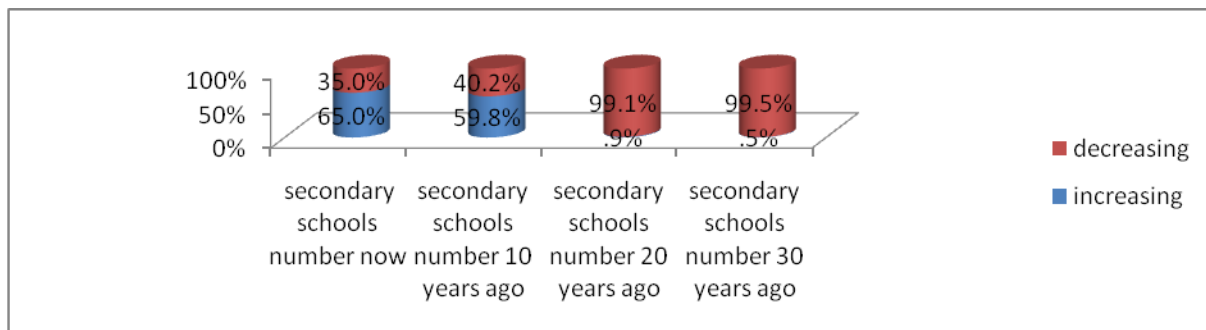


Figure 4.30: Changes in trends of number of secondary schools for the last three decades

As indicated by Figure 4.30, the majority (99.5%) of the respondents gave their opinion that the trend of secondary schools was low in last thirty years than now and that the secondary schools was increased. In depth discussion at focus group, the issue was associated with opening of the first secondary school in the neighbourhood in the last 10 years.

4.3.4.3: Changes in trends of number of health facilities for the last three decades

Figure 4.31 below shows changes in trend of numbers of health facilities

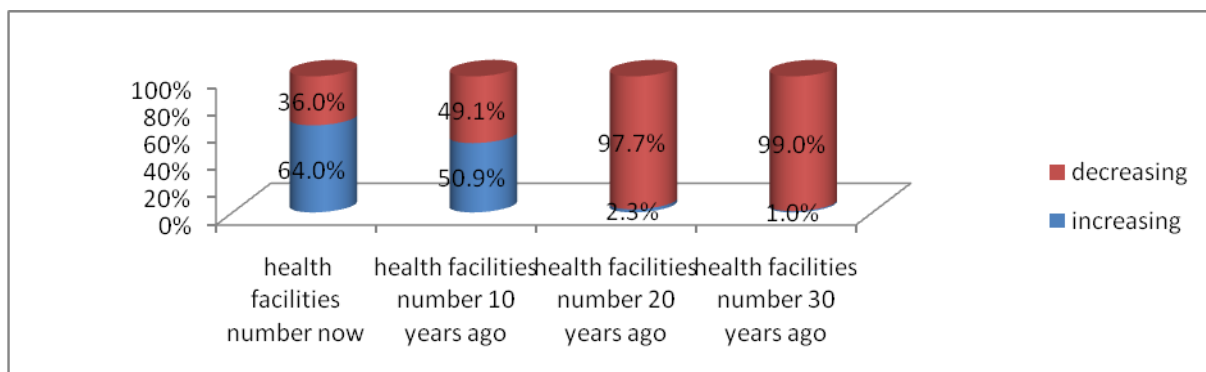


Figure 4.31: Changes in trends of number of health facilities for the last three decades

As indicated by Figure 4.31, the majority (99.0%) of the respondents gave their opinion that the trend of health facilities was low in last thirty years than now and that the health facilities was increased. In depth discussion at focus group, the issue was associated with opening of the health facility in the neighbourhood in the last 10 years.

4.3.4.4: Changes in trends of malaria occurrence for the last three decades

Figure 4.32 below shows change in trend of malaria occurrence

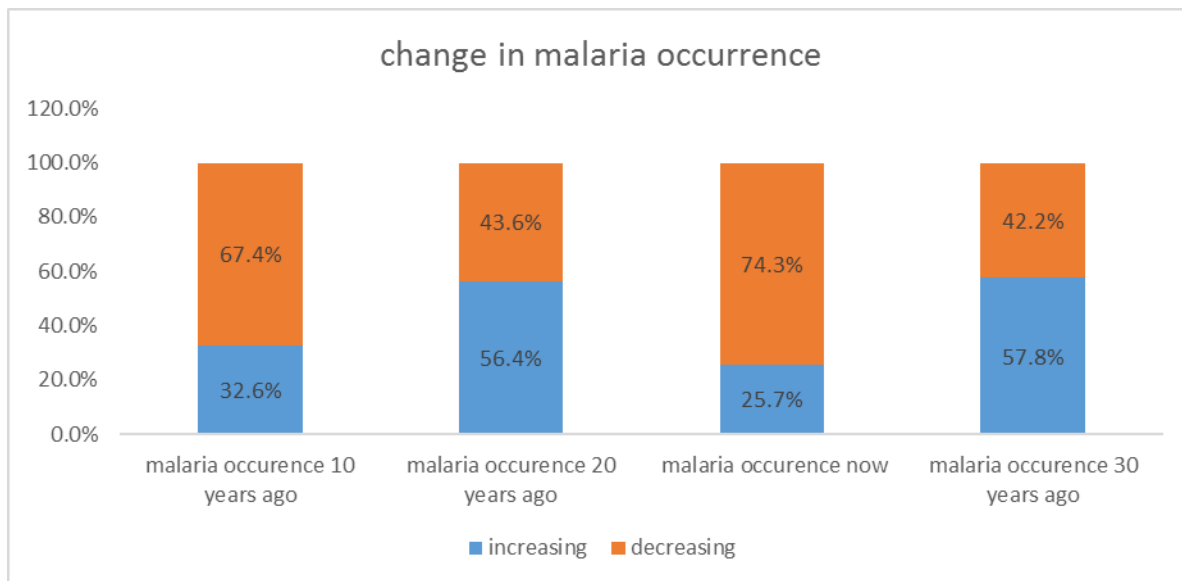


Figure 4.32: Changes in trends of malaria occurrence for the last three decades

As indicated by Figure 4.32, the majority (57.8%) of the respondents gave their opinion that the trend of malaria occurrence was high in last thirty years than now and that the malaria occurrence had decreased. In depth discussion at focus group, the issue was associated with opening of the health facility in the neighbourhood in the last 10 years and awareness and importance of going to hospital.

4.3.4.5: Changes in trends of use of radios and mobile phones for last three decades

Figure 4.33 below shows changes in trends of use of radios and mobile phones

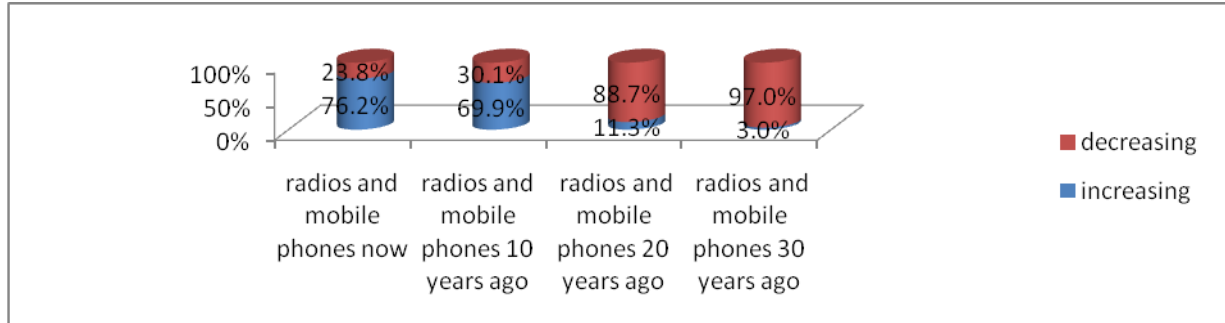


Figure 4.33: Changes in trends of Use of radios and mobile phones for the last three decades

As indicated by Figure 4.33, the majority (97.0%) of the respondents gave their opinion that the trend of radios and mobile phones was low in last thirty years than now and that the radios and mobile phones was increased. In depth discussion at focus group, the issue was associated with opening of schools in the neighbourhood in the last 10 years, availability of cash and mobile network and migration of some community members to neighbouring market centres

4.3.5: Changes in trends of financial capital for the last three decades

The opinion of the respondents were sought to indicate the trends of banks availability, credit facilities availability, pension availability and savings

4.3.5.1: Changes in trends of banks availability for the last three decades

Figure 4.34 below shows changes in trend of availability of banks

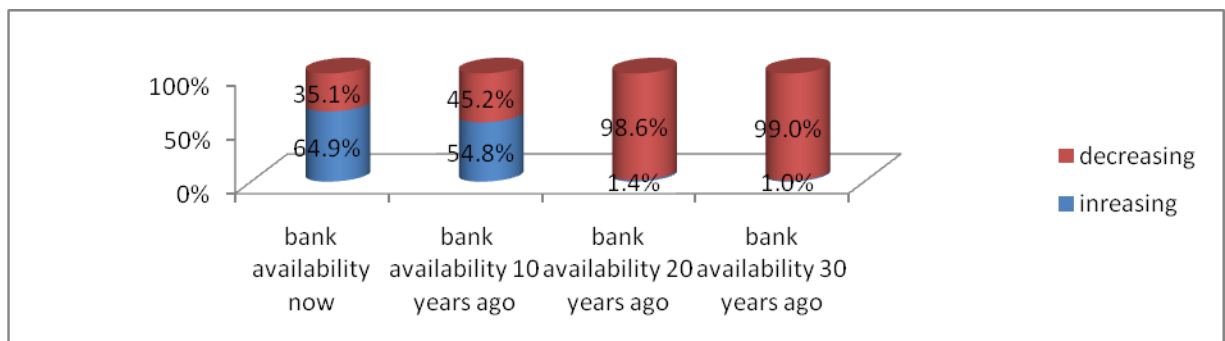


Figure 4.34: Changes in trends of banks availability for the last three decades

As indicated by Figure 4.34, the majority (99.0%) of the respondents gave their opinion that the trend of banks availability was low in last thirty years than now and that the banks availability had increased. In depth discussion at focus group, the issue was associated with opening of Sacco banks in the neighbourhood in the last 10 years and migration of some community members to neighbouring market centres to operate small business where they had access to banking facilities. These migrations are also attributed to changing environmental conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy.

4.3.5.2: Changes in trends of credit facilities availability for the last three decades

Figure 4.35 below shows changes in trend in availability of credit facilities

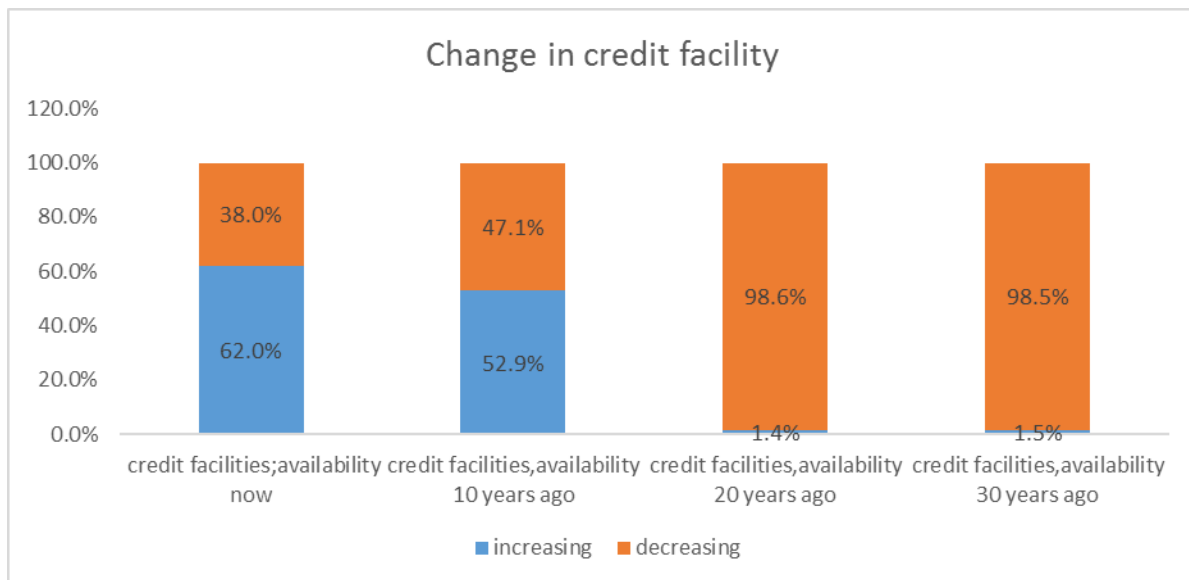


Figure 4.35: Changes in trends of credit facilities availability for the last three decades

As indicated by Figure 4.35, the majority (98.5%) of the respondents gave their opinion that the trend of credit facilities availability was low in last thirty years than now and that the credit facilities availability had increased. In depth discussion at focus group, the issue was associated with opening of Sacco banks in the neighbourhood in the last 10 years and migration of some community members to neighbouring market centres to operate small business where they had access to credit facilities. These migrations are also attributed to changing environmental

conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy.

4.3.5.3: Changes in trends of pension availability for the last three decades

Figure 4.36 below shows changes in trends of pension availability.

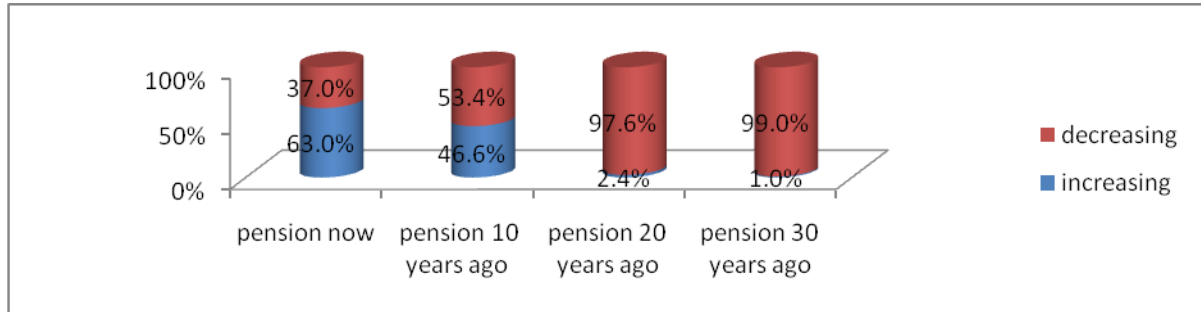


Figure 4.36: Changes in trends of pension availability for the last three decades

As indicated by Figure 4.36, the majority (99.0%) of the respondents gave their opinion that the trend of pension availability was low in last thirty years than now and that the pension availability had increased. In depth discussion at focus group, the issue was associated with lack of employed community members in the last three decade and the few employed by neighbouring community as herds men are retiring without pension except few teachers who retired in the last ten years.

4.3.5.4: Changes in trends of savings for the last three decades

Figure 4.37 below shows changes in trend of savings.

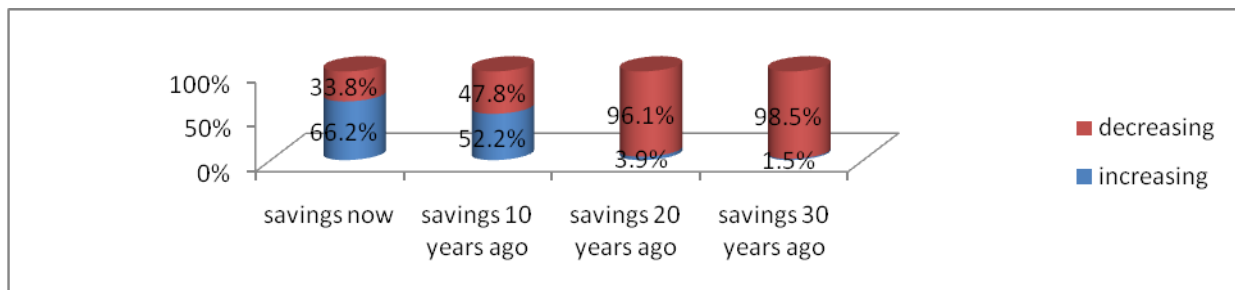


Figure 4.37: Changes in trends of Savings for the last three decades

As indicated by Figure 4.37, the majority (98.5%) of the respondents gave their opinion that the trend of savings was low in last thirty years than now and that the savings availability had

increased. In depth discussion at focus group, the issue was associated with opening of Sacco banks in the neighbourhood in the last 10 years and migration of some community members to neighbouring market centres to operate small business where they had savings. These migrations are also attributed changing environmental conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy.

4.3.6: Changes in trends of political capital for the last three decades

The opinion of the respondents were sought to indicate the trends in member of county assembly influence, member of parliament influence, county government governor influence, county women representative influence ,member of senate influence and President of the republic influence

4.3.6.1: Changes in trends in member of county assembly influence for the last three decades

Figure 4.38 below shows changes in trend in member of county assemble influence.

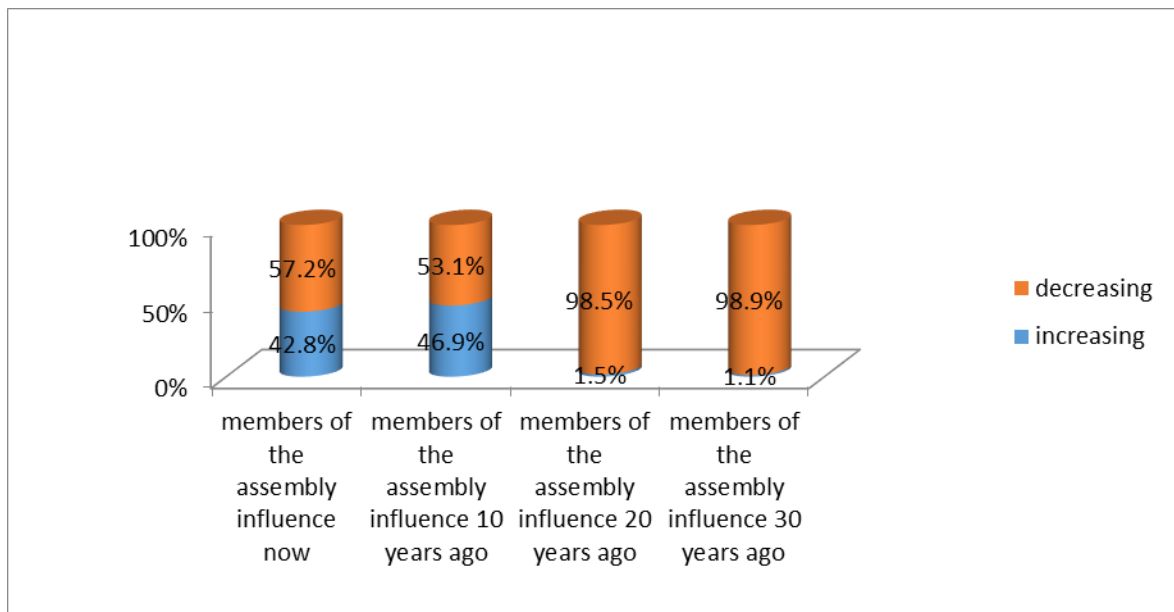


Figure 4.38: Changes in trends in member of county assembly influence for the last three decades

As indicated by Figure 4.38, the majority (98.9%) of the respondents gave their opinion that the trend in member of county assembly influence was low in last thirty years than now and that the

trend in member of county assembly influence had increased. In depth discussion at focus group and key informants the issue was associated with government devolution status coming into being last ten years. Therefore in last thirty and twenty years the member of county assembly offices were not established.

4.3.6.2: Changes in trends in Member of Parliament influence for last three decades

Figure 4.39 changes in trend in Member of Parliament influence.

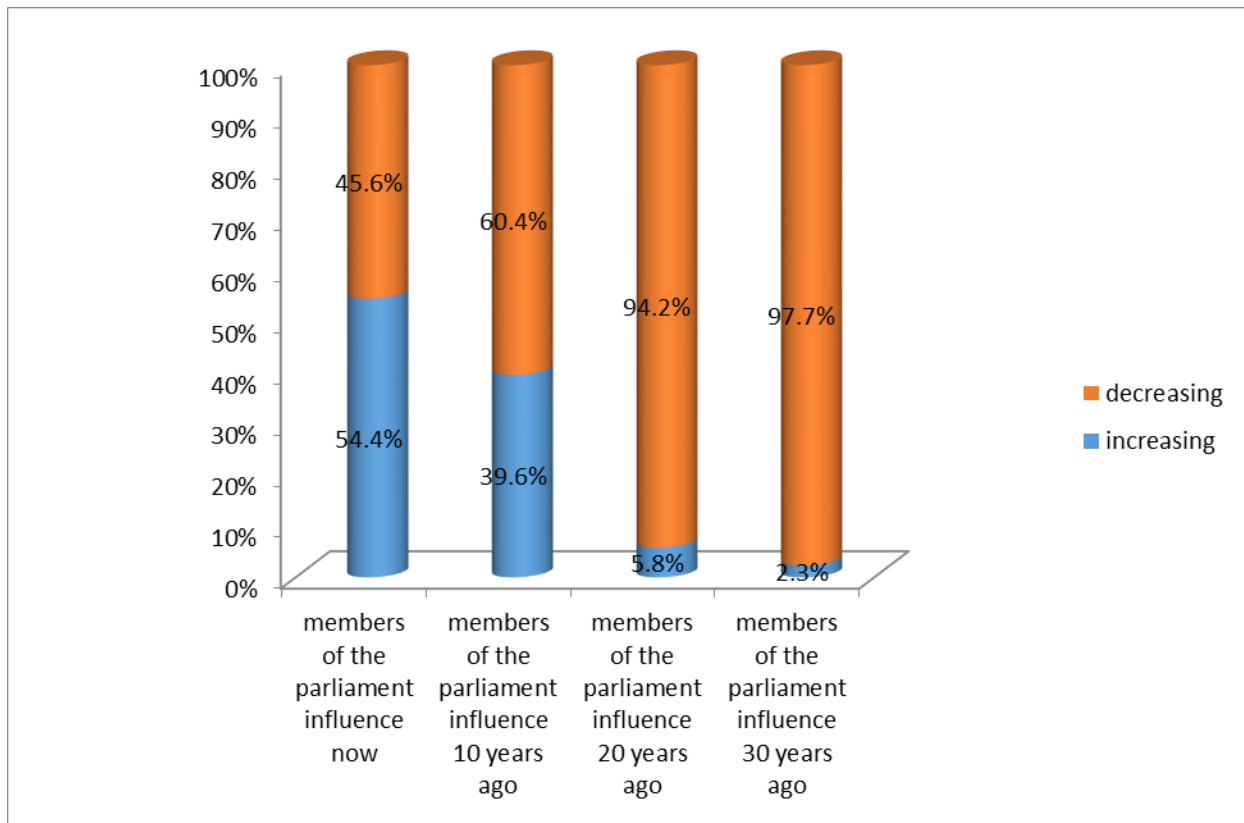


Figure 4.39: Changes in trends in Member of Parliament influence the last three decades

As indicated by Figure 4.39, the majority (97.7%) of the respondents gave their opinion that the trend Member of Parliament was low in last thirty years than now and that the Member of Parliament had increased. In depth discussion at focus group and key informants the issue of low influence in the last thirty and twenty years was associated with marginalisation of the community due low population which had negligible impact in political sphere, which lead to negligible address of climatic related mitigation measures.

4.3.6.3: Changes in trends in county government governor influence for the last three decades

Figure 4.40 changes in trend in county governor influence

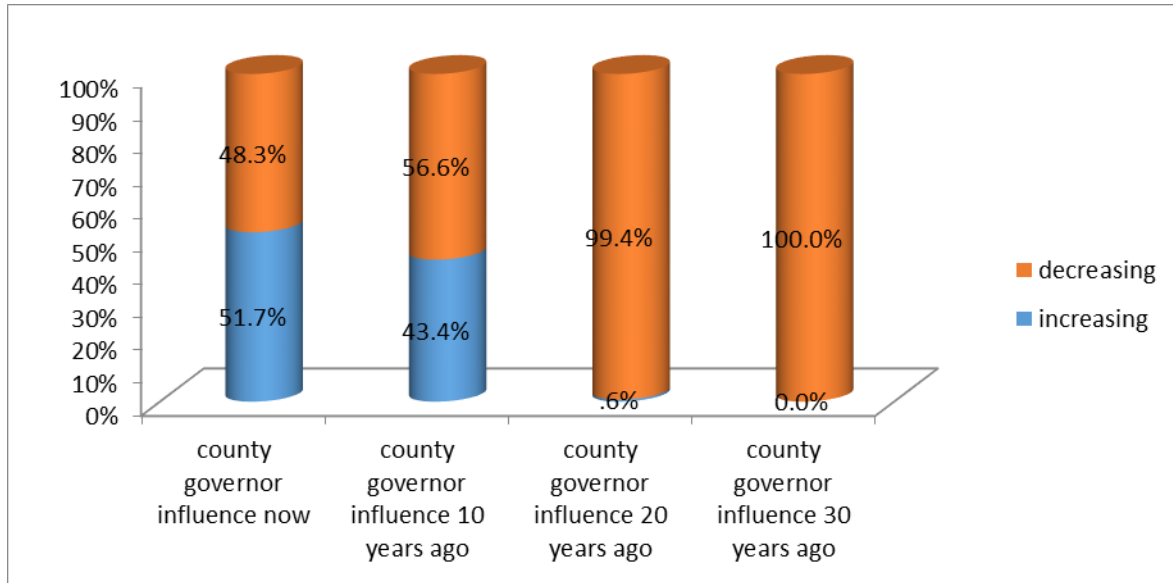


Figure 4.40: changes in trend in county governor influence

As indicated by Figure 4.40 the majority (100%) of the respondents gave their opinion that the trend in county government governor influence was low in last thirty years than now and that the in county government governor influence had increased. In depth discussion at focus group and key informants the issue was associated with government devolution status coming into being last ten years. Therefore in last thirty and twenty years the county government governor office was not established.

4.3.6.4: Changes in trends in county women representative influence for the last three decades

Figure 4.41 below shows changes in trend in county women representative influence.

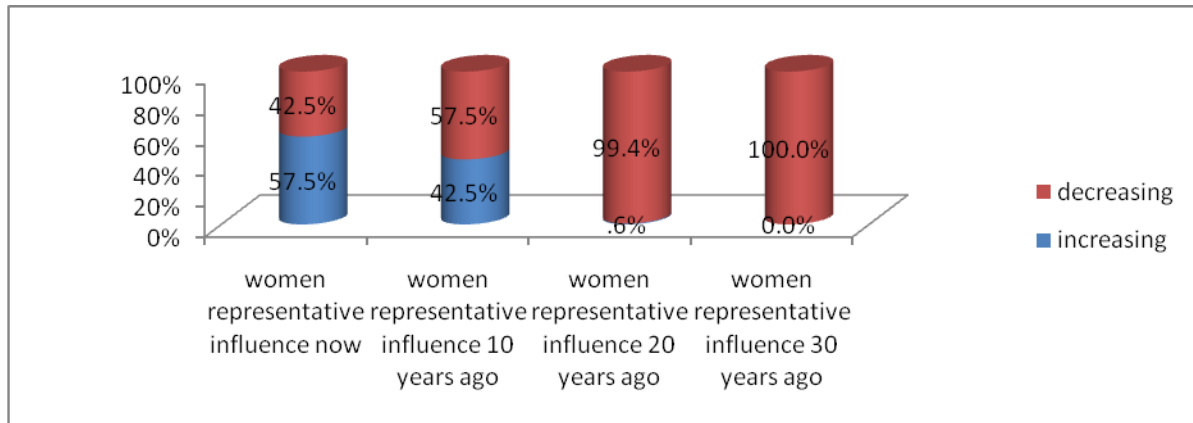


Figure 4.41: Changes in trends in county women representative influence the last three decades

As indicated by Figure 4.41 the majority (100%) of the respondents gave their opinion that the trend in county women representative influence was low in last thirty years than now and that the in county women representative influence had increased. In depth discussion at focus group and key informants the issue was associated with government devolution status coming into being last ten years. Therefore in last thirty and twenty years the county government governor office was not established.

4.3.6.5: Changes in trends in member of senate influence for the last three decades

Figure 4.42 below shows changes in trend in member of senate influence

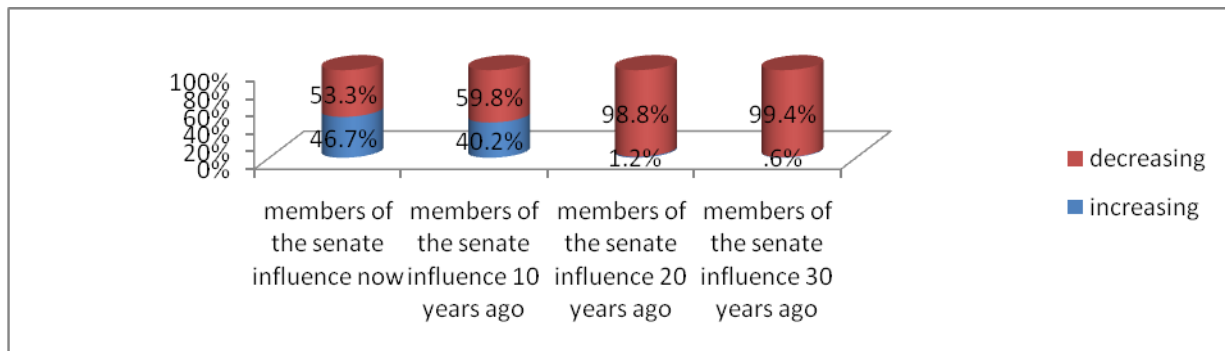


Figure 4.42: Changes in trends in member of senate influence the last three decades

As indicated by Figure 4.42 the majority (94.4%) of the respondents gave their opinion that the trend in member of senate influence was low in last thirty years than now and that the in member of senate influence had increased. In depth discussion at focus group and key informants the issue was associated with government devolution status coming into being last ten years. Therefore in last thirty and twenty years the county Senate office was not established.

4.3.6.6: Changes in trends in president of the republic influence for the last three decades

Figure 4.43 below shows changes in president of the republic influence

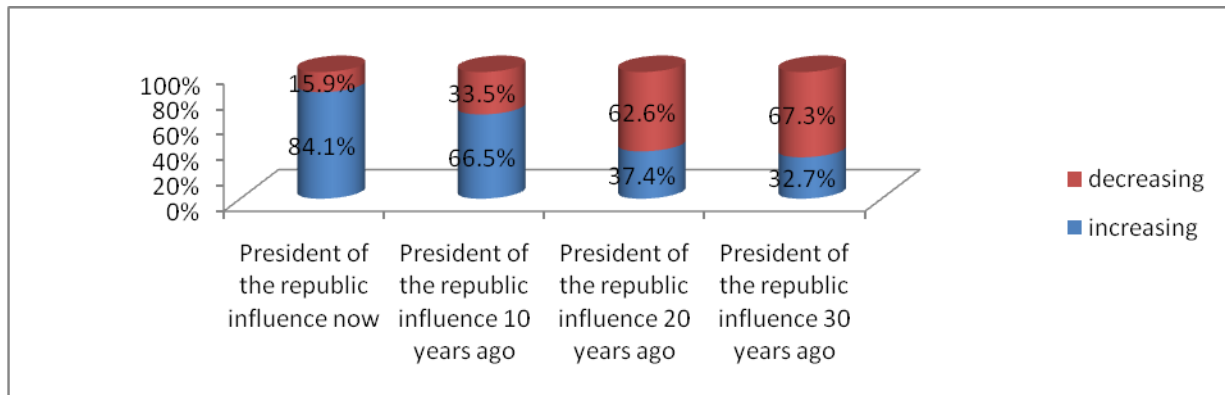


Figure 4.43: Changes in trends in president of the republic influence the last three decades

As indicated by Figure 4.43, the majority (67.3%) of the respondents gave their opinion that the trend in the influence of the President of the Republic was low in last thirty years than now and that the trend in the President of the Republic had increased. In depth discussion at focus group and key informants the issue of low influence in the last thirty and twenty years was associated with marginalisation of the community due low population which had negligible impact in political sphere, which lead to negligible address of climatic related mitigation measures.

4.3.6.7: Address of climate change and adaptation issues in the community

Figure 4.44 below shows who addresses the issues of climate change and adaptations in the community

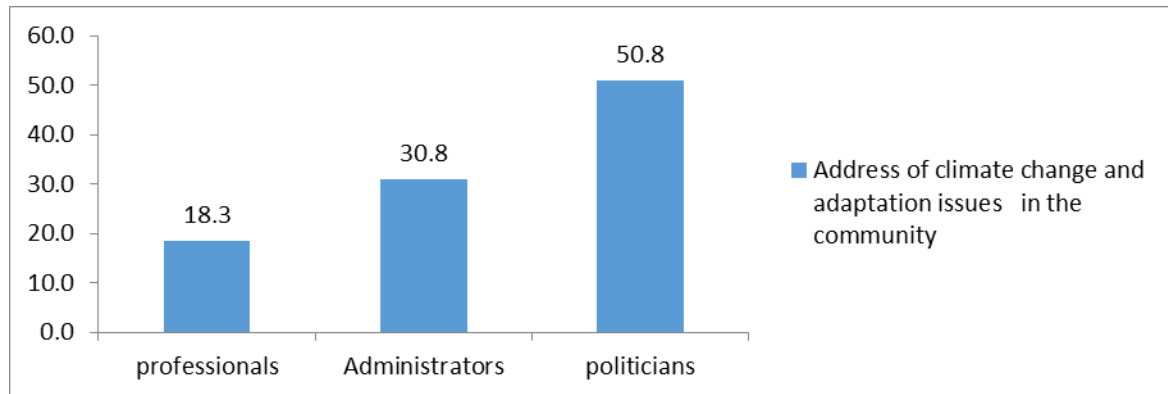


Figure 4.44: Address of climate change and adaptation issues in the community

As indicated in Figure 4.44, the majority of the respondents (58.5%) in Yaaku community indicated that politicians addressed issues of climate change in the community, with only 18.3% and 30.8% of them said that climate change issues were addressed by professionals and administrators respectively. Therefore the politicians were key in addressing the impacts of climate change although they had not known/understood that the impacts are of climate change but either campaign goodies or development agenda (figure 4.46)

4.3.6.8: Address of development agenda in the community

Figure 4.45 below shows who addresses development issues in the community

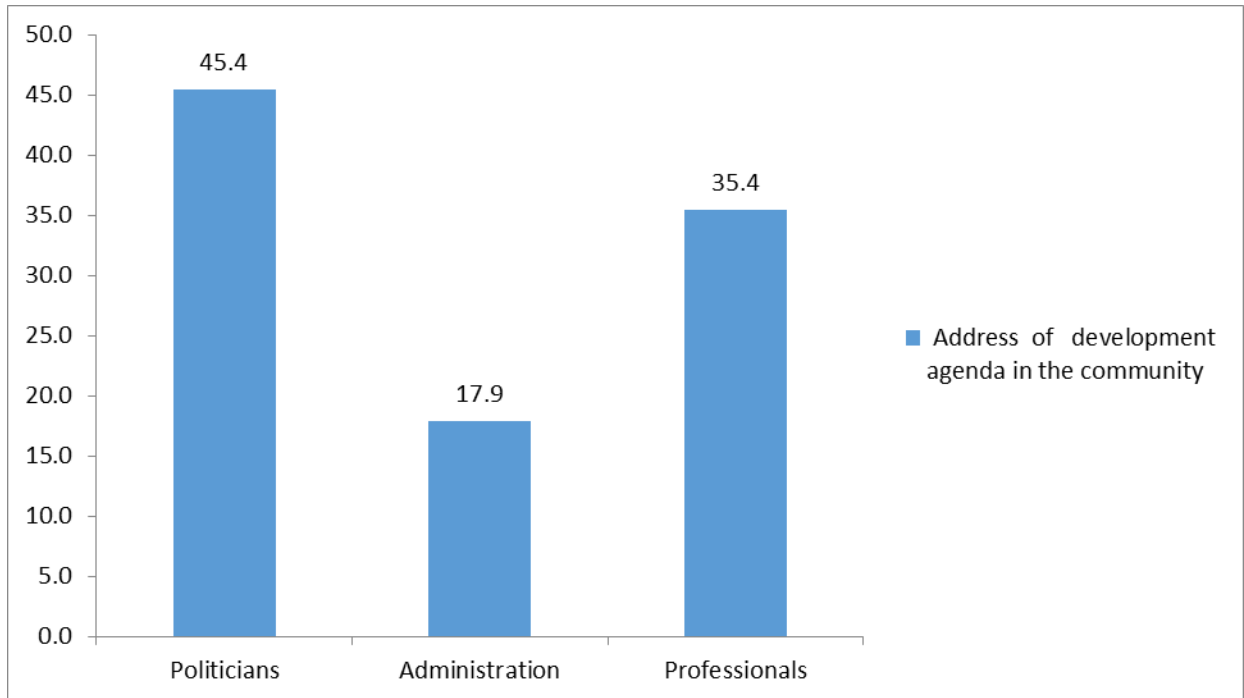


Figure 4.45: Address of the development agenda in the community.

As indicated by Figure 4.45 where almost similar opinion of 45.4%, 35.4% and 17.9% said it was politicians, professionals and administrators respectively. Therefore the politicians were key in addressing the impacts of climate change although they had not known or understood that the impacts are of climate change but either campaign goodies or development agenda (Figure 4.46).

4.3.6.9: Whether politicians or leaders understand climate related risks on livelihoods

Figure 4.46 below shows who understand climate related risks on livelihoods among politicians and other leaders.

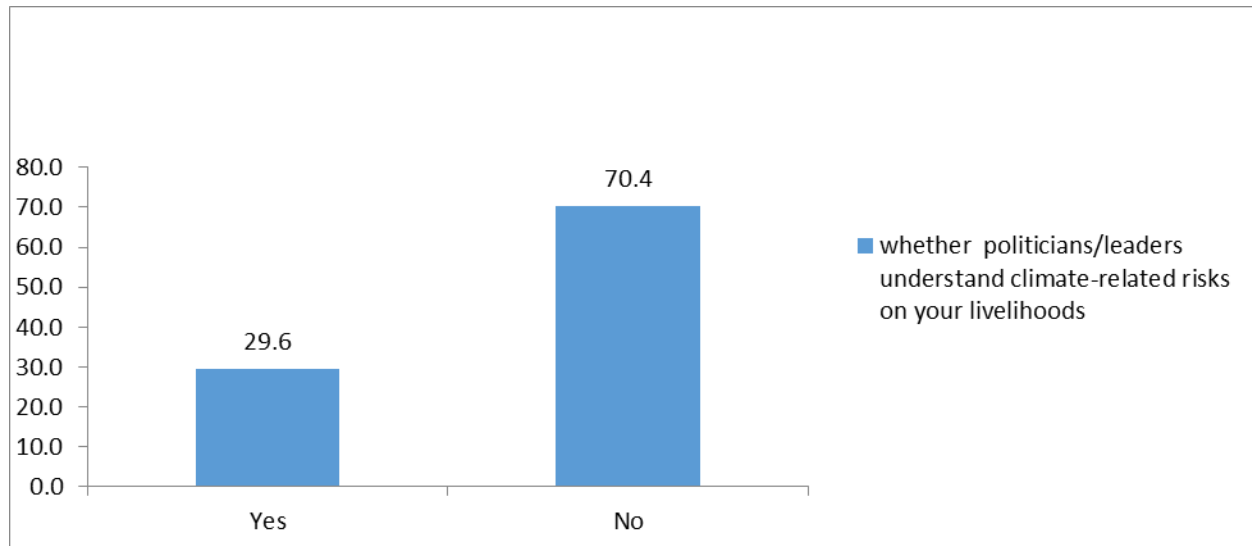


Figure 4.46: Whether politicians or other leaders understands climate-related risks on livelihoods

As indicated in Figure 4.46, the majority (70.4%) of the respondents gave their opinion that politicians and other leaders do not understand climate related risks on livelihoods. Politicians being the main decision makers on development issues(section 4.3.6.9 above) in local set up in developing countries where Kenya is one of them, decisions on climate change and adaption need be discussed and understood by politicians and other leaders. Therefore policy formulation is needed as from county level and national level on how to mainstream politicians in issues of climate change and adaptations. In the case of the Yaaku community, low human capital in form of education and minority in numbers as led the forested pastoral community to lack political commitment within the community set up.

4.4: Climate change vulnerability on Yaaku community for last three decades.

Discussion were accomplished through use of respective selected indicators such as key impacts and corresponding vulnerabilities, climate resilience livelihood, disaster risk reduction measures, Capacity developments initiatives and underlying courses of vulnerability to climate change.

4.4.1 Climate change key impacts

Figure 4.47 below shows sensitivity to vulnerability to climate change.

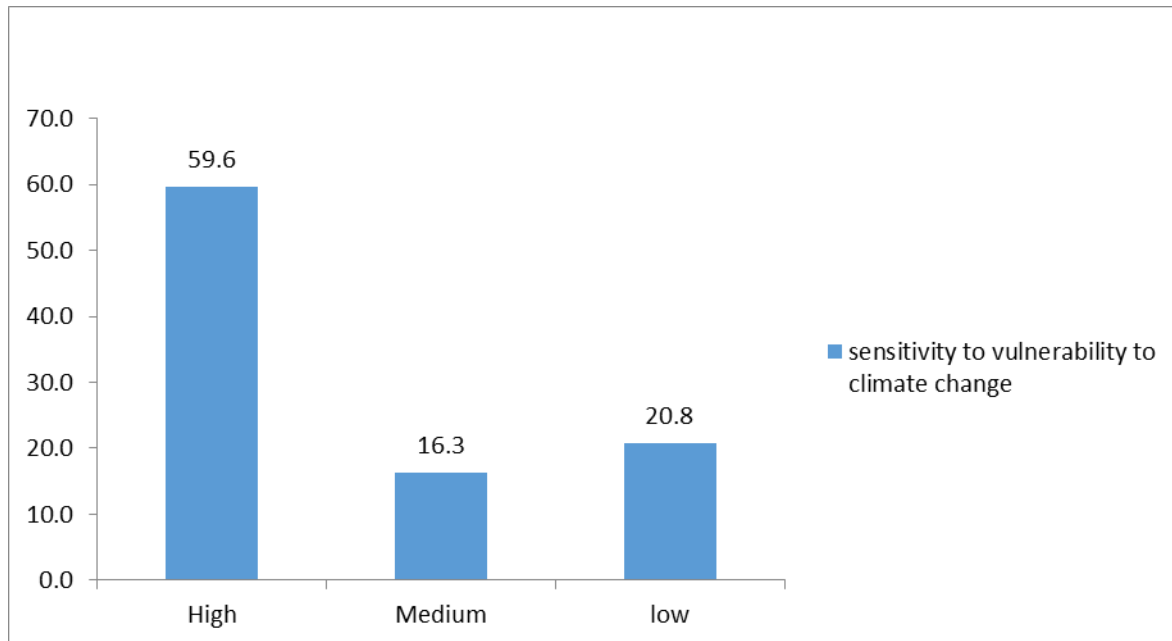


Figure 4.47: Sensitivity to vulnerability to climate change

As indicated in Figure 4.47, Climate change vulnerability was assessed by sought of opinion of the respondents on the key impacts of climate change and their corresponding vulnerabilities in response to sensitivity to vulnerability, which was high (59.6%), medium (16.3%)and low (20.8%).When the sensitivity to vulnerability to climate change impact is high, then the community is highly susceptible to the impacts of climate change and disaster risk reduction and contingency plans needed to be in place.

Figure 4.48 below shows exposure to vulnerability to climate change.

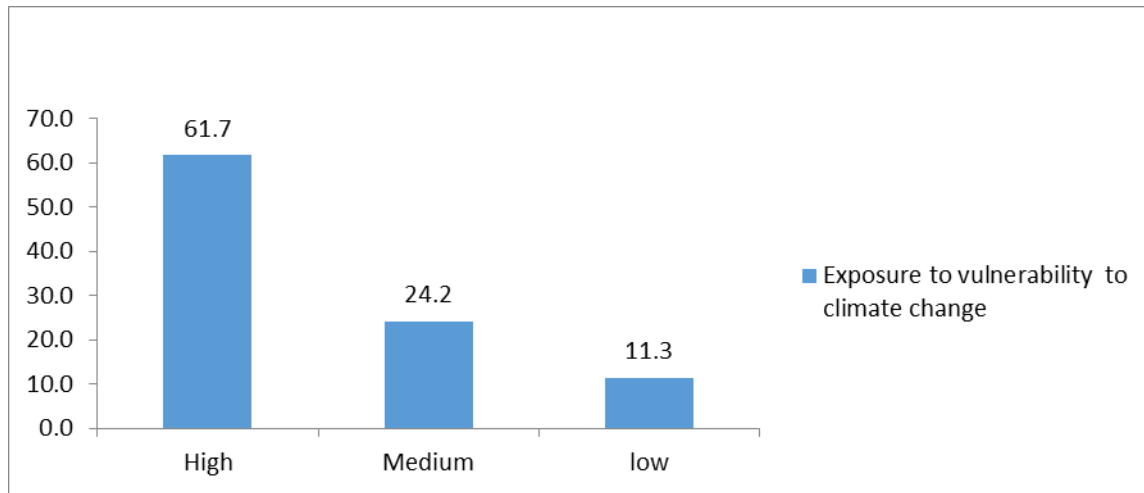


Figure 4.48: Exposure to vulnerability to climate change

As indicated in Figure 4.48, Climate change vulnerability was assessed by sought of opinion of the respondents on the key impacts of climate change and their corresponding vulnerabilities in response to exposure to vulnerability, which was high (61.7%), medium (24.2%) and low (11.3%). When the exposure to vulnerability to climate change impact is high, then the community is highly susceptible to the impacts of climate change and disaster risk reduction and contingency plans needed to be in place. Figure 4.49 below shows adaptive capacity to vulnerability to climate change.

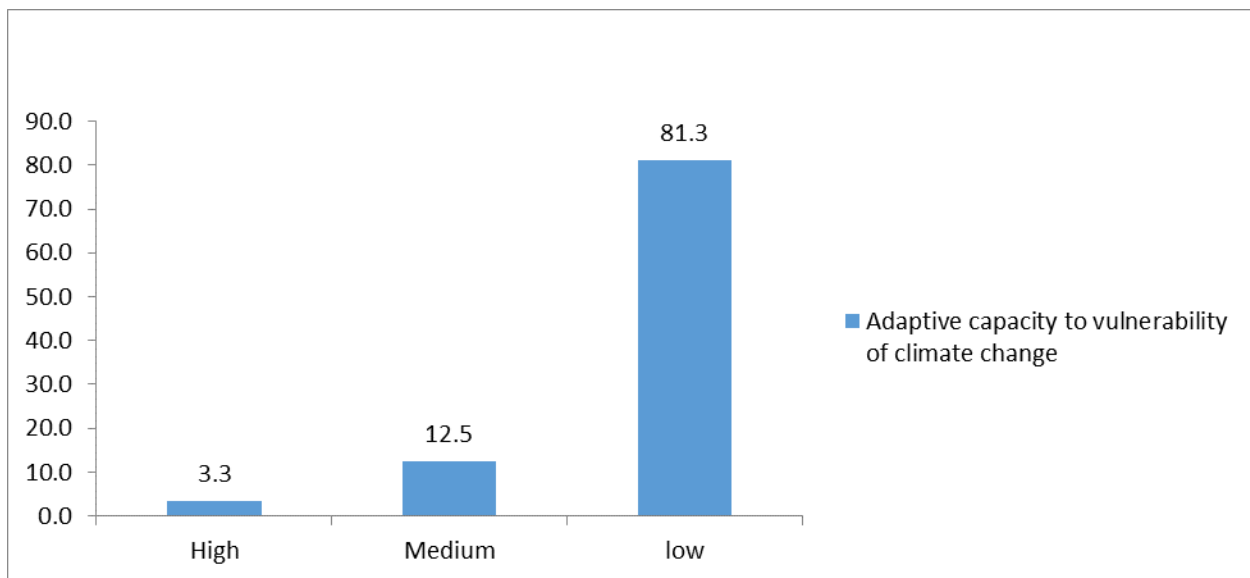


Figure 4.49: Adaptive to vulnerability to climate change

As indicated in Figure 4.49, Climate change vulnerability was assessed by sought of opinion of the respondents on the key impacts of climate change and their corresponding vulnerabilities in response to adaptive capacity to vulnerability, which was high (3.3%), medium (12.5%) and low (81.3%)When the adaptive capacity to vulnerability to climate change impacts is low, then the community is highly susceptible to the impacts of climate change and disaster risk reduction and contingency plans needed to be in place.

If sensitivity is high, while exposure is high and adaptive capacities high then the community internal response mechanism are enough to address the climate change impact. Many scenarios presents them self but the address is based on the situation at hand for each climate change impact.

4.4.2 Climate resilience livelihood

The assessment was based on availability to access to scale down climate projections, access to information on current or future climate risks and availability of policies or plans to support climate resilient livelihood. Figure 4.50 below shows access to scaled down climate projections.

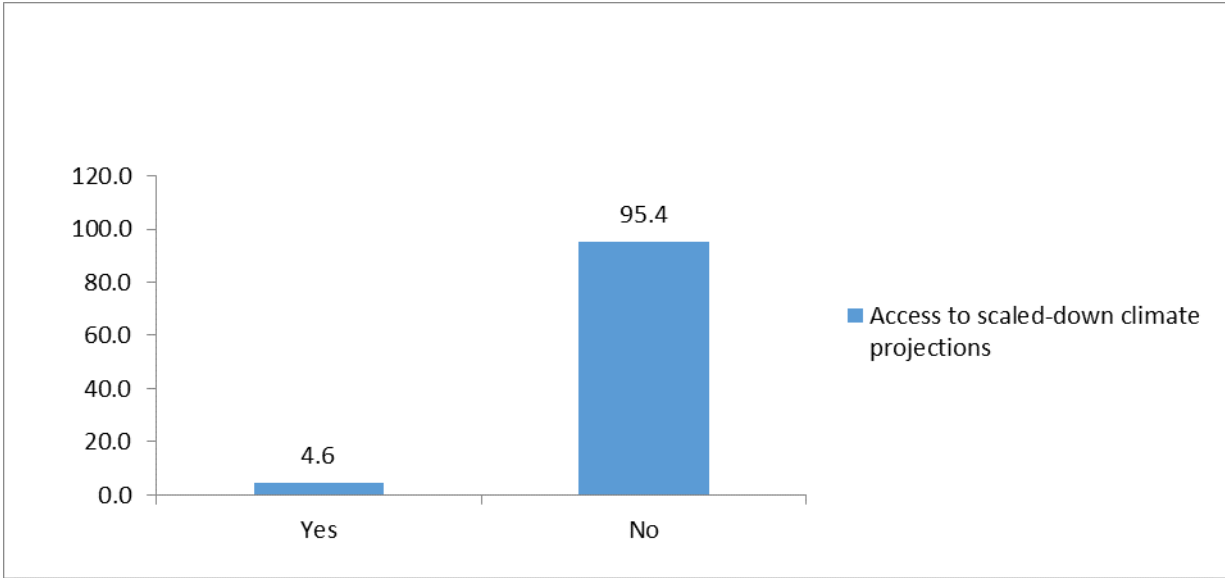


Figure 4.50: Access to scaled down climate projections

As indicated in Figure 4.50, the availability of scaled down climate projections, are not available of which the opinion of the respondents are 95.4%, according these results the livelihoods are not

resilient to climate change impacts. Therefore the livelihoods are vulnerable to climate change impacts. Figure 4.51 below shows access to information on current or future climate risks

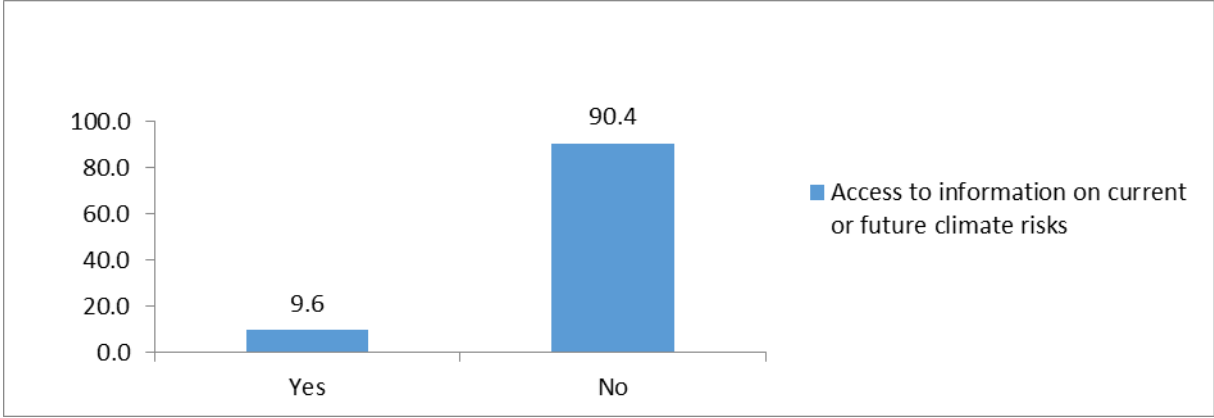


Figure 4.51: Access to information on current or future climate risks

As indicated in Figure 4.51, the availability of information on current or future climate risk is limited, of which the opinions of the respondents is 90.4%. According to these results the livelihoods of the community are at risk. Therefore the livelihoods are vulnerable to climate change impacts. Figure 4.52 below shows access policies or plans to support climate resilient livelihood.

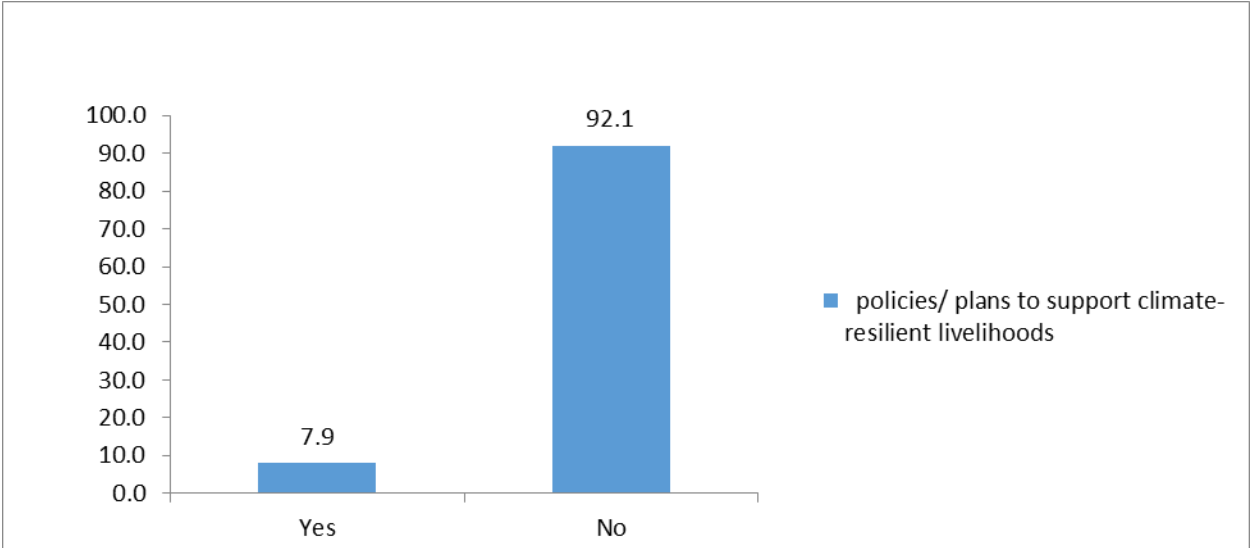


Figure 4.52: Policies or plans to support climate resilience livelihoods

As indicated in Figure 4.52, policies or plan to support climate resilience livelihood are not available of which the opinion of the respondents are 92.1%, according to these results the livelihoods had no policy or plans to support climate resilience livelihoods. Therefore the livelihoods are vulnerable to climate change impacts. Figure 4.65 below shows access policies or plans to support climate resilient livelihood.

4.4.3 Disaster risk reduction measures

The assessment was based on opinion of respondents on access to information on disaster risks, disaster risk management plans implementation in the county, availability of early warning system in the county and county capacity to respond to livelihood disasters. Figure 4.53 below shows access to information on disaster risk.

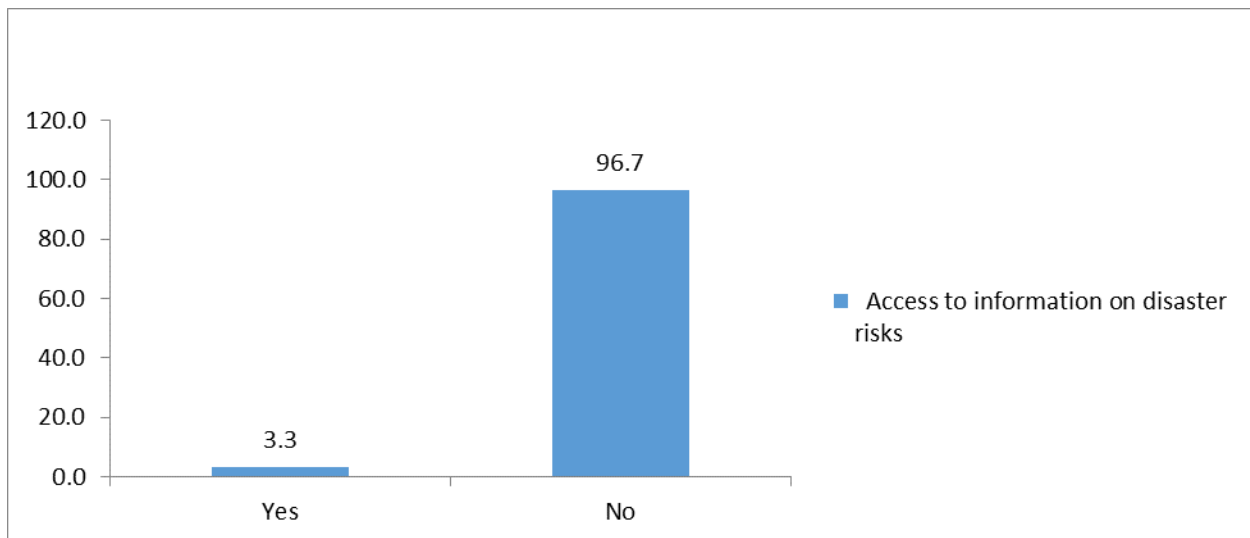


Figure 4.53: Access to information on disaster risk

As indicated in Figure 4.53, the access to information on disaster risks is not available. However the opinion of the respondents was 96.7%, according the results the community are lacking information on disaster risks. Therefore during the study, community managed disaster and risk reduction (CMDRR) exercise (form of focus group discussion) was undertaken and the outputs was disaster risk reduction plan and contingency plans for the community (all in Appendix 4).

Figure 4.54 below shows disaster risk management plans implementation in the county.

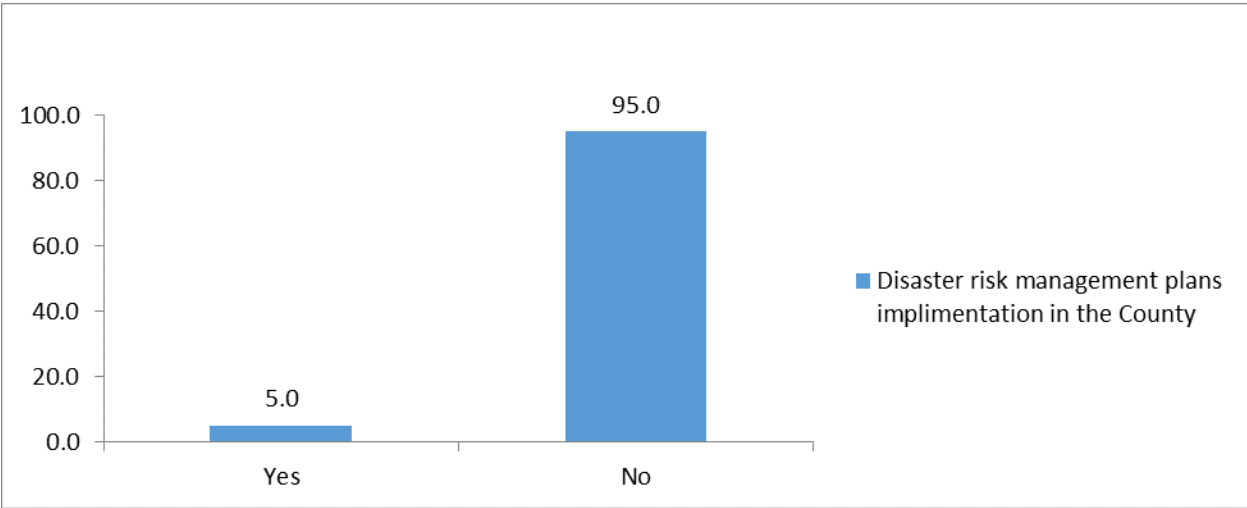


Figure 4.54: Access to information on disaster risk management plans implementation.

As indicated in Figure 4.54, disaster risk management plans implementation in the county are not available. However the opinion of the respondents was 95.0% according the results the community are lacking information on disaster risk and had no disaster management plans. Therefore during the study community managed disaster and risk reduction(CMDRR) exercise (form of focus group discussion) was undertaken and the outputs was disaster risk reduction plan and contingency plans for the community. Figure 4.55 below shows availability of early warning system.

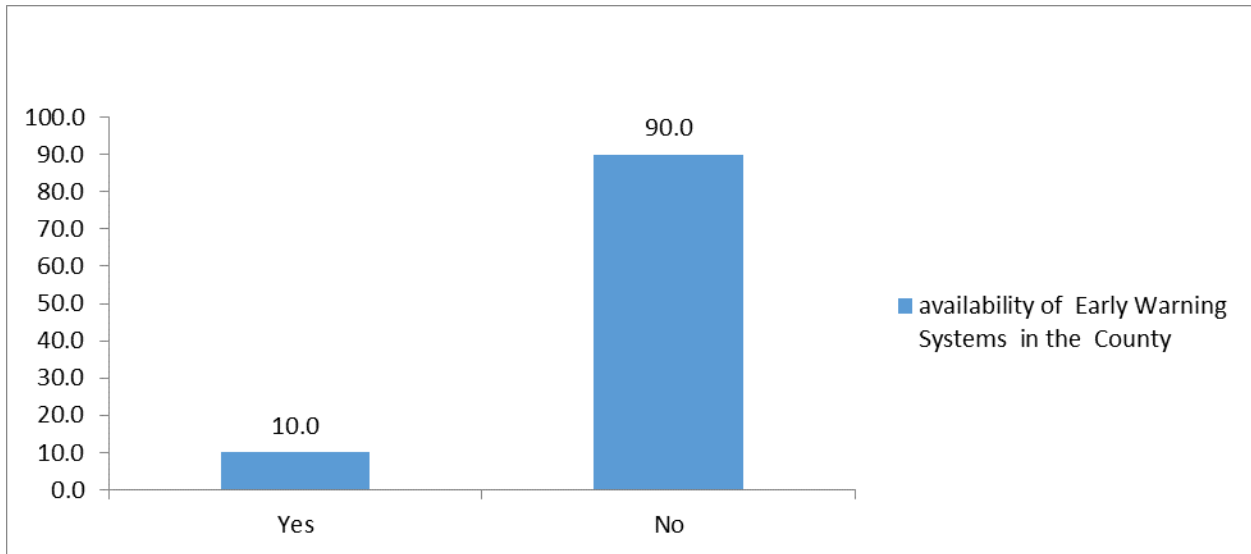


Figure 4.55: Availability of early warning system in the county.

As indicated in Figure 4.55, availability of early warning system was not available. However the opinion of the respondents was 90.0%, according these results the community are lacking information on early warning system. Figure 4.56 below shows county capacity to respond to livelihood disasters.

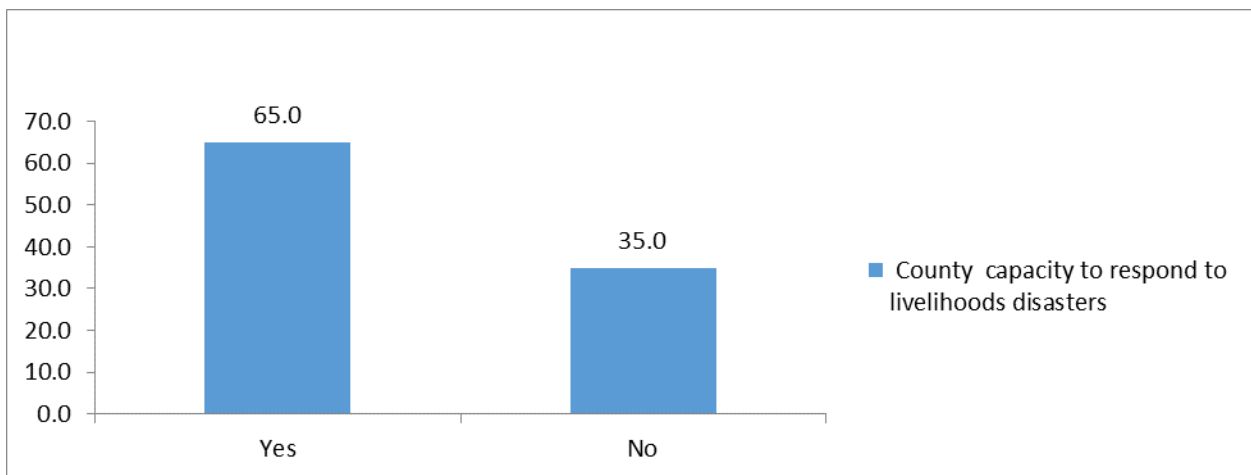


Figure 4.56: County capacity to respond to livelihood disasters.

As indicated in Figure 4.56, the county had capacity to respond to disaster according to the respondent’s opinion (65.0%). According these results the county had capacity to respond, Therefore during the study, community managed disaster and risk reduction (CMDRR) exercise (form of focus group discussion) was undertaken and the outputs was disaster risk reduction plan and contingency plans for the community.

4.4.4: Respondent’s opinion on capacity developments initiatives

The assessment was based on opinion of the respondents on availability of institutions involved in research, planning and implementations of adaptations in the County government having the capacity to monitor and analyse information on current and future climate risks, availability of mechanisms in place to disseminate the information to the pastoralists in the County, County government and other stake holders providers having the capacity to plan and implement adaptation activities and availability of resources allocated for the implementation of adaptation related policies or plans. Figure 457 below shows the availability of institutions involved in research, planning and implementations of adaptations in the County.

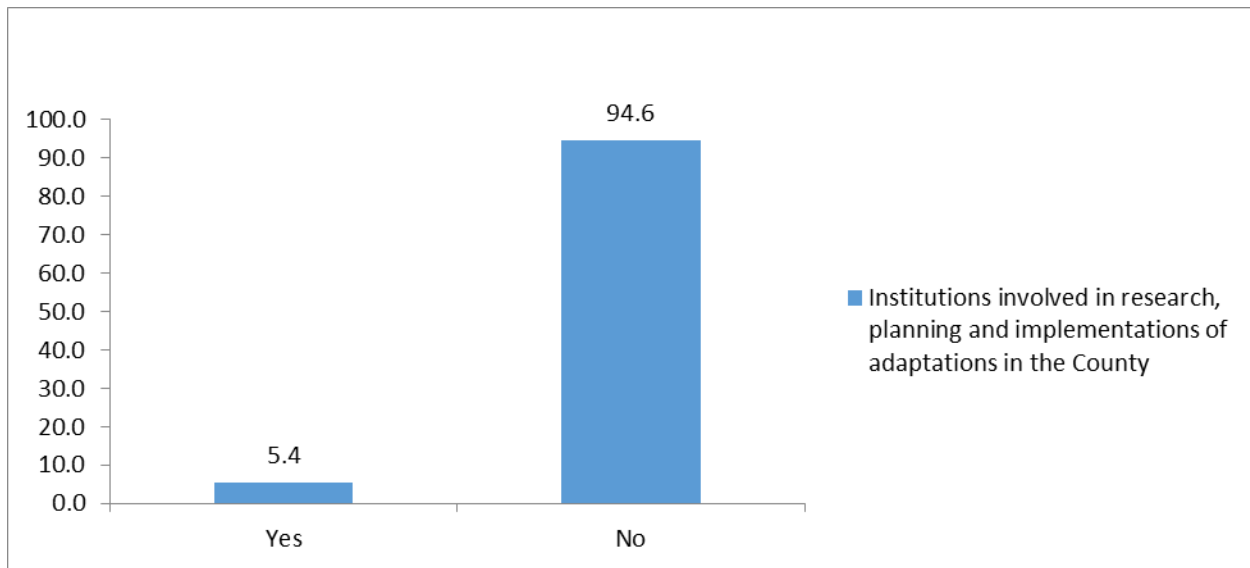


Figure 4.57: Availability of institutions involved in research, planning and implementation of adaptations.

As indicated in Figure 4.57, the availability of institutions involved in research, planning and implementations of adaptations in the County, were not available. However the opinion of the

respondents was 94.6%, accordingly the results indicate the community was lacking institution for implementation of adaptations. Therefore what is needed is to increase government and stakeholder capacity to address the climate change issues in the community. Figure 4.58 below shows County government having the capacity to monitor and analyse information on current and future climate risks.

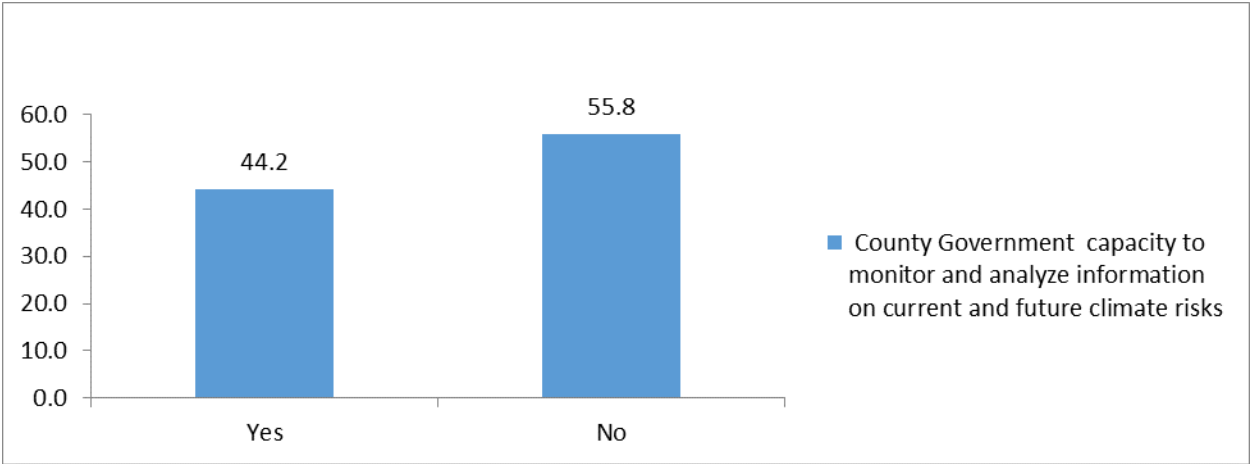


Figure 4.58: County government to monitor and analyse information on current and future climate risks

As indicated in Figure 4.58, 55.8% of the respondents gave their opinion that County government had no capacity to monitor and analyse information on current and future climate risks. However according to the results what is needed is to increase government and stakeholder capacity to address the climate change issues in the community.

Figure 4.59 below shows mechanisms to disseminate the climate change information to the pastoralists in the county.

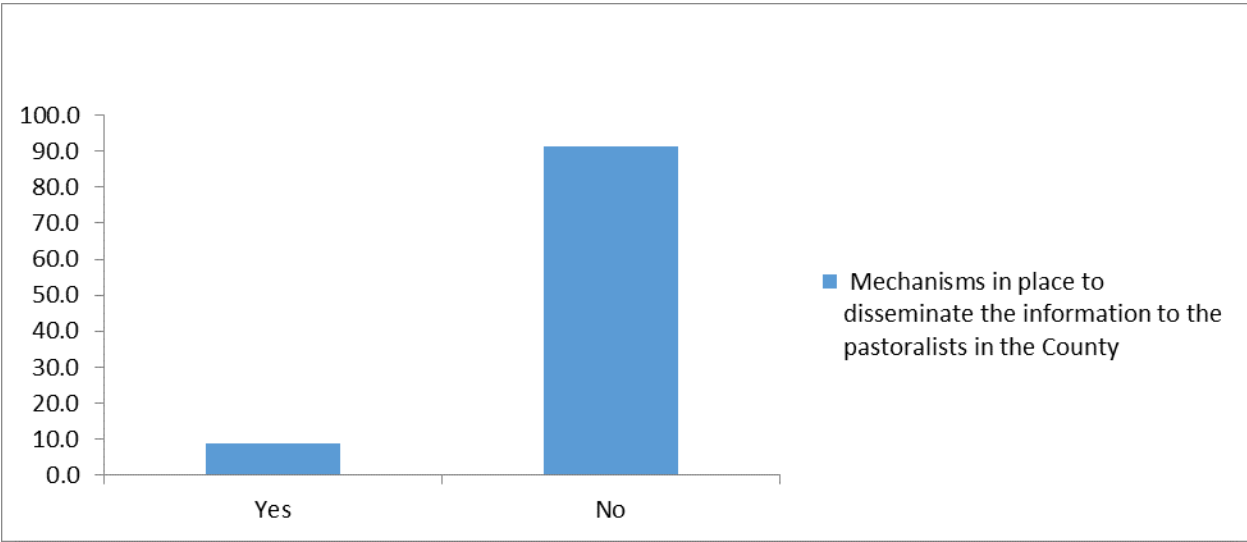


Figure 4.59: mechanisms in place to disseminate information

As indicated in Figure 4.59, 91.3.8% of the respondents gave their opinion that mechanisms were not in place to disseminate the climate change information. However according to the results what was needed was to increase government and stakeholder capacity to have mechanisms to disseminate the climate change issues in the community. Figure 4.60 below shows county governments and other stakeholder provider’s capacity to plan and implement adaptation activities.

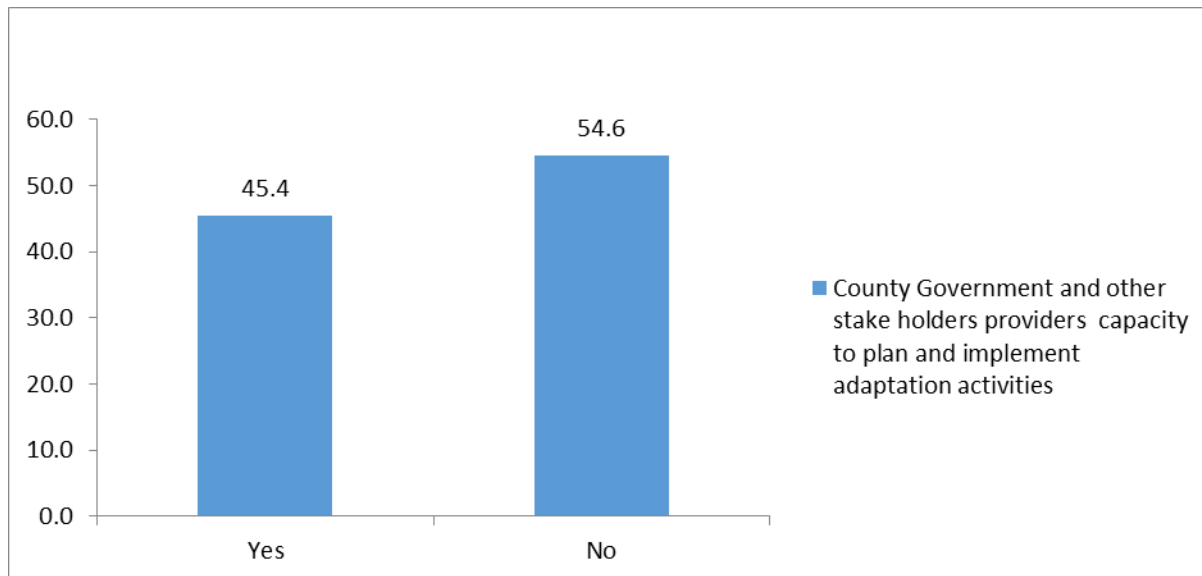


Figure 4.60: County Government and other stakeholder provider’s capacity to plan and implement adaptation activities

As indicated in Figure 4.60, 54.6% of the respondents gave their opinion that county governments and other stake holder providers had no capacity to plan and implement climate change adaptation activities. However according to the results what was needed was to increase government and stakeholder capacity to plan and implement climate change adaptation activities in the community. Figure 4.61 below shows resource allocated for the implementation of climate change adaptation related policies.

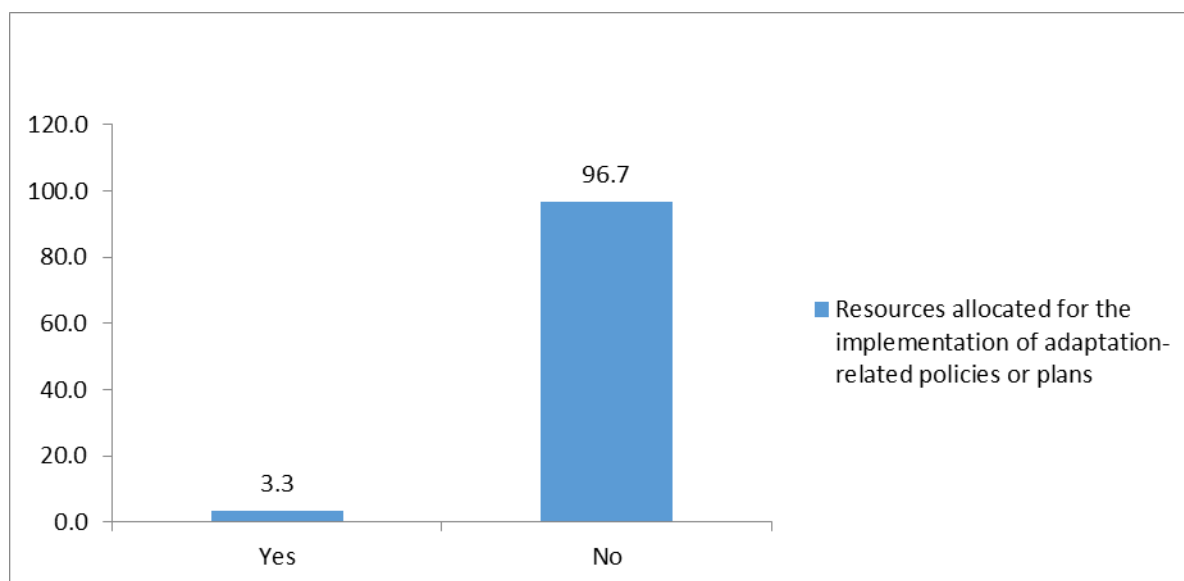


Figure 4.61: Resources allocated for the implementation of adaptation-related policies or plans

As indicated in Figure 4.61, 96.7% of the respondents gave their opinion that there were no resources allocated for the implementation of climate change adaptation related policies. However according to the results what was needed was to increase awareness to government and other stakeholders on climate change issues in order to allocate resources and have policies of how to utilize those resources.

4.4.5: Underlying causes of vulnerability to climate change

The assessment was based on opinion of respondents on involvement of stakeholders and marginalized groups and women in climate related vulnerability planning, policies that provided for access and control over critical livelihoods resources for the pastoralists, factors that constrained the adaptive capacity of the most vulnerable groups within the community ,the vulnerable groups had any influence over factors that constrain the adaptive capacity and if their existed vulnerability maps for the current and under a changing climate. Figure 4.62 below shows stakeholder involved in climate change related vulnerability planning

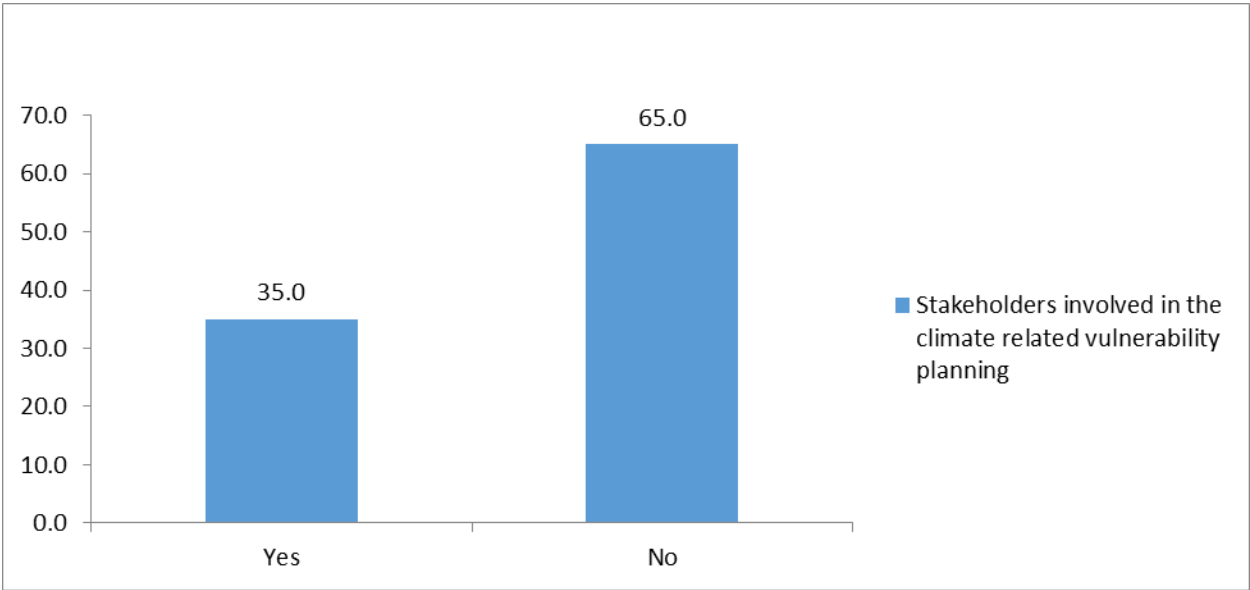


Figure 4.62: Stakeholders involved in the climate related vulnerability planning

As indicated in Figure 4.62, 65.0% of the respondents gave their opinion that there was no involvement of stakeholders in the climate change related vulnerability planning. According to these results the community stake holders, were not involved in climate change vulnerability planning and therefore the study had to do so in the CMDRR exercise. Figure 4.63 below shows marginalised and women involved in climate rerated vulnerability planning.

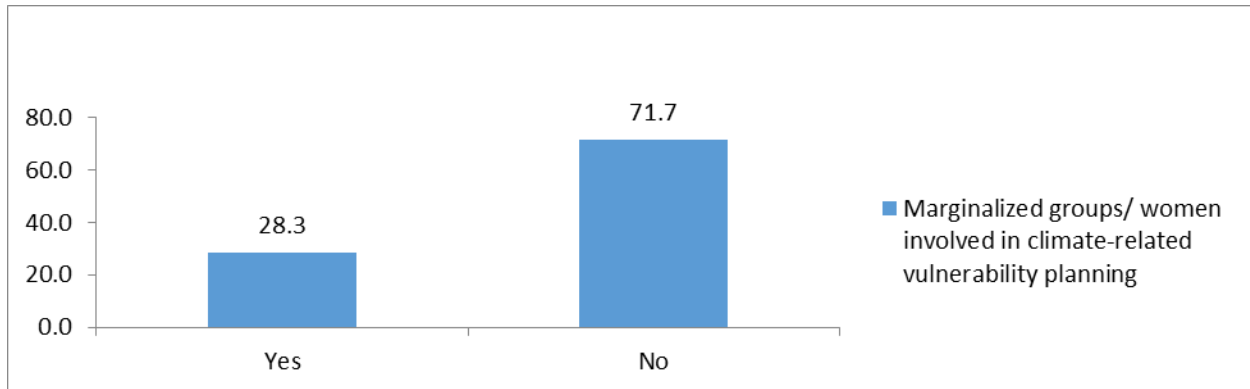


Figure 4.63: Marginalized groups and women involved in the above planning

As indicated in Figure 4.63, 71.7% of the respondents gave their opinion that there were no involvement of marginalised groups and women in the climate change related vulnerability planning. According to these results the community marginalised groups and women were not involved in climate change vulnerability planning meetings and therefore the study had to do so in the CMDRR exercise. Figure 4.64 below shows policies that provide access to and control over critical livelihoods resources for pastoralists.

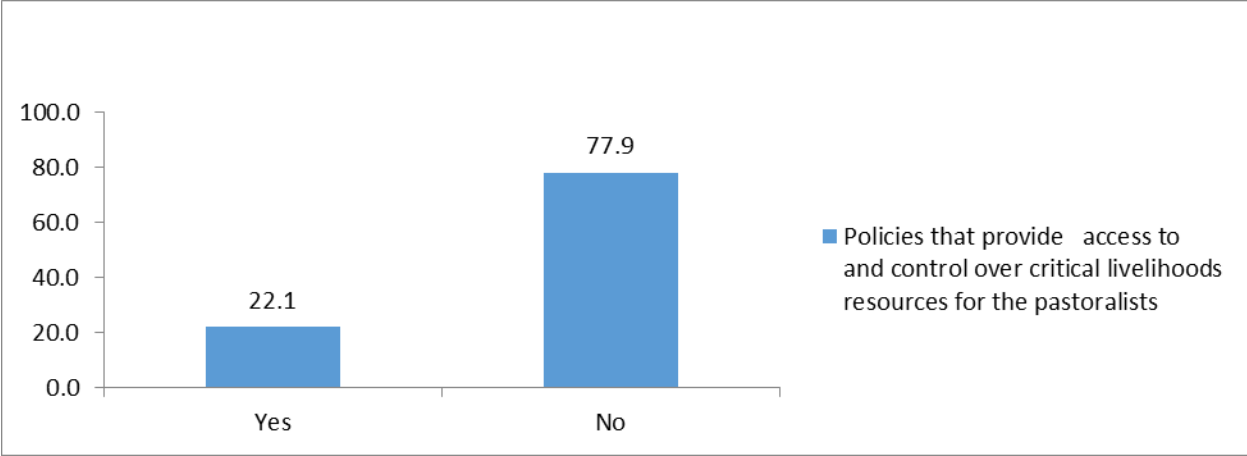


Figure 4.64: Policies that provide access to and control over critical livelihoods resources for the pastoralists

As indicated in Figure 4.64, 77.9% of the respondents gave their opinion that there were no policies that provided access to and control over critical livelihoods resources for the pastoralists. The policies to guide on access and control of resources was said not to be in place but the study had no time and resource to undertake the task however recommendations are made to county and national government to undertake policy development on access and control of livelihoods resources for pastoralists. Figure 4.65 below shows vulnerability groups influence over factors that constrains the adaptive capacity.

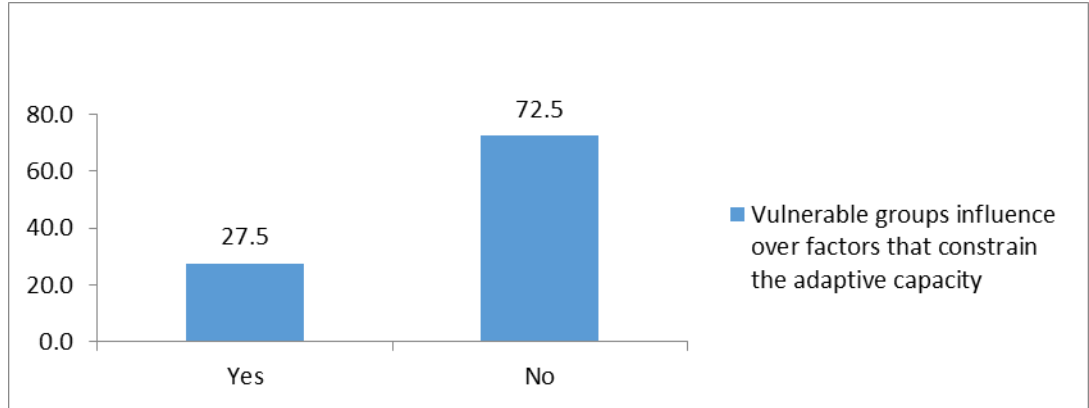


Figure 4.65: Vulnerable groups influence over factors that constrain the adaptive capacity

As indicated in Figure 4.65, 72.5% of the respondents gave their opinion that there was no vulnerable groups’ influence over factors that constrain the adaptive capacity. Therefore there was room to improve adaptive capacity to impacts of climate change of the community by proposal of various interventions to address issues of climate change in the community. Some of

the intervention agreed at focus group discussion(CMDRR) were: provision of ideal livestock breeds for the forested ecosystem, provision of water accessible water both for livestock and human use, diversification of livelihoods as alternative source of income, a systematic off take and marketing system for sale of livestock that has efficient and effective flow of market information, provision of enough feed reserves for livestock and food for human, planting of climate change tolerant crops, planting of trees(afforestation) in degraded area of the forest and reseedling of the denuded areas. The full report on the climate change vulnerability and capacity assessment is in Appendix 4. Figure 4.66 below shows existent of vulnerable maps for the current and under a changing climate.

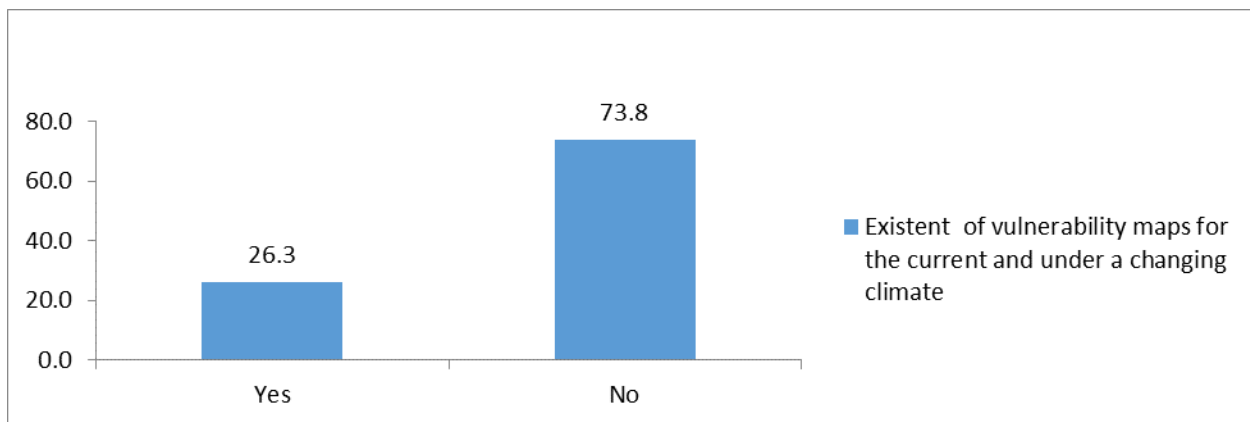


Figure 4.66: Existent of vulnerability maps for the current and under a changing climate

As indicated in Figure 4.66, 73.8% of the respondents gave their opinion that there were no existent of vulnerability maps for the current and under a changing climate. However on the matters of vulnerability map; the study with the community mapped and ranked the villages of the Yaaku according to their vulnerability to climate change (results in objective 3).

4.5: The results of each of the four study objectives

These relates to the climate change impacts and adaptive responses of pastoral communities in forested areas. (i) Climate trend of Laikipia County for the last three decades.(ii) Changes in land use and management for the last three decades.(iii)Vulnerability and impacts to climate change of the Yaaku community, (iv) response strategies for the Yaaku community to reduce climate change impacts.

4.5.1: Objective 1: Climate trend of Laikipia County for the last three decades

This was achieved by analysis of average annual rainfall and average maximum and minimum temperatures of Laikipia County and Mukogodo area for the last three decades as from 1986 to 2016.

4.5.1.1: Rainfall trend of Laikipia County for the last three decades.

Figure 4.67 below shows rainfall trend of Laikipia County for the last three decades

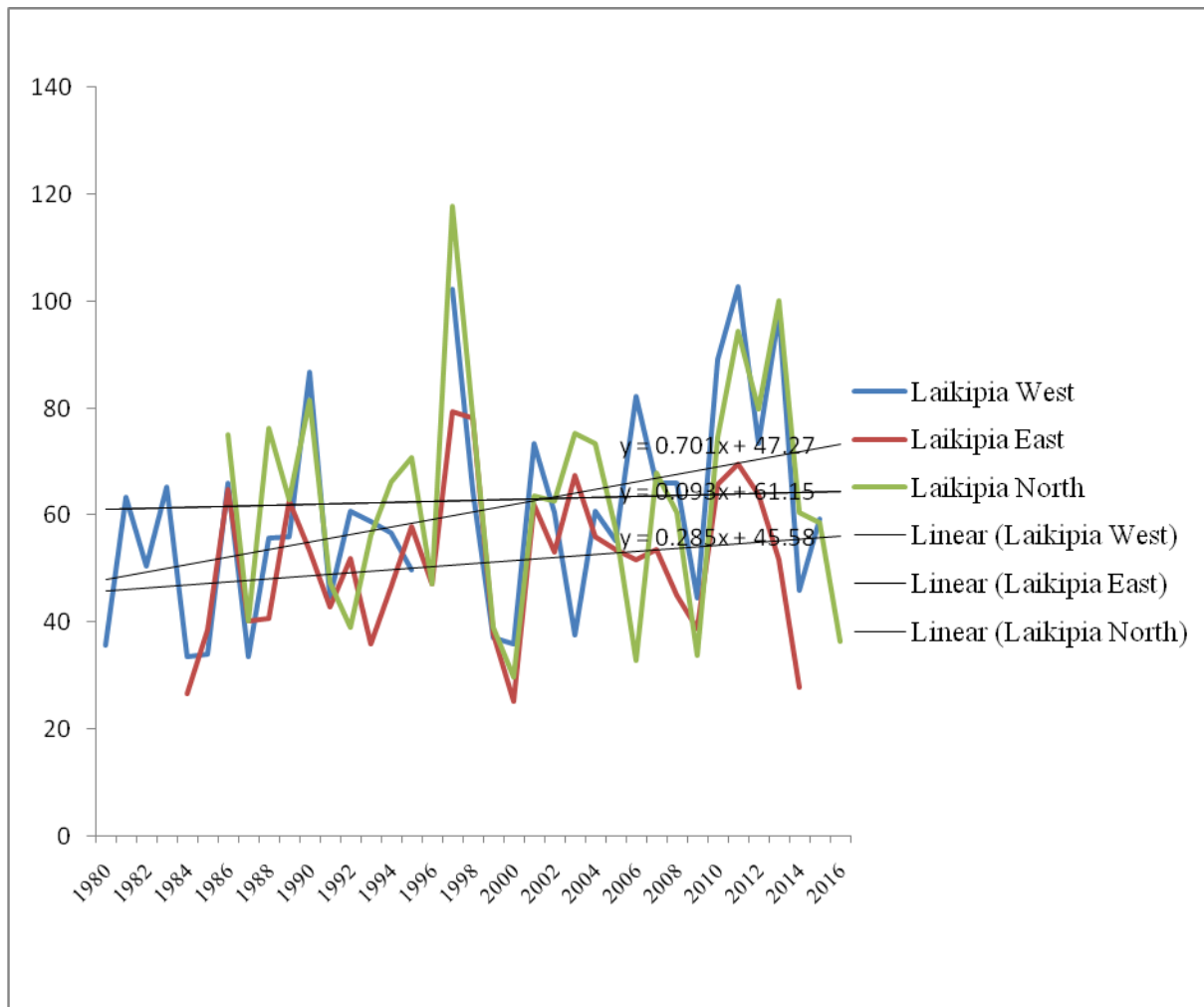


Figure 4.67: Laikipia County Average Annual Rainfall Trends

As indicated in Figure 4.67, on average Laikipia west received more rainfall followed by areas of Laikipia North of Mukogodo forest area and surrounding Mt Kenya. Laikipia East got the lowest rainfall over the period. The high rainfall peaks were during the El Nino years of 1990-1991,

1997 and 2013 which recorded most rainfall while the La Niña low period of 1992-1993, 2000-2001, 2008 period reported very low rainfall. However, in Mukogodo the rainfall high peaks were in 1990, 1997, 2006 and 2012-2013 which were mostly the El Niño years. The low peaks were observed in 1992, 2000 and 2008 which were La Niña years. The county has various climatically regions of which Figure 4.80 above was to give the general trend of the climate conditions of the County. Figure 4.68 below shows Mukogodo area average annual rainfall trends.

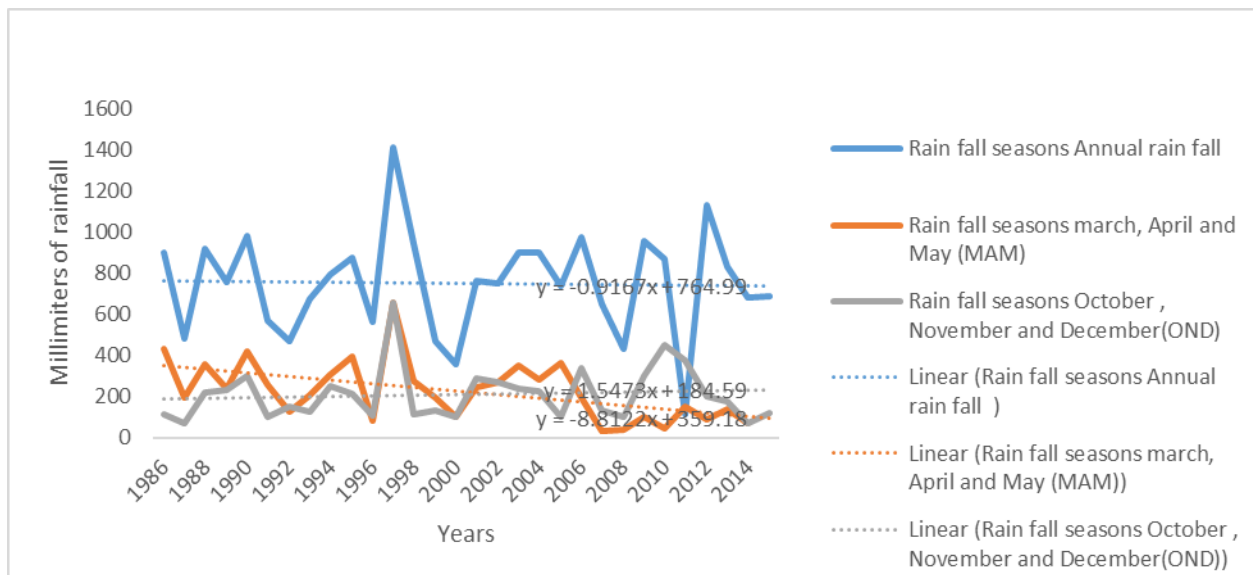


Figure 4.68: Mukogodo area average annual rainfall trends

As indicated in Figure 4.68, Mukogodo rain fall trends had different scenarios from other part of Laikipia in that although the annual average rainfall increased in last three decades, the March, April and May (MAM) rainfall trends decreased progressively, while the October November and December (OND) increased slightly over the three decades. The general increase of average rainfall which was not the sum of MAM and OND was due to recorded rainfall in the other months of the year which are not defined seasons of Mukogodo area.

The impacts of climate change led to unreliability of the seasons in which MAM used to be the main long rain season in earlier years but now OND has turned to be more reliable in the Mukogodo area although less than normal season during last three decades. Therefore the

changes have affected the amounts, intensity, distribution, seasonality, and reliability of rainfall, thus affected the livelihood of the Yaaku. The rainfall general net decrease of 200mm was witnessed over the period of which the most affected were the traditionally known seasons of MAM and OND. The change in rainfall over the study period in Yaaku community of Mukogodo forested ecosystem was attributed to climate change (section 4.2).

4.5.1.2: The temperature trends of Laikipia County for the last three decades.

Figure 4.69 below shows Mukogodo average annual maximum temperatures

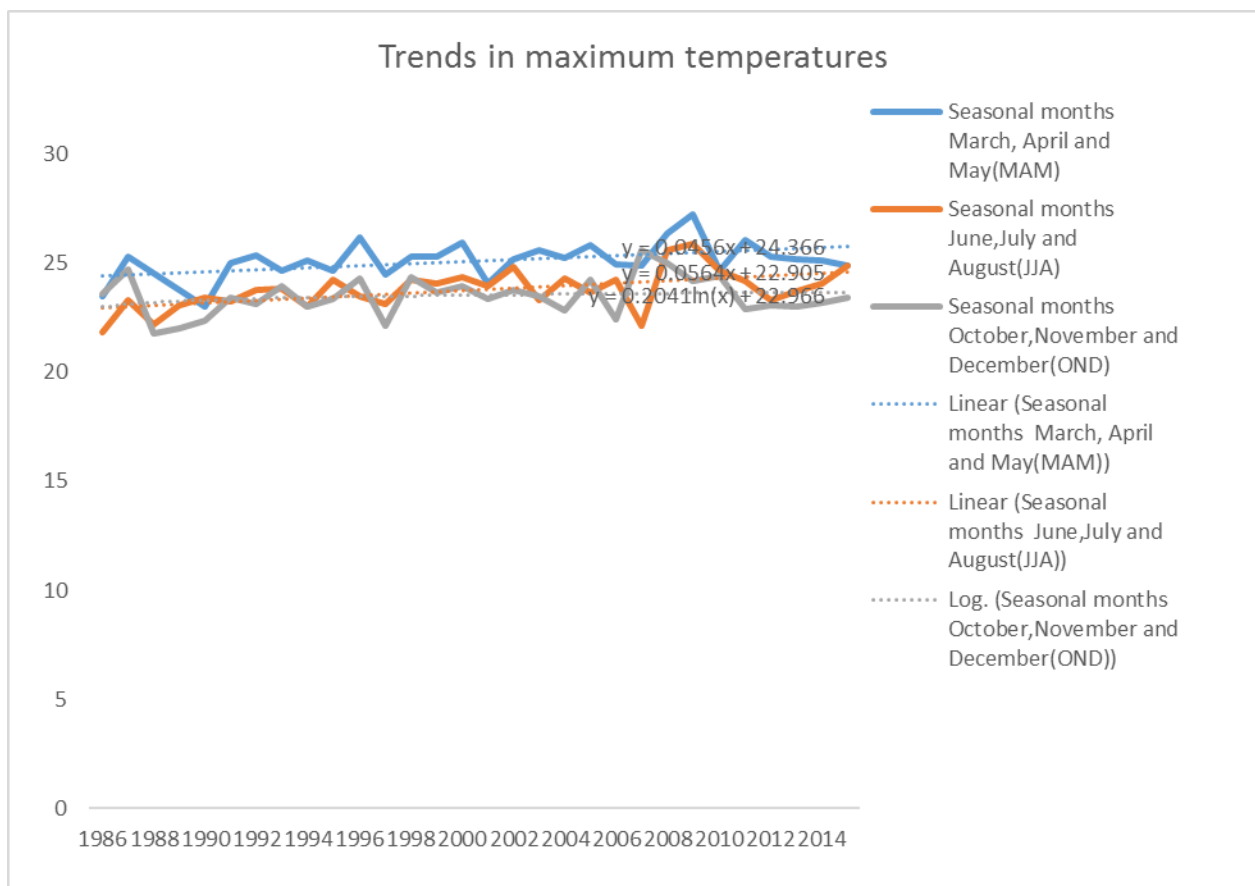


Figure 4.69: Mukogodo area average annual temperatures

As indicated in Figure 4.69, there was an increase in maximum temperatures over the years. Maximum temperatures were higher during the main seasons of MAM and OND but lower in between in the months of June, July and August. In Mukogodo area the year 2010 recoded the months with highest temperature and 2007 and 2008 had the lowest temperature, in June, July,

August and OND. Generally there was trend in temperature increase in the whole of three decades with the lowest average annual maximum temperature of 21.7°C in OND of 1989 and highest average annual maximum temperatures of 27.2°C in MAM 2009. The maximum temperature increased by 1.43°C, 2.98°C and 0.18°C during MAM, JJA and OND seasons respectively, which gave an average increase of 1.5°C in the period. Figure 4.70 below shows Mukogodo area average annual minimum temperature.

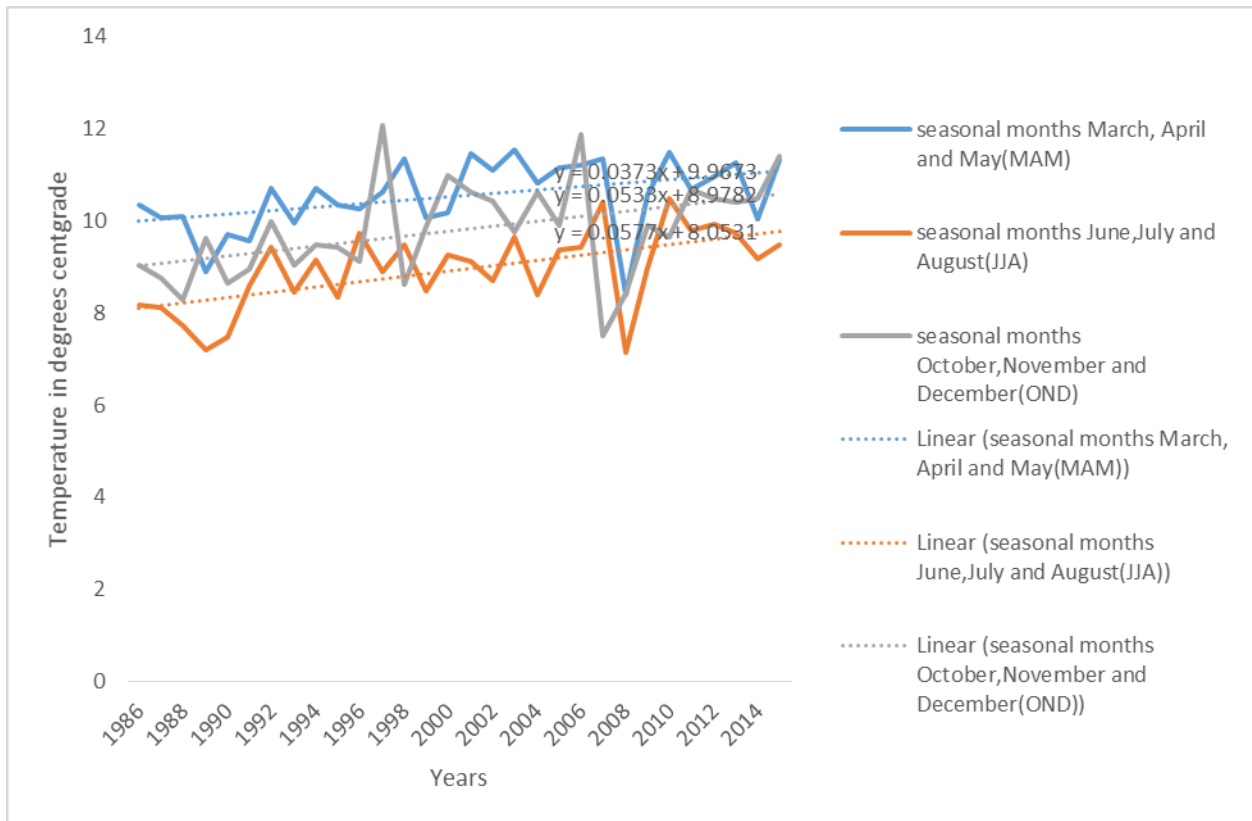


Figure 4.70: Mukogodo area average annual minimum temperatures

While there was an increase in minimum temperatures over the years as indicated in Figure 4.70, Minimum temperatures were highest in MAM season followed by OND and lowest between the season in June, July and August. The minimum temperature increased by 0.91°C, 1.30°C and 2.37°C during MAM, JJA and OND seasons respectively, which gave an average increase of 1.5°C in the period. These trends of increase in temperature in the last three decades were attributed to climate change by the Yaaku community as indicated at section 4.2. This was inline as evidenced by (Thomas et al. 2007; Songok et al. 2011a) that increases in temperature, in sub-Saharan Africa was expected to cause changes in rainfall intensity due to climate change.

4.5.2: Objective 2: Changes in land use and management for the last three decades.

This objective was addressed by secondary data and ground visits for confirmation. The changes were obtained by classifying Land sat images for 4 (four) epochs; 1984, 1995, 2004 and 2014. The epochs were at a period of 10 years to allow clear and notable change detection. The study site was visualised by Google earth for comparison with present situation as form of confirmation by ground visits to some of the areas. Plate 4.1 below shows Google Earth visualisation of Mukogodo East Ward and part of enclosed Mukogodo Forest.

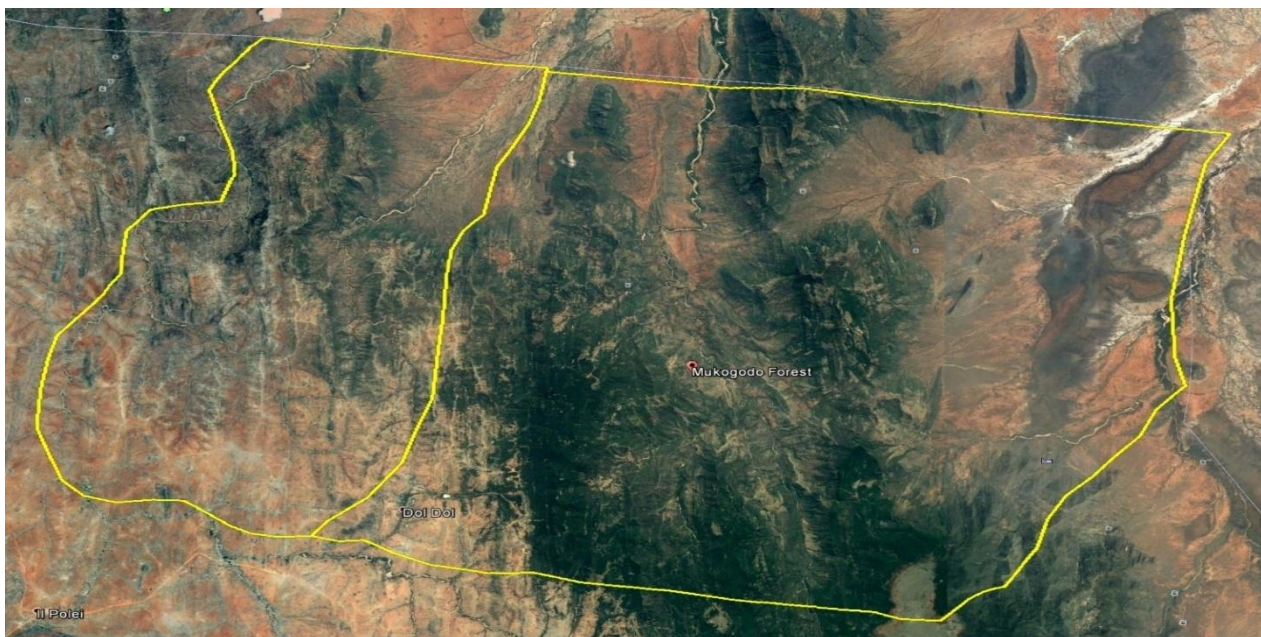


Plate 4.1: Mukogodo East ward and part of the enclosed Mukogodo Forest

As was visualized from the Google Earth image plate 4.1, there were a lot of spaces within the Forest ecosystem and most of those spaces were earlier covered by grassland and in the recent past, (notably seen in the image of 2014 plate 4.4) these areas are now covered by shrubs and woodland that had little value to pastoralist. Additional information, for example the growth of Doldol town was extracted from Google Earth image. Doldol town was seen to expand from 7 hectares to 14 hectares between 1984 and 2014. There were other small settlements but they were too small to be mapped at this scale. Plate 4.2 below shows Mukogodo land cover in 1984.

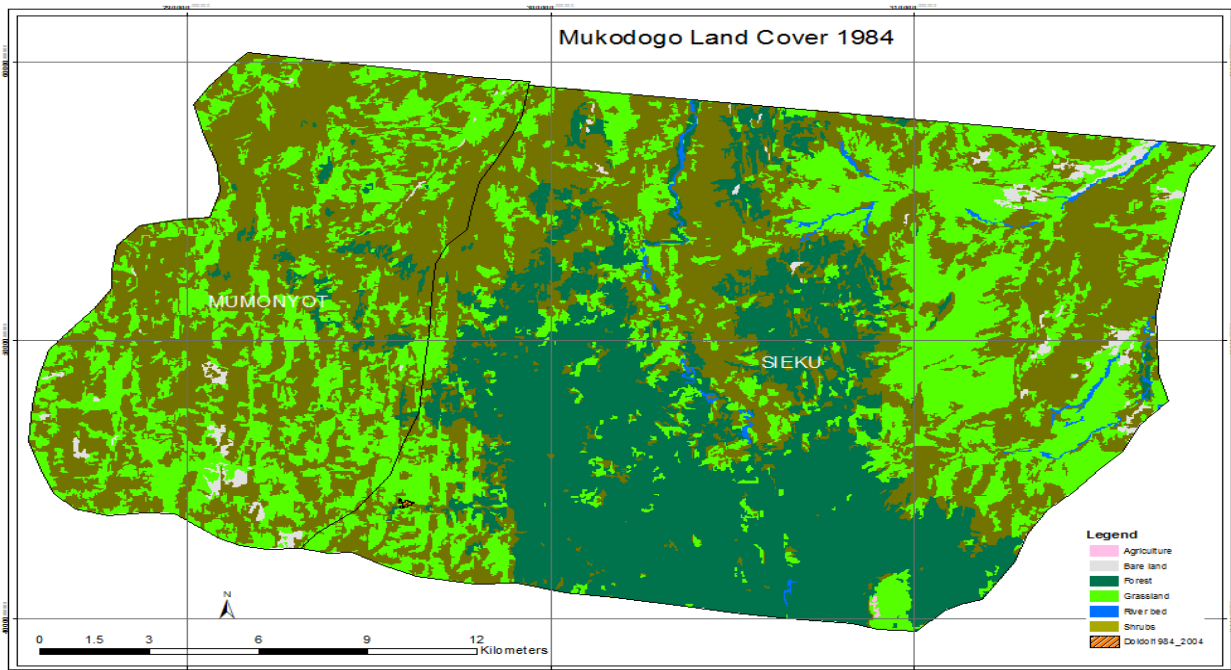


Plate 4.2: Mukogodo land cover 1984

As indicated in plate 4.2, the epoch of 1984, had very little agricultural activity and the area was covered by forest the (the green and dark green colour in plate 4.2). This epoch is used by the study as a base map in getting the land use changes in last three decades.

Plate 4.3 below shows Mukogodo land cover 1995.

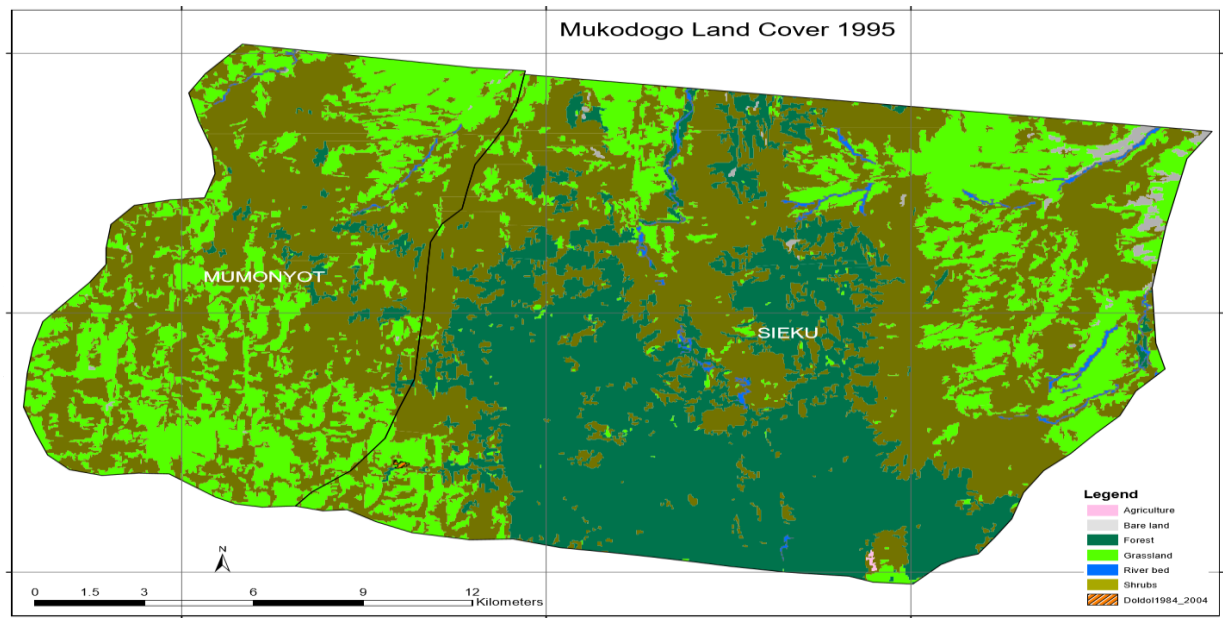


Plate 4.3: Mukogodo land cover 1995

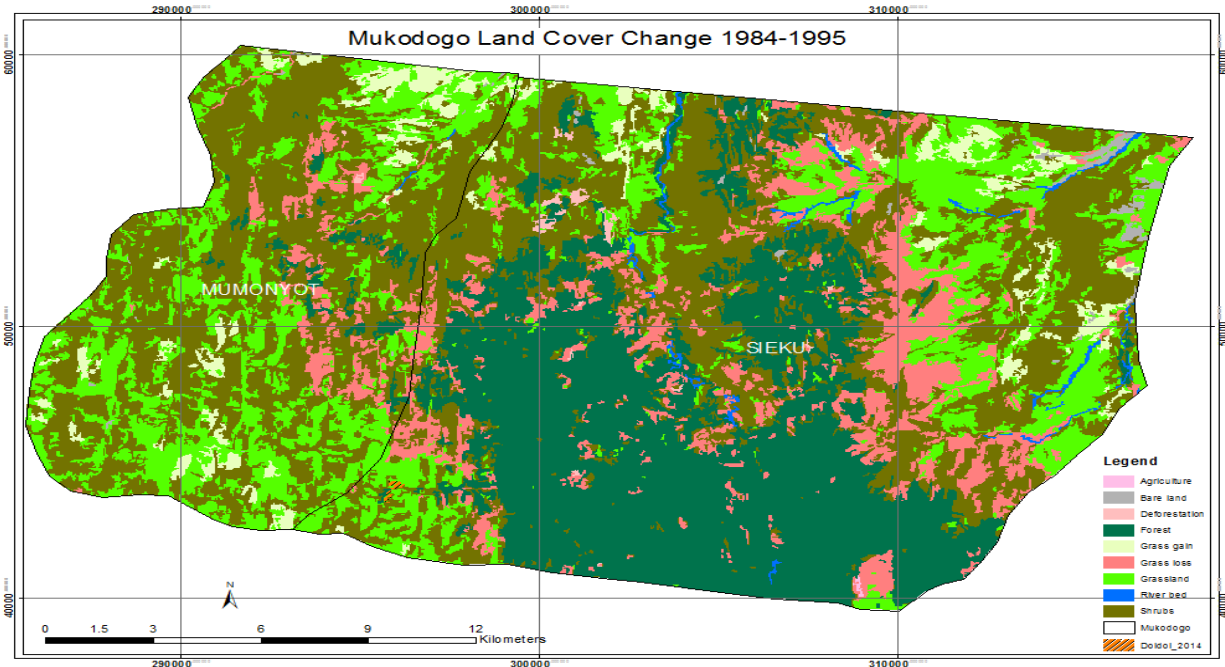


Plate 4.4: 1984 to 1995 change map

As indicated in plate 4.4, the period 1984 to 1995 the grasslands had decreased but agriculture land remained unchanged. However there was regeneration of grass in some area while there was loss in others. In general there was net loss of grassland and forest was deforested. Table 4.3 below shows land use changes in the period beginning 1984 to 1995.

Table 4.3: 1984-1995 epochs

Land_cover_change1984_1994mod								
	FID	Shape *	ID	T1_class_1	1984_LC	1995_LC	Change	Area
▶	0	Polygon	14	14	Grassland	Grassland	Grassland	9887.578861
	1	Polygon	40	12	Shrubs	Shrubs	Shrubs	19297.830684
	2	Polygon	147	11	Bare land	Bare land	Bare land	238.417348
	3	Polygon	220	14	Shrubs	Grassland	Grass gain	1731.422213
	4	Polygon	898	9	Forest	Forest	Forest	12684.397535
	5	Polygon	108	14	River bed	River bed	River bed	299.99352
	6	Polygon	117	14	Grassland	Shrubs	Grass loss	4835.685697
	7	Polygon	182	9	Forest	Shrubs	Deforestation	127.53
	8	Polygon	125	12	Agriculture	Agriculture	Agriculture	9.36

As indicated in Table 4.3, between 1984 and 1995, 9,888 hectares of grassland and 9 hectares of agriculture land remained unchanged. However, there was a regeneration of 1,731 hectares of grassland in some areas and a loss of 4,836 hectares in others. Therefore in total there was a loss of 3,105 hectares of grassland. In the same period, 127 hectares of forest were deforested. Plate 4.5 below shows Mukogodo land cover 2004.

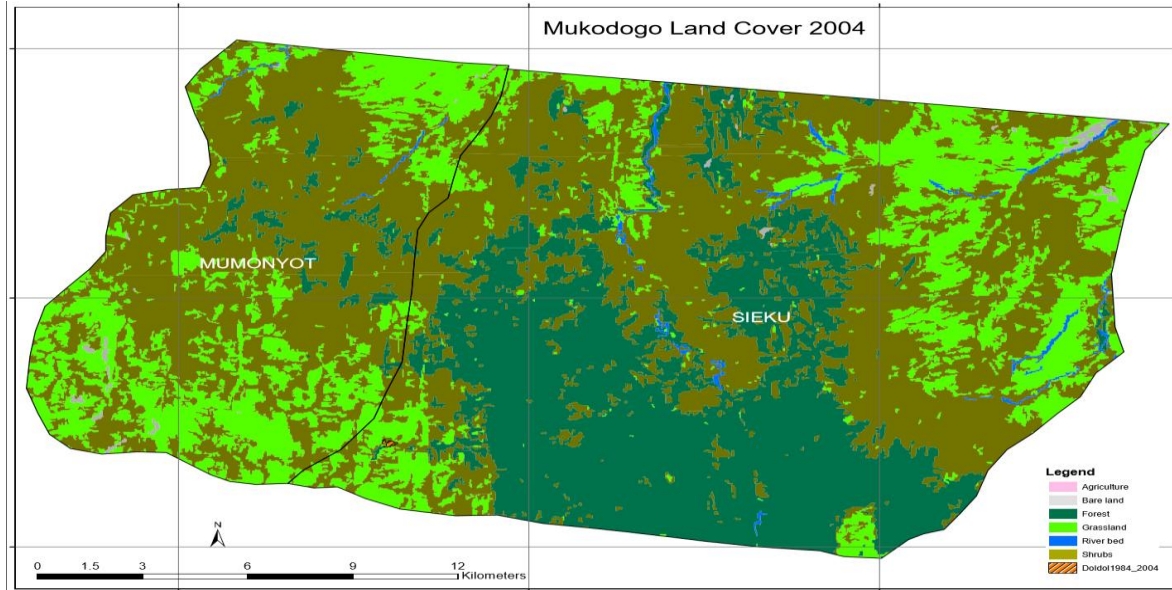


Plate 4.5: Mukogodo land cover 2004

As indicated in plate 4.5, the epoch of 2004, had no agricultural activity at all and the area was covered by forest the (the green and dark green colour in plate 4.5).in this epoch shrub land had been noticed encroaching areas which had grassland which was reducing gradually. In deep discussion in focus group it came out that the drought of 2000 to 2001 had discouraged the few farming households in Mukogodo area and stayed without farming up to 2005. Plate 4.6 below shows Mukogodo land cover change 1995 to 2004

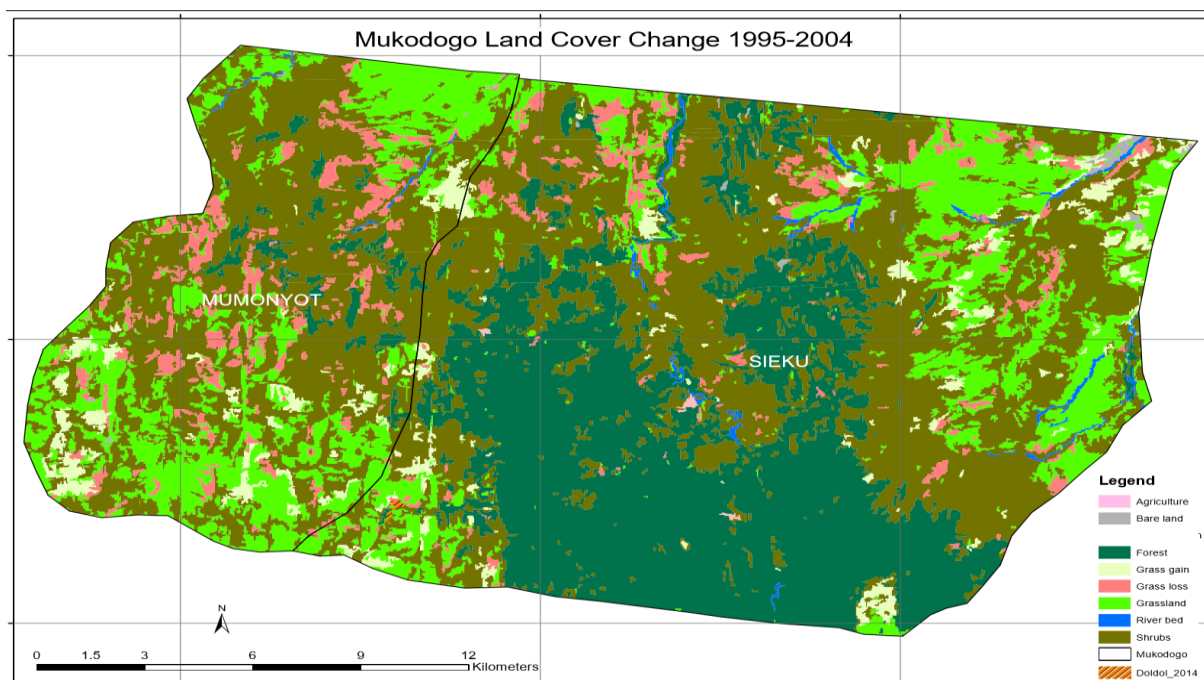


Plate 4.6: 1995 to 2004 change map

As indicated in plate 4.6, the period 1995 to 2004 the grasslands were lost and forested areas remained unchanged. Some areas of grassland regenerated while others lost grass cover giving a net grass loss. Deforestation continued and no evidence of agricultural activity in this epoch. Table 4.4 below shows the land use changes between 1995 and 2004.

Table 4.4:1995-2004 epochs

T1_class_1	1995_LC	2004_LC	Change	Area
14	Grassland	Grassland	Grassland	9213.474869
12	Shrubs	Shrubs	Shrubs	22507.795209
11	Bare land	Bare land	Bare land	122.545048
14	River bed	River bed	River bed	330.50352
14	Grassland	Shrubs	Grass loss	2405.526205
9	Forest	Forest	Forest	12919.207535
14	Shrubs	Grassland	Grass gain	1583.733473
14	Forest	Shrubs	Deforestation	29.43

As indicated in Table 4.4, between 1995 and 2004, 9,213 hectares of grassland and 12,919 hectares of forest remained unchanged; there was a regeneration of 1,584 hectares of grassland and a loss of 2,406 hectares of grassland. In total there was a loss of 822 hectares of

grassland. Deforestation counted for 29 hectares of loss of forest in this epoch. Agricultural activity had no evidence in that epoch. Plate 4.7 below shows the Mukogodo land cover 2014.

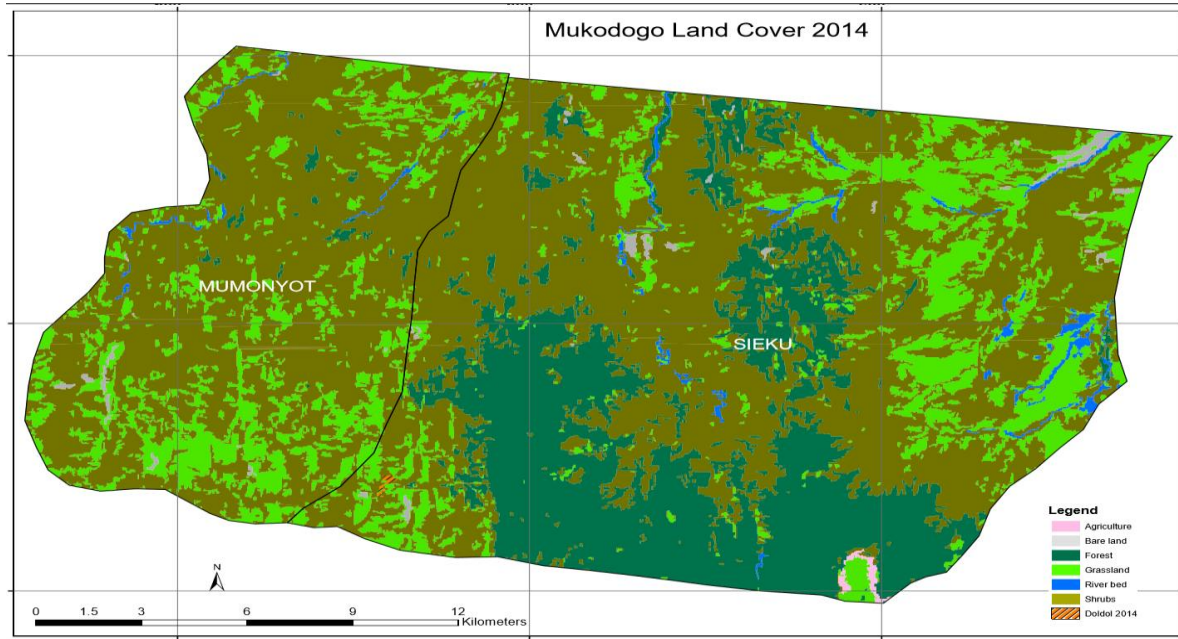


Plate 4.7: Mukogodo land cover 2014

As indicated in plate 4.7, the epoch of 2014, agricultural activity increased by more than 600% in this fourth epoch and the area was covered by forest (the green and dark green colour in plate 4.6). In this epoch shrub land had been noticed encroaching areas which had grassland. Grassland continued to reduce gradually of which by 2014, it had reduced by 40% as from 1984. The increase in agricultural activity during this epoch was attributed at Focus group discussion stage to be due to population increase and changing of livelihoods from pastoral to crop farming due to changing climate. Plate 4.8 below shows Mukogodo land cover change 2004to 2014

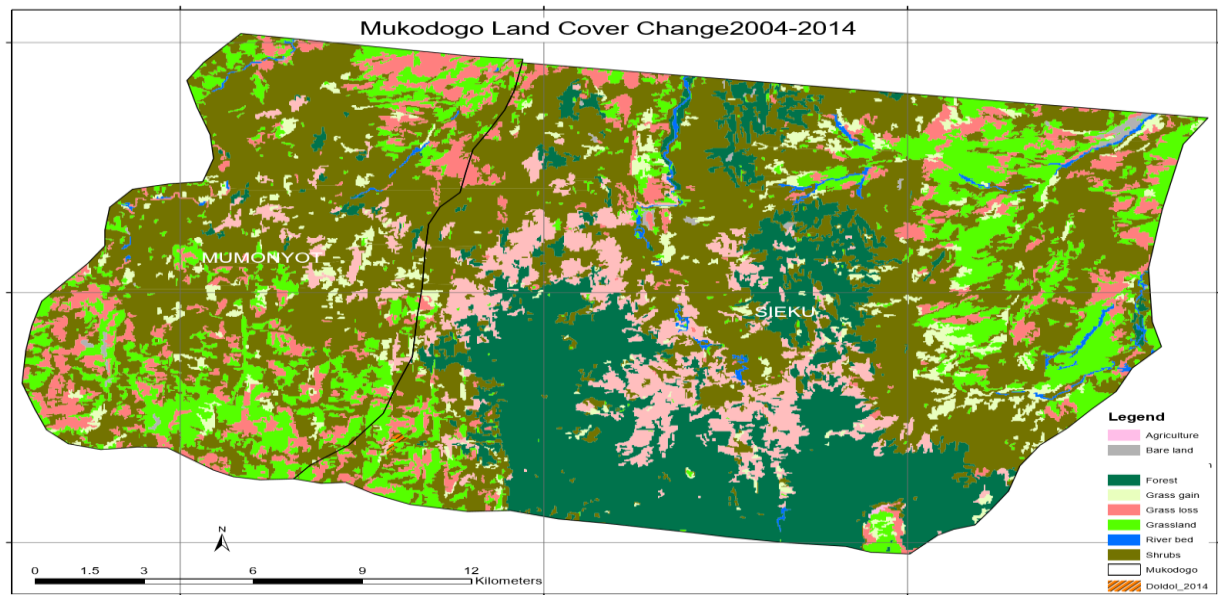


Plate 4.8:2004 to 2014 change map.

As indicated in plate 4.8, the period 2004 to 2014 the grasslands were lost and forested areas remained unchanged. Some areas of grassland regenerated while others lost grass cover giving a net grass loss. Deforestation continued. Table 4.5 below shows the land use changes in 2004 to 2014.

Table 4.5: 2004-2014 epoch

T1_class_1	2004_LC	2014_LC	Change	Area
14	Grassland	Grassland	Grassland	6875.922483
12	Shrubs	Shrubs	Shrubs	22858.861236
11	Bare land	Bare land	Bare land	147.327158
14	Grassland	Shrubs	Grass loss	3921.28586
14	River bed	River bed	River bed	351.417255
14	Shrubs	Grassland	Grass gain	1982.861362
9	Forest	Forest	Forest	9661.442734
12	Forest	Shrubs	Deforestation	3304.277771
12	Shrubs	Agriculture	Agriculture	8.82

As indicated in Table 4.5, between 2004 and 2014, 6,876 ha of grassland, 22,859 ha of shrubs and bush-land, 9,661 ha of forest remained unchanged. There was however a regeneration of 1,983ha of grassland against a more than double (3,921ha) loss of grassland. Deforestation was also at a record high of 3,304ha. Table 4.6 below shows of the land use changes in 1984 to 2014.

Table 4.6: Land use change in 1984 to 2014

Epoch	Land Cover Area in Hectares						Total Land cover
	Agriculture	Bare land	Forest	Grassland	River bed	Shrubs	
1984	9	527	12732	14723	292	20829	49112
1995	9	309	12710	11619	331	24134	49112
2004	-	173	12919	10797	331	24893	49113
2014	61	289	9661	8859	501	29741	49112

As indicated in Table 4.6, the first 3 epochs, (1984, 1995, 2004), there was very little agricultural activity which increased by more than 600% in the fourth epoch of which the third epoch (2004) had no agricultural activity at all. However, agriculture covered less than 0.2% of the total land cover. Grassland continued to reduce gradually of which by 2014, it had reduced by 40% as from 1984. The beneficially class cover was the shrubs and wood land which increased from 20,829hectares in 1984 to 29,741hectares in 2014. An average increase in hectares of shrubs and wood land of 42% in the three decades, with corresponding reduction of forest canopy from 12,732hectares in 1984 to 9,661 in 2014 a decrease of 24% gave the trend of vegetation changes.

4.5.2.1: Summary

This sub-section summarizes the results and discussions of determination of the change in land use and management in the last thirty years. Figure 4.84 below shows specific land use change per epoch.

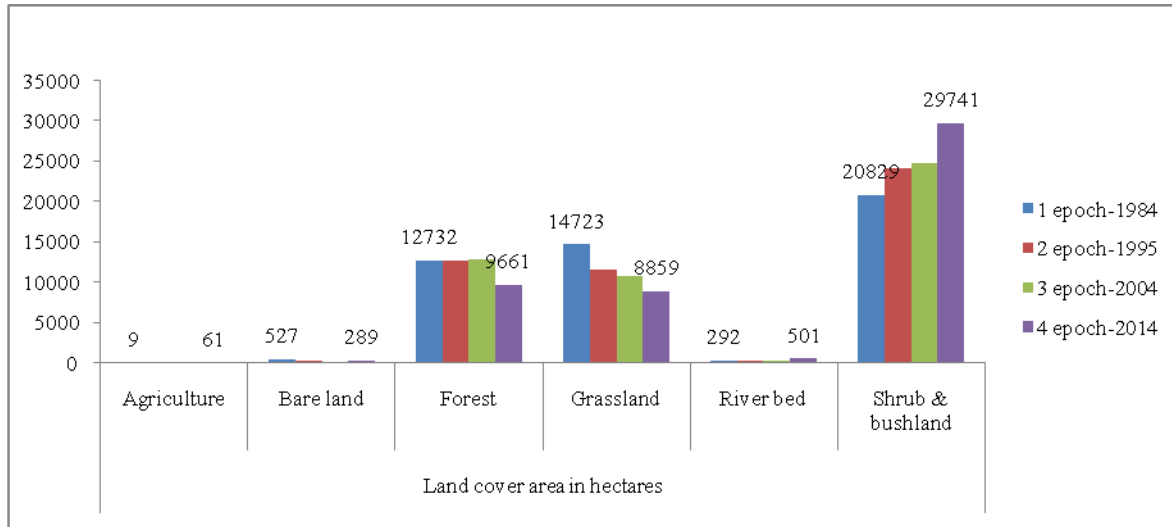


Figure 4.71: Specific land use change per epoch

In general as indicated by Figure 4.71, the land use types of study area were six of which three were main and other three minor. The main three, forest, shrub or bush-land and grassland changed during the last three decades of which grasslands reduced by 5,864 hectares (40%), forest by 3,071 hectares (24%), shrub & bush-land increased by 8,912 hectares (43%). The other three minor land use types were bare land which had reduced by 238 hectares (45%), river bed vegetation increased by 209 hectares (72%) and agriculture increased by 52 hectares (600%) over the last three decades. The opinion of the community on the change of land use and management was attributed to climate change and also adaptation strategies applied by the community over time as discussed under section 4.3 and also due to characteristic of parameters of climate as discussed in section 4.5.1. As evidenced by (Niang *et al.* 2014; Muller *et al.* 2011; Sarr 2012). Climate change impacts include shortening or disruption of growing seasons, reductions or increase in the area suitable for agriculture, and declines in agricultural yields in many regions of sub-Saharan Africa. In Yaaku community all these impacts were evidenced and thus mitigation measures were suggested to address the impacts.

4.5.3 Objective 3: Vulnerability and impacts to climate change of the Yaaku community

For this different stakeholder quantified the vulnerability and impacts of climate change under the following: hazard assessment and ranking, vulnerability assessment due to climate change and capacity assessment in relation to climate change. Plate 4.9 below shows stakeholders

involvement in quantification of the vulnerability and impacts to climate change of Yaaku Community.



Plate 4.9: Yaaku community of Sieku location and other stakeholders at Sieku Primary School during a CMDRR exercise

As indicated in plate 4.9 different stake holders were involved in the quantification of the vulnerability and impacts to climate change. These stakeholders included community leaders, men, women, youth, elderly, people living with disability, people living with HIV& Aids, professionals of various sectors both government and non-government, religious leaders and politicians in a venue at the community level where they deliberated for five days. This was a focus group discussion referred to as Community Managed Disaster and Risk Reduction (CMDRR). All issues of quantification of vulnerability and impacts to climate change were huddled by this group of thirty persons drawn from the nine villages which represented the community. This participatory tool of community mobilisation used assisted to identify and quantify the vulnerability and impacts of climate change in the community and first ranked the hazards and subsequent ranking of villages in degree of vulnerability to the hazard.

As indicated by O'brien et al., (2004) that the first step in vulnerability mapping involves the creation of a climate change vulnerability profile, and that Vulnerability to climate change is generally understood to be a function of a range of biophysical and socioeconomic factors; in

this study the (biophysical and socio-economic factors were classified in to five livelihood capitals (DFID 1999) and political capital to map vulnerability due to climate change. As reported by *McCarthy et al., 2001*) that Intergovernmental Panel on Climate Change (IPCC) provides a useful typology suggesting that vulnerability may be characterized as a function of three components: adaptive capacity, sensitivity, and exposure, the same was used by the study but utilised a community managed participatory tool and community respondents opinion on the same (section 4.4) to get (sensitivity, exposure and adaptive capacity) to climate change at the community level.

4.5.3.1: Hazard Assessment

Hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. One group of participants with the eldest man who was aged 50 years was asked to profile various hazards the community had experienced in the past. The hazard, year of occurrence and the magnitude of impact and frequency were identified and ranked in order of socio-economic importance. The group came up with a list of various hazards which were subjected to plenary discussion by the three groups and came up with three most important hazards that were further subjected to hazard assessment(Appendix 4) of which climate change was ranked first (Table 4.7) and subjected to the analysis

Table 4.7 below shows hazard which affect Yaaku community ranked in order.

Table 4.7: Hazard assessment and ranking

HAZARDS	FL	FR	CC	HC	HD	LD	L	HWC	IP	ED	SCORE	RANK
Floods (FL)	FL	FR	CC	HC	HD	LD	FL	HWC	IP	ED	1	9
Fires (FR)		FR	CC	HC	HD	LD	FR	HWC	IP	ED	2	8
Drought-Climate change (CC)			CC	CC	CC	CC	CC	CC	CC	CC	9	1
Human Conflict (HC)				HC	HC	HC	HC	HC	HC	HC	8	2
Human Diseases (HD)					HD	HD	HD	HD	ED	ED	6	3
Livestock Diseases(LD)						LD	LD	HWC	LD	LD	5	5
Locust infestation(L)								HWC	IP	ED	0	10
Human wildlife conflict(HWC)									IP	HWC	5	4
Invasive Plants(IP)										IP	5	6
Environmental Degradation (ED)											4	7

From the analysis in the Table4.7, it is clear that climate change scored the highest (score of 9) and therefore was ranked number one (1) hazard. Locust infestation was the least felt with a score of zero (0) and hence ranked number ten (10) this was because the few cases of army worm over the years was confused with locust. Therefore the hazard which affect the Yaaku community were ranked in descending order as follows: climate change (drought), human conflict, human diseases, human wildlife conflict, livestock diseases, and invasive plants environmental degradation, fires, floods and locust infestation.

4.5.3.2: Vulnerability assessment in relation to climate change

This refers to the identification done on what elements were at risk because of the exposure of their location to the climate change. The location of the element at risk (the rich and poor houses) determined the degree of exposure to climate change or the degree of vulnerability. That

indicated that whether rich or poor, all persons who lived in that location had equal degree of vulnerability to the impact of climate change. The class elements were as listed below;

Elements; Men, Women, Children, Youth, Elderly, people living with disability (PLWD) and People living with HIV and Aids. Table 4.8 below shows village's ranked in order of their vulnerability to climate change,

Table 4.8: Ranking of villages on vulnerability to climate change.

Names of villages	Location	NM	SK	ND	KM	BK	S	LT	LM	T/P	SCORE	RANK
Narmaral (NM)	sieku			NM	NM	NM	NM	NM	NM	NM	8	1
Sieku (SK)	sieku			SK	SK	SK	SK	SK	SK	SK	7	2
Nadungoru (ND)	sieku				K/M	B/K	S	L/T	L/M	T/P	0	9
Kurikuri (KM)	mukogodo					BK	S	L/T	L/M	T/P	1	8
Bokish/Kantama(BK)	mukogodo						B/K	B/K	B/K	B/K	6	3
Seek(S)	mukogodo							L/T	L/M	S	3	6
Lorien/Tool(LT)	mukogodo								L/M	L/K	3	5
Loreprepi/	mukogodo									L/M	5	4
Maraimenek(LM)												
Toirai/	mukogodo										2	7
Pisho(TP)												

From the analysis in the Table 4.8, it is clear that Naimaral scored the highest (score of 7) and therefore was ranked number one (1) most vulnerable. Nadunguru was ranked least after scoring (0) least vulnerable. The villages in the order from the most vulnerable to least vulnerable are as follows: Narmaral (NM), Sieku (SK), Bokisha & Kantama (BK), Loreprepi & Maraimenek (LM), Lorien & Tool (LT), Seek (S) Toirai & Pisho (TP), Kurikuri (KM) and Nadunguru (ND), respectively.

The degree of vulnerabilities of the villages increased as the village distance increased in relation to infrastructure such as market centres, schools, water facilities, roads, police station, mobile network communication and health facilities. Climate change has affected these facilities in the Mukogodo ecosystem in that they are either underdeveloped or in poor condition. This ranking will help all stakeholders when addressing the climate change and other development issues in the Mukogodo area so that the neediest village are targeted. Figure 4.72 below shows map of Yaaku village's vulnerability to climate change

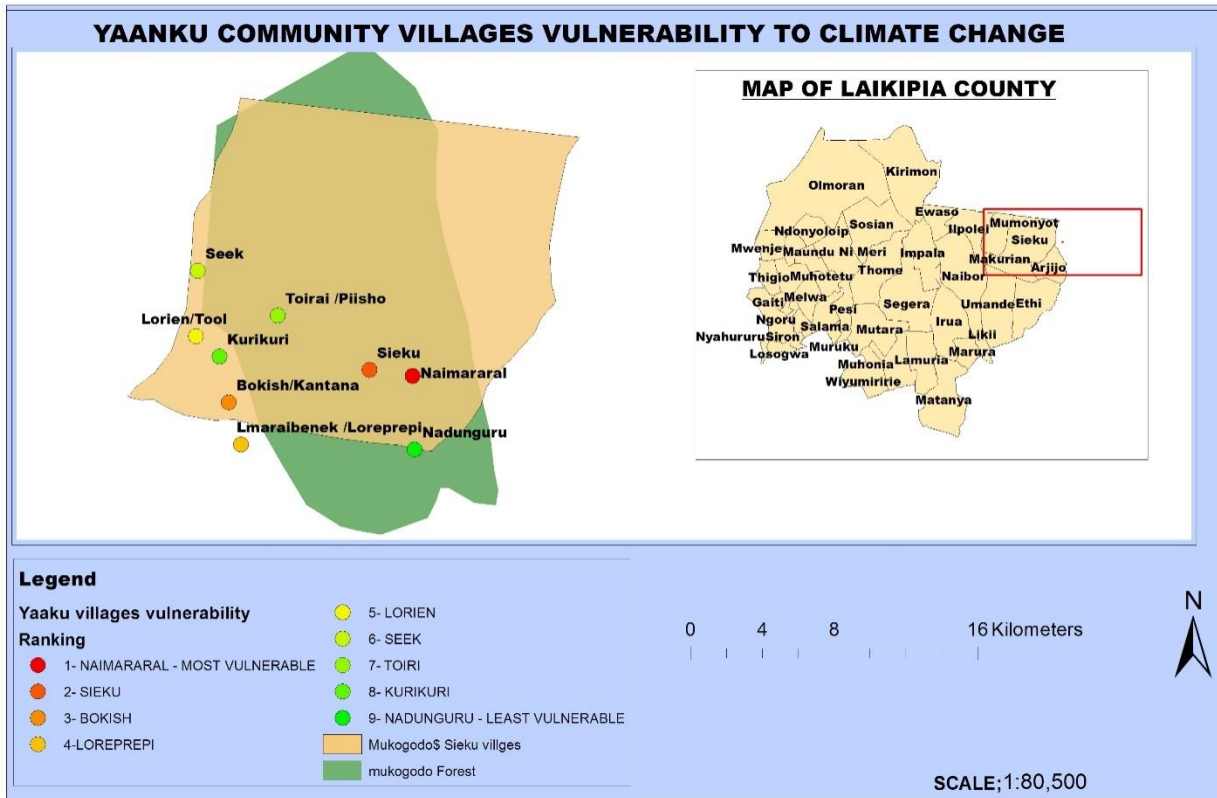


Figure 4.72: Map of vulnerability to climate change impacts of Yaaku villages.

As indicated in the Figure 4.72, the villages are mapped for ease of identification and location. The vulnerability mapping of villages is based on a drought situation in assumption that even if the forested pastoral community moves in search of livestock feed and water during drought, the women and children with few milking herd are left at the village.

4.5.3.3: Capacities Assessment in relation to climate change

The capacities are a combination of all the strengths and resources available within a community, society or organizations that can help reduce the level of risk or effects of a disaster. Capacity included physical, social, institutional, political or economic means as well as skilled personal or collective attributes such as leadership and management (livelihood frame works capital plus political capital) It identified the status of people’s coping strategies which referred to the resources available for preparedness, mitigation and emergency response, as well as to who had access and control over those resources. Plate 4.10 below shows the resources of the Mukogodo location.

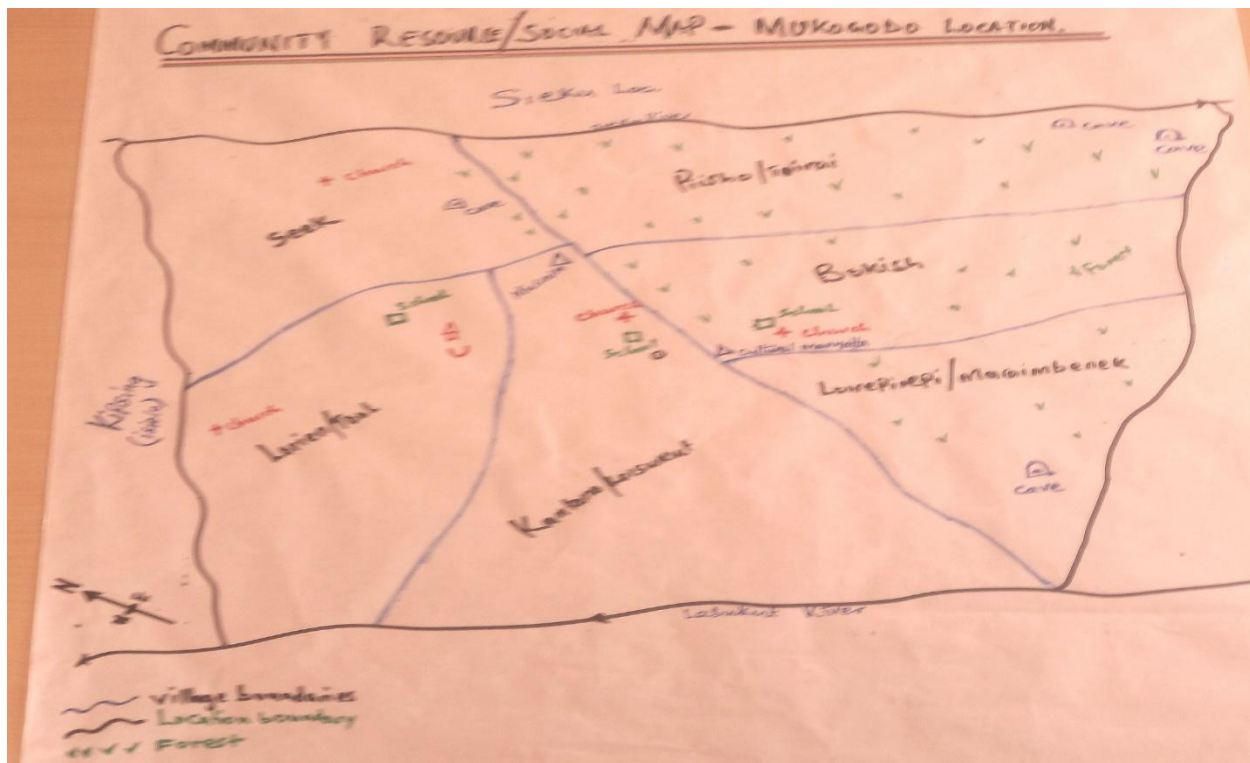


Plate 4.10: Mukogodo location Community resource map

Plate 4.10 above tries to help analyse what is where and proximity for utilization. Who owns what in a given community or household and also who has the control or just the access to the usage of the asset or resource. According to the plate 4.10, this location is covered half is forested and people live in both forested and deforested areas. The location has dry river valley along one of its side forest, a school and no evidence of roads. Therefore in assessment of the capacity, all resources were considered. Table 4.9 below shows livelihoods strategies of the Yaaku community.

Table 4.9: livelihood strategies of Yaaku community

Livelihoods	Ranking of the livelihood in the community
1. Bee keeping	2
2. Livestock keeping	1
3. Formal Employment	5
4. Business	3
5. Farming	4
6. Hunting & Gathering	6

As indicated by table 4.9, the livelihood of the Yaaku depends on livestock, beekeeping, business, farming, formal employment and lastly hunting and gathering. Therefore their capacities were assessed base on the resources they have to sustain their livelihood as per the listed livelihood strategies. Because the main the main two are livestock and bee keeping, the community wealth was ranked based on the two livelihoods. Table 4.10 below shows wealth ranking in Mukogodo.

Table 4.10: Wealth Ranking in Mukogodo

Category	Characteristics
Rich 2%	50 cows and above 100 sheep & goats and above 300 hives and above
Middle 18%	10-50-cows (30-100) Shoats (100-300) Hives.
Poor 80%	0-10 cows 0-30 shoats 0-100 hives

As indicated in table 4.10, majority of the households are poor followed by the middle group then the rich based on livestock and bee keeping ownership. This is because ownership of livestock (cattle) is a very important indicator of wealth or poverty in Yaaku community. Wealth ranking in Yaaku community is therefore closely linked to either owning or not owning livestock or cattle within the community (and of course the numbers).

For example one is considered poor if the household owns zero to nine cows which is 80% of the population. Considered in meddle group if the household owns ten to forty nine cows which is 18% of the population and considered rich if the household owns fifty and above cows which is only 2% of the community. These findings in pastoral forested community concur with Aboud, (1982) that livestock is insurance to their survival and with (Hudson, 1970) that cattle play a major role in pastoralist personal aspiration, political inclination. Therefore the majority of the Yaaku community (80%) have no capacity to address, mitigate or even implement adaptation issues of climate change.

4.5.4: Objective 4: Development of response strategies for Yaaku community

As illustrated in section 4.1, Yaaku community occupied two locations and lived in nine villages. Therefore for effective interaction with the community the researcher, community administrators, conservation specialist within the community such as Kurikuri conservancy leadership, Lekuruki conservancy leadership, local county and national government administrators, extension staff of various ministries, women, youth and peoples living with disability representative organised ten days focus group discussion workshop for the community at location level. Each location had five days to give ten day for both locations, to discuss and come out with way forward for their community, the representation come from all the nine villages headed by the chief and community chairperson or elder. The facilitators come from line government's ministry or authorities and local non-governmental organizations. Their resources were mapped, problems identified in relation to climate change. The response strategies identified analysed by pair-wise ranking and documented as Disaster risk reduction plan as indicated by table 4.11 below.

Table 4.11: Yaaku Community Disaster risk reduction plan (DRR)-climate change

Identified Capacity GAP/ Problem	DRR measures /Recommendations/ Opportunities	Objectives	Activities Targets	Output/ impacts	Resources needed/ Budget	Responsibility/ Indicators
1. Water availability	Putting-up /construction of more water sources / facilities in the ward.	Availability and accessibility of quality water in the ward (4 locations)	Drilling of 8 strategic boreholes (2 per location)	Availability of quality water	40 m	Community Water Mgt Committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Construction of 12 water pans / dams (3 per location)	Availability of quality water	48 m	Community Water Mgt Committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Construction and installation of Piped water in the ward	Availability of quality water	20 m	Community Water Mgt Committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Spring protection (Protect all the water springs in the ward)	Availability of quality water	10 m	Community Water Mgt Committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Promote / support water	Availability of	25 m	Community Water Mgt Committee, Resilience,

			harvesting technologies in the ward	quality water		NDMA, LCG, any other relevant stakeholders/ Partners.
2. Livestock Marketing Programmes	- Having functional LMAs. - Having modern livestock markets	Effective and efficient livestock marketing system.	Formation & training of LMAs	Proper mgt of livestock markets.	0.6 m	LMAs, Laikipia LMA, Resilience, NDMA, LCG, any other relevant stakeholders.
			Strengthening & modernizing of the existing livestock markets, e.g. Chumvi, Doldol, Arjijo. (e.g. Installation of weigh bridges, loading ramp etc.)	Better returns from sale of livestock in the ward.	10.0 m	LMAs, Laikipia LMA, Resilience, NDMA, LCG, any other relevant stakeholders.
3. Pasture production and storage facility.	Large scale pasture production and storage facility	To provide adequate pastures to sustain livestock throughout the year.	Trainings in pasture production & conservation	Empowered community in terms of pasture production and conservation	1m	Community pastures production committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Seed bulking	Availability of indigenous pasture seeds	4m	Community pastures production committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Pasture production	Availability of pastures for livestock	10m	Community pastures production committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Hay stores / shades	Availability of pasture storage facility	3m	Community pastures production committee, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
4. Reseeding Programmes	Carry out reseeding programs	To have a well conserved environment	To carry out campaigns & trainings in rangeland reseeding	Empowered community in Range management	2 m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders
			Fencing, ploughing and reseeding of denuded areas	Reseeded rangelands	10m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders
			Use of biological	Eradicated	5m	Community Environmental

			means to clear the Opuntia	invasive plants		Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
			Uprooting and burying of the invader species.	Eradicated invasive plants	10m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
6. Environmental Conservation Programmes	To carry out environmental conservation programs	To have a well conserved environment	To carry out trainings in gully control	Empowered community in gully control	3m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
			To carry out campaigns in tree planting	Increased forest cover	5m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
			To control stocking rates	Controlled stocking rates	2m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
			Community capacity building in proper Range mgt practices	Well conserved environment	3m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
7. Livestock Disease Control/ Treatment Programmes	To carry out regular disease surveillance, vaccination campaigns and vet services	To have a disease free livestock in the ward	To carry out community trainings in livestock diseases and control	Empowered community on livestock diseases and control	3m	Community veterinary scouts, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
			To respond efficiently/effectively to reported livestock disease incidents in the ward	Efficient and effective response to livestock disease incidents	5m	Community veterinary scouts, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
			To conduct routine Vaccination campaigns in the ward	Disease free livestock in the ward	30m	Community veterinary scouts, Resilience, NDMA/LCG, OOP, any other relevant stakeholders/partners.
8. Trainings & support on breeds improvement	Campaigns, trainings and support on improved breeds	To have the ideal breeds for the area	Trainings & capacity building in ideal breeds.	Empowered community in terms of ideal	2m	Community breeds improvement committees, Resilience, NDMA, and LCG, any other relevant stakeholders / Partners.

t & preservation programmes				breeds		
			Support on breeds improvement & Conservation of those with superior traits.	Improved production from livestock	10m	Community breeds improvement committees, Resilience, NDMA, and LCG, any other relevant stakeholders / Partners.
9. Livelihood Diversification Programmes	Starting of other forms of livelihoods in the ward.	Having diversified livelihood strategies.	Promote and support engagement in Bee-keeping, poultry production, Leather production, Gums & Resins production, Small IGAs etc.	Increased diversified source of incomes.	25 m	Community livelihood Diversification committees, Resilience, NDMA, LCG, Chamber of commerce, any other relevant stakeholders/ Partners.
10. Grazing management system	To structure the grazing system in Mukogodo East Ward.	To have a well conserved environment in Mukogodo East (as a result of well-coordinated grazing system)	Designing Grazing Mgt system	Existence of Grazing mgt system & necessary structures / laws.	1.0 m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders
			Training in proper grazing systems. (Training in well-coordinated grazing system in the ward)	Empowered community in terms of environmental conservation	1.0 m	Community Environmental Conservation Committees, Resilience, NDMA/LCG, OOP, any other relevant stakeholders.
11. Proper stocking rates of livestock	-To carryout community sensitization on proper stocking rates -Destocking programmes - Accelerated livestock off-take.	To have the right number of livestock that can be sustained by the available pastures and water	Designing land carrying capacities.	Existence of known land carrying capacities in the Sub-County.	1.0 m	Community Environmental Conservation Committees, Resilience, NDMA/LCG/stakeholders.
			Campaigns in proper stocking rates.	Adoption of proper stocking rates by the community	0.8m	Community Environmental Conservation Committees, Resilience, NDMA/LCG/stakeholders.
			Facilitate destocking (Accelerated off-take)	Having proper stocking rates	10.0 m	Community LMAs, Resilience, NDMA, LCG and Partners.

12. Food preservation techniques & Cottage industries	-To carryout campaigns & trainings in food preservation. -Put up cottage industries.	Availability of food cottage industries and empowered community in food technology.	Campaigns and Training in food preservation.	Empowered community in terms of food technology	0.6 m	Community HOMECEC committees, Resilience, NDMA, LCG, any other relevant stakeholders
			Putting up of Food cottage industries in the ward.	Available food cottage industries	10.0 m	Community HOMECEC committees, Resilience, NDMA, LCG, Partners.
13. Afforestation Programmes	To carry out large scale planting of trees in the ward	To improve forest cover and general environmental health	Tree planting campaigns	Awareness created	0.3m	Community Environmental Conservation Committees, Resilience, NDMA/LCG/Forest Dept.
			Starting tree nurseries	Availability of tree seedlings for planting in the ward	0.8m	Community Environmental Conservation Committees, Resilience, NDMA/LCG/Forest Dept.
			Trainings	Well empowered community in Environmental conservation	0.5m	Community Environmental Conservation Committees, Resilience, NDMA/LCG/Forest Dept.
14. Fully fledged primary & secondary boarding schools	To put up fully fledged primary and secondary boarding schools in the ward	To keep pupils in school during climate change and enhance transition rates	Construction of the primary & secondary boarding schools in the ward	Availability of boarding schools in the ward	120m	Community road network committee, LCG, any other relevant stakeholders/ Partners.
			Equipping the boarding schools in the ward with the necessities	Availability of well-equipped boarding schools	40m	Community road network committee, LCG, any other relevant stakeholders/ Partners.
15. Road network to livestock markets programmes	To improve/construct access roads to livestock markets in the ward	To have easily accessible livestock markets in the ward	Construction / grading of roads.	Motorable roads leading livestock markets in the ward	100m	Community road network committee, LCG, any other relevant stakeholders/ Partners.
			Repairing & making of bridges	Opened up inaccessible livestock markets	50m	Community road network committee, LCG, any other relevant stakeholders/ Partners
16. Well-equipped	To construct and stock	Affordable and	Construct the health centre	Availability of	100m	Community road network committee, LCG, any other

health facilities	health centres and provide mobile service in the ward	accessible health service in the ward	& stock them with drugs / equipment.	affordable and accessible health service in the ward		relevant stakeholders/ Partners
			Provide four well stocked & equipped mobile clinics	Availability of affordable and accessible health service in the ward	10m	Community road network committee, LCG, any other relevant stakeholders/ Partners
17. More health personnel, CHWs & TBAs	Train and employ more health personnel in the ward	To improve health service delivery in the ward	Employ more health personnel.	Availability of trained health workers in the ward	3m	Community health committees, NDMA, LCG, any other relevant stakeholders/ Partners.
			Train and license more CHWs & TBAs	Availability of community based health workers in the ward	2m	Community health committees, NDMA, LCG, any other relevant stakeholders/ Partners.
18. Structured & well-Coordinated community organization s/ systems / Social systems	To have in place a well-structured community user/social groups in the ward	To enhance harmonious coexistence and usage of natural resources	Formation of User / social associations.	Existence user/social groups in the ward	1m	Community development committees, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Enacting of by-laws.	Existence of user bylaws	0.5m	Community development committees, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.
			Capacity building & exposure tours of user groups	Well managed and coordinated user/social groups	2m	Community development committees, Resilience, NDMA, LCG, any other relevant stakeholders/ Partners.

As indicated in table 4.11, various objectives were identified to address climate change impact at community level ranging from water provision to human health. Also various stakeholder identified whom could address the objectives and approximate cost of the activities

CHAPTER FIVE: SYNTHESIS AND DISCUSSIONS

5. 0: Introduction

This Chapter, brings together the key findings in the study and makes connections across and between the specific objectives, and derives a higher order discussion that addresses the overall objective.

5.1: Synthesis and discussions

The trend of weather elements of the forested pastoral ecosystem of Mukogodo, rainfall amounts, intensity and seasonality were more in last three decade and decreased progressively to present day. While the temperatures increased in the same period progressively. The distribution and reliability of rainfall was better in last thirty years than today. This was attributed to climate variability which has led to frequent droughts. Such changes in the rainfall regimes have been most keenly felt in dry forested ecosystem where water availability and timing are key factors controlling biogeochemical cycles, primary productivity and the phenology of growth and reproduction.

The impacts of climate change led to unreliability of the seasons in which MAM used to be the main long rain season in earlier years but now OND has turned to be more reliable in the Mukogodo area although less than normal season during last three decades. Therefore the changes have affected the amounts, intensity, distribution, seasonality, and reliability of rainfall, thus affected the livelihood of the Yaaku. The rainfall general net decrease of 200 mm witnessed over the period of which the most affected are the traditionally known seasons of MAM and OND.

There was an increase in maximum temperatures over the years. Maximum temperatures were higher during the main seasons of MAM and OND but lower in between in the months of June, July and august. Generally there was trend in temperature increase in the whole of three decades with the lowest average annual maximum temperature of 21.7°C in OND of 1989 and highest average annual maximum temperatures of 27.2°C in MAM 2009. The maximum temperature

increased by 1.43°C, 2.98°C and 0.18°C during MAM, JJA and OND seasons respectively, which gave an average increase of 1.5°C in the period.

The progressive increase of temperatures over the last three decades and changing rainfall distribution intensity amounts, seasonality and reliability, in Mukogodo area has led to changes in land use and management over the same period. The Mukogodo area has six land use types of which three are main and other three minor. The main three, forest, shrub or bush-land and grassland changed during the last three decades of which grasslands reduced by (40%), forest by (24%), shrub & bushland increased by (43%). The other three minor land use types are bare land which had reduced by (45%), river bed vegetation increased by (72%) and agriculture increased by (600%) over the last three decades. The community had the opinion that the change of land use and management was due to climate change. The community opinion proved the secondary analysed data over the period that the changes were due to climate change and also as evidenced by (Niang *et al.* 2014; Muller *et al.* 2011; Sarr 2012), climate change impacts include shortening or disruption of growing seasons, reductions or increase in the area suitable for agriculture, and declines in agricultural yields in many regions of sub-Saharan Africa.

The community could attribute the changes in the various capitals such as, the changing trend on, species biodiversity, water resources, wildlife number, land use, livestock numbers and bee keeping over last three decade to population increase which used the resources over the period coupled with climate change. However over the same period there was decrease in forest resources harvesting due to strong adaptation structure and strategies to impacts of climate change enforced in forest conservation by the community and community owned conservancies. Over the same period lack of social capital had aggravated the impacts of climate change to Mukogodo community. Thus the trend on community leadership, network without and within the community, conservation groups and stock friendship (livestock and Bees) were more in last three decade and decreased progressively. Also there was decrease in family cohesion (divorce or separation rate), number of community groups, in the same period. The physical capital that is sanitation, energy (electricity supply), roads network, farming equipment' sand housing structures and human capital trend on primary schools number, secondary schools number, health facilities numbers, malaria occurrence, use of radios and mobile phones increased over the period due to change in education level of community, practicing crop farming near their

sheltered home stead's, increase in awareness of political representation. In the case of financial capital the trend on banks availability, credit facilities availability, pension availability and savings were increasing due to changing environmental conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy.

Political landscape was the most dynamic over the period in that it was the period when the Kenya constitution 2010 came in use, and thus the community witnessed new political dispensation of which there was high hope that the dispensation will address the issues of climate change and adaptation. Therefore the influence has increased over the period of thirty years mostly of the Member of Parliament and Presidency. However last thirty and twenty years was associated with marginalisation of the community due to low human population which had negligible impact in political sphere, which lead to negligible address of climatic related mitigation measures by the political offices of day. The political sphere seemed to be the main delivery of adaptations and other issues of climate change.

The elements of weather such as rainfall and temperature, and the anthropogenic activities on various capitals in Mukogodo ecosystem led to Yaaku community being vulnerable to climate change. Therefore the relation of vulnerability of the Yaaku community and their adaptive capacity was specifically focused on political aspect of the social capital which is out-smarting all the other five capitals. In this region of Africa all climate related impacts are addressed politically either as a promise in order to get votes or as a development agenda by politicians.

Many climate change vulnerability scholars have drawn linkages between the capitals or entitlements (livelihood resources or assets) and adaptive capacity, particularly as it relates to social capital (Adger, 2003; Pelling and High, 2005).

Therefore a methodology of priorities of projects which were to help address climate change impacts were ranked as: Provision of adequate safe water programmes, livelihood diversification programmes example beekeeping, pasture production & storage programmes, reseeded programmes, environmental conservation programmes, livestock disease control programmes, modern livestock market programmes, livestock breeds improvement programmes, grazing management and stocking rates programmes, food preservation or cottage industries programmes forestation programmes, affordable boarding schools programmes, road network or

Infrastructure programmes, health facilities and personnel programmes and Structured community organizations or systems or social networks programmes. Having understood the bases in resilience of Yaaku community to impacts of climate change and the way they are using their local adaptive responses for continuous survival in the forested ecosystem, the study had to further documents the contingency plans, drought risk reduction plans and advise on policies to be put in place so the community is better place in climate change and adaptation related issues.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0: Introduction

This is the chapter where discoveries, deductions, inferences and solutions on targeted study courses of resilience of the pastoral communities in Laikipia to the impacts of climate change and how local adaptive responses are used by the community are documented.

6.1 Summary

The study had four specific objectives of which the summaries are based.

6.1.1: To identify the climate trend of Laikipia county for the last three decades.

The data on average annual rainfall and daily maximum and minimum temperatures from 1986 to 2015 was collected from Laikipia Meteorological Station in Kalalu of Mukogodo East Ward (Laikipia North) which is within the study area and Rumuruti (Laikipia West) and Laikipia air base (Laikipia East) for county situation comparison. A socio-ecological survey using a structured questionnaire was used to collect respondent's opinions on climate changes and adaptations on rainfall and temperature characteristics for last three decades from 1986 to 2015.

Laikipia county is diverse as per as climatic conditions are concerned in that it range from high rainfall and relatively low temperatures in Laikipia west (Nyahururu area) to high temperatures low rainfall areas in Laikipia North areas of Kimanjo. Mukogodo area is neither of these for is a dry land forested ecosystem. On average Laikipia west received more rainfall followed by areas of Laikipia North of Mukogodo forest area and surrounding Mt Kenya. Laikipia East got the lowest rainfall over the period. The high rainfall peaks were during the El Nino years of 1990 to 1991, 1997 and 2013 which recorded most rainfall while the La Niña low period of 1992 to 1993, 2000 to 2001, 2008 period reported very low rainfall. However, in Mukogodo the rainfall high peaks were in 1990, 1997, 2006 and 2012 to 2013 which were mostly the El Niño years. The lows peaks were observed in 1992, 2000 and 2008 which were La Niña years.

Mukogodo rainfall trends has different scenarios from other part of Laikipia in that although the annual average rainfall increased in last three decades, the March, April and May (MAM) rainfall trends decreased progressively, while the October November and December (OND)

increased slightly over the three decades. The general increase of average rainfall which was not the sum of MAM and OND was due to recorded rainfall in the other months of the year which are not defined seasons of Mukogodo area. The impacts of climate change led to unreliability of the seasons in which MAM used to be the main long rain season in earlier years but now OND has turned to be more reliable in the Mukogodo area although less than normal season during last three decades. Therefore the changes have affected the amounts, intensity, distribution, seasonality, and reliability of rainfall, thus affected the livelihood of the Yaaku. The rainfall general net decrease of 200mm was witnessed over the period of which the most affected were the traditionally known seasons of MAM and OND. The change in rainfall over the study period in Yaaku community of Mukogodo forested ecosystem was attributed to climate variability.

There was an increase in maximum temperatures over the years. Maximum temperatures were higher during the main seasons of MAM and OND but lower in between in the months of June, July and August. In Mukogodo area the year 2010 recoded the months with highest temperature and 2007 and 2008 had the lowest temperature, in June, July, August and OND. Generally there was trend in temperature increase in the whole of three decades with the lowest average annual maximum temperature of 21.7°C in OND of 1989 and highest average annual maximum temperatures of 27.2°C in MAM 2009. The maximum temperature increased by 1.43°C, 2.98°C and 0.18°C during MAM, JJA and OND seasons respectively, which gave an average increase of 1.5°C in the period.

The opinion on trend of climate elements of the respondent of the Yaaku community, rainfall amounts, intensity and seasonality were more in last three decade and decreased progressively to present day. While the temperatures increased in the same period progressively. The distribution and reliability of rainfall was better in last thirty years than today. This was attributed to climate change which has led to frequent droughts as indicated by focus group discussions and key informants. However Climate change has altered not only the overall magnitude of rainfall but also its seasonal distribution and inter-annual variability worldwide (Easterling,2000): Such changes in the rainfall regimes have been most keenly felt in dry forested ecosystem where water availability and timing are key factors controlling biogeochemical cycles, primary

productivity and the phenology of growth and reproduction. Mukogodo forested pastoral ecosystem is no exceptional to these climate change impacts.

6.1.2: To determine the changes in land use and management for the last three decades.

The remote sensed data from land-sat images of the area for last three decades was collected from regional centre for mapping of resources for development (RCMRD) to determine land use changes. In the classification, maps were generated using specialist software (IMPACT Toolbox, Erdas and ArcGIS). The maps show the land cover status of the four Epochs, 1984, 1995, 2004, changes between each of the epoch; i.e. 1984-1995, 1995-2004 and 2004-2014 which show the statistics of change. Field validation was done to improve the classification and to come up with class cover validation and errors of classification computed. A socio-ecological survey using a structured questionnaire was used to collect respondent's opinion on climate changes and adaptation on land use and management in specific based on livelihood capitals for last three decades as from 1986 to 2015.

The first 3 epochs, (1984, 1995, 2004), there was very little agricultural activity which increased by more than 600% in the fourth epoch of which the third epoch (2004) had no agricultural activity at all. However, agriculture covered less than 0.2% of the total land cover. Grassland continued to reduce gradually of which by 2014, it had reduced by 40% as from 1984. The beneficially class cover was the shrubs and wood land which increased from 20,829 hectares in 1984 to 29,741 hectares in 2014. An average increase in hectares of shrubs and wood land of 42% in the three decades, with corresponding reduction of forest canopy from 12,732 hectares in 1984 to 9,661 in 2014 a decrease of 24% gave the trend of vegetation changes.

In general the land use types of study area were six of which three were major and other three minor. The main three, forest, shrub or bushland and grassland changed during the last three decades of which grasslands reduced by 5,864 hectares (40%), forest by 3,071 hectares (24%), shrub & bushland increased by 8,912 hectares (43%). The other three minor land use types were bare land which had reduced by 238 hectares (45%), river bed vegetation increased by 209 hectares (72%) and agriculture increased by 52 hectares (600%) over the last three decades. The opinion of the community on the change of land use and management was attributed to climate

change and also adaptation strategies applied by the community over time and also due to characteristic of parameters of climate as evidenced by Niang *et al.*, (2014), Muller *et al.* (2011), and Sarr (2012). Climate change impacts include shortening or disruption of growing seasons, reductions or increase in the area suitable for agriculture, and declines in agricultural yields in many regions of sub-Saharan Africa. In Yaaku community all these impacts were evidenced and thus adaptation and mitigation measures were suggested to address the impacts.

The remote sensed data was triangulated by data from household survey where the community gave their opinion on trend of various livelihoods capitals over the period of thirty years , the opinion on trend of selected natural capitals or assets of the respondent of the forested pastoral ecosystem of Mukogodo, home of Yaaku community the trend on, species biodiversity, water resources, wildlife number, land use, livestock numbers and bee keeping were more in last three decade and decreased progressively to present day. This was due to population increase which used the resources over the period coupled with climate change. There was decrease in forest resources harvesting in the last thirty years. This phenomenon was contrary to the norm but was explained by the community that strong adaptation structure and strategies to impacts of climate change were enforced in forest conservation. This was attributed to climate change which has led to various impacts as indicated by focus group discussions and key informants.

The opinion on trend of selected social capitals or assets of the respondent on community leadership, network without and within the community, conservation groups and stock friendship (livestock and Bees) were more in last three decade and decreased progressively. This was due to population increase which used the resources over the period coupled with climate change. There was decrease in family cohesion (divorce or separation rate), number of community groups, in the same period progressively and the community leadership slightly remained constant. The issues associated with this change ranged from change in education levels of female gender, lack of property by the male gender, coming of communication system example mobile phones, and interaction with other none neighbouring community and migration to market centres example Doldol. Social capital plays an important role in people's adaptive capacity.

The opinion on trend of selected physical capitals or assets of the respondent of the Yaaku community on sanitation, energy(electricity supply), roads network, farming equipment' sand housing structures were less in last three decade and increased progressively to present day. This was attributed to in coming of political influence and education facilities in the recent years. Water structures availability was almost constant in the three decades. The issues associated with this change ranged from change in education level of community, practicing crop farming near their sheltered homesteads, lack of political representation

The opinion on trend of selected human capitals or assets of the respondent of Yaaku community on primary schools number, secondary schools number, health facilities numbers, malaria occurrence, use of radios and mobile phones were less in last three decade and increased progressively to present day. The issues associated with this change ranged from change in political representation to help in schools, and health facilities establishment in last 10 years. Malaria occurrence was more in the last three decades than now. The issues associated with this change ranged from change in political representation to help in schools, and health facilities establishment in last 10 years.

The opinion on trend of selected financial capitals or assets of the respondent of Yaaku community on banks availability, credit facilities availability, pension availability and Savings were less in last three decade and increased progressively to present day. These migrations were attributed to changing environmental conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy. The last thirty and twenty years these activities were insignificant and were believed to surface in the last ten years due to opening of Sacco and banks in the neighbourhood in the last 10 years and migration of some community members to neighbouring market centres to operate small business. These migrations were attributed to changing environmental conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy.

The opinion on trend of selected political capitals or assets of the respondent of Yaaku community was increasing in member of county assembly influence, Member of Parliament influence, and County government governor influence, county women representative influence, member of senate influence and President of the republic influence were less in last three decade

and increased progressively to present day. This is due to change in governance after the implication of the new constitution few years ago. There was a decreasing influence because some of the political offices like the member of county assembly, county women representative, governor and member of senate were associated with government devolution status coming into being last ten years, thus their offices were not operational in the last thirty and twenty years. However last thirty and twenty years was associated with marginalisation of the community due to low population which had negligible impact in political sphere, which lead to negligible address of climatic related mitigation measures by the political offices of the day.

6.1.3: Objective 3: To quantify the vulnerability and impacts to climate change.

The methodology used by (Abdi & Cordaid (2011), IIRR & Cordaid (2013), CARE international (2015) of assessing vulnerability was applied. In this methodology, vulnerability, is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes, and also is a function of the character, magnitude and rate of climate variation to which a system is exposed and its adaptive capacity (IPCC, 2001).

Degree of exposure varied for the different elements at risk of climate change impacts (human and non-human economic assets, institutions, and critical service which provide facilities (IIRR & Cordaid, 2013). That is: human disaggregated by gender, age, special conditions, productive assets e.g. livestock, farmland/crops, shops, critical service providing facilities e.g. schools, health units, markets, roads, bridges, the tools used are vulnerability mapping and vulnerable village ranking, livelihoods strategies and wealth ranking. Capacity: Referred to individual and collective strengths and resources that can be enhanced, mobilized and accessed to allow individuals and communities to shape their future by reducing climate change risk. The aim of capacity assessment was to identify the existing capacities, the required capacities to cope in the face of the climate change impact and the gaps. Capacity was classified into the following categories, human capabilities (knowledge, skills, attitudes), economic (assets e.g. livestock, farm land money), natural (forests, rivers, waters sources), physical (roads, bridges, hospitals) and social (institutional, cultural, political, and ideological). The tools used were social or resource map, livelihood strategies and wealth ranking. A socio-ecological survey using a structured questionnaire was used to collect respondent's opinion on climate changes and

adaptation on vulnerability of household of Yaaku community for last three decades as from 1986 to 2015.

Climate change vulnerability was assessed by sought of opinion of the respondents on the key impacts of climate change and their corresponding vulnerabilities in response to sensitivity to vulnerability, which was high (59.6%), medium (16.3%) and low (20.8%). When the sensitivity to vulnerability to climate change impact is high, then the community is highly susceptible to the impacts of climate change and disaster risk reduction and contingency plans needed to be in place. In response to exposure to vulnerability, was high (61.7%), medium (24.2%) and low (11.3%). When the exposure to vulnerability to climate change impact is high, then the community is highly susceptible to the impacts of climate change and disaster risk reduction and contingency plans needed to be in place. The corresponding vulnerabilities in response to adaptive capacity to vulnerability, was high (3.3%), medium (12.5%) and low (81.3%). When the adaptive capacity to vulnerability to climate change impacts is low, then the community is highly susceptible to the impacts of climate change and disaster risk reduction and contingency plans needed to be in place. If sensitivity is high, while exposure is high and adaptive capacities high then the community internal response mechanism are enough to address the climate change impact. Many scenarios presents them self but the address is based on the situation at hand for each climate change impact.

In the case scenario of Yaaku the sensitivity was high, the exposure high and adaptive capacity low. This means that the community is very vulnerable to impacts of climate change only that they had tradition adaptation mechanism of environmental protection whereby they only collect and use old dead trees not live ones. This belief in the community has conserved the environment to some extent.

6.1.4: To Work with the community to develop suitable response strategies.

A tool employed was community managed disaster risk reduction (CMDRR) as used by Abdi & Cordaid, (2011) and CARE International (2015) to help community to participate in development of response strategies to reduce climate change impacts. Data was used to draw community disaster risk reduction plans and community contingency plans. With help of area

administration and the extension workers, the Key Informant (KI) interview consisted of eight participants purposively sampled within various social economic groups of Yaaku pastoralists which helped to develop preparedness and response strategies. A socio-ecological survey using a structured questionnaire was used to collect respondent's opinion on climate changes and response strategies to climate change impacts of household of Yaaku community for last three decades as from 1986 to 2015.

The respondents gave their opinion of various issues in relation to response strategies and all were said to be lacking but in different opinion percentages, for access to information on disaster risks, for disaster risk management plans implementation in the county, the community are lacking information on disaster risks, had no disaster management plans, no information on early warning system, was lacking institution for implementation of adaptations, that County government had no capacity to monitor and analyse information on current and future climate risks, that mechanisms were not in place to disseminate the climate change information, that county governments and other stake holder providers had no capacity to plan and implement climate change adaptation activities, that there were no resources allocated for the implementation of climate change adaptation related policies, that there were no involvement of stakeholders in the climate change related vulnerability planning, that there were no involvement of marginalised groups and women in the climate change related vulnerability planning, that there were no policies that provided access to and control over critical livelihoods resources for the pastoralists, of the respondents gave their opinion that there were no vulnerable groups influence over factors that constrain the adaptive capacity, that there were no existent of vulnerability maps for the current and under a changing climate. However on the matters of vulnerability map; the study with the community mapped and ranked the villages of the Yaaku according to their vulnerability to climate change.

Therefore there was room to improve adaptive capacity to impacts of climate change of the community by proposal of various interventions to address issues of climate change in the community. Some of the intervention agreed at focus group discussion (CMDRR) were: provision of ideal livestock breeds for the forested ecosystem, provision of water accessible to both livestock and human, diversification of livelihoods as alternative source of income, a systematic off take and marketing system for sale of livestock that has efficient and effective

flow of market information, provision of enough feed reserves for livestock and food for human, planting of climate change tolerant crops, planting of trees (afforestation) in degraded area of the forest and reseedling of the denuded areas.

6.2: Conclusions

The purpose of this study was to understand through targeted studies what caused the resilience of the pastoral communities in Laikipia to the impacts of climate change by identifying the climate trend of Laikipia county, determining the changes in land use and management quantified the vulnerability and impacts to climate change of the Yaaku community for the last three decades while developing response strategies for the Yaaku community.

The impacts of climate change led to unreliability of the seasons in which MAM used to be the main long rain season in earlier years but now OND has turned to be more reliable in the Mukogodo area although less than normal season during last three decades. Therefore the changes have affected the amounts, intensity, distribution, seasonality, and reliability of rainfall, thus affected the livelihood of the Yaaku. The rainfall general net decrease of 200mm was witnessed over the period of which the most affected were the traditionally known seasons of MAM and OND. The change in rainfall over the study period in Yaaku community of Mukogodo forested ecosystem was attributed to climate change

There was an increase in maximum temperatures over the years. Generally there was trend in temperature increase in the whole of three decades with the lowest average annual maximum temperature of 21.7°C in OND of 1989 and highest average annual maximum temperatures of 27.2°C in MAM 2009. The maximum temperature increased by 1.43°C, 2.98°C and 0.18°C during MAM, JJA and OND seasons respectively, which gave an average increase of 1.5°C in the period.

As indicated by Easterling (2000), that climate change has altered not only the overall magnitude of rainfall but also its seasonal distribution and interannual variability worldwide; same has been witnessed for Mukogodo ecosystem. Such changes in the rainfall regimes have been most keenly felt in dry forested ecosystem where water availability and timing are key factors controlling biogeochemical cycles, primary productivity and the phenology of growth and reproduction. Mukogodo forested pastoral ecosystem is no exceptional to these climate change impacts.

The land use types of study area are six of which three are major and other three minor. The main three, forest, shrub or bushland and grassland changed during the last three decades of which grasslands reduced by 5,864 hectares (40%), forest by 3,071 hectares (24%), shrub & bushland increased by 8,912 hectares (43%). The other three minor land use types were bare land which had reduced by 238 hectares (45%), river bed vegetation increased by 209 hectares (72%) and agriculture increased by 52 hectares (600%) over the last three decades.

The change of land use and management was due to climate change and also adaptation strategies applied by the community over time and also due to characteristic of parameters of climate as evidenced by Niang *et al.* (2014), Muller *et al.* (2011) and Sarr (2012). Climate change impacts include shortening or disruption of growing seasons, reductions or increase in the area suitable for agriculture, and declines in agricultural yields in many regions of sub-Saharan Africa. In Yaaku community all these impacts were evidenced and thus adaptation and mitigation measures were suggested to address the impacts.

The trend of selected natural capitals, such as social capitals, was more in last three decade and decreased progressively to present day. The change of species diversity and degradation of scenery site of caves due to climate change has reduced tourism activity around Mukogodo forest. This was due to population increase which used the resources over the period coupled with climate change and that social capital plays an important role in people's adaptive capacity.

The trend of selected physical capitals, human capitals and financial capitals or assets were less in last three decade and increased progressively to present day. This was attributed to in coming of political influence and education facilities in the recent years and for financial capital attributed to changing environmental conditions of the forested ecosystem due to climate change which influenced livelihoods from pastoral to cash economy.

The political influence has increased over the period of thirty years mostly of the Member of Parliament and Presidency. However last thirty and twenty years was associated with marginalisation of the community due to low human population which had negligible impact in political sphere, which lead to negligible address of climatic related mitigation measures by the

political offices of day. The political sphere seemed to be the main delivery of adaptations and other issues of climate change.

The vulnerability of the Yaaku community and their adaptive capacity was specifically focused on political aspect of the social capital which is out-smarting all the other five capitals. In this region of Africa all climate related impacts are addressed politically either as a promise in order to get votes or as a development a gender by politicians.

That one of the most appropriate method of assessing vulnerability due to climate change is by community participation approach such as Community Managed Disaster and Risk Reduction (CMDRR).

6.3: Recommendations

Several recommendations were made to address climate change impacts in pastoral community in forested ecosystem as on strategy, policy and further study.

6.3.1. On strategy

- First, there were need to involve or inform the community through various media, especially through workshops the existence of climate change and its impacts to the ecosystem and community; where by the researcher organised one workshop to give research findings of the study.
- To address the unreliability of rainfall :It was recommended to have rainwater harvesting facilities for both domestic, livestock and irrigation probably in the lower un forested areas.
- To address increase in temperatures: It was recommended to engage in re-afforestation programme in denuded areas probably by indigenous species and stop any activity which may accelerate increase in temperature due to climate change .for example cutting of live trees and charcoal burning.
- To address changes in land use where shrub or bush land are replacing grazing areas: controlled bush management and indigenous grass reseeding programme was advocated to restore original grasslands.

- To address decreasing numbers livestock: A strategy or a programme to address livestock production and health value chain be in place, including control of livestock theft.
- To address decreasing number of bee keeping activities: Community needed to adapt to modern beekeeping practice instead of over dependence on gathered forest honey
- To address decreasing social capital for example (networking, conservation groups, and stock friendship): Capacity building of the community was recommended on group dynamics and their importance in the community.
- To fast track increase in financial capital for example (Sacco, credit facilities, banks): capacity building needed to avoid group owned capital or assets securing credit for personal use.
- To solicit funds for addressing climate change impacts: The community should use the (CMDRR) report to solicit assistance from national, county government and other stake holders to help address climate change impacts in the pastoral forested ecosystem.
- To address response strategies: The traditional adaptation strategies of the Yaaku community to climate change impacts be documented and used in conjunction with the modern strategies for ecosystem sustainability.
- To address future climate change impacts: The community governments and other stakeholders need have vulnerability maps, contingency plans and disaster risk reduction plans.

6.3.2. On policy

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- To address increasing agricultural activities, agricultural (crop farming) activities be carried out in designated areas outside the forest conservation areas (ecosystem zoning) all in consultation with community and other stakeholders.
- To address decreasing numbers of wildlife: The conservancies of kurikuri, Lekuruki and neighbouring conservancies need to intensify surveillance to endanger wildlife species in the area in consultation with other concerned stakeholder.
- That the community was recommended to have some organised groups (environmental management committee) as suggested by Sjöholm and Shabani (1995) to address conservation, political and vulnerability issues in the pastoral forested ecosystem.

- To fast track increase in physical capital for example (sanitation, roads, electricity): The establishment of these structures need be in consultation with the community and environmental management plan in place.
- To fast track increase in human capital for example (primary schools, secondary schools and health facilities): The establishment of these structures need be in consultation with the community and environmental management plan in place.
- To fast track increase in political capital for example (member of county assembly, Member of Parliament, member of national senate, women representative, County governor and the presidency): Affirmative consideration of non-populous communities in decision making, resources allocation and human resource deployment.)
- To address vulnerability to climate change impacts: In the pastoral forested ecosystem be bottom up not top-down and probably done by use of participatory methodology; example Community Managed Disaster and Risk Reduction (CMDRR).
- To address trans-disciplinarily in vulnerability to climate change impacts: All stakeholders (institutions both government and non-government, marginalised group women youth people living with HIV & Aids people living with disability and elderly) involved in the assessment analyses and dissemination stages
- To address the climate change impact related issues: increase awareness to government and other stakeholders on climate change issues for example (allocation of resources and policies of how to utilize those resources)

6.3.3: Suggestion for further research

The following issues came out during the study and further investigations are needed.

- There is need to document the changes in species composition of the Mukogodo ecosystem over time.
- Investigations is needed to ascertain if there was any link of some of tradition adaptation strategies to climate change
- A study needed on Yaaku traditional adaptation strategies to climate change impacts and subsequent documentation.

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CHAPTER EIGHT: APPENDICES

Appendix 1: Questionnaire for household survey

Climate change impacts and adaptive responses; household survey May 2016 in Mukogodo East ward of Laikipia County

My name is Kiambi Gilbert M'mboroki . I am a student at the University of Nairobi pursuing a PhD degree in climate change and adaptation. I am collecting information for a study looking at the impacts of climate change and their adaptive responses on the Yaaku community .This study and survey are for educational purpose only. The information you provide will be treated with utmost confidentiality, and will NOT be personalized. Your identity will thus not be exposed. The information you provide will be treated with utmost confidence and will only be used for the purpose of this research. Your participation in this interview is voluntary and will not attract any direct benefits to yourself. You are free to withdraw from this interview at any moment. Your assistance in answering the questions truthfully and accuracy will be highly appreciated.

Do I have your permission to proceed with the interview? YES [] NO []

Questionnaire No.: []

Back ground information

Location: _____

Group ranch /conservancy: _____

Ward: _____

Village: _____

Name of the respondent: _____

(1) Gender of respondent: 1. Male [] 2. Female []

(2) Respondent's relationship to the head of household []

1. Head
2. Spouse
3. Parent

- 4. In laws
- 5. Child
- 6. Grandchild
- 7. Employee

(3) Name of head of the household: _____

(4) Age of head of the household/respondent

- 1. Below 25 years [] 4. 45 – 55 years []
- 2. 25 – 35 years [] 5. Above 55 years []
- 3. 35 – 45 years []

(5) Highest educational level reached by head of household:

- 1. University [] 2. College/technical training [] 3. Secondary school []
- 4. Primary school [] 5. Pre-primary school [] 6. No formal education []

Section 1: Climate change trends on livelihood capitals

1) Climate parameters:

A-Rainfall:

How has been the rainfall behaved in the last three decades, enter the codes in the table below.

Rainfall characteristics	Now	10 years ago	20 years ago	30 years ago
Amounts:(1=High 2=Low)				
Intensity (1=High 2=Low)				
Distribution:(1=Even 2=Poor)				
Seasonality:(1=Good 2=Poor)				
Reliability:(1=Ok 2=Not)				

B-Temperature:

How have been the temperatures behaved in the last three decades, enter the codes in the table below.

Temperatures characteristics	Now	10 years ago	20 years ago	30 years ago
Seasonal temperatures: (1=High 2=Low)				
Annual temperatures: (1=Ok 2=Not)				

2) Livelihood capitals

A-Natural capital

What change has occurred to the natural capitals in the last three decades? Enter the codes in the table below.

Natural capital/assets	Now	10 years ago	20 years ago	30 years ago
Harvesting of forest products (1=Increasing 2=Decreasing)				
Species biodiversity ;Trees shrubs, herbs, pastures (1=Increasing 2=Decreasing)				
Forest water resources; rivers, springs, wells(1=Increasing 2=Decreasing)				
Wildlife numbers (1=Increasing 2=Decreasing)				
Land use; degradation (1=Increasing 2=Decreasing)				
Livestock keeping; cattle/goats (1=Increasing 2=Decreasing)				
Bee keeping (1=Increasing 2=Decreasing)				

B-Social capital

What change has occurred to the social capitals in the last three decades? Enter the codes in the table below.

Social capital/assets	Now	10 years ago	20 years ago	30 years ago
Family cohesion ;divorce /separation rate (1=Increasing 2=Decreasing)				
Number of community groups (1=Increasing 2=Decreasing)				
Community leadership structure (1=Strong 2=Weak)				
Networks within and without the community (1=Increasing 2=Decreasing)				
Conservation groups (1=Increasing 2=Decreasing)				
Stock friendship; livestock and bees (1=Increasing 2=Decreasing)				

C-Physical capital

What change has occurred to the physical capitals in the last three decades? Enter the codes in the table below.

Physical capital/assets	Now	10 years ago	20 years ago	30 years ago
Water structures availability (1=Yes 2=No)				
Sanitation (1=Yes 2=No)				
Energy(electricity supply) (1=Yes 2=No)				
Roads network (1=Yes 2=No)				
Farming equipments (1=Yes 2=No)				
Housing structures ; for households				

(1=Permanent 2=Not Permanent)				
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D-Human capital

What change has occurred to the human capitals in the last three decades? Enter the codes in the table below.

Human capital/assets	Now	10 years ago	20 years ago	30 years ago
Primary Schools number (1=Increasing 2=Decreasing)				
Secondary schools number (1=Increasing 2=Decreasing)				
Health facilities numbers(1=Increasing 2=Decreasing)				
Malaria occurrence (1=Increasing 2=Decreasing)				
Use of radios and mobile phones (1=Increasing 2=Decreasing)				

E-Financial capital

What change has occurred to the financial capitals in the last three decades? Enter the codes in the table below.

Financial capital/assets	Now	10 years ago	20 years ago	30 years ago
Banks availability (1=Increasing 2=Decreasing)				
Credit facilities; micro finance, cooperatives availability (1=Increasing 2=Decreasing)				
Pension availability (1=Increasing 2=Decreasing)				
Savings (1=Increasing 2=Decreasing)				

F-Political influence

What change has occurred to the political environment in the last three decades? Enter the codes in the table below.

Political influence	Now	10 years ago	20 years ago	30 years ago
Member of county assembly influence <i>(1=Increasing 2=Decreasing)</i>				
Member of parliament influence <i>(1=Increasing 2=Decreasing)</i>				
County government governor influence <i>(1=Increasing 2=Decreasing)</i>				
County women representative influence <i>(1=Increasing 2=Decreasing)</i>				
Member of senate influence <i>(1=Increasing 2=Decreasing)</i>				
President of the republic influence <i>(1=Increasing 2=Decreasing)</i>				

In your own opinion who do you think can address the issues of climate change and adaptation in your community? Tick the answer.

- 1. Politicians []
- 2. Administrators []
- 3. Professionals []

Give short explanation of your answer.

Section 2: Climate Change Vulnerability

1) Key impacts

What are the key impacts and corresponding vulnerabilities in your area?

Key impacts	Corresponding key vulnerability	Sensitivity to vulnerability <i>(1=High 2=Medium 3=Low)</i>	Exposure to vulnerability <i>(1=High 2=Medium 3=Low)</i>	Adaptive capacity to vulnerability <i>(1=High2=Medium 3=Low)</i>

2) Climate-resilient Livelihoods:

a) Do you have access to scaled-down climate projections?

1. Yes [] 2. No []

b) Do you have access to information on current or future climate risks?

1. Yes [] 2. No []

c) Are there policies or plans to support climate-resilient livelihoods?

1. Yes [] 2. No []

d) List these policies/plans:

e) Do you think politicians/leaders understand climate-related risks on your livelihoods?

1. Yes [] 2. No []

f) How do they promote the adaptation strategies against these risks?

Risks	Adaptation strategy

3) Disaster Risk Reductions:

a) Which are the climate-related hazards that affect your livelihoods?

b) Do you have access to information on disaster risks?

1. Yes [] 2. No []

c) Are there disaster risk management plans being implemented in the County?

1. Yes [] 2. No []

d) Are there Early Warning Systems in Place in the County?

1. Yes [] 2. No []

e) Does the County Government have the capacity to respond to livelihoods disasters?

1. Yes [] 2. No []

f) List any other institutions in the County that are involved in disaster risk management

Institution	Location

4 Capacity Developments:

a) Are there institutions involved in research, planning and implementations of adaptations in the County?

1. Yes [] 2. No []

b) List the institutions:

Institution	Location

c) Does the County Government have the capacity to monitor and analyse information on current and future climate risks?

1. Yes [] 2. No []

d) Are there mechanisms put in place to disseminate the information to the pastoralists in the County?

1. Yes [] 2. No []

e) Does the County Government and other stakeholder's providers have the capacity to plan and implement adaptation activities?

1. Yes [] 2. No []

f) Are there resources allocated for the implementation of adaptation-related policies or plans?

1. Yes [] 2. No []

g) List the policies and Resource allocation:

Policy	Resource Allocation

h) Who is responsible for the resource allocation?

Resource	Responsible

h) What are the capacity needs and gaps for climate change adaptation?

Capacity Needs	Gaps

i) What are resource needs and gaps for climate change adaptation?

Resource Needs	Gaps

5 Underlying causes of Vulnerability:

a) Please indicate the social groups within your community who are more vulnerable to climate change:

b) Are the stakeholders involved in the climate-related vulnerability planning?

1. Yes [] 2. No []

c) Are the marginalized groups/women involved in climate-related vulnerability planning?

1. Yes [] 2. No []

d) Are there policies that provide for access to and control over critical livelihoods resources for all the pastoralists?

1. Yes [] 2. No []

e) Indicate factors that constrain the adaptive capacity of the most vulnerable groups within the community:

f) Do the vulnerable groups have any influence over the above factors?

1. Yes [] 2. No []

12. Are there existing vulnerability maps for the current and under a changing climate?

1. Yes [] 2. No []

Section 3: Sustainable Adaptation Strategies

1 Key adaptive strategy

What are key adaptive strategies to climate change do you have at the community level

Key adaptive strategy	How to address	Who to address

13. How do you rank the climate change adaptation strategies you have in place to safeguard your livelihoods in rate of 1-5 as follows: (1=Poor, 2=Fair, 3=Good, 4=Very Good, 5=excellent)

Key Adaptation strategies		Poor	Fair	Good	Very Good	excellent
i						
ii						

iii						
iv						
v						

2. In present scenario of current strategies to address climate change challenges associated with implementation of the above strategies, which strategies do you think are sustainable in your forested pastoral livelihoods under a changing climate in the County?

3. Please explain why you think the strategies are sustainable for the County situation

	Strategy	Explanation
i		
ii		
iii		
iv		
v		

4. What other action do you think should be taken by the National or County Government or any other stakeholder to enhance your livelihood resilience under a changing climate in the County?

THANK YOU VERY MUCH FOR YOUR TIME AND IDEAS!!!!

Appendix2: Questionnaire for Key Informant survey

Climate change impacts and adaptive responses; household survey May 2016 in Mukogodo east ward of Laikipia county

Sir/Madam: My name is: _____

Of _____

I am gathering information for a study looking at the impacts of climate change and their adaptive responses on the Yaaku Community

This study and survey are for educational purpose only. The information you provide will be treated with utmost confidentiality, and will NOT be personalized. Your identity will thus not be exposed. Your assistance in answering the questions truthfully and accuracy will be highly appreciated.

Name of the respondent _____

Sex _____ Age _____ Ward _____

Location _____ group ranch/conservancy _____

Village _____

Date of interview _____ Place of interview _____

Occupation and rank _____

Community role/position: _____

The Questions:

1. Are you aware of Climate Change?
2. What are the parameters that show that climate has changed?
3. How have these parameters changed over a period of time in the County?
4. What are the effects of these changes on livelihoods in the County?
5. What are the key impacts of climatic change on the livelihoods at the community level?

6. Which strategies can you employ to safeguard the livelihoods against the effects of climate change?
7. Which major challenges do encounter when applying the above strategies?
8. How vulnerable is the community under a changing climate?
9. In terms of:
 - i. What is the local context within which these changes to climate are occurring?
 - ii. What is community's level of exposure to these impacts?
 - iii. What is the community's capacity to respond effectively?
10. What are the climate change adaptation strategies for livelihoods at community level?
11. In your own opinion whom do you think is better placed to address climate change adaptation strategies apart from community itself?

THANK YOU VERY MUCH FOR YOUR TIME AND IDEAS!!!!

APPENDIX 3: COMMUNITY MANAGED DISASTER RISK REDUCTION (CMDRR) TOOL

Community Managed Disaster Risk Reduction can be defined as “a process of bringing people together within the same community to enable them to collectively address common disaster risks, and pursue common disaster risk reduction measures. It is a process that mobilises a group of people in a systematic way towards achieving a safe and resilient community. It envisions a dynamic community that is cohesive in making decisions, deals with conflicts resolves issues, manages collective and individual tasks, respects the rights of each individual, demands their rights and addresses and bounces back from hazard events” (Binas, 2010).

The CMDRR process aligns well with other disaster risk reduction frameworks. It focuses on avoidance (prevention) and limiting the adverse impacts of hazards within the broad context of sustainable development (through mitigation and preparedness). CMDRR is an emerging framework and strategy for development that provides a comprehensive way to address disaster risk. However, CMDRR is different from most other DRR approaches, in that it starts at the community level, by stimulating and facilitating community members to increase their own capacity to address disaster risk. It is not implemented in communities, but by communities themselves, who lead the way.

In this way, CMDRR enables communities and individuals to prepare themselves for hazards in a way that reflects their own priorities. The joint focus of CMDRR on community management and combining different short and long term disaster risk reduction (DRR) measures, involves a major shift in the thinking and attitudes of stakeholders; Abdi and Cordaid (2011). All have to start working in a proactive and flexible way that is responsive to changing situations and changing needs. Rather than merely responding after a disaster has happened .CMDRR aims at prevention and preparedness, at the community level. The process is managed by communities who seek their own ways to reduce disaster risk. Hazards will always exist and may increase, but wellprepared communities can always cope with them.

Basic philosophies and principles for CMDRR

The CMDRR approach advocates for the building of resilient communities as a building block for resilient nations. Although its emphasis is on the community, it also recognises the need for governments and other actors to assist.

The approach is guided by the following principles:

Communities have accumulated local knowledge in addressing hazard events.

Communities are survivors, not victims.

Basic rights are the foundation of human safety.

Community organisation is the key to successful disaster risk reduction initiatives.

Communities must take responsibility for their members who are most at risk (i.e. the poor or those with less capacity to cope, or the most affected).

The community should decide whether or not they are in a state of disaster, and whether they can cope on their own or need external assistance.

Resilience is not merely accumulated physical assets or secured livelihoods, it is also the individual person's will and ability to survive, and to claim his/her rights as a member of a just and equitable society.

In Abdi (2011) the four essential parts (the basic minimums) of facilitating CMDRR were outlined as:

- A. Participatory Disaster Risk Assessment and Analysis (PDRA&A)
- B. Development of Disaster Risk Reduction measures (a development plan and a contingency plan)
- C. Building strong community organizations
- D. Participatory Planning, Monitoring, Evaluation & Learning

CMDRR PROCESS AND METHODS

- Phases and steps in Community Managed Disaster Risk Reduction:
- Phase I: relationship setting-Commitment
- Phase II: engaging- Enhancing
- Phase III: institutionalizing
- Group exercise

Steps in Community Managed Disaster Risk Reduction:

Phase I: relationship setting-Committing

1. **Site entry and rapport building** – beyond physical presence establish a friendly and purposeful relationship (community sanction and commitment to partnership) the process

whereby the organizer/ development worker establishes rapport and a constructive relationship with the people; mutual respect and trust. A courtesy call to formal and informant leaders of different community groups/stakeholders(identify before), introduce the facilitating organization and team and clarify the goal of CMDRR, role of community and reciprocal role of the development workers

2. Maintaining purposeful relationship with community-interacts and maintains purposeful relationship with diverse and conflicting parties and views. Maintain your non-partisan position as you engage.
3. **Participatory Disaster Risk Assessment** – the process of gathering all relevant data about the community, such as physical characteristics (e.g., location, area, natural resources, climate, etc.), demographic features, economic and sociopolitical aspects of the community, environmental problems, etc. and able to determine the nature and extent of risk by analysing the characteristics of hazards, the degree of vulnerability and the capacity of the community.

3. 1 Community Hazard Assessment – defines the threats and understands the nature and behaviour of particular hazards. The assessment brings out information on the characteristics of hazards, specifically warning signs and signals, forewarning, speed of onset, frequency, period of occurrence and duration. PLA Tools: Hazard Source-Force Tree/Problem Tree, Scoring matrix/Pair wise ranking, Mapping, Story telling

3.2 Community Vulnerability Assessment – Vulnerability analysis is the process of estimating the susceptibility of 'elements at risk' in the community to various hazards. This assessment is to understand the complex combination of interrelated, mutually reinforcing and dynamic factors.

3.3 Community Capacity Assessment – Identify the strengths and resources present in individuals, households and the community to cope with, withstand, prevent, prepare for, mitigate or quickly recover from a disaster. Coping means managing resources in adverse situations. **PRA tools: Venn diagram**

3.4 Disaster risk analysis – drawing conclusions regarding the degree of disaster risk based on the findings of H, V and C assessments. It is the basis of recommending appropriate DRR measures

4.0 Identification of community leaders and priority target group – the process of identifying the target groups, leaders or sector of the project or most in need/most at risk. This group is the solid basis for partnership and community organization to steer succeeding phases.

- **Feedback/validation of results of community disaster risk analysis** – the purpose is to inform the people about the whole risk situation of the community and to fill in the gaps. It is also at this point that the priority group presents to the entire community their plight as the utmost “beneficiaries” – partners of any disaster risk reduction initiative. In this process you also solicit to the community their social responsibility to their most at risk groups in their community.
- **Further analysis of the priority community disaster risk** - the process whereby the community discusses and analyzes their community disaster risk priority and transformed it into community risk reduction goal.

5.0 Developing DRR strategy and community action Plan – prioritizing and organizing strategy and measures into

- Organization development plan(CO)
- DRR Plan/Development Plan, Land Use Plan, Environmental Protection & Restoration Plan &
- Participatory M&EL framework
- All with goals, activities/measures, responsibilities and resources and timeline

6.0 CO or people’s organization takes full responsibility for their DRR vision

7.0 Exit strategy and continued progression

- Includes capacity building support

What is the impact of Community Managed Disaster Risk Reduction?

- Resilient, resistant and safe community/County
 - High level of survivability of individuals to any hazard events
 - High level of readiness of county/community to any hazard events

- Cohesive community organization/county structure functioning to manage hazard events and continuously building the community/county capacity to reduce the impact of hazards events, eliminating and reducing vulnerability to a hazard.

- **CMDRR-Bottom line**

“Outsider is an agent of learning not an agent of change” “Outsiders can help but insiders must do the job” ‘Go to the people, Live among the people ,Learn from the people, Plan with the people, Work with the people, Start with what they know, Build on what the people have, Teach by showing, Learn by doing, Not a showcase but a pattern,Not odds and ends but a system,Not piecemeal but integrated approach,Not to conform but to transform,Not relief but release’ “Relief breeds parasites, release develops partners” Dr. Y.C. James Yen(1893-1990)

- Community Risk Assessments: PDRAs
- Steps in PDRA

Four Steps

1. Hazard Assessment
2. Vulnerability Assessment
3. Capacity Assessment
4. Disaster Risk Analysis

Appendix 4: Hazard, Vulnerability and Capacity Assessment

Table A 1: Hazard: Climate Change

Characteristics	Elements of characteristic of the hazard	Analytical Description of Hazard	Exposure Variables	
			How will it affect individual?	How will it affect the community?
Cause/Origin	anthropogenic activities Overstocking Deforestation	Climate change is a natural phenomenal caused by anthropogenic activities. It is characterized by, high temperature changes and varying weather patterns drying of water sources. Its onset occurs slowly. Has slow warning signs and long period for signals to be noticed. Climate change continuous	Children Less than 5 yrs Malnourishment Prone to diseases Children male 5 – 18 yrs School dropouts Shortage of food Prone to diseases Weak and emaciated Children female 5- 18 yrs School dropouts Shortage of food Weak and emaciated Prone to diseases Youth male 19 – 35 yrs School dropout Weak and emaciated Shortage of food Unmarried More domestic chores Idling Livestock rustling Youth female 19 – 35 yrs Shortage of food School dropout Weak and emaciated Exposed to wild animals in search of water firewood Walk long distances in search of water Adult male 36 – 60 yrs Family breakup or divorce as they care for livestock Emaciated Loss of livelihood Stressed Adult female 36 – 60 yrs	1.Productive assets Livestock Cattle Limited pastures Diseases Emaciated Death Walk long distances in search of pasture and water Loss in milk Camels Emaciated Shrubs depleted Diseases Reduced milk Death Shoats Emaciated Reduced milk Deaths Diseases Lack of water and pasture Grazing resources Depleted pastures Farm land Crops wither and die Crop failure Insufficient water for irrigation Low yields Business Inflation of prices due to food demand Lack of food in the
Force	Drought High temperatures Thirst Hunger Dehydration Diseases			
Warning signs & signals	Migration of people. Increase in temperatures. Dry up of water sources. Clear sky with no clouds Missing of rains in particular seasons. Lack of certain special insects(butterflies) In intestine of slaughtered animals			
Forewarning	slow			
Speed of onset	Slow on-set			

Frequency	Continuous		<p>Walk long distances in search of water Divorced Emaciated More workload Neglected Take care of children as men herd Break up of families Elderly above 60 yrs Neglected Emaciated People with Disability Neglected Emaciated Orphans Neglected Insufficient food Special Conditions Visually challenged Not able to see the enemies Neglected Insufficient food Physically challenged Neglected Emaciated Malnutrition Expectant mothers Limited movement Insufficient food Miscarriages</p> <p>-Lack of money/school fees -Lack of food -Human diseases -Death -Lack of water for both livestock and human -Stress/Depression -Families separation/fights within families -School drop outs</p>	<p>markets Closure of livestock markets 2.Critical facilities Boreholes Low recharge Low water table Overcrowded Water pans Dried up Water contamination Schools School dropouts Reduced class enrolment Lack of drinking water More food required Dispensary Register high numbers of patients Shortage of drugs Lean staff Lack of laboratory No ambulance</p> <p>-Conflicts between communities -Lack of markets/closing of markets -Livestock diseases/diseases outbreaks -Lack of water sources/drying</p>
Period of occurrence	Continuous			
Duration	Continuous			

Table A2: Assessment of vulnerability

Element at Risk	Location of Element	Level of Vulnerability H.M.L	Why the element was at that Location
(a) Human Elements Under five Youth Morans Men Women Elderly 60 yrs PLWD	Home School/home Home/fields Home Home Home Home	H H M M H H H	In the care of the parents In the care of parents and learning Taking care of animals. Taking care of the families Taking care of families Dependent on their kins Dependent on the kins
(b) Non human Elements:- (Productive Assets) Livestock Cattle Sheep Goat Camel Crop Critical facilities Dips Hospitals Water pan/dams Boreholes Schools Markets	Home & fields Fields/Shambas Within the community (ideal areas) fields Towns, Centres	H H M L H M H H M H H	They are in the field grazing and at home when resting. That is their ideal place Those are their ideal place of being accessible by the community.
Environmental features Pastures Forests Land Community Organizations & systems LMAs Grazing mgt committees Nyumba kumi School Committees Water committees Self help groups Community Health facilities committees	Fields Fields Fields Within the community	H M M H H H H H H	Ideal places for providing the required service Within the community to provide the required service, cohesion, peace & unity

NB-H-high, M-medium, L- low

Table A3: Capacities addressing hazard – climate change:-

	<i>Capacities</i>		
	Existing	Requires	Gaps
(i)Hazard prevention measures (Applicable to only man made hazard)	-	-	-
(ii) Hazard mitigation measures	(i)Small scale planting of trees.	Large scale planting of trees (afforestation)	Large scale afforestation programs.
	(ii)Small scale destocking	Proper stocking rates of livestock	Accelerated off take. Destocking programmes. Community sensitization on stocking rates.
	(iii)small scale grazing systems	Proper &well-coordinated grazing systems/well reinforced	Training in proper grazing systems. Training in well-coordinated grazing system.

Table A4: Capacities Addressing Vulnerability to Climate change:-

a) Individual survivability

Element at Risk	Before /During Hazard	Capacities		
		Existing	Required	Gaps
a) Human Elements Under fives Youth Morans Men Women Elderly PLWD		Small scale preservation of food for the dry season	Enough food preserved to last the whole dry spell season	Trainings in food preservation techniques. Cottage industries for preserving food/ food products.
		Small scale sale of livestock to reserve the money for use later (but poor infrastructures & exploitation by middlemen)	A systematic off-take and marketing system for sale of livestock- that has efficient & effective flow of market information.	Creation & training of market LMAs Strengthening and modernization of the existing livestock markets. e.g. Chumvi, Doldol, Arjijo. (Use of weigh bridge for the sale of the animals).
		Use of alternative source of income e.g. Honey/bee-keeping, poultry production.	Diversified form of livelihoods.	Trainings and engagement in different IGAs. Provision of loans in the different IGAs.
		Digging of shallow wells along dry laggas	Availability of accessible water	Drill boreholes Big Water pans Big Water dams Water harvesting (rock catchment, roof catchment etc) Springs protection Piped water.
b) Non-Human Elements i) Productive Assets Livestock Crops ii) Critical facilities Water sources Hospitals Market facilities Boreholes Schools iii) Environmental/ Physical features Pastures Forests Land iv). Community org. & Systems LMAs Grazing		Small scale supplementation feeding of livestock & pasture production	Have enough feed reserve and concentrates/supplements	Planting of pastures in large scale Storage of concentrates/ supplements.

management committees Nyumba kumi School committees Development committees Water committees Resource User associations				Feed/ Hay stores/storage facility. Training in pasture production conservation.
		Use of tolerant breeds of livestock at a small scale	Ideal breeds of livestock for the environment (Mukogodo east)	Breeds improvement & conservation of ideal ones. Training /capacity building in the ideal breeds for the area.
		Planting of trees at small scale (individual level)	Large scale planting of trees to attain the required 10% forest cover and reseeded of denuded areas.	Afforestation at large scale. Reseeding of the denuded areas.
		Eating of wild fruits honey, wild animal meat, etc.	Have available and accessible food during dry spells that meets their dietary requirements	Supply & distribution of a complete ration (relief food). Supply & distribution of animal feed (Hay, concentrates, supplements, molasses)
		Planting of climate change tolerant crops at small scale (planting once a year/one season).	Have the right crops for the area and use of appropriate technology	Training in better agronomic practices ideal for the area. Introduction of appropriate technology. Introduction of climate change tolerant crops.

Table A5: Community Readiness

Community readiness	Before/ During	CAPACITIES		
		Existing	Required	GAP
		Small scale grazing systems for dry & wet season grazing.	An organized/ systematic and structured grazing management system in place.	Trainings in proper Grazing system. Formation of grazing management committees Setting by laws controlling the grazing as per season.
		Use of communal shallow wells & hand dug small pans	Availability of reliable & accessible water.	Boreholes. Big/large water pans/dams. Protection of springs. Large scale water harvesting. Piped water.
		Small scale communal control of gullies, reseeded of denuded areas	A well conserved environment	Training in environmental conservation. Proper stocking rates. Seed bulking for production of ideal seeds for reseeded denuded areas. Range land rehabilitation of denuded areas by seed broadcasting and protection of the area.
		Small scale vaccination & treatment of livestock	Well-coordinated vaccination campaigns &	Training in livestock disease identification. Treatment / control.

			treatment of livestock	Training in Animal Production. Well-coordinated/regular vaccination campaigns. Enforcement of quarantines managed by community.
		Grazing livestock in the private ranches at subsidized charges/sometimes free	Have an availability of enough pastures for the right number of livestock.	Training in proper stocking rates. Large scale pastures production & preservation. Pasture/Hay storage facility.
		Selling of livestock during dry season (At throw away prices due to inaccessible markets/networks).	Well-coordinated & modern livestock markets	Establishment of modern livestock markets (Weigh bridge, management, information flow). Improvement of road networks (roads, bridges).
		Transfer of school going children to boarding schools outside the Ward. Forced stay/ residence in an area where the school is.	Availability of enough and affordable boarding schools.	To put up affordable and well equipped boarding schools that are running from nursery up to secondary level. Enhanced school feeding programme.
		Small scale reclamation of land by planting of sisal, pastures, trees and construction of terraces etc. Leaving some areas	A well conserved/sustainable environment	Environmental campaigns & trainings. Large scale reseeded. Tree planting programmes. Opuntia eradication

		fallow after being used as cattle bomas.		programmes.
		Use of traditional herbs during disease outbreaks. Use of Mobile clinic (private & GoK) Use of the few community health workers (CHWs) Purchase of drugs from shops	Well-equipped and stocked health centres/dispensaries in every corner of the ward.	Equip all the existing dispensaries with drugs & health personnel (and also make them easily accessible). Train more CHWS/TBAs Equip the CHWS/TBAs Have more mobile clinics that are well equipped & regular/reliable.
		Having smaller clusters of committees which are likely to move together when there is climate change. Also having provision of co-opting other members into the various committees as officials /members on temporal basis to enable the continuation of the systems running/operating smoothly.	Well-coordinated and structured community organizations/systems that take care of the prevailing circumstances.	Formation of the groups/ committee for various resources/functions. Capacity building in group dynamics. Having constitution and by-laws.

Appendix 5: community resource /social map –Mukogodo East Ward



Plate A 1:-COMMUNITY RESOURCE / SOCIAL MAP – Mukogodo East Ward

Appendix 6: committee selected by community to guide on addressing climate change impacts

Mukogodo and Sieku Location Committee members-climate change

S/NO	NAME	MOBILE NO.	POSITION
1.	GEORGE RAMBEI	0703681672	CHAIRMAN
2.	JAMES NTULA	0718467356	MEMBER
3.	JAMES TIPATET	0714642755	MEMBER
4.	SIMON LOLASHO	0720970847	MEMBER
5.	HARISON SAIKONG	0715236660	MEMBER
6.	LUCY PARDERO	0702041452	TREASURER
7.	ELIZABETH LENTULA	0734370204	MEMBER
8.	JAMES MATUNGE	0715317960	SECRETARY
9.	CHRISTINE LEITIKO	0724056564	MEMBER
10.	TERESIA SAKUI	0720752356	MEMBER
11.	STEPHEN POKISA	0721996256	MEMBER
12.	DANIEL LESI	0711294769	MEMBER
13.	ANN NTIYA	0714290274	MEMBER

SIEKU CMDRR

S/NO.	NAME	VILLAGE	MOBILE NO.	POSITION
1.	YOAZZIN MATUNGE	SIEKU	0715955940	MEMBER
2.	SIMON NAPEI	NADUNGORO	0718620700	MEMBER
3.	KATAKA LANGAPO	SIEKU	0717789437	MEMBER
4.	MAIREN SAKUI	NADUNGORO	0796742647	CHAIRMAN
5.	AMOS MOIYARE	NAIMARAL	0701857811	SECRETARY
6.	RIMPAT NANTIRI	NAIMARAL	0792676687	MEMBER
7.	EUNICE MOILE	SIEKU	0702741389	TREASURER
8.	MARY SAKUI	NADUNGORO	070669600	MEMBER
9.	MARIAMU PARMASHU	NAIMARAL	079585920	MEMBER

APPENDEX 7: SIEKU AND MUKOGODO LOCATION HOUSEHOLDS AND JOURNAL ABSTRACTS

NUDUNGURU VILLAGE

1. EDEN SANANG'I
2. PENIYE SANANG'I
3. NDILA SANANG'I
4. KOZIKE MOILE
5. JAMES MOILE
6. JOHN MOILE
7. DERII MOILE
8. MPILAYON MOILE
9. MOIUKI MOILE
10. JOHN MOILE
11. MASANET MOILE
12. LEPENAN MOILE
13. NKURDALU MOILE
14. PARENJA MOILE
15. SILAILET MOILE
16. MOSES MOILE
17. JANE MOILE
18. LEMEDUNG'I MOILE
19. LEMOLO MOILE
20. LESHULUKO MOILE
21. NOMEYO MOILE
22. LEKUNGU MOILE
23. LEPAPRENJA MOILE
24. NENGIRAKA MOILE
25. PAUL MOILE
26. KOINA MOILE
27. PEMPULI MOILE
28. MANTAZIAN MOILE
29. REKONA MOILE
30. DANIEL MOILE
31. LEKATO NAPEI
32. SIMON NAPEI
33. JOHN NAPEI
34. LEINDEN NAPEI
35. KIMPEITWAN NAPEI
36. DANIEL NAPEI
37. SEREWAN NAPEI
38. MORIS NAPEI
39. SUBULAA NAPEI
40. ILPEKENAN NAOEI
41. JAMES NAPEI
42. LEELO NAPEI
43. RAIZON NAPEI
44. KALISHO NAPEI
45. RESHMAN NAPEI
46. LEKEKEY NAPEI
47. LEMASHILIGA NAPEI
48. SANETI NAPEI
49. PERENIKA NAPEI
50. LERIKIIN SAKUI
51. RENGEYAN SAKUI
52. YASOI SAKUI
53. KEMITI SAKUI
54. MPITALI SAKUI
55. ILDIKIR SAKUI
56. NJAKUI SAKUI
57. LEMAIRE SAKUI
58. NANTITOIYA SAKUI
59. LPORONAN SAKUI
60. RESINA SAKUI
61. WOILA SAKUI
62. MUSEVENI SAKUI
63. MAIREN SAKUI
64. DADII SAKUI
65. KIROROI SAKUI
66. THOMAS SAKUI
67. ANTON SAKUI
68. WASHINGTON SAKUI
69. LKANISAL SAKUI
70. KALOLOT SAKUI
71. JOHN SAKUI
72. MAKAI KARUJA
73. MURAKERI KARUJA
74. LOLKOKONYO KINYANYI
75. PETER MOIYARE
76. AMOS MOIYARE
77. JAMES MOIYARE
78. KIBAKI MOIYARE
79. JOHN MOIYARE
80. KINYA PARMASHU
81. LEBAN PARMASHU
82. LEKUBUSEN PARMASHU
83. MUTUNGEI PARMASHU
84. DAVID PARMASHU
85. LEPRON PARMASHU
86. NAPAUISON PARMASHU

SIEKU VILLAGE

1. RAMAITA NAPEI

2. LTHEENOI NAPEI
3. SARAIYO MOILE
4. LTIPIRON MOILE
5. KAIYOK MOILE
6. PESIPESI MOILE
7. LENAREKI MOILE
8. PAUL SAKUI
9. LEMARIA SUPUKO
10. LENGIRIA SUPUKO
11. JOYCE NAPEI
12. KOIPASE PARMASHU
13. SIRITE PARMASHU
14. MANIRETA NAPEI
15. NTEREN NAPEI
16. JENIFER MOIYARE
17. MAMII MOILE
18. NGOIYOK NANTIRI
19. KARERIAN MOILE
20. TEIYANTO KARUJA
21. LENENTIIN MATUNGE
22. LENTUUNI MATUNGE
23. SIRERE MATUNGE
24. MARY MATUNGE
25. SAMSON LENDIRAH
26. LERIKAAN LOUROOKEK
27. LOMUNGEYAN NANTIRI
28. JOSPHAT MOILE
29. JAMES MOILE
30. SPIKA MOILE
31. TOSHA MOILE
32. NTULALA NAPEI
33. NANTETEYO NAPEI
34. RARIIN NAPEI
35. LISAYA NAPEI
36. SUKUMAA MOILE
37. SEKINA KINAIT
38. ANN NAPEI
39. SENETO KUNAO
40. KEINIE MOILE
41. JOHN PARMASHU
42. SEMENOI KANTA
43. NALANG'U KANTA
44. NTARA KANTA
45. NAIDIKO KANTA
46. SIMON KILIPAN
47. JANE KILIPANI
48. LEMAMA KILIPAN
49. KARTUTUNOI LEITIKO
50. IROIYA RONIMIHU
51. MBAYAN LEITIKO
52. DELIDELA PARMASHU
53. JACKLINE LEKARTIWA
54. NOOMERINTI KILIPAN
55. NJOKONI LEORSO
56. SUSANA LESASUYANI
57. MUCHENI LESASUTA
58. YAASI LESASUTAN
59. JOHN LEMAASAN
60. SARAILE LEMAASAN
61. LENAİKARE KILIPAN
62. WONDESI KILIPAN
63. JOSPHINE KILIPAN
64. LEKAURA KILIPAN
65. LKUOO SOSIO
66. REN SOSIO
67. NDIRII SOSIO
68. KANTA SOSIO
69. NOONGISHU SOSIO
70. NARENTIRENYA LEITIKO
71. MPEINA LEITIKO
72. NAISIMUNI LEITIKO
73. LEKAUT KILIPAN
74. NANGUTUR KILIPAN
75. NARIKUNI KILAPAN
76. JACKLINE KILIPAN
77. LEKINEJI MOILE
78. NABARA MOILE
79. LEKAS SAKUI
80. PANASEI SAKUI
81. LEMUNGUTA SAKUI
82. JOSPHINE SAKUI
83. NERITO MOILE
84. LENESETI MOILE
85. NOORRARAK MOILE
86. LEMASOTE PARMASHU
87. JOSPHINE PARMASHU
88. SAMBURI LENGEJU
89. NAOROI KINAIT
90. NASIMARI PARMASHU
91. LARASURUA LENATASA
92. NOOPARAKUO LENATASA
93. JAMES LETORONGOS

94. MARIANOI LETORONGOS
95. NAISIMUNI LETORONGOS
96. LOIBAI NANTIRI
97. JACKLINE NANTIRI

NAIMARAL VILLAGE

1. LESUMI SANANGI
2. JACKLINE SANANGI
3. NG'ATUNTO SANANGI
4. ROSE SANANGI
5. LOOSANIA NANTIRI
6. JOSPHINE NANTIRI
7. NTAI LEKORTOLIO
8. NARKUNI SAKUI
9. MINTOIYA KANTA
10. NASHIPAI KANTA
11. LEPILA KANTA
12. MEIDIMU KANTA
13. NAILEIPU KANTA
14. LNGILIKUN LEITIKO
15. LAITA LEITIKO
16. LEKINA LEITIKO
17. LISATON LEITIKO
18. LENKARO KINAIT
19. ROITA KINAIT
20. ROITA KANTA
21. KUMOKNTARE KANTA
22. NALPARAKUO KANTA
23. NANGIRO KANTA
24. KOPIRO TIMORIT
25. NJERI TIMORIT
26. SKUNTA KWALE
27. JOSPHINE KWALE
28. RAUSEN KWALE
29. NTAIYAN KWALE
30. NTIPAYON NAISABU
31. NTALALO NAISABU
32. JACKSON MATUNGE
33. JACKLINE MATUNGE
34. YOAZZIN MATUNGE
35. JULIAN MATUNGE
36. BENSON MATUNGE
37. SUSAN MATUNGE
38. LESANGISA NAPEI
39. VIVIAN NAPEI
40. LAINA NAPEI

41. NAITUNGUNG TIMORIT
42. NAARU TIMORIT
43. LEKARINA MATUNGE
44. NAMUSOKI MATUNGE
45. NAPONG MATUNGE
46. PETER PARMASHU
47. RICHARD PARMASHU
48. JACKOSN PARMASHU
49. MAIN PARMASHU
50. TOBIKO PARMASHU
51. SHUNGANIYA PARMASHU
52. LETENGEN PARMASHU
53. NTURURUU PARMASHU
54. LTANUNI PARMASHU
55. DENIS PARMASHU
56. JOHN PARMASHU
57. SAKAYA LEITIKO
58. LMEREKI LEITIKO
59. LETUCK PARMASHU
60. SAMSON PARMASHU
61. SIMINTEI SANANGI
62. KAYOKO SANANGI
63. JOYCE SANANGI
64. SAIPERE SANANGI
65. IKAYO SANANGI
66. REMAN SANANGI
67. LOZIKANYA SANANGI
68. WILSON SANANGI
69. LEKIPIM RAMASHU
70. KIYARA PARMASHU
71. ROBERT PARMASHU
72. MARTIN SAKUI
73. RIMPANT NANTIRI
74. LEKINJI KINYANYI
75. NTURUME LEITIKIO
76. NOITAKA LEITIKO
77. SIKILWA MOILE
78. KURACH SUPUKO
79. LENCHUANI SUPUKO
80. MPOTON SUPUKO
81. MOSOPIRO SUPUKO
82. TAKAAINE KINYANYI
83. LEMAIYAN KALOSOI
84. LIE KINYANYI
85. MAMA LIE KINYANYI
86. MUNCHULA KILEPO

87. LPEESON NTULA

MUKOGODO LOCATION HOUSE
HOLDS

ILMUKONGO / KURI – KURI
VILLAGE

1. ALASH NKILELENGI
2. TITAI LEITIKO
3. KASAU MOIYARE
4. JAMES MOIYARE
5. UTARAYAN KINYANYI
6. NOOLANAT KINYANYI
7. TOPIA KINYANYI
8. RAITAN KINYANYI
9. NAPIRATARE KINYANYI
10. NAKITARI KWALE
11. PAISON KWALE
12. FRANCIS KWALE
13. LONGIDA KWALE
14. LOIYAYO KWALE
15. KAIYOK KWALE
16. NANUNUKO NAITAJEU
17. LENKUSIA NAITAJEU
18. NANTITO MOIYARE
19. NADERANI MOIYARE
20. MASIO LEPARDERO
21. LUCY TEIYAN
22. SAITABAU PARDERO
23. MEILANYI PARDERO
24. RAIPEKI LENTULA
25. REUBEN LENTULA
26. SUSAN LENTULA
27. DENIS PARDERO
28. JOHN PARDERO
29. JOHN LEITIKO
30. EUNICE LEITIKO
31. MARIAMU LEITIKO
32. NANGUNGUO LEITIKO
33. JOHN LEMARI
34. JOSEPHN LEMARI
35. LOITEMU LEMARI
36. METIAN PARDERO
37. DANIEL PARDERO
38. JAMES PARDERO
39. MIKE PARDERO
40. BENSON PARDERO
41. LIPALON NKILELENGI
42. LOKURESHA SAIKONG
43. SIMON SAIKONG
44. SUSAN SAIKONG
45. REUT SAIKONG
46. KASONI SAIKONG
47. LEMEREGI LEITIKO
48. NKIGERIA LEKWALE
49. MPETEIYAN LEKWALE
50. LONKWAN LEKWALE
51. KAPIRO LEKWALE
52. NANKUREN LEKWALE
53. KALAI LEKWALE
54. SUKUMAI KINYANYI
55. LEE KINYANYI
56. LONGIDA KINYANYI
57. MELIKI KINYANYI
58. SIYANTOI KISERE
59. SIMON KISERE
60. LESARERO LENTULA
61. SIMON LENTULA
62. KOITEES LENTULA
63. KATAU LEITIKO
64. LOOWAAKUTK LEITIKO
65. RUNKUNTAT PARDERO
66. MUNCHULA KILEPU
67. PANDAL SAIKONG
68. JAMES SAIKONG
69. ELIJAH SAIKONG
70. JAMES LEITIKO
71. SIPETO LEITIKO
72. RONDE LEITIKO
73. MORRIS LENTULA
74. JAMES LENTULA
75. PAPAIYO LENTULA
76. KINTAI LENTULA
77. LEMINKI LENTULA
78. MARY LEITIKO
79. SAMMY LEITIKO
80. KOROSIOM SAKUI
81. TIROO PARDERO
82. NTAINI PARDERO
83. SAITAN SAKUI
84. RARAIS SAKUI

85. SUSAN KILEPU
86. JAMES KILEPU
87. STEPHEN LERIMAN
88. KOSMA LEIRMAN
89. DAUDI LERIMAN

**LOIREPIREPI MARAIBENEK /
LOORETET VILLAGE**

1. JOHN SHUNGANA LEITIKO
2. LOKIDIKIDO SACHORE
3. TIAMPATI SACHORE
4. NGARRO SACHORE
5. LEMUGIE LEITIKO
6. NKAAYENI SACHORE
7. LEPIRDAN SACHORE
8. LMEEKENYWA PARDERO
9. SADIKA SACHORESAMPWATI
MUSIA
10. LEUWA LEITIKO
11. LMAALEN LEITIKO
12. LOIKURRUDO LEITIKO
13. LETURIAKI SAKUI
14. SNEIYO SAKUI
15. 1MNANGWA LEITIKO
16. LMINIS SAKUI
17. KOIRENY MOILE
18. BITIRO MOILE
19. TURIAS LEMOLE
20. KARIITU SACHORE
21. NENTUKAI NAPEI
22. LENTUALA PASHORIO
23. LETEEYA LEITIKO
24. NGURROTI MOILE
25. NGILOWON SACHORE
26. NONCHAINGUNY MORITOI
27. NAPIRNTARE SACHORE
28. SARAMA PARDERO
29. JOHN SAKUI
30. NTIPASON PASHORIO
31. NGUNISIA NAPEI
32. SANAWA NAPEI
33. NOOLKIRIPAN SAKUI
34. MAMAI SAKUI
35. JOSHUA LERIMANLETEIYAN
LEITIKO

36. KIMPAI LEITIKO
37. SARINGOI KINYANYI
38. LTAISAN KINYANYI
39. MARY KILEPU
40. NAISIMARI KELEPU
41. ILKUMEI LEKINAIT
42. RANDISA KALESOI
43. KIILUM KALESOI
44. MAUREEN SAIKONG
45. JOHN LENKWALE
46. JAMES MEPUKORI
47. IMAANI MOHAMED
48. MANDEKI LEITIKO
49. TAKAAINE KINYANYI
50. LEMAIYAN KALOSOI
51. LIE KINYANYI
52. MAMA LIE KINYANYI
53. MUNCHULA KILEPO
54. LPEESON NTULA
55. KASPETA KARUJA
56. NJINIA RIMORIT
57. PERESIKA MOIYARE
58. SARBABI LENTULA
59. LUMEIYA LENTULA
60. NGISA MOIYARE
61. LEIPIAN MOIYARE
62. PILAIKAN SAIKONG
63. LONGELES MOIYARE
64. TIPATET NALAKITI
65. CATHERINE SAIKONG

BOKISH / KANTANA VILLAGE

1. LEKASITE PARDERO
2. NCHOKOIMA PARDERO
3. KIMPA LEITIKO
4. LENAIPUTAKI MOILE
5. KAIPOI LENTULA
6. LEKINI LENTULA
7. LEMUYA KINYANYI
8. BESHAMEN KINYANYI
9. DISON SOSIO
10. LENCHIRPALO LEITIKO
11. LPELEON SACHORE
12. NAUNOI POKISA
13. LOITURAK MATUNGE
14. OYAMO MATUNGE

15. KAMANDAN MATUNGE
16. RAISI MATUNGE
17. KANTASI KWALE
18. NADOKIE SAKUI
19. LENASHE LEITIKO
20. LETIPALO PARTOBIKU
21. LETOOLE TOOLE
22. LENAISEIYE SACHORE
23. KAIYOK MOILE
24. TIRDU SAKUI
25. SAALICHOI SACHORE
26. LEMINCHILA MOILE
27. LOIKISHILI SACHORE
28. KISAAMPO MORIJOI
29. KATAKA MATUNGE
30. KIRANTEI MATUNGE
31. MAKENZI MATUNGE
32. MALANKEI MATUNGE
33. LEMORKUMA POKISA
34. LEMEKINY POKISA
35. LESAKUI SAKUI
36. LENAIYARA SUPUKO
37. LOITIL LEITIKO
38. NAISOPIA LEITIKO
39. LMERUMU LEITIKO
40. DAVID LEITIKO
41. MELI RINGATO
42. LESALANGA LEITIKO
43. LEIYEIYO LEITIKO
44. LEMASI KARUJA
45. LEUSEN SACHORE
46. LERUMA RUMA
47. LENAIRAGIE LEITIKO
48. NANGUNGUR LEITIKO
49. NTANGASHARIO LEITIKO
50. NTIPILIKWA RINGATO
51. LESAMIA SACHORE
52. LATOI LENTULA
53. LENTIANI PARTOBIKO
54. SANKALE SAIKONG
55. LOMANIRA LEITIKO
56. SINDIKISHA LEITIKO
57. MPENYE LEITIKO
58. RICHARD SUPUKO
59. LEMPOROKI
60. PAIM MPOPOKI
61. LERATAN MATUNGE
62. SLIRI MATUNGE
63. LEMPTITO MBITO
64. WISIAM MBITO
65. LAMAIYO KWALE
66. LTAPISI KWALE
67. SAINA KWALE
68. LEKOTIP KWALE
69. CLAUSE NAIKODO
70. SAKEMI MATUNGE
71. NOAH MATUNGE
72. KIPARA MATUNGE
73. LENALEPO MATUNGE
74. KIPONU MATUNGE
75. RMBEI LIBA
76. SORONGEN LIBA
77. SANOE LIBA
78. LION LEITIKO
79. NAISWAKA MATUNGE
80. MANDEL MATUNGE
81. LEISLE SUPUKO
82. SOLOMON PUSI
83. PETER MATUNGE
84. JOHANA SAKUI
85. JAMES MATUNGE
86. MAMA LESALI
87. MAMA NKARASI LEITIKO
88. NAJILAN SACHORE
89. ELIZABETH LENTULA
90. KAIRO SAIKONG
91. PAMELA KUKUTON
92. NASIEKU LEITIKO
93. LEKUNAO KUNA
94. NENKINAIYO SAIKONG
95. NKOKOYEI LEITIKO
96. MAMA MELI RINGATO
97. MAMA LENKARO LEITIKO
98. NAIKODO MATUNGE
99. MAMA NAARU LKITARII
100. MAMA LENTEIPA
101. MAMA JOSHUA LKITARII
102. RANTILEI LEKALOIYA
103. KIRIANOI LEKALOIYA
104. MAMA MURAN LENGU
105. MAMA NAANYU LENGU
106. NOINGELW LEKEMOISA

107. NALONGLE LEKUMOISA
108. NKUUMEI LEKEMOISA
109. NOLTERUK LEKUMOISA
110. NOLAMALA LEFAMTA
111. MATUMI LEKANTA
112. NOLKERESI LAKALYA
113. MAMA MAMADI LEKAY
114. MAMA NTURBANAI
115. MUSUNGUI KAPUNA

116. VERONICA NANTIRI
117. SARAMAT NANTIRI
118. LETIRNA NANTIRI
119. MASERIAN NANTIRI
120. TIYARE NANTIRI
121. NAIPANTEYE NANTIRI
122. KMAIYO NANTIRI
123. LENANTEI NANTIRI
124. LMERUMU LEITIKO
125. LENGELI LEITIKO
126. NDUNYO LEITIKO
127. KATAKA MATUNGE
128. NJESMON MATUNGE
129. SUKUMAI KINYANYI
130. ILII KINYANYI

TOIRAI/PISHO VILLAGE

1. KUKUYO SAUL
2. MARAMPA SAKUI
3. LOIKAMIRAM SAKUI
4. DUNCAN SAKUI
5. NDEPIY MALUNGE
6. MKAMBI MATUNGE
7. LEKIPRONO MATUNGE
8. SAOTIAN MATUNGE
9. NONGUTA MATUNGE
10. NTURUME LEITIKIO
11. NOITAKA LEITIKO
12. SIKILWA MOILE
13. KURACH SUPUKO
14. LENCHUANI SUPUKO
15. MPOTON SUPUKO
16. MOSOPIRO SUPUKO
17. KIPAALÉ SUPUKO
18. MONTARE SUPUKO

19. TIPASO SUPUKO
20. SETIKA SUPUKO
21. MAMA KIPAALÉ SUPUKO
22. KANANDE SUPUKO
23. SEEMINA SUPUKO
24. NONKICHUNAROK SUPUKO
25. DAVID LEYITIKO
26. NAREIYA LEITIKO
27. SITETIAN KINAIT
28. MAMA SITETIAN KINAIT
29. NTIROK KINAIT
30. LOPONU KINAIT
31. LEMAKIA LEITIKO
32. KIARA MOILE
33. MAMA KIARA MOILE
34. MAMA SISANA MOILE
35. KATIMO MOILE
36. ITARAIYAN KINYANYI
37. NOLANAI KINYANYI
38. LMASHORON MOILE
39. OPIRI MOILE
40. NOREMEYA MOILE
41. NAISHORUA NALAKITI
42. ROSE TENDUDA
43. LATERO NKILENGI
44. SHINANAI LEITIKO
45. LOLBAKULI LEITIKO
46. NJAKAI LEITIKO
47. NGEIYAN LEITIKO
48. NENINI LENTULA
49. EVALYNE MATUNGE
50. ORADE MATUNGE
51. IMATAYO MATUNGE
52. SHALANG'O MOIYARE
53. KANYERE MOIYARE
54. MAANTEN MOIYARE
55. LEMAKIYA MOIYARE
56. NGOOLO MOIYARE
57. NKANASA MOIYARE
58. PENTEKO MOILE
59. NKAUWO MOILE
60. LESURURU SAIKONG
61. KUTEREI SAIKONG
62. LEMAIYAN KALESOI
63. SHANAATON LENALAKITI
64. WILLIAM LEITIKO

65. THOO KIPISH
66. NALANG'U MOIYARE
67. NOIKIRAMAT SAIKANG
68. LEKURINYO LEITIKO
69. LESHIDAI LEITIKO

LORIEN/TOOL VILLAGE

1. MUTUNKEI SAIKONG
2. KAKURE SAIKONG
3. NOUTWALAN SAIKONG
4. NTIONGAI SAIKONG
5. PARAKET SAIKONG
6. MUREFU SAIKONG
7. MARY SAIKONG
8. MOSES LOOLASHO
9. NAPAIYO LOOLASHO
10. SAKIYAN LOOLASHO
11. LPAREJION LOOLASHO
12. NAIWANG'U KIPISH
13. NENTWALA MAIYARE
14. NAIMALUMALU MOIYARE
15. KEPUNA LOOLASHO
16. NYIKWA SAIKONG
17. LTAIKAN SAIKONG
18. LEEM SAILAN
19. NANGORI MPOPOKI
20. MORINAMU SARIOYO
21. NTIKON KIPISH
22. NYAUSI NDIRAH
23. KUKUMEIYA PARTANGU
24. FRANCIS NDIRAH
25. MUNGAINA NDIRAH
26. LEBEI NDIRAH
27. SUAN KIPISH
28. RATAYA NDIRAH
29. SAPTEN KIPISH
30. LESUKUI KIPISH
31. JULIUS KIPISH
32. PAIMAN PASHENO
33. LOBUKA KUTAI
34. PARKENGA SAIKANG
35. NOOHERUK KIPISH
36. BUNGE KIPISH
37. LANGEI LOOLASHO
38. KILIYAN LOOLASHO
39. PATEI MPOPOKI

40. MPITEI MPOPOKI
41. PARMUNYO MOIYARE
42. NJOKANA MOIYARE
43. KALAYA SAIKONG
44. DAVID SAIKONG
45. JOSPHINE SAIKONG
46. NESAPARI TEREUWA
47. RANTILEI MOILE
48. LMAITIYAN MOILE
49. RISINOI MOILE
50. JOHANA MOILE
51. NAITIEMU MOILE
52. KERIMANGO MOILE
53. PIRISI MOILE
54. LIKAM LERUMA
55. LESIRI LERUMA
56. MUSEREN LEITIKO
57. KUYAN MATUNGE
58. MPETATI MATUNGE
59. KISERIAN MATUNGE
60. SAWAIYA NDIRAH
61. RAITEI MPOOKI
62. KUIYANA KUTAI
63. MAKAIYE MATUNGE
64. LEUTA SAIKONG
65. SALISAN SAIKONG
66. ATEI SAIKONG
67. SOSO MATUNGE
68. NANTOOLA SAIKONG
69. GRACE MOIYARE
70. MARANGA SAIKONG
71. KARKEIYA SAIKONG
72. NAREIYAN SAIKONG
73. KATOI KIPISH
74. LOLIKANA KIPISH
75. KIKIO KIPISH
76. MILITA KIPISH
77. NAMPANEI MOIYARE
78. LEMERIAN MOIYARE
79. SUSAYO LPETAI
80. LMALAT MPOPOKO
81. NAIKUDUDA MAIYARE
82. NERIYO SARIOYO
83. MAMELI SAIKONG
84. RIMISEL MAIYARE
85. NYANGWALI LEITIKO

86. NKAIYENI LEITIKO
87. NTAMEI MATUNGE
88. KAILENYA LEITIKO
89. NAKUTAT SAIKONG
90. MIRANTEI SAIKONG
91. MPAIYEYO LELIBA
92. IYAPAITIE SAIKONG

SEEK VILLAGE

1. NOLNGUESI SAILONG
2. LIPINO LENTIYA
3. SIYAN SAIKONG
4. MASAAMU SAIKONG
5. NAIMALAS MPOPOKI
6. NONTAWA MPOPOKI
7. NAMUNU MOIYARS
8. NAMUNYA MOYARS
9. JENIFER MOIYARE
10. NOONJISAU MOIYARE
11. PUSIAN MPOKONYOK
12. YAMO MPOPOK
13. MALAKIN LSNAILONGOYS
14. NAIPANOI MPOKONYOK
15. LDNOSI SAIKONG
16. NTOPIP SAIKONG
17. NKATAIYO SAIKONG
18. BETRAS SAIKONG
19. NABULU SAIKONG
20. NTURUURA MPOPOKI
21. MAMA SEMPELAI MOIYARE
22. NOSAIKITO MOIYARE
23. NONTARE MOIYARE
24. SOFIA MPOPOKI
25. NALAMIT NKOLIA
26. RAINES NKOLIA
27. JULIUS NKOLIA
28. NANYOIKIE SIAYATO
29. NCHAONI NKOLIA
30. DEBRA NKOLIA
31. PAMELA NKOLIA
32. KOROLE NKOLIA
33. NCHEKATI SANANGIT
34. KULEIYO SANAGI
35. SEYAROI NKOLIA
36. RITAS NKOBIA

37. NGNUR NKOLIA
38. MATANKA NKOLIA
39. MAMPESI SANANGI
40. KORONCHON SANANGI
41. MAASON SANANGI
42. SIMIA SANANGI
43. MPEDETON TATULA
44. NONTAWA MUSA SANANGI
45. KETON POKISA
46. MAMA LTUMOKI POKISA
47. NAVIAPO POKISA
48. NAKIKWE NTULA
49. MAMA SEPEN KITADO
50. MAGARET TIMORIT
51. GUMAATO SANANGI
52. NAITUKWA KITADO
53. NKUMEI LPETIN KITADO
54. PASIYO KITADO
55. KAKUDEL KUIYE
56. MISIRI KUIYE
57. MATINTE, KUYE
58. NESITI LOUROLKET
59. MPERESI MOKO
60. MAA ELISEA NDIRAI
61. TOIYE SANANGI
62. JANE SANANGI
63. ROSALINE NKOLIA
64. MAMA MPERSIN LENKOMAN
65. MAMA LEREKIN LENKOMAN
66. MAMA MBOTAR LENBOMAN
67. MAMA NTLE LENSALIA
68. MAMA LTURUNYWA
LENASALIA
69. NABENEI KIPISU
70. NKALAIYO KIPISU
71. NATIYA LOROGOR
72. NKARPAIYAN SACHORE
73. PIJOLI SIYANTO
74. MAMA LTAPARWA SIYANTO
75. JOSIA SIYANTO
76. MAMA KARORI LEKOONA
77. MITINGI LEKOONA
78. MAMA MPONUNO KALESOI

79. MAMA NABIKI LENYARWE
80. MAMA YAMATI LELWALE
81. MAMA JEULA LEKWALE
82. MAMA SABUKOO LEKWALE
83. MAMA LESIYE SANANGI
84. JINGANA LEKAJA
85. MAMA LENTUKU KINAIT
86. NOLOROKUSHU LEMARTILE
87. MAMA NKUNINI KINAIT
88. NOLOROKUSHU LEMARTILE
89. MAMA LKIPKUI LEPORE

Published journals Abstracts

Climate change impacts detection in Mukogodo forested ecosystem as indicated by vegetation cover change

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Key words: *detection, climate change adaptations, impacts, dry forested ecosystem, land use, vegetation cover, Yaaku*

Abstract

An understanding of land use or land cover change at local, regional, and global scales is important in an increasingly human dominated biosphere. The terms land cover and land use although often used interchangeably; their actual meanings are quite distinct. Land cover refers to the surface cover on the ground; while land use refers to the purpose the land serves. In this

study the terms are used interchangeably because both aspects are in consideration. Change detection is an important process in monitoring and managing natural resources, land use change analysis, monitoring of shifting cultivation and assessment of deforestation because it provides quantitative analysis of the spatial distribution of the population of interest. The objective of the study was to detect and identify land cover changes that have occurred during the last three decades. Which was accomplished by getting remote sensed data from land sat images of the area for last three decades. In analysis and classification, maps were generated using specialist software (IMPACT Tool, Erdas and ArcGIS). The maps shown the land cover status of the four Epochs, 1984, 1995, 2004, and 2014 of which changes between each of the epoch for; 1984-1995, 1995-2004 and 2004-2014 gave the statistics of change. The epochs were at a period of 10 years to allow clear and notable change detection. Field validation was done to improve the classification and to come up with class cover validation and errors of classification computed. A simple random sampling was conducted where 30 percent of the households in each of the nine villages were selected. The selection of

households was by stratified randomly (odd numbers) from a list of Yaaku households guided by the initial participatory activity done within the study community (Community Managed Disaster Risk Reduction-CMDRR).The study also undertook Focus Group Discussions (FGD), and Key Informants (KI) interviews to help in the triangulation of the data .A socio-ecological survey using a structured Questionnaire was used to collect respondent's opinion on climate changes and adaptation on land use and management in specific based on livelihood capitals for last three decades as from 1986 to 2015. Data from social ecological survey was analysed after entry in to Statistical Package for Social Sciences (SPSS version 20) to get the respondents' views of land use and management within the three decades. The land use types of study area are six of which three are main and other three minor. The main three, forest, shrub or bush land and grassland changed during the last three decades of which grasslands reduced by 5,864 hectares (40%), forest by 3,071 hectares (24%), shrub & bush land increased by 8,912 hectares (43%).The other three minor land use types were bare land which had reduced by 238 hectares (45%), river bed vegetation increased by 209 hectares

(72%) and agriculture increased by 52 hectares (600%) over the last three decades. The opinion of the community on the change of land use and management was attributed to climate change and also adaptation strategies applied by the community over time. For example unlike the common understanding that forest resources utilisation increases with increasing human population, the Mukogodo dry forested ecosystem case is different in that the majority of the respondents (78.9%) reported that the forest resource use was more in last three decades than now and also a similar majority (74.2%) had the same opinion that forest resources utilisation was low compared to last thirty years. In Yaaku community change impacts were evidenced and thus mitigation measures suggested to address the impacts included ; Controlled bush management and indigenous grass reseeded programme was advocated to restore original grasslands, Agricultural (crop farming) activities be carried out in designated areas outside the forest conservation areas (ecosystem zoning) all in consultation with community and other stakeholders. Groups be organised (environmental management committee) to address conservation, political and vulnerability issues in the pastoral dry

forested ecosystem which will sustain pastoralism in the ecosystem.

Political influence or asset as a main livelihood capital addressing climate change impacts in Mokogodo forested ecosystem home of Yaaku of Laikipia County- Kenya

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Key words: political capital, livelihoods, climate change adaptations, impacts,

Abstract

Livelihood approach seeks to gain correct and realistic understanding of people's potency (here called "assets" or "capitals"). It is important to resolve how people are determined to convert these strengths into positive livelihood outcomes. The approach is based on a belief that to achieve a positive livelihood people need to acquire a range of assets. Hence the sustainable livelihood

framework identifies five types of capital or assets upon which livelihoods are built which includes; social capital, human capital, natural capital, financial capital and physical capital. Political influence or capital is not among the five main livelihood capitals but included in social capital. Therefore the objective of the study is to try to indicate that political capital is as important as other capitals if not the controller of other capitals. A simple random sampling was conducted where 30 percent of the households in each of the nine villages were selected. The selection of households was by stratified randomly (odd numbers) from a list of Yaaku households guided by the initial participatory activity done within the study community (Community Managed Disaster Risk Reduction-CMDRR). A structured questionnaire was administered to 240 household heads or their representatives within the nine villages. The study also undertook Focus Group Discussions (FGD), and Key Informants (KI) interviews to help in the triangulation of the data. A socio-ecological survey using a structured questionnaire was used to collect respondent's opinion on climate changes and adaptation on livelihood capitals for last three decades as from 1986 to 2015. Data

from social ecological survey was analysed after entry in to statistical package for social sciences (SPSS) to get the respondents' views of livelihood capitals for the last three decades. The majority of the respondents 58.5% in Yaaku community indicated that politicians addressed issues of climate change in the community, with only 18.3% and 30.8% of them said that climate change issues were addressed by professionals and administrators respectively. However similar respondent of opinion of 45.4%, 35.4% and 17.9% said it was politicians, professionals and administrators who address development issues respectively. The majority 70.4% of the respondents gave their opinion that politicians and other leaders do not understand climate related risks on livelihoods while a small minority 29.6% were on the opinion that the politicians and other leaders understood climate related risks on the livelihoods in pastoral communities. Politicians being the main decision makers on development issues in local set up in developing countries where Kenya is one of them, decisions on climate change and adaption need be discussed and understood by politicians. Therefore policy formulation is needed as from county level and national level on how to mainstream politicians in issues of

climate change and adaptations. In case of Yaaku community, low human capital in form of education and minority in numbers has led the forested pastoral community to lack political commitment within the community set up. Therefore the politicians were key in addressing the impacts of climate change although they had not known or understood that the impacts are of climate change but either campaign goodies or development agenda. Therefore to address climate change impacts and their adaptations strategies political angle need be applied which makes political influence capital a main livelihood capital in addressing issues of climate change.

ASSESSMENT AND MAPPING OF VULNERABILITY DUE TO CLIMATE CHANGE FOR DRY FORESTED PASTORAL ECOSYSTEM.

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Hazard, livelihood, adaptive, capacity, sensitivity, exposure

Abstract

The objective of the study was assessment and mapping of the community villages in order to rank degree of vulnerabilities to climate change. On sensitivity to vulnerability, the majority of the respondents indicated that it was high (59.6%), medium (16.3%) and low (20.8%).of which on response to exposure to vulnerability, the respondents who indicated high (61.7%), medium (24.2% and low (11.3%).On vulnerabilities in response to adaptive capacity to vulnerability, was high (3.3%), medium (12.5%) and low (81.3%).This study demonstrated that participatory approach of addressing vulnerability to climate change which involved all stakeholders is effective in this dry forested pastoral ecosystem.
