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Determination of Drought Adaptation Capacity and Adaptation Options as an Indicator of Climate Change in Pastoral Production System in Laisamis, Northern Kenya

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Abstract:
Pastoral production systems are highly vulnerable to drought due to reliance on climatic factors mainly rainfall in the Arid and Semi Arid Lands. Pastoralists have used various methods to adapt to recurrent droughts and have developed adaptation options. However, the various drought adaptation gaps and options have not been well researched and documented among the pastoral production systems in Northern Kenya. The objectives of the study are to: 1. Determine the levels of adaptation capacity gaps to drought and 2. Identify adaptation options to drought in the pastoral production system. Simple random sampling was used to collect data from 384 householders through questionnaires. 30 indicators of biophysical and socio-economic indicators were used to determine adaptation capacities. Options for drought adaptation was obtained through specific questions in the questionnaire and consultations with community members and experts working on drought adaptation in the study area. Secondary information was collected from relevant research and technical reports and meteorological records. The results show that the key determinants under adaptive capacity were livestock ownership. 63.8 % of the community own 1-20 cattle, 65.1 % own 1- 20 camels, 74.7 % own 1 - 40 goats, 81.5 % own 1 - 40 sheep and 52.1 % own 1-3 donkeys. Other capacity gaps in addressing drought include 54 % unemployment, 82 % had no productive assets, 35.7 % have no access to credit facilities, 93.8% had no formal education, 37 % had no access to extension services, 60.1 % had no access to drought early warning system, 44.3 % did not receive external remittances and 55 % belonged only to one social group while 47 % of women belonged to various women groups. The drought coping strategies used by the pastoral community indicate 60 % as shifting to another site, 27 % as livestock sales, 7 % as famine relief supplies, 4 % as external remittances and 2 % in form of cash savings. The study will help in identify adaptation capacity gaps and inform on the adaptation options for pastoral production systems in Northern Kenya. Adaptation options may be used by development organisations through project interventions.

Keywords: *Pastoralism, Drought, Adaptation, Arid, Semi-Arid, climate change*

1. Introduction

Studies by Kabubo-Mariara (2009) and Silvestri et al. (2012) reveal that extreme weather events such as prolonged droughts and intense rainfall are already impacting negatively on pastoral communities in arid and semi-arid (ASALs) parts of Kenya. At present, nearly 30 percent of total Kenya human population reside in the ASALs which cover approximately 88 percent of the country's land mass and hold almost 70 percent livestock herd (Opiyo 2014).In northern Kenya, where dryness is most pronounced, 28 major droughts have been recorded in the past 100 years, (Schilling and Remling, 2011). The drought frequency has increased as 4 of the 28 droughts occurred in the last 10 years (Mude et al. 2009). According to pastoralists, rains use to fail every nine or ten years, while they now experience drought every two or three years (Schilling and Remling, 2011). In some parts of northern Kenya, droughts have been recorded in subsequent years without breaks resulting in livestock deaths and severe mulnutrition among the pastoralists. This trend is not only perceived in Northern Kenya but also at the southern border to Tanzania (Schelling and Remling, 2011). Despite the devastating effects of droughts in Northern Kenya, adaptation capacity gaps and options for adaptation has not been comprehensively studied and documented.

Pastoral communities in Kenya live in challenging environment facing unreliable and erratic rainfall, high temperatures, frequent droughts, conflicts over access to natural resources, livestock and human diseases among other socio-economic factors that undermine their livelihoods. Climate Change is a reality and the effects are observed in every continent and in all sectors. It is difficult to prevent the effects of climate change including drought at local levels. However, it is possible to mitigate the effects and develop strategies for adaptation. Due to overreliance on livestock for their livelihoods, frequent droughts are the most challenging factor. Therefore, there is need to build community capacity to adapt to the frequent droughts through exploration of adaptation options.

An integrate approach for drought adaptation capacity has been used which combines both socio-economic and bio-physical factors. This approach includes all internal and external situations. The integrated approach has been applied by Madu (2012) in Ethiopia in

agro-ecological based household vulnerability study and by Deressa (2008) for regionally based vulnerability study. In this study, we have applied a similar approach for determining drought adaptation capacities.

Since addressing Adaptation Capacity Gaps is a major factor in reducing vulnerabilities, the study will give prominence in identifying adaptation capacity gaps. This is key to improving socio-economic characteristics of communities, households and industry as it includes adjustments in both behaviour and in resources and technologies, and is a necessary condition for design and implementation of effective adaptation strategies. Currently there are no adequate studies on adaptation capacity gaps in the study area and at national level.

Pastoralism in Africa evolved in response to long-term climate variability and lack of reliable supplies of permanent water, and is by its very nature a form of adaptation to climate change. Pastoralism incorporates a variety of risk management strategies and has helped people survive in an increasingly arid and unpredictable environment describes a UNEP (2009) report. Pastoralists move livestock according to the availability of water and pasture to optimize the use of rangelands and maintain diverse herds including browsers and grazers explains Brooks (2006). However, this has now changed due to rapid population growth, grazing land has been taken over by urbanisation and resulted in reduced grazing areas. This scenario calls for a more innovate approach to climate change adaptation. With the increase in frequency and intensity of droughts brought about by global warming, it is likely that the adaptive capacity of Africans may be progressively weakened. The resources they draw upon to build their resilience will be eroded and the impacts of climate change may be progressively damaging in the near future. The adaptation capacity gaps and adaptation strategies of ‘’modern day’’ pastoralists are not well understood and documented especially in Eastern Africa including Kenya. Options for adaptations are not well researched, understood and documented. This study has highlighted what "modern day" pastoralist could do with more access to technologies, better roads and better access to socio-economic and political productivity enhancing scenarios.

Across Kenya, the effects of climate change are wreaking havoc (MEMR, 2009b.3). The prolonged droughts of the past decade have threatened food security and societal stability, especially in vulnerable pastoral areas (Economist 2009; GOK 2007b; UNDP, 2007). There is critical need for adaptation assessment and measures to be taken (MEMR, 2009a).

Many adaptation actions implemented by national and international schemes require an initial assessment of challenges and opportunities to climate change, key impacts and vulnerabilities, so that proposed recommendations and adaptation measures are context-driven and the risks for mal-adaptation measures are minimised (Graciela et al, 2014). No climate adaptation challenges have been studied in the study area.

Studies carried out by Nyariki*et al, (*2009) in Kajiado indicate three methods of adaptation to climate change including expansion of grazing range, diversification of income sources through farming and migration to urban centres. Nyariki*et al,* (2009) describes that in Turkana, climatic conditions make farming impossible and a shift from livestock keeping to small scale farming as observed in Kajiado unfeasible. The Turkana population purely relies on pastoralism (GOK 2008A, 2007b). This calls for a different approach and options in Turkana and other parts of Kenya with high Aridity Index including the study area, Laisamis Sub-County. Pastoralists in Kajiado and Turkana do not use the full spectrum of adaptation options available to them according to Schilling *et al.*, (2011). The options used in Turkana and Kajiado are mostly traditional, meaning they have evolved over hundreds of years. In addition to the indigenous adaptation, pastoralism may embrace modified or alternative livelihoods including tourism, irrigated agriculture or keeping of alternative livestock tolerant to droughts including camels and growing of crops with short maturing periods or drought escaping capabilities. Apart from isolated studies conducted in Kajiado and Turkana, there are no comprehensive studies on options for adaptation to climate change by pastoralists. Knowledge and skills on adaptation options and adaptation capacity gaps assessments are limited in pastoral livestock production systems. Therefore, this study has enhanced the knowledge and skills in pastoralists production system.

Knowledge is an important factor for adaptation according to Galvin & Lesorogol (2008). A World Bank report (2009), indicates that Kenya’s level of knowledge on climate change lies slightly below the continent’s average. The Knowledge Index (2009) of Kenya was put at 2.69 (UNDP). This figure is considered low. The low level of knowledge was confirmed at the study area level through this study. While Kenya’s score of 2.69 might seem low, it should be noted that the index hardly takes indigenous knowledge into account which has been identified by several studies to be critical in terms of successful climate change adaptation as mentioned by Ensor (2009), Folke *et al*. (2005) and Pedersen (2008). Closely interlinked with the level of knowledge, is the level of technology. Based on Technology Readiness Index, Kenya is among the last of all ranked countries (rank 101 0f 139). In orderfor the country to improve on its knowledge on climate change adaptation, studies such as this should be carried out to enhance the knowledge gap on options for adaptation to climate change. Little *et al*, (2009) have shown that formal education of pastoralists can reduce their risk towards drought. However, no such study has been conducted in the study area to determine the adaptation options for the target community and the county at large.

Many traditional adaptive knowledge and livelihood strategies practised in dry lands for centuries no longer suffice or are inefficient described Boko *et al*., (2007). Efforts to reduce vulnerability of dry land populations therefore must reinforce their risk management and coping capacities by augmenting existing adaptation mechanisms and supplementing them with options that are tailored to the unique local contexts (UNEP 2009). Adaptation to climate change is not accomplished in a single intervention. Rather, it is a continuum requiring overarching approach that incorporates underlying drivers of vulnerability to those designed exclusively to respond to climate change impacts (ODI, 2010). To strengthen adaptation planning and implementation, more concrete, economically and politically feasible measures are necessary. Governments and development partners need to develop strategies based on clear understanding of vulnerabilities through comprehensive assessments (Graciela et al, 2014). The exercise of adaptation assessment is time-demanding task and often requires significant stakeholder participation and access to climatic, social and economic data. Such studies are limited in the study area.

Adaptation process and strategies need to be location and context–specific, integrated and flexible. Although many researchers have identified different types of adaptation and presented a number of concepts and frameworks to describe them, most of the literature on adaptation focuses on providing policy directions rather that providing practical guidelines (MRC 2010). This study has attempt to come up with practical suggestions that may be implemented by the various stakeholders.

1.1. Objectives of the Study

1. Determine drought adaptation capacities among pastoralists production system.
2. Determine drought adaptation options among pastoralists systems.

2. Literature Review

2.1. Climate Change Adaptation

Although definition of adaptation in the natural sciences is disputed, it broadly refers to the development of genetic or behavioural characteristics which enables organisms or systems to cope with environmental changes in order to survive and reproduce, (Smith and Wandel, 2006). Adaptation in the context of human dimensions of global change usually refers to a process or action or outcome in a system (house hold, community, group, sector, region or country) in order for the system to better cope with, manage or adjust to some changing conditions, stress, hazard, risk or opportunity, Brooks, (2003). Khajuria and Ravindranath (2012) describe Adaptation as, the systems adaptive capacity i.e. the ability of a system to adjust with climate change to moderate potential damages, to take advantage of opportunities or cope with the consequences.

Fussel and Klein (2006) explain that *adaptive capacity* of a system or society describes its ability to modify its characteristics or behaviour so as to cope better with changes in external conditions. Brooks (2003), in Fussel and Klein (2006), classified factors that determine adaptive capacity into hazard-specific and generic factors, and into endogenous and exogenous factors. He goes further to explain, generic determinants of adaptive capacity in social systems comprise such non-climatic factors as economic resources, technology, information and skills, infrastructure, institutions, and equity. Smit and Pilifosora, (2001); Yohe and Tol, (2002) expressed a similar view. Fussel and Klein (2006) explain that considerations of relevant non-climatic drivers e.g. demographics, economic and socio-political situations, technological and biophysical drivers are important in assessing adaptation. These drivers affect relevant non-climatic factors e.g. the economic diversification, the level of education, and the strength of social networks that in turn, determine sensitivity of a system or community to climate change. Metzeger et al (200) in Doll (2009) explained that, adaptive capacity is generally quantified by indicators, which often include gross domestic product. In this study, we also considered the similar factors to determine the household adaptive capacities through the application of indicators for principal components that contribute towards household vulnerability.

The main purpose adaptive capacity assessment is to contribute to policy making by providing specific recommendations to planners and policy makers on the enhancement of adaptive capacity gaps and the implementation of adaptive policies, explains Fussel and Klein (2006). Scheraga and Furlow, (2001), in Fussel and Klein (2006) emphasize that decision-makers require very specific type of information in order to design and implement effective adaptive responses, and that uncertainties about future climate change and its impacts are a crucial issue in this context. GIZ (2015) add that there is no single approach to adaptive capacity assessment and its components are highly dependent on the system at stake. There have been numerous attempts to structure the ingredients of capacity and to introduce standard indicators for assessments. The key dimensions found in literature are knowledge, technology, institutions and economy (GIZ, 2015). This study considered these elements in additional to others.

Fussel and Klein (2006) identified two types of adaptation, firstly, *facilitation* which refers to activities that enhance *adaptive capacity* such as scientific research, data collection, awareness raising, capacity building, and the establishment of institutions, information networks, and legal frameworks. Secondly, *implementation* which refers to activities that actually avoid adverse climate impacts on a system by reducing its exposure or sensitivity to climate hazard, or by moderating relevant non-climatic factors. The authors went further to give examples of *facilitation* as measures such as establishment of carbon trading schemes and an example of *implementation* as replacement of an old power plant with a less carbon- intensive one. In this study, we use *adaptive capacity* to jointly refer to *implementation*, *facilitation* and *mitigation*.

Graciela et al (2014) describe ecosystem-based adaptation (EbA), which uses a range of opportunities for sustainable management, conservation and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. As such, an analysis of the current state, threats and uses of the main ecosystem services is needed to identify appropriate and feasible EbA options (Graciela et al, 2014). In this analysis, multidisciplinary team is needed with specialists in climate science, ecosystems and biodiversity, socio-economic scientists, experts in stakeholder engagement, policy development and communications (Graciela et al, 2014). No such study using the approach has been used in the study area. This study has incorporated the services and technical support of the various relevant experts.

Smith and Wandel (2006) explain that, adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard risk or opportunity. The author went further to explain that, the concepts of adaptation, adaptation capacity, vulnerability, exposure and sensitivity are interrelated and have wide application to global climate change science. GIZ (2015) agree with Smith and Wandel (2006) and add that, adaptation is a process and not an outcome. In practice, there is often no clear distinction between development activities and climate change adaptation interventions (IDS, 2008). Many adaptation measures contain a 'development' component, whether implicitly or explicitly. Conversely, climate change adaptation

concerns are mainstreamed into development efforts (GIZ, 2015). Because adaptation measures are applied in anticipation of future climate change impacts, they are accompanied by a high level of uncertainty. 'No regret' measures is one approach various challenge. This refers to activities which create beneficial or desirable outcomes – not only in the future, but already today –even if the assumed changes do not take place (GIZ, 2015).

UNFCC (2009) in MRC (2010) provides interesting insights into experiences with adaptation planning. However, the document does not reflect on any specific methods or tools but focuses on how to integrate adaptation planning across different scales and sectors. Tyler and Fajber (2009) discuss how land and water management in Asia can inform adaptation to climate change.

Several studies conducted globally mainly focus on rate or rank potential adaptations, but they rarely investigate the process through which adaptation measures are undertaken, either in the light of climate change specifically (which is very rare) or part of policy and decision making process to which adaptations to climate change might relate, (Smit,2006). The focus of this study was on what capacity currently exists within the community and identify the capacity gaps. This object will help direct adaptation efforts to those areas with the greatest or least adaptive capacity. One noteworthy development in this applied work on adaptation process is that of ``mainstreaming'' the whole adaptation process associated with climate change (or other environmental changes) actually addressed in decision-making and carrying out practical solutions (Smit, 2006). The most viable option for Africa is to manage the impacts of climate change in the region through adaptation practices. However, the continent's low adaptive capacity serves as a major constraint to her ability to adapt. This limited adaptive capacity results from the region's poor financial resources, low technological capacities, weak institutions and limited awareness due to inadequate research capacities, (Nkomo *etal.,* 2006).

Africa's contribution to the climate change is very insignificant and yet it is one of the hardest hit by the negative impacts. Efforts should be made by the more developed countries who contribute the bulk of the greenhouse gases responsible for the global warming to cut down on their emissions to acceptable limits and provide funds and technical capacity to enable Africa adapt to climate change, (Nkomo *et al*., 2006). It may not be possible to measure the contribution of the greenhouses at the study site level; however, attempts will be made to identify what undermines local adaptation to climate change.

Decimation of livestock herds occur during severe droughts and have frightening implications for pastoralists. For example, in Kajiado District of Kenya, Masai pastoralists lost nearly 30% of their livestock population following the drought of 1960 – 1961. The cattle loss was estimated at US $ 7 million, Oba &Lusigi, (1987). Similarly, in Turkana, Kenya, losses of 80% sheep and goats, 40 %of camels and 90% of cattle was reported during 1979 – 1980 drought, Oba and Lusigi, (1987). From these statistics, it is clear that there are substantial levels of vulnerabilities and low adaptive capacities among these communities with regards to drought preparedness, coping and recovering from the effects. This study addressed capacity building options in order to reduce vulnerabilities. Various studies conducted mainly focus on losses rather that addressing the adaptive capacities of households and communities. The focus of this study is to identify gaps in adaptation measures in the light of drought management as an indicate of climate change, which has been rare nationally and at study area level. The main expected results of adaptation gaps assessment are to provide recommendations for specific adaptation strategies. The expected application of adaptation assessment should be directed to those areas with the greatest exposures or least adaptive capacity, (Smith and Wendel, 2006).

Droughts are not a recent phenomenon in Kenya. For centuries, pastoralists and farmers have adjusted their livelihoods to periods of resource scarcity. However, the combination of unsustainable use, inadequate national and regional policies, and intensifying climate change threaten to overwhelm the existing adaptive capabilities of pastoralists, (Schilling and Remling, 2011). This study focused on identifying drought adaptation capacities and what options are available to the pastoralists.

The World Resource Institute (2009) suggests an approach that starts by assessing the functions of Adaptive Systems, which includes assessment of vulnerability, impact adaptation practices and climate sensitivity activities. The logic of carrying adaptability assessment is not clear in this method. WRI (2009) proposes that adaptation planning be carried out over a long period of time e.g. ten years. However, adaptation needs to be assessed based on time and place rather than over extended period.

The use of indicators has been one of the most widely proposed approaches, which has primarily been applied to adaptive capacity, Adger and Vincent 2005; Erikson and Kelly 2007. The development of indicators can be seen as a way to identify proxies for adaptation. To be reliable and effective, indicators need to reflect an explicit conceptual framework of adaptation. Many scientists are cautious about the use of indicators, Hinkel 2010; Barnett et al 2008.

The 2010/2011 drought, which affected the Horn of Africa, in particular the pastoral communities in Kenya, Ethiopia and Somalia, and caused migration across the borders, immense loss of livestock as well as human losses, with more than 13 million people affected, was not unexpected (ISDR 2012). Such negative incidences happen because there are no adequate mitigation and community adaptation mechanisms established in the region. In addition, there are no adequate research studies to provide policy directions.

Prolonged droughts of the past decade in Kenya have threatened food security and societal stability, especially in pastoral areas (Schilling & Remling, 2011). This scenario exacerbated by severe capacity gaps within the pastoral communities. Little et al. (2009) in Schilling & Remling (2011), have shown that formal education of pastoralists can reduce their risks towards droughts. In Kenya, there is evidence that education has contributed towards capacity building against drought.

Kenya's education ranges above the average of Sub-Saharan Africa, according to the inequality–adjusted education index which combines adult literacy rates and gross enrolment ratios (UNDP 2010). The Government of Kenya has made efforts to increase the number of schools in Kenya and enhance primary education through free education. However, in rural Kenya, especially the study area, the density of schools is too low to offer the local population sufficient access to education (Schilling & Remling, 2011).

The disparity between urban and rural parts of Kenya is also evident when health of the population is concerned. While 83 per cent of the population in cities have access to improved drinking water sources, this value drops to 59 per cent in rural areas (Schilling & Remling, 2011). Indicators for performance of community institutions are not clear. However, this may be measured in terms of what

they have achieved towards reducing the gaps in climate change vulnerabilities. A number of community institutions exist within communities formed formally or informally by development organisations for example Disaster Risk Reduction Committees (DRR) established in 23 counties through National Drought Management Authority (NDMA) support.

Knowledge is an important factor for adaptation (Galvin 2008; Lesorogol 2008) in Schilling & Remling (2011). According to the World Bank, Kenya's level of knowledge lies slightly below the continent's average. The index measures a country's ability to generate, adopt and diffuse knowledge'' (World Bank 2009). While Kenya's score of 2.69 might seem low, it should be mentioned that the index hardly takes indigenous knowledge into account which has been identified by several studies to be critical in terms of successful climate change adaptation (Ensor & Berger 2009; Folke et al. 2005; Pedersen & Benjamin 2008) in Schilling & Remling (2011). Closely interlinked with the level of knowledge is the level of technology. Based on the Technological Readiness Index, Kenya is among the last of all the countries (rank 101 of 139), Schilling and Remling (2011). The index combines several components including foreign direct investments, availability of latest technologies and number of internet users (Schwab 2010) in schilling & Remling (2011). The use of mobile phones and internet increases the availability of information and this can strengthen the mechanism to cope with climate stresses (Schilling & Remling 2011). Climate Change has been associated with conflicts in pastoral areas. Regardless of the uncertainty associated with climate change as a driver of conflict over access to natural resources, it is widely acknowledged that climate change negatively impacts the economy, food security and livelihoods in Kenya (Herrero et al. 2010; Lobell & Burke 2010; Oluoko-Odingo 2010) in Schilling & Remling (2011). It is therefore important to understand adaptation capacity gaps in order to strengthen local adaptation.

2.2. Adaptation Options of Pastoralists

It is believed that 20 million pastoralists household are found worldwide, Blench, (2001) to 268 million pastoralists in Africa alone according to Africa Union figures, Dima, (2011). Pastoral systems are grassland based production systems with more than 90% of the household income resulting from livestock production system and more than 90% of the livestock fodder comes from natural rangeland vegetation, (Sere and Steinfield, 1996). However due to the challenges of drought and climate change, the pastoralists are not able to access adequate pasture and water. This calls for the need for adapt measures to drought and climate change.

The average annual rainfall in the study area is 200 – 300 mm per annum. Due to high average temperatures reaching a maximum of 39 degree centigrade, the evapo-transpiration can reach 3,000 mm per year, thereby causing overall moisture deficit for the better part of the year, (Schwart et al., 1991).Exposure to such harsh environment implies that there is need for innovate approaches to explore options for adaptation. Some recent approaches focus on adaptation planning in the context of uncertainty and recognise many social, economic and environmental changes besides climate change, (MRC 2010). This study has attempted to identify various options available to pastoralists, based on experiences from the study area, other pastoral areas of Kenya and the globe.

Adaptive capacity is similar to or closely related to a host of other commonly used concepts, including adaptability, coping ability, management capacity stability, robustness, flexibility and resilience, (Fussel et al., 2006). Adaptive capacity is context-specific and varies from country to country, from community to community, among social groups and individuals and over time. It varies not only in terms of its value but also according to its nature. Adaptive capacity has been analysed in various ways, including via threshold and ''coping ranges'', defined by the conditions that a system can deal with, accommodate, adapt to, and recover from, (Smit et al., 2006). The study has identified options available to the community.

Drylands in many poor countries have been neglected in development plans, policies and processes. However, there is abundant evidence that with appropriate incentives, technological innovations and investments, dry lands can be productive, (UNDP, 2007). Drought coping strategies depend upon past history, the kinds of livestock raised and available resources. In general sense, the entire concept of nomadism may be considered as a means of coping with and exploiting the highly variable resources. This is made possible in part through the ability of nomads to maintain several species of diverse livestock herds – camels, cattle, sheep and goats – and by their geographic mobility, (Oba & Lusigi, 1987).

Pastoralists need large herds not only to meet household requirements but also as a means of building social alliances through transfer to friends and kin as loans, (Oba & Lusigi, 1987). Though the above strategies worked in the 1960 – 1980s, they may not be effective under the prevailing climatic, environmental, socio-economic and political dispensation, increased human and livestock populations. In recent decades, it has become increasingly clear that pastoral strategies have been significantly strained and pastoralists adaptive capacity to resist or recover from climate related shocks have been undermined.

The mobility and access to key natural resources has been severely restricted, their ability to manage their livestock has been repeatedly undermined, Paranello, (2009). This scenario therefore, calls for updated research on how nomadic pastoralists survive under the changed circumstances. Deagrarianisation has been considered as an option. This refers to a long-term shift away from agriculture or livestock based livelihoods in rural areas (Newsham, Naess and Guthiga, 2011). Newsham et al., (2011), explain that this system is significantly altering the role played by small-holder farming in rural livelihoods across manyparts of Africa and further afield, and will have profound implications for adaptation pathways. There is need to intensify adaptation measures to ensure that agricultural productivity is increased even in the presence of climate change explain, Newsham et al., (2011). Climate change impact is likely to make agriculture more difficult in the future for many African farmers. Livelihood diversification as a form of climate change adaptation is clearly worth contemplating, Newsham*, et. al.*, (2011). Diversification away from agriculture into other climate insensitive activities is already happening and is likely to increase. Therefore, for it to be used as a development strategy as much as it does an adaptation, we need to find ways for deagrarianisation to move people out of poverty, rather than into other forms of entrenched poverty (Newsham, *et al.,* 2011).

Droughts and floods (the major climatic disasters) comprise 80 per cent of disasters in Kenya are not a recent phenomenon. For centuries, pastoralists have adjusted their livelihoods to periods of resource scarcity. However, the combination of unsustainable resource use, inadequate national policies and intensifying climate change threaten to overwhelm the existing adaptive capacities (Schilling & Remling 2011).

Pastoralists have developed highly successful adaptation strategies to climate change in different parts of the world. For example, Boranas of Southern Ethiopia have developed deep wells, concomitant social organisation which underlines construction, access, usage and maintenance of these impressive structures, (Menger and Ahmed, 2000). The question is, what adaptation options do pastoralists have and which do they actually adopt? The dynamics of changes taking place in the pastoral sector in Kenya and elsewhere are poorly understood and often simply overlooked, (Menger et al, 2000).

Pastoralist use mobile production system characterised by several strategies that allow the systems to maintain its functions (i.e. provide livelihood for pastoral households through income and livestock products) despite the uneven forage distribution and uncertain rainfall. However, many pastoralists are exiting from the traditional highly mobile forms and entering into agro-pastoralism or sedentarisation and other livelihood options, ODI, (2010). The principal strategy is to match forage requirements of the different household's herd livestock species with the forage on offer in the different grazing units. This is done throughout the year through an extended grazing itinerary. Most pastoral groups are found in environments with low and highly seasonal rainfall, where it is impossible to graze animals all year on the same pasture.

Movement allows herders to use a variety of pastures, water points and other resources such as salt licks, and is a sophisticated adaptation to the challenge of risky environments, UNDP, (2007). However, there are increasing limitations to herd mobility including insecurity, climatic variations, demographic and environmental degradation, Kaufmann, (2012). The livestock belonging to one household are usually kept in different herds, and the so-called satellite herds, which comprise majority of animals. The Rendille pastoralists in the study area were previously highly mobile with their livestock. However, households have now become sedentary due to number of socio-economic reasons since the 1960s. Settlements have sprung up; schools, hospitals and other infrastructure have been developed forcing communities to settle in order to access the facilities, (Kaufmann, 2012). A destitute pastoral population is also emerging, as is the phenomenon of significant and unprecedented emigration, (ODI, 2010).Pastoral societies had apparently lost their ability to handle droughts, or were at least facing much lower thresholds to famine and destitution, (Mange and Ahmed, 2000). Despite these challenges, the pastoralists continue to survive.

A challenge to pastoral development is in diversifying the pastoral economy to reduce people's vulnerability to drought, floods and famine. Concrete strategies are therefore needed to improve the pastoralists' coping options, Omiti, (2000c). The concept of adaptation, adaptive capacity, vulnerability, resilience, exposure and sensitivity are interrelated and have wide application to global change science, Smit *et al*., (2006).

There are various innovate ways of coping with climate change related phenomenon which needs to be documented in a participatory manner with the target community. Two fundamental response options to the risks posed by anthropogenic climate change are mitigation and adaptation to climate change (Fussel & Klein 2006). Adaptation primarily aims at moderating the adverse effects of unavoided climate change through wide range actions that are targeted at the vulnerable system (Fussel& Klein, 2006). It may also include taking action to seize new opportunities brought about by climate change. Historically, pastoralists communities regarded fish as snakes in water and consumption of fish was culturally prohibited, Cordaid, (2007). There is need for pastoralists to diversify their diet to include fish and poultry.

Three main ways of adapting to resource scarcity caused by more frequent and prolonged drought were identified among the Masai of Kajiado, including expansion of grazing range, diversifying income sources and migration to urban centres, (Schilling and Remling, 2011). The pastoralists move livestock according to pasture and water availability. However, the Masai in Namanga reported that the grazing area was too dry and small making expansion of the grazing areas necessary resulting in insecurity and conflicts with the neigbouring pastoralists. As an adaptation strategy, Kenyan Masai have crossed the border into Tanzania exposing them to harassment and imprisonment by Tanzanian security forces (Schelling and Remling, 2011).

Certain aspects of pastoral adaptation are troublesome and costly and at the general level, the dry lands of Africa have been politically unstable, characterised by unrests and confrontations between competing groups, Menger, L, et al, (2000). The problems of the pastoral societies seem intractable, but pastoralism still seems the only viable alternative for large groups of people in the arid and semi-arid parts of Africa, Menger, L, & Ahmed, A.G.M. (2000).

Identifying adaptation option and more precisely, identifying which factors need to be addressed and in what way, and the subsequent designing of adaptation measures builds on the understanding of vulnerability and capacity. This is because adaptation is a process with no definite end point, since what we are adapting to is constantly changing, there never is an absolute conclusion, MRC (2010). Nevertheless, innovation tools for evaluating effectiveness of adaptation strategies are in high demand from donors, governments and ngos, who are eager to know the success of investments.

3. Methodology

3.1. Study Area

The study area, Laisamis is a Sub-County within Marsabit County which borders Ethiopia to the North and North East, Wajir County to the East, Isiolo County to the South and South West and Turkana County to the North West and Sumburu County to the West. The County has a population of 291,166 (2009) and a current estimated population of 350,000 persons. The County covers a vast area of 70,961 sq. km. with a population density of 4 persons per sq km. The poverty level is 92 per cent (Kenya Population Census 2009) for

Marsabit County. The county livelihoods include nomadic pastoralists, semi pastoralists, agro pastoralists, small businesses and employment. The main economic activity in the study area is nomadic pastoralism. The economy almost entirely revolves around livestock rearing i.e. camels, cattle, sheep, goats and donkeys. All most each household keeps livestock and facets of livestock industry impact on all other economic and social segments. The study area is mainly inhabited by Rendille and Samburu communities, who are considered to be the most efficient producers of livestock under nomadic pastoralism. A few ethnic Somali community members practicing trade in food commodities and livestock around the trading centres. The rainfall figures in the study area ranges from 200 mm – 500 mm annually. The rainfall is erratic and unreliable resulting in recurrent droughts and floods. This has increased the community's vulnerabilities towards climate change related hazards, exacerbated by high poverty levels, poorly developed infrastructure and socio-economic marginalisation. The study area is characterised by low lying plains prone to floods. However, in Ngurenet area, one of the study enumeration areas, has mountains and season rivers that provide good browse vegetation for livestock and a small population of elephants. The rest of the study area is open grassland that provides highly nutrition livestock food plants including *Acacia tortilis* and *Indigofera spinosa*. High soil erosion and land degradation is evident from the amount of bare soil and presence of invasive plants including *Duosperma spp*, *Acacia seyal, Senseveria spp*. and *Ipomea spp*. among others.

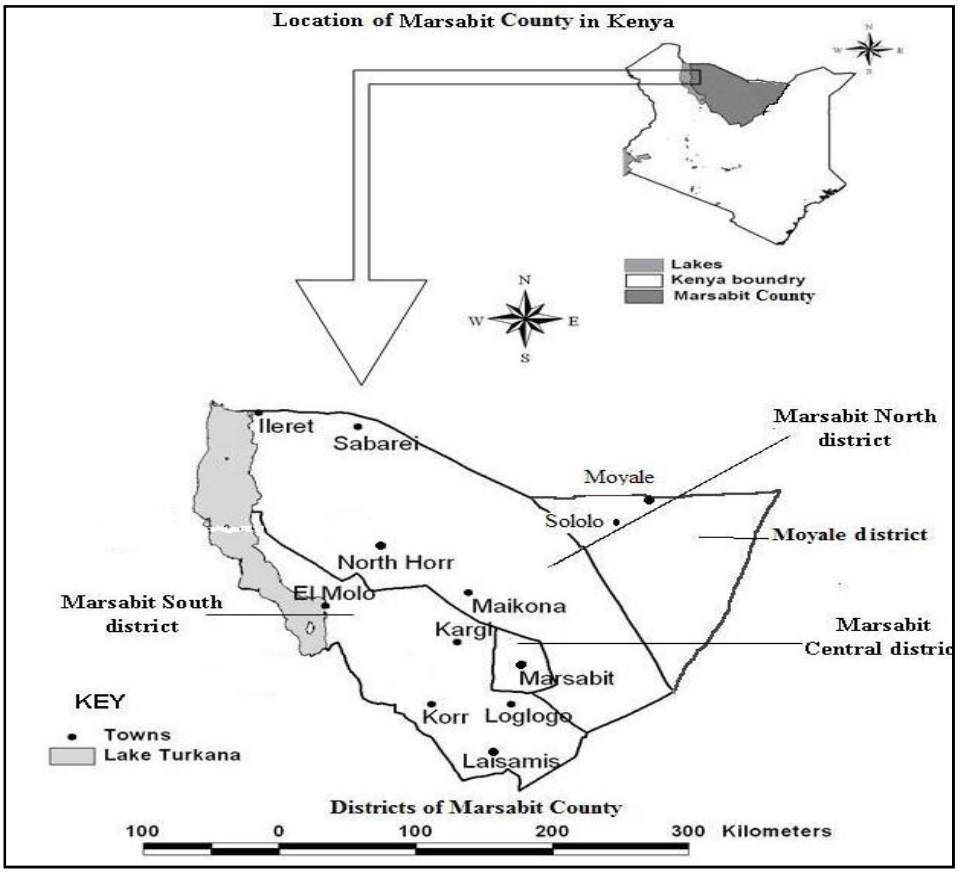

Figure 1: The map of Kenya indicating the Study Area.
Source: Marsabit County Maps, 2012

3.2. Research Design

Random proportional sampling was carried out in 4 villages with household as unit of analysis. A total of 384 questionnaires were administered in the four villages. Each village had 80 – 108 questionnaires depending on the number of households in each village. In addition, expert interviews were held at county and sub county levels with ngos, relevant Government of Kenyadepartments and other key stakeholders.

3.3. Sampling Population and Sample Size

Primary data was collected from 384 households across the study area in four villages. Proportional allocation of questionnaires was done depending on the size of the population of the village. The four villages include Ngurunet, Korr, Log Logo and Laisamis. The population for Ngurunet is 6,058, Korr is 9100, Laisamis is 6,424 and for Logologois 5,144 persons. The household numbers are 1,665 for Ngurunet, 1,619 for Korr, 1,705 for Laisamis and 1,193 for Logologo (Kenya 2009 Population and Household Census). In Ngurunet 80, Log Logo 90, Korr 106 and Laisamis 108 questionnaires were administered. The questionnaires were designed to address *adaptive capacity* and adaptation options questions. The sampling was randomly done by skipping every two households in a transect walk. The household was selected as the main unit of analysis because major decisions about adaptation to climate change–induced stresses and livelihood processes are taken at that level.

4. Data Collection Methods

4.1. Data Requirements

Primary data was collected from 384 households through questionnaire and interviews were held with the main policy makers in climate sensitive sectors at the county level. Secondary data was collected from meteorological stations, government reports, NGOs reports and County Government reports. Other data was collected through observations, listening and photography.

4.2. Primary Data Collection

384 Household Questionnaire were administered to four villages through proportional allocation. The questions in the questionnaire is based onadaptive capacity gaps and options for adaptation. Additional data was collected from NGOs, GoK and other development partners working in the study area at county level through. Observations and photographic data and hearings was used to enrich the raw data.

Village	Number of households	Population	Number of respondents
Log Logo	1,193	5,144	90
Laisamis	1,705	6,424	108
Korr	1,619	9,100	106
Ngurunet	1,665	6,058	80
Totals	**6,182**	**26,726**	**384**

Table 1: Sampled Villages

4.3. Secondary Data Collection

Records on frequencies of droughts and floods was obtained from the relevant Government of Kenya authorities in the Sub-County. Rainfall and temperature data over 30 - 50years was collected. Other secondary data was collected from Non-Governmental Organisations, published and unpublished reports and other relevant sources.

5. Data Analyses and Results Presentation

5.1. Qualitative Data Analyses

This was done because two objectives of the research i.e. Identification of adaptive capacity gaps and Options for adaptation requires in depth qualitative explanation. The questionnaire and experts' interviews were checked for completeness and cleaned. Field notes made during administration of questionnaires was organised into themes in line with the study objectives and analysed. The results are presented in form of texts explanatory notes, tables and charts.

5.2. Quantitative Data Analyses

This study used an integrated adaptation capacity analysis approach, which combines both socio-economic and bio-physical factors. This approach was applied by Madu (2012) in agro-ecological based household vulnerability analysis in Ethiopia and by Derese et al (2008) in regionally based vulnerability analysis. This study replicates an integrated vulnerability approach to develop vulnerability indices for each household as proposed by Madu(2012) and adapted by Tesso et al (2012) in Ethiopia. Adaptive capacity is a major component of Vulnerability assessment. The questionnaires and expert interview results were checked for completeness, cleaned and coding used to represent responses for specific questions. Quantitative data collected were based on different themes relevant to the objectives of the research. The data collected was based on Principle Component Analysis (PCA). SPSS and MS Excel computer programmes were used to work out the calculations. The results are presented in form of tables, percentage, bar graphs and pie charts.
Factors considered under adaptive capacity include livestock ownership, livestock diversity, income from other sources, remittances, social networks, livestock mobility, household mobility, political representation, access to early warning systems, roads, access to public transport systems, access to mobile phones, access to internet, access to credit facilities, access to extension services, access to veterinary services, access to livestock markets, access to livestock marketing information, access to livestock insurance. Drought adaptation capacity gaps and options for adaptation to drought were identified.

6. Results

6.1. Livestock Ownership and Species Diversity

Livestock ownership and herd distribution is an important livelihood strategy among the community. Most of the households own between 1 to 20 cattle (63.8%) whereas for 1- 20 camels are owned by 65.1 % of households as indicated in table 2. Table 3 shows species diversity for sheep and goats. Most of the households own between 1 to 40 goats (74.7%) whereas 81.5 % of household's own sheep. 52.1 % of the households own 1- 3 donkeys (table 4).

Cattle					Camels		
Valid		Frequency	Percent	Valid		Frequency	Percent
	None	76	19.8		**None**	101	26.3
	1-20	245	63.8		**1-20**	250	65.1
	21-40	34	8.9		**21-40**	25	6.5
	41-60	16	4.2		**41-60**	3	0.8
	61-80	4	1		**61-80**	2	0.5
	81-100	5	1.3		**81-100**	1	0.3
	Above 101	4	1		**Above 101**	2	0.5
	Total	384	100		**Total**	384	100

Table 2: Species distribution and diversity (cattle and camels)

	Goats				Sheep		
Valid		Frequency	Percent	Valid		Frequency	Percent
	None	13	3.4		**None**	21	5.5
	1-40	287	74.7		**1-40**	313	81.5
	41-80	55	14.3		**41-80**	37	9.6
	81-120	18	4.7		**81-120**	11	2.9
	121-160	2	0.5		**121-160**	1	0.3
	161-200	6	1.6		**161-200**	1	0.3
	Above 201	3	0.8		**Total**	384	100
	Total	384	100				

Table 3: Species distribution and diversity (goats and sheep)

	Donkeys		
Valid		Frequency	Percent
	None	164	42.7
	1-3	200	52.1
	4-6	12	3.1
	7-9	5	1.3
	Above 10	3	0.8
	Total	384	100

Table 4: Species diversity, donkeys

6.2. Sources of Income

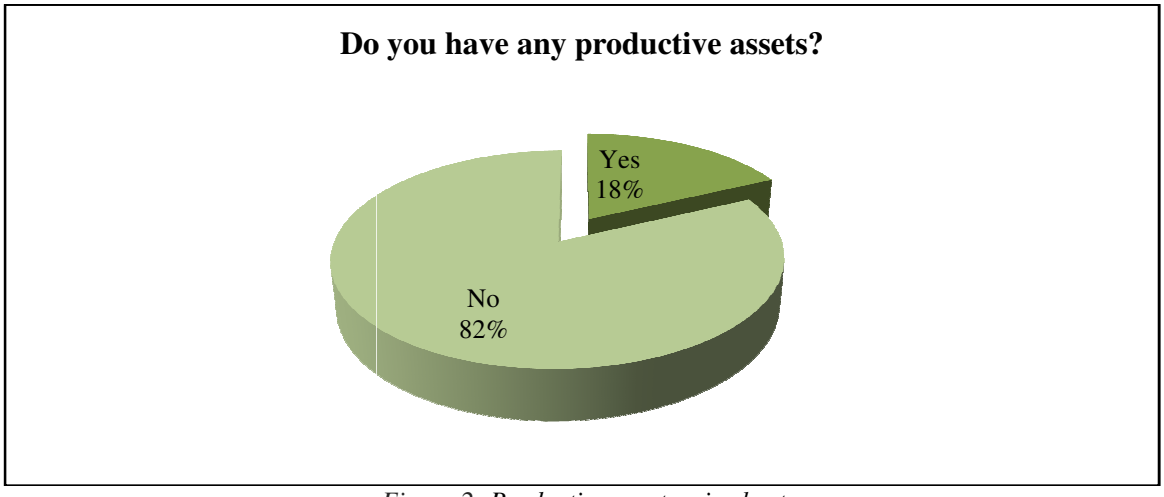

Figure 2: Productive assets, pie chart

The pastoralists in study area have a high proportion (82%) who don't have any productive assets with just 18% who have productive assets. This is alarming since it reduces capacities of households in managing drought and makes them highly vulnerable. The figures for the four enumeration areas are indicated in figure 3.

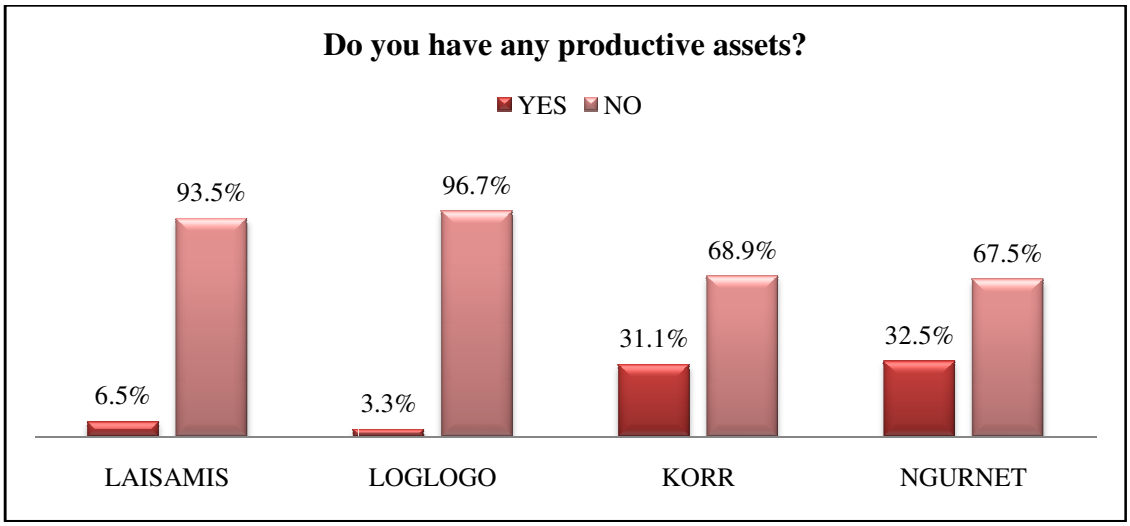

Figure 3: Productive Assets for Enumeration Areas

For Laisamis and Loglogo those who have productive assets are 6.5% and 3.3% respectively, whereas for Korr and Ngurnet it is quite encouraging that 31.1% and 32.5% respectively have productive assets. Incomes from various productive assets are described in table 5.

ENUMERATION AREA	INCOME ASSET	Frequency	Percent
Laisamis	Kiosk	1	11.1
	Motor bike operator	5	55.6
	Selling Firewood	2	22.2
	Selling of livestock	1	11.1
	TOTAL	**9**	**100.0**
Loglogo	Sale of livestock	5	55.6
	Small shop	3	33.3
	Giving out loans	1	11.1
	TOTAL	**9**	**100**
Korr	Butchery	6	21.4
	Retail shop/Small shop	9	32.1
	Sale of livestock	7	25.0
	Selling Charcoal	2	7.1
	Selling miraa	1	3.6
	Women group	3	0.1
	TOTAL	**28**	**100.0**
Ngurnet	Looking after animals	2	8
	Sale of livestock	6	24
	Selling blacksmith	2	8
	Selling in a kiosk	2	8
	Selling of goods	1	4
	Selling of milk	2	8
	Fetching and selling of firewood	2	8
	Fetching of water	1	4
	From his salary	1	4
	Looking after animals	5	20
	Watchman at the school	1	4
	TOTAL	**25**	**100**

Table 5: Incomes from productive assets

6.3. Employment Status

From the study area, a greater percentage (54%) of the pastoralists were unemployed with just a small percentage (2%) being employed (figure 4). The employment status in the four enumeration areas are as indicated in figure 5.

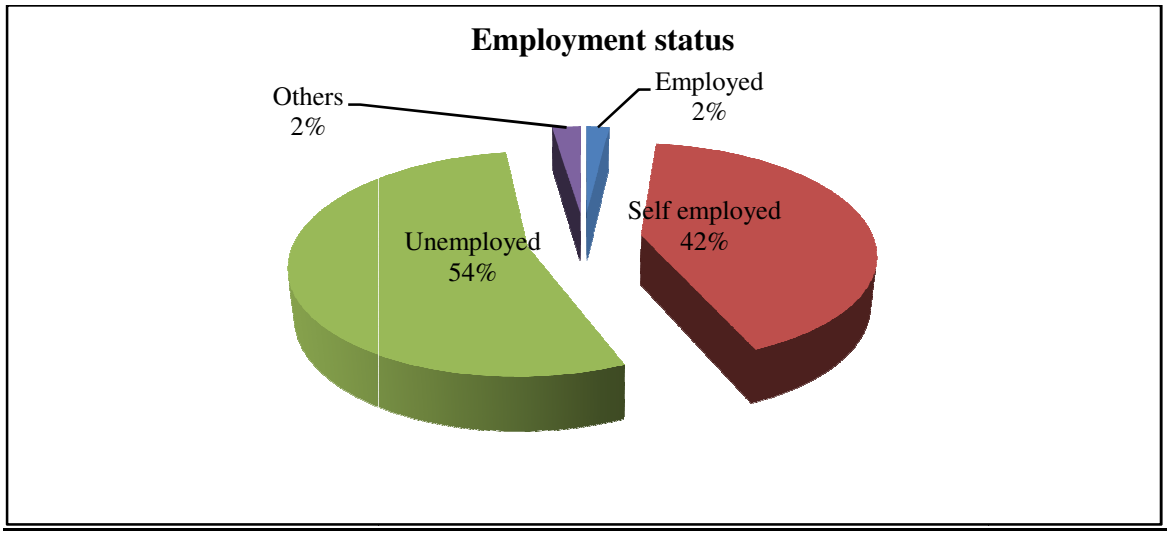

Figure 4: Employment status, pie chart
NB: Others: - Selling of livestock, looking after livestock, doing manual casual jobs

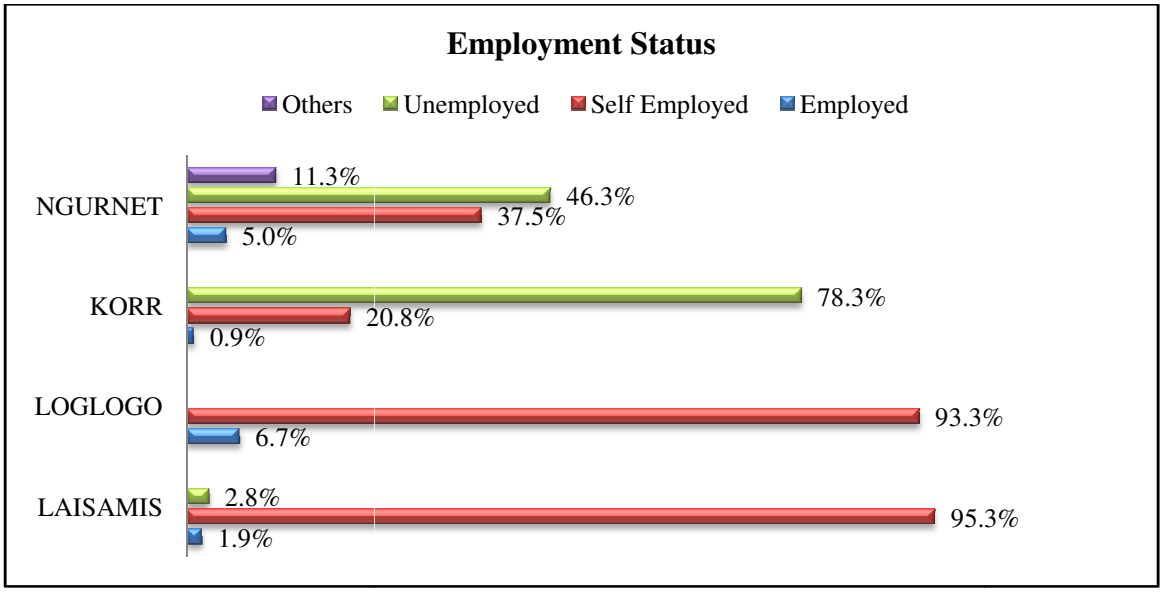

Figure 5: Employment status, bar chart

For Ngurnet the highest proportion of the households (46.3%) were unemployed, For Korr the highest proportion (78.3%) were also unemployed. However, for Loglogo and Laisamis where the high proportion, 93.3% and 95.3% respectively were self-employed.

6.4. Social Networks

The results show that 55% of the pastoralists are members of just one social network, 25 % belonged to more than one group, while 20 % do not belong to any group in the study area (figure 6). The various social networks that the households belonged to are indicated in figure 7. Higher proportion of pastoralists (47.1%) belong to Women's groups with the least (1.5%) to belonging to community Cooperatives.

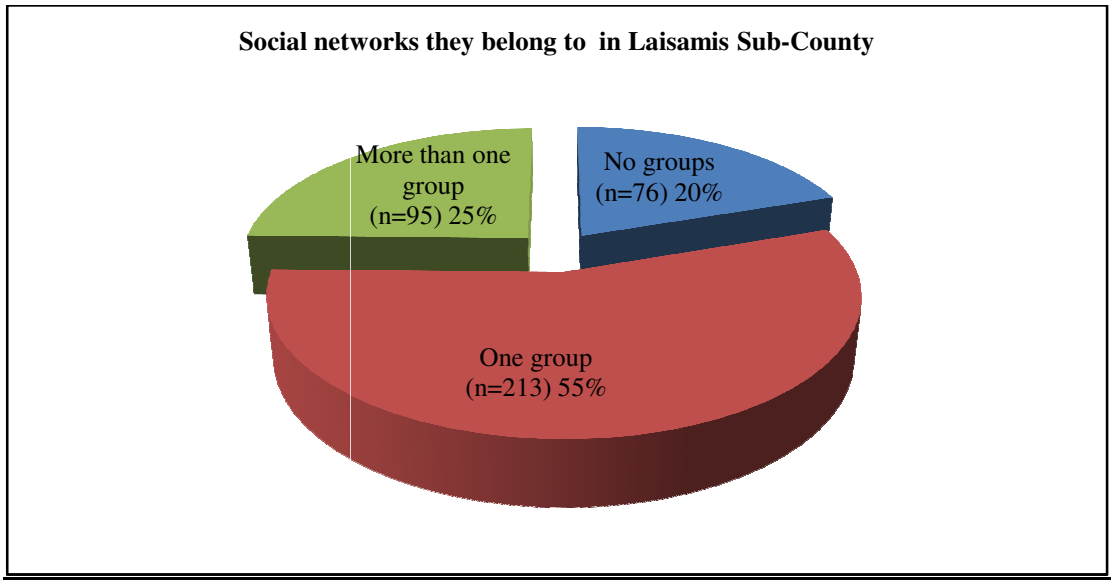

Figure 6: Social networks, Pie chart

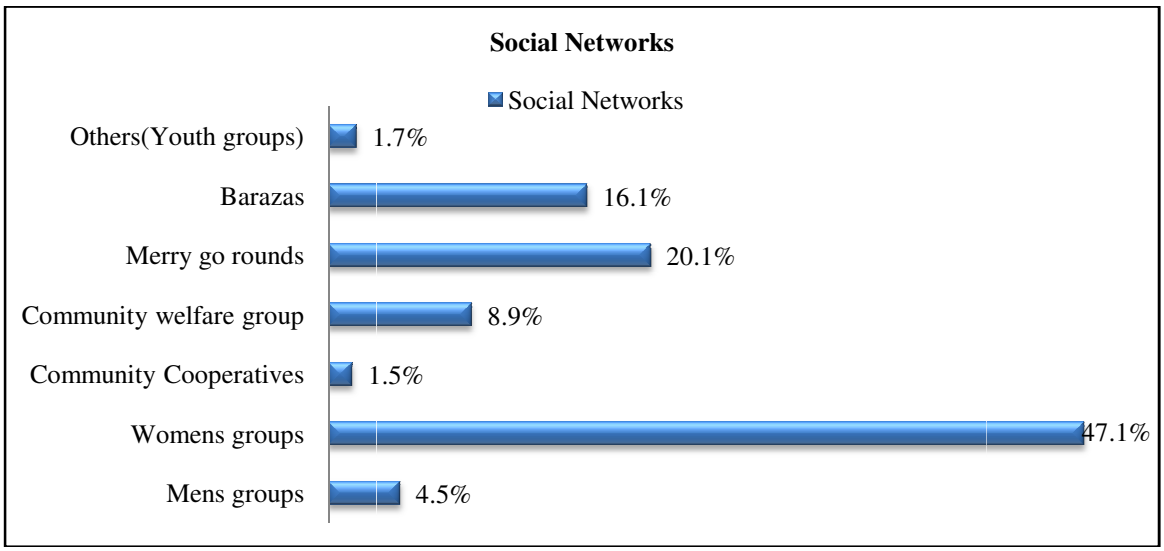

Figure 7: Social networks, bar chart

6.5. Access to Extension Services

From figure 8, 63% of households have moderate access to extension services and 37 % have to access in the study area. We went further to look at the access to extension services according to enumeration areas. In the four enumeration areas, Laisamis had a high proportion of No Access of 74.10% and 25.9 Moderate Access, Loglogo had 18.2 % No Access, 80.7 % Moderate Access and 1.1 Adequate Access. Korr had 9.5 % No Access and 90.5 % Moderate Access. While Ngurunet had 44.2 % No Access to 55.8 % Moderate Access (figure 9).

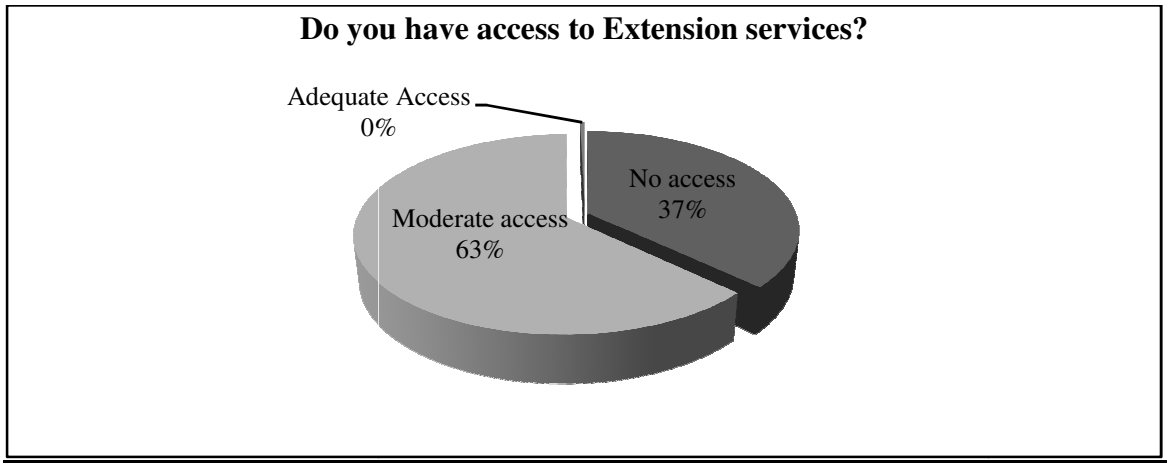

Figure 8: Extension services

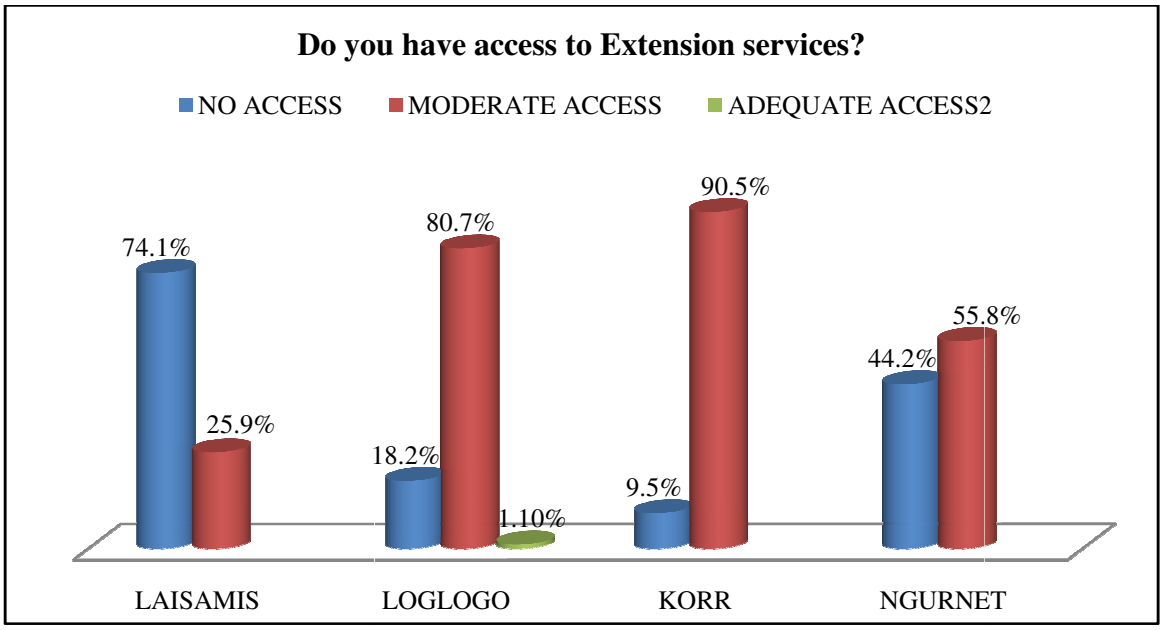

Figure 9: Extension services, bar chart

6.6. Early Warning Systems

Do you have access to climate related disaster early warning systems?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No access	200	60.1	60.1	60.1
	Moderate access	184	39.9	39.9	100.0
	Total	384	100.0	100.0	

Table 6: Early Warning Systems

The results indicate that 60.1% of households do not have access to climate related disaster early warning systems and just a 39.9% has moderate access (table 6). Access to disaster early warning systems according to the four enumeration areas is described in figure 10.

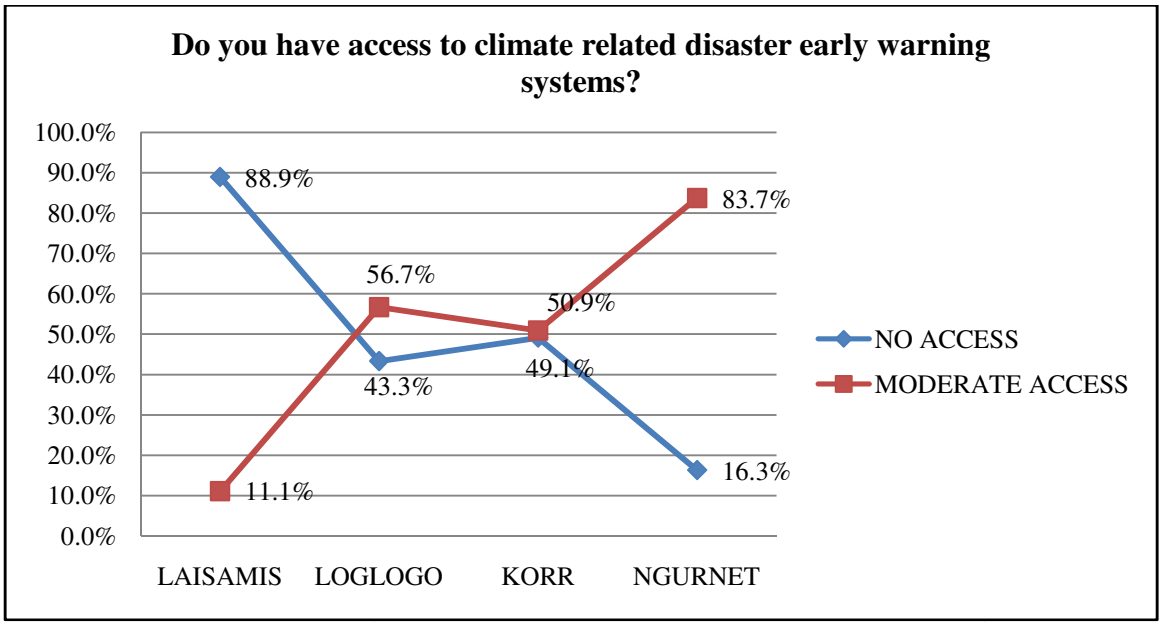

Figure 10: Early Warning Systems, line graph

For Laisamis and Ngurnet, there is a wide difference with a high fraction for those who have No access (88.9%) and (16.3%) respectively to climate related disaster early warning systems. Log Logo had 43.3 % No Access while Korr had 49.1 % No Access to disaster early warning systems. 11.1%, 56.7 %, 50.9 % and 83.7 % have Moderate Access in Laisamis, Log Logo, Korr and Ngurunet respectively (figure 10).

6.7. Remittances

From the results, 55.7% of pastoralists in the study area received remittances whereas 44.3% did not receive remittances (table 7).

Do you receive remittances from relatives?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	214	55.7	55.7	55.7
	No	170	44.3	44.3	100.0
	Total	384	100.0	100.0	

Table 7: Remittances from relatives

From the four enumeration areas, Ngurnet received the highest proportion of 82.5% of remittances whereas Laisamis pastoralists receive the least of 42.6% of the remittances (figure 11)

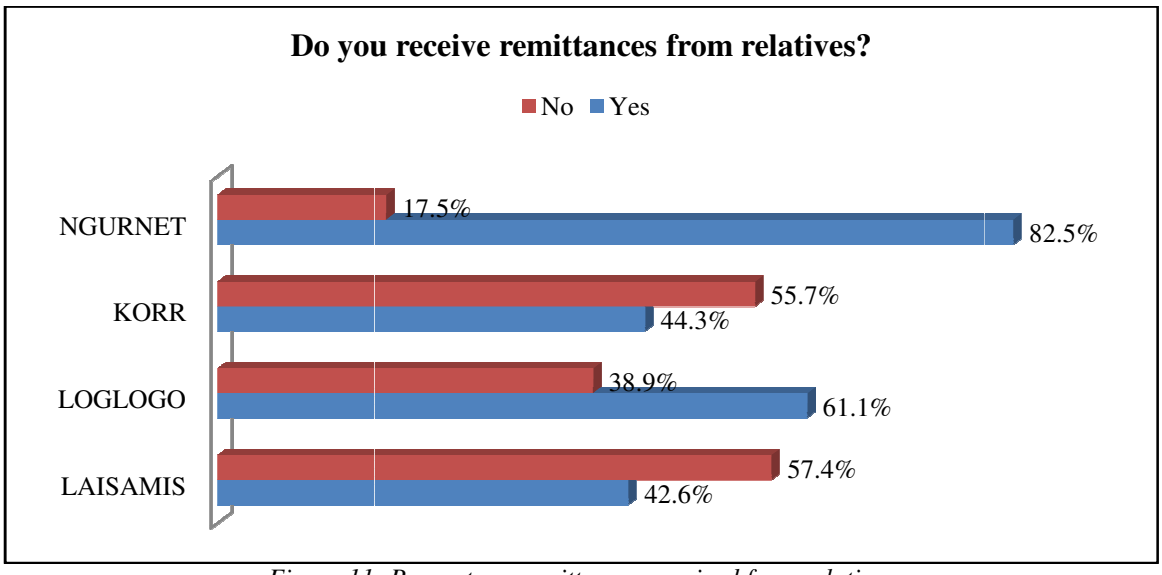

Figure 11: Percentage remittances received from relatives

The amount received in each of the four enumeration areas are described in figure 12.

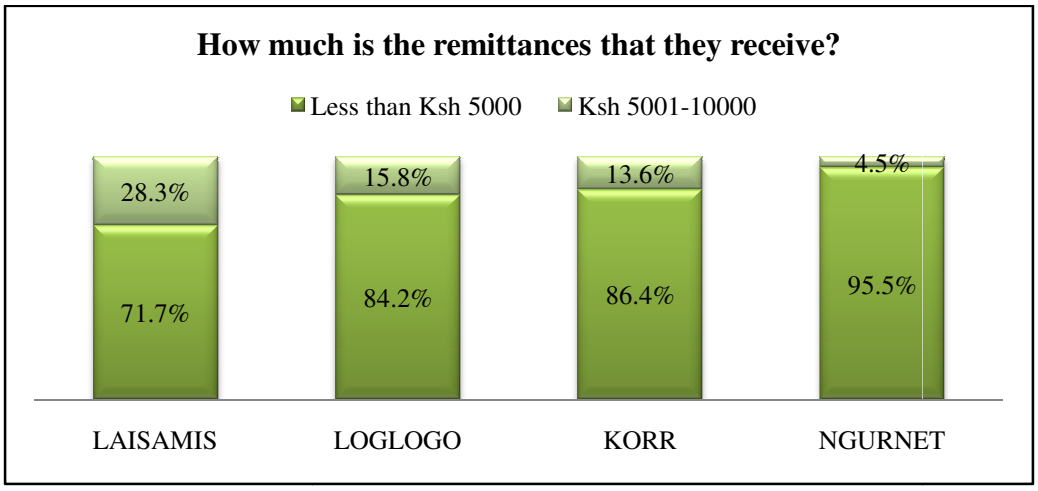

Figure 12: Amount of remittance received

The results indicate highest proportion of 95.5% of Ngurnet households received remittances less than Ksh 5000 (50 US Dollars), 4.5 % received between ksh. 5,000- ksh. 10,000 (100 US Dollars). 71.7 % of Laisamis households received less than ksh. 5,000 while 28.3 % received ksh. 5,000 – ksh. 10,000. In Log logo, 84.2 households received less than ksh. 5,000, while 15.8 % received between ksh. 5,000 – ksh. 10,000. 86.4 % of households in Korr received less than ksh. 5,000, while 13.6 % received ksh. 5,000 – ksh. 10,000 per month (figure 12).

6.8. Access to Credit Facilities

Do you access to credit facilities?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No access	137	35.7	35.7	35.7
	Moderate access	245	63.8	63.8	99.5
	Adequate access	2	.5	.5	100.0
	Total	384	100.0	100.0	

Table 8: Access to credit

The results in the study area indicate that higher fraction of 63.8% of households had moderate access to credit facilities and just 35.7% had No access to credit facilities and a negligible fraction of 0.5% had adequate access (table 8). The results from the four enumeration areas are described in figure 13.

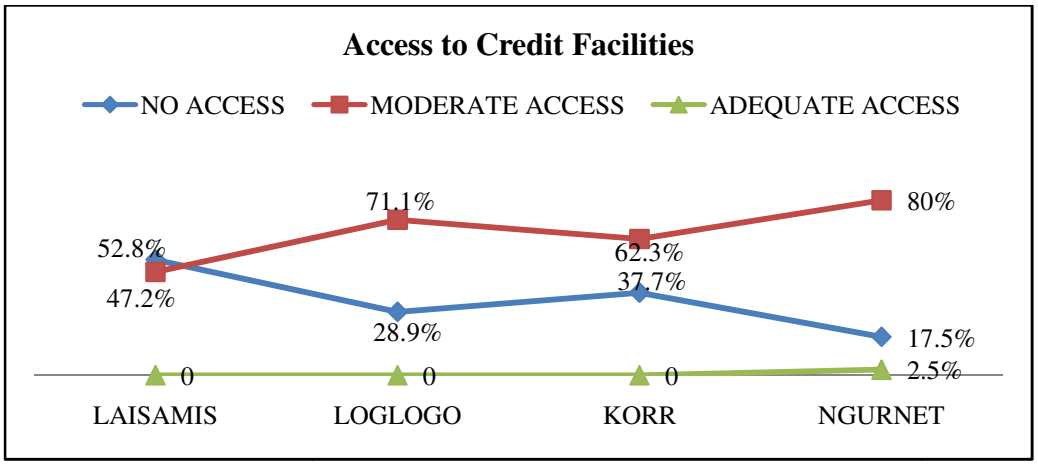

Figure 13: Access to credit, line graph

For Laisamis there was a small difference between those who have No access of 52.8% and those with moderate access of 47.2%. In Ngurnet there was a wide difference between those who have No access of 17.5% and those with moderate access of 80%.

6.9. Level of Education

Highest level of education attained					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No formal education	360	93.8	93.8	93.8
	Primary education	19	4.9	4.9	98.7
	Secondary education	5	1.3	1.3	100.0
	Total	384	100.0	100.0	

Table 9: Level of education

93.8% of the households do not have formal education in the study area. Only 1.3 % have limited primary education and a negligible number had secondary education (table 9).
The proportion with no formal education is the highest of all ranging from 85 - 90 %.Primary and secondary education levels are significantly low in all the enumeration areas (figure 14

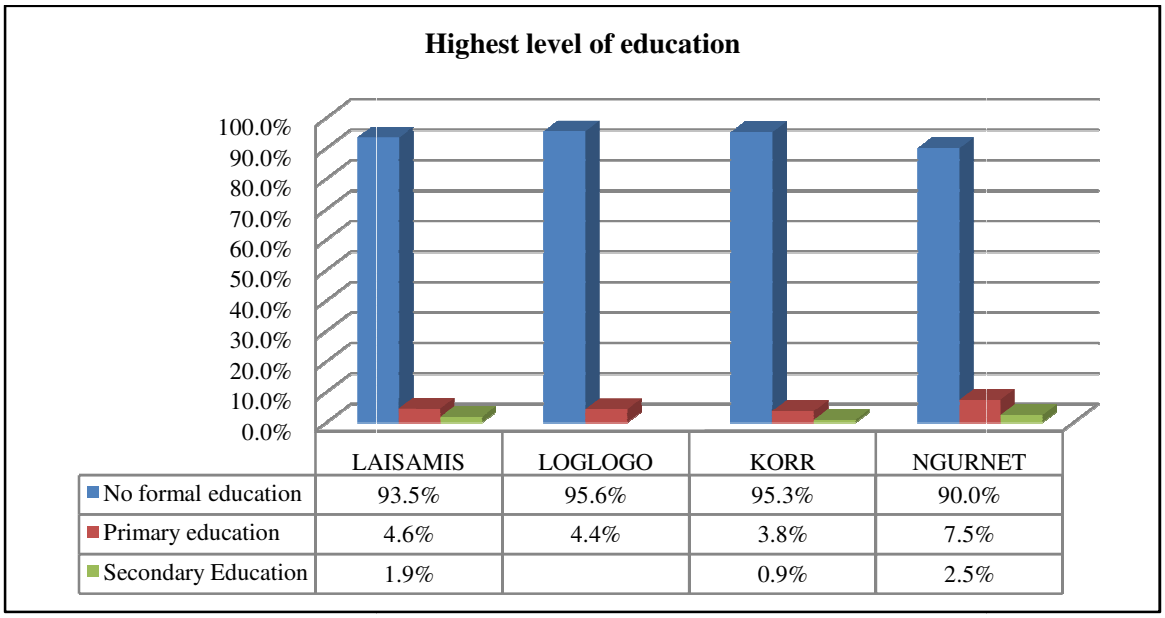

Figure 14: Level of education

6.10. Access to Technology
Results indicate that 62 % of households have no access to technologies, while 39 % have access to various technologies in the study area (figure 15).

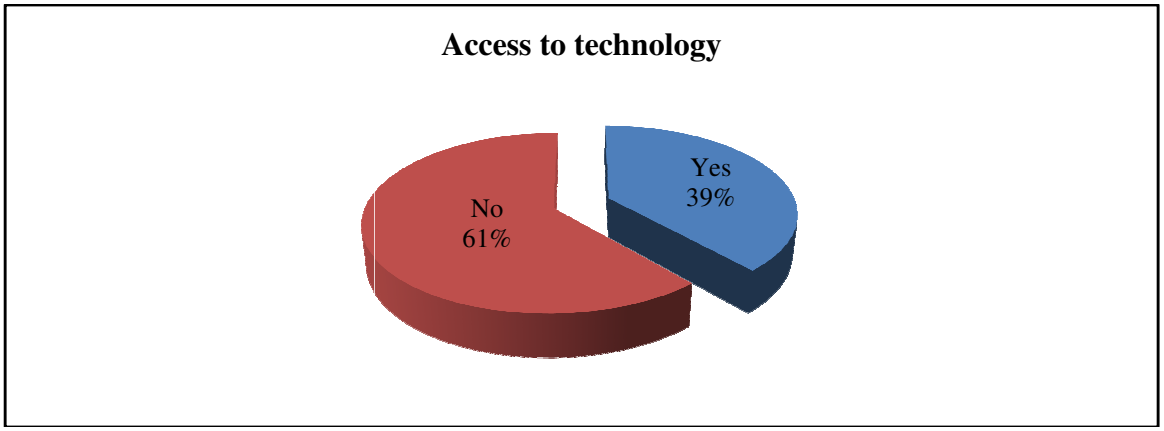

Figure 15: Access to technology

36.2% of the households in the study area had access to M-Pesa Money Transfer services, with the least being access to dipping and Tattooing both at 1.3%. The access to technology % is described in figure 16.

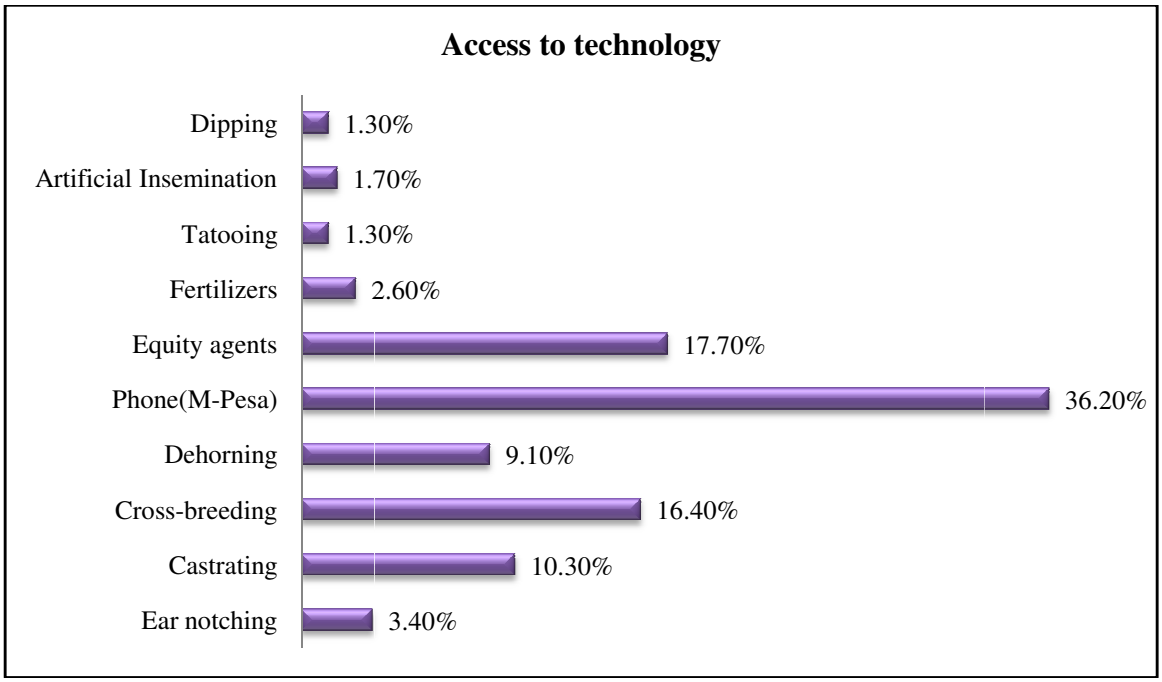

Figure 16: Access to technology, bar chart

6.11. Drought Coping Strategies Drought Coping Strategies

In Laisamis Sub-County, the pastoralists have used various drought coping strategies ranging from famine relief supplies, remittances from external sources, cash savings, livestock sales and shifting or nomadic way of life. As indicated in the figure 17,a greater proportion of the pastoralists i.e. 60% shifted to other sites, 27 % sold off their livestock to purchase cereals and other home utilities, 7 % received famine relief supplies, 4 % received remittances from relatives while 2 % utilised their cash savings to cope with drought. Closer analysis indicates that the community in the study area relied on own resources i.e. 60 shifting, 27 % selling of livestock and 2 % utilising own savings in coping with drought. The community relies 89 % on own resources in coping with drought.

6.12. Drought Coping Options

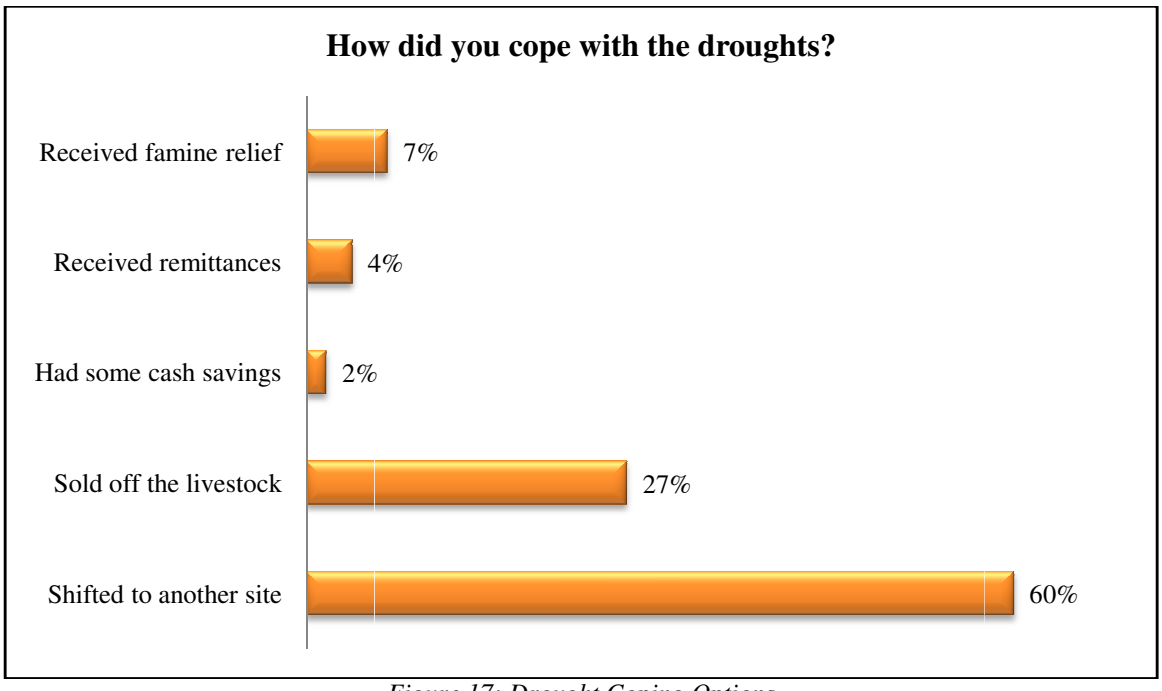

Figure 17: Drought Coping Options

7. Discussions

Various capacities gaps in coping with drought were identified during the study in. The capacity gaps identified include low livestock ownership and species diversity, low levels of formal education, limited sources of incomes and asset-base, low external remittances and low amounts, low employment status, poor social networks, low access to extension services, poor access to drought Early Warning Information, low access to credit facilities and poor access to modern technologies that may enhance livestock or other economic productivities. Major gaps in accessing the described parameters is likely to subject the households to more climate related stresses including drought, climate variabilities and climate change. Access to the above services depends on individual households and the geographic locations. For instance, communities in Korr and Ngurunet are likely to experience poor services because they are off the main Nairobi/Addis Abeba international highway. Laisamis Town and Log Log are situated along the main highway international highway. Therefore, in order to build community resilience, the above indicated gaps needs to be addressed through community capacity building initiatives. Enhancing community capacity towards drought will result in sustained and resilience households.

Contrary to a common belief that the communities in Northern Kenya are dependent on famine relief, the communities in the study area relied only on famine relief at 7 % of their drought coping strategies. The households relied on external remittances by only 4 %. The community relied 2 % on own savings, sold of livestock for 27 % of the time and shifted livestock 60% of the time as a drought coping mechanism. From the analysis, it is clear that the households depended on own coping mechanism for 93 % of the time. This implies that the local community drought resilience system is still working and needs to be enhanced. The external support should be minimized at it undermines community resilience towards drought. Since households mainly depended on shifting from place to place, as a drought coping mechanism, insecurity or conflicts needs to be minimized to enhance livestock and human mobility in the study area and beyond. Peace building and conflict prevention initiatives are necessary. Efforts have been made to improve access to secondary education. For instance, there is a girl's secondary school operating in Log Logo and Laisamis. More secondary schools need to be established in the study area.

Agricultural extension is the application of scientific research and new knowledge to agricultural practices through farmer or pastoralists education. The field of 'extension' now encompasses a wider range of communication and learning activities organized for rural people by educators from different disciplines, including agriculture, agricultural marketing, health, and business studies. Efforts should be made to redouble provision of extensions services in the study area.

Linkages is a connection or relationship between two or more socio-economic issues in a society. Among the benefits of linkages are increase in program outreach and visibility, technology transfer and dissemination among the community network and respective partners, sharing of knowledge, skills, expertise and experiences in improving the effectiveness and efficiency of project or programme implementation, partnerships aid in replication and scaling-up of project ideas and concepts, and enhance community or individual recovery from disasters through contributions from the society. In the study area, social networks are poor resulting in highly vulnerable households to drought and other disasters. Networks are important after disasters for fund raising and contribution of resources to support affected communities recover from a disaster event.

8. Conclusion

Major gaps were identified in formal education, access to extension and veterinary services, access to drought Early Warning Systems, access to credit facilities, access to drought insurance, and access to technologies need to be improved in order to enhance productivity and enhance drought resilience. Efforts should be made to close the gaps identified during the study. It is evident that the communities have built-in resilience to cope with drought. The community and the households need to be capacity built to enhance livestock productivity, cash savings and encourage individual and community investments through a development fund. Further drought adaptation research among the pastoralists in Northern Kenya and other parts of Africa is necessary.

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