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Drought Vulnerability Assessment in Pastoral Production System in Laisamis, Northern Kenya

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Abstract:
Arid and semi arid lands (ASALs) make up 80 per cent of Kenya's land area dominated by pastoral production system. The communities are faced with a number of challenges. Key among the challenges is the recurrent droughts affecting large numbers of humans and livestock. In northern Kenya, 28 major droughts have been recorded in the past 100 years. The drought frequency has increased as 4 of the 28 droughts occurred in the last 10 years. In some parts of Kenya, droughts have been recorded in subsequent years without breaks resulting in livestock deaths and severe malnutrition. Globally, regionally, nationally and in the study area, limited specific studies on drought have been conducted. The study area is vulnerable to drought and other exacerbating biophysical and socio-economic factors. However, the magnitudes of vulnerabilities to drought and other exacerbating factors are not well understood. Development interventions have been inappropriate due to inability to assess vulnerability levels. Comprehensive studies through an integrated approach are limited in the study area. The purpose of the study is to 1. Assess the magnitude of vulnerability to drought and 2. Identify capacity gaps contributing to drought vulnerabilities. Simple random sampling was used for primary data collection through questionnaires and scheduled interviews. 384 households were interviewed in a household population of about 19,000 households. A statistical formula was used to decide on the number of households to be interviewed. The research was conducted in four villages and random sampling procedures of interviewing a household after 3 households in a transect was conducted. Tools used for primary data collection were questionnaire and scheduled interviews with experts. Secondary data was obtained from meteorological records and relevant public and development partners. The study considered various biophysical and socio-economic indicators. Principle Component Analysis (PCA) was used and weights for different indicators to calculate the household vulnerability index (HVI). The data was analysed through computer Excel and SPSS programmes. This study considered 30 socio-economic and biophysical indicators which are the main determinants of vulnerability under exposure, sensitivity and adaptive capacity parameters. Key determinants were selected under each parameter. The results show that 2.3 % of the households were highly vulnerable, 32.6 % were moderately vulnerable and 65.1 % less vulnerable. Apparently, majority of the households are less vulnerable, while the highly vulnerable are only 2.3 %. There is need to target the highly and moderately vulnerable with long-term sustainable drought resilience interventions. The findings can be used by development organisations for proper targeting for development interventions.

Keywords: *drought, vulnerability, exposure, sensitivity, adaptation*

1. Introduction

1.1. Background to the Study

A growing number of countries all over the world are assessing climate change vulnerabilities in their zones. The objective is to provide a world-wide estimate of socio-economic and ecological implications. The primary aim is to generate vulnerability results on a global scale (Delft, 1993). However, there is no evidence of such a study at the household, Location, Ward, Sub-County, County and national levels in Kenya.

Globally vulnerability assessment has been used by policy makers, decision makers, donor organisations, civil society groups and community organisations for the purpose of identify current and potential hotspots, identify entry points for interventions and tracking changes in vulnerability through monitoring and evaluation of adaptation. This technique has been used to track climate change vulnerability over time.

Assessment of vulnerabilities of all resources of the world's zones required detailed global information on the distribution, density and the state of the resources on the impact of hazardous events such as drought (Delft, 1993). For many resources, such as ecosystems for instance, data on global scale are not yet available. Global data sources for vulnerability assessment allowed only for a limited spatial resolution for a number of variables resulting in inaccuracies on the scale of countries (Delft, 1993). There exists a great variety of

literature and databases describing vulnerabilities globally. However, some countries have no data or have inadequate data in order to conduct a comprehensive vulnerability assessment.

Previous studies by Brooks et al. (2005) and Intergovernmental Panel on Climate Change (2012) globally, concluded that majority of households are particularly vulnerable to the impacts of climate change in the arid and semi-arid regions. However, the authors were not able to indicate the levels and magnitudes of vulnerabilities among the households.

A study conducted by Sadek (2011) in Western Asia on climate change vulnerability assessment confirms that there is need to assess vulnerability in view of better understanding of the effects of Climate Change on sustainable development in the region. Sadek (2011) used integrated model-based approach for impact and Vulnerability assessments. However, the vulnerability assessment mainly focused on impacts on water resources and long-term water policies with no considerations for livelihoods and other socio-economic and bio-physical factors have been made. The study of Sadek (2011) mainly focused on water availability with no consideration for other key components in vulnerability assessment including adaptive capacity, sensitivity and exposure to hazard. There is need to incorporate all the key determinants of vulnerability. During the assessments of community vulnerabilities, the existing capacities and capacity gaps were identified.

In a study conducted in Germany, Fussel (2006) describes four steps in vulnerability assessment: impact assessment, first generation vulnerability assessment, second generation assessment and adaptation assessment. The step from climate change impact to first-generation vulnerability assessment is characterised by the evaluation of climate impacts in terms of relevance for society and by consideration of potential adaptation. The main novelty of the second-generation vulnerability assessment is the more thorough assessment of the adaptive capacity of people, thus shifting from potential to feasible adaptation. However, there is need to first assess the *exposure* and *sensitivity* before determining the *impact*. *Impact* is a function of *exposure* and *sensitivity*. Low adaptive capacity contributes significantly to high vulnerability levels. Fussel (2006), failed to recognise that Adaptive Capacity is a component of Vulnerability Assessment. Fussel (2006) never described Adaptive Capacity of humans and their livelihoods. The analysis of both exposure and sensitivity is necessary in order to obtain an objective and more comprehensive analysis of vulnerability. Clear identifications of Adaptive Capacity gaps are necessary to assess the magnitude of vulnerability to climate change. Majority of studies analyse Vulnerabilities and Adaptation Capacity gaps separately, which should not be the case.

An integrated approach which combines both socio-economic and bio-physical factors that includes all internal and external situations, has been applied by Madu (2012) in Ethiopia in agro-ecological based household vulnerability study and by Deressa (2008) for regionally based vulnerability study. These studies are comprehensive and includes the major components to be considered for vulnerability assessment.

According to a study by Busby *et al,* (2011) in Eastern Africa, five factors were selected that interact to influence overall vulnerability to climate change i.e. physical exposure, human induced environmental stress, population density, household vulnerability, governance and conflict. Complex interactions between socio-economic factors and the environment are important in determining vulnerabilities of communities and households to climate change according to Busby *et al,* (2011). Though not exactly the same parameters, the factors considered by Busby et al, (2011) comprehensively covers exposure, sensitivity and adaptive capacity gaps Studies that include comprehensive inclusion of the above factors have never been carried out in the study area.

Klein et al. (2007) observed that vulnerability analysis to climate change is needed at the level that would enable policy makers to tackle climate change challenges with the precision that is necessary, particularly in the arid and semi-arid regions of Africa. In the study area, no micro household level and Sub-County and County level vulnerability assessment has been conducted.

Studies conducted in 10 Countries in North Africa by CCAPS (2011) considers all climate-related geographical variables under physical vulnerability including past data on cyclone surge frequency, cyclone wind frequency, flood frequency, drought frequency, wildfires frequency, fresh water availability, all occurring between 1980 and 2001. Based on these data, future predictions and trends may be predicted. Water vulnerability was estimated based on available water consumed locally and water from other countries.

Given the importance of drought and low elevation, coastal areas exposure was given Vulnerability Index of 23.33 % in the study's Physical Vulnerability Index. Cyclones, wildfires and floods each were allocated 7.5 %. This method may not provide reliable information because of the short period of 20 years (Dima, 2011). Longer periods of 30 – 50 years may provide more comprehensive and reliable data. Water Availability Index is not a suitable analysis to assess vulnerability index because of overlooking other key elements in determination of vulnerability e.g. livelihoods (livestock), socio-economic, political and governance factors. Thus, there is need to derive vulnerability index which incorporates livelihood means, socio-economic and political factors.

As observed by Hume *et al*, (2005), there has been relatively little work published on climate change research subjects for Africa. In Latin America, Graciela et al (2014) explain that guidance on approaches and tools for conducting the assessments of the dimensions of vulnerability is limited and insufficiently shared. Most assessments are based on global maps, of which Africa is only featured. Other studies mainly focused on economic performance while little attention or no attention is paid to climate change vulnerabilities and adaptation capacity gaps. A framework integrating the components needed for climate change vulnerability, impact and adaptation assessment can guide practitioners in structuring its design, and selecting most appropriate methods and tools.

According to a study conducted in Eastern and Central Africa by Busby *et al.,* (2011), factors were selected that interact to influence overall vulnerability to climate change, these include: Climate-related hazards and physical exposure; human induced environmental stress; population density; house hold vulnerability; and governance and conflict. This method leaves out critical element of sensitivity to climate change. Not all livelihood sources or critical facilities are sensitive to climate change hazards. Physical exposure to climate-related hazards including drought, floods and hailstones, is a crucial measure of vulnerability in the East and Central Africa region explains Busby *et a.,* (2011). However, he was not able to include other vulnerability exacerbating factors including socio-economic factors.

A study conducted in 10 North African countries by Deka *et al*, (2011) assessed vulnerability based on four 'baskets' i.e. physical vulnerability, population and migration, household vulnerability and governance and political violence. This method does not consider sensitivity and critical elements of community livelihoods which forms the basis of the adaptive capacity. This method only compares percentage contribution within the same basket rather than comparing all the four baskets. Due to failure to assess Adaptation Capacity Gaps, it has been difficult to provide recommendations for Adaptation Options.

In Senegal and Burkina Faso, local land users have adapted traditional pruning and fertilising techniques to double tree densities in semi-arid areas. Though tree planting is not a new phenomenon, it is being undertaken on a much more comprehensive scale to counter the impacts of climate change describes a UNEP (2009) report. 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.

In arid and semi arid lands (ASALs), which make up 80 % of Kenya's land area, droughts are a common phenomenon (GOK, 2007b). 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 malnutrition 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 overwhelming devastation and suffering caused by droughts, studies on vulnerabilities to drought are not well studied and documented.

In recent times, many extreme weather events, especially drought and floods have been attributed to climate change. The identification of vulnerable areas to climate change related hazards and disasters has not been carried out any many counties and regions in Kenya, Dhanapal (2014). Through this study, we attempted to identify a vulnerable area and the degree of vulnerability among the households in the study area.

There is need to identify the determinants of vulnerability and measure micro-level vulnerability of pastoralists in arid rangelands of Kenya. The vital information that is obtained from household level vulnerability analysis is presently lacking in national and regional level assessments (Opiyo et al, 2014). Deressa et al (2008), Pearson et al (2008) and Sherwood (2013) in Opiyo et al (2014) show that vulnerability contexts are diverse for different multiple spatial scales, and therefore this approach can contextualise how climate change and variability affect pastoralists livelihoods in Kenya.

Kenya's economy is highly dependent on natural resource base, making it highly vulnerable to climate change (GOK, 2014). However no comprehensive study has been carried out to assess the levels of vulnerability at national and community levels. In Northern Kenya, where the dryness is most pronounced, 28 major droughts have been recorded in the past 100 years. The frequency of droughts has increase as four of the major 28 droughts occurred in the last decade (schilling et al, 2011). Pastoralists in the study area are highly vulnerable to drought. However, the scale of vulnerability is not well understood locally and nationally.

Opiyo et al (2014) in a study in Turkana County, gave a blanket exposure to drought for all the communities in the study area. Depending on the specific location, the exposure may defer as indicated by the results of this study in the four enumeration areas of Korr, Log Logo, Laisamis and Ngurunet. Exposure and predisposing factors cannot be the same as described by Opiyo et al (2014).

High levels of vulnerability to drought in the study area is linked to high reliance on natural resources, limited ability to adapt financially and institutionally, low per capita income, high poverty levels and lack of safety nets (PACIDA 2009). Despite the threats posed by the recurrent droughts to pastoralists livelihoods, adequate research on vulnerabilities have not been carried out in the study area. Failure to carry out vulnerability assessments, has led to inability to intervene effectively by development organisations.

Elliot (2004) describes the challenges faced by the pastoralists in the study area as drought and famine, rapid population growth, loss of common property rights especially land, sedentarisation and rural urban migration. Majority of pastoralists in the study area have opted to settle around the trading centres including Korr, Ngurunet, Log Logo and Laisamis to access famine relief food and medical supplies leading to undermining of pastoralists livelihoods production systems. Despite all the challenges faced by the communities in the study area, adequate research on drought and related disasters have not been carried out in the study area.

1.2. Research Objectives

1. Carry out magnitude of vulnerability to drought
2. Identify capacity gaps contributing to drought vulnerabilities.

1.3. Statement of the Problem

Most assessments are based on global maps, of which Africa is only featured. Some of the studies mainly focus on economic performance while little attention or no attention is paid to climate change vulnerabilities and adaptation capacity gaps. The Intergovernmental Panel on Climate Change (IPCC) has noted that Africa is highly vulnerable to Climate Change. However, no indices or levels of vulnerabilities have been assessed. This scenario has resulted in poorly prepared adaptation strategies and implementation frameworks both at international and national levels.

Factors that interact to influence overall vulnerability to climate change include, Climate-related hazards and physical exposure, human induced environmental stress, population density, household vulnerability, and governance and conflict. Most studies exclude critical element of sensitivity and physical exposure to climate-related hazards.

Some countries have no data or inadequate data in order to conduct a comprehensive vulnerability assessment. The data sources are non-uniform and some data sources present contradicting information (Delft 1993). These limitations indicate that there is need to carry out country and community level vulnerability assessment in order to obtain reliable assessment results. Complex interactions

between socio-economic factors and the environment are important in determining vulnerabilities of communities and households to climate change according to Busby *et al,* (2011). This study will consider the key factors contributing towards vulnerability.

Though some levels of vulnerabilities are known, the magnitude and distribution is not well understood. Hence, there is need to assess levels of vulnerability of livelihood and other economic and social factors related to climate change. As observed by Hume *et al*, (2005), there has been relatively little work published on climate change research subjects for Africa.

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 vulnerability and adaptation assessment and identify measures to be taken (MEMR, 2009a).

Due to climate change and drought phenomenon, Kenya's temperature has risen by 1 degree centigrade over the last 50 years (IPCC, 2007). The country is warming at the rate of roughly 1.5 times the global average and is projected to increase up to 2.8 degrees centigrade in 2060 and up to 4.5 degrees centigrade in 2090 (Schilling et al, 2011).

In the Arid and semi-arid parts of Kenya, which make 80 per cent of the dry land area, droughts are a common feature (GOK, 2007). Such projected negative trends call for early vulnerability assessment for household in order to have adequate preparedness plans to cope with the projected rising temperatures.

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 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). Despite the significance of economic contribution of the ASALs, no comprehensive studies have been conducted on vulnerabilities, adaptation capacities and adaptation options.

Kenya's economy is highly dependent on natural resource base, making it highly vulnerable to climate change (GOK 2014). In Northern Kenya, where the dryness is most pronounced, 28 major droughts have been recorded in the past 100 years. The frequency of droughts has increase as four of the major 28 droughts occurred in the last decade (schilling et al 2011). Pastoralists in the study area are highly vulnerable to drought. However, the scale of vulnerability is not well understood locally in the study area, county level and nationally.

Pastoral communities in Kenya live in the challenging environment facing unreliable and erratic rainfall, high temperatures, frequent droughts, conflicts over access to resources, livestock and human diseases among other socio-economic factors that undermine their livelihoods. Due to overreliance on livestock for their livelihoods, frequent droughts are the most challenging factor. The communities living in the pastoral areas are highly vulnerable to drought. However, the magnitude of the vulnerabilities is not well understood, adaptation capacities and options are not well understood.

Based on technology readiness index, Kenya is among the last of all ranked countries (rank 101 0f 139). In order for the country to improve on its knowledge on climate change adaptation, studies such as this should be carried out to enhance the knowledge gap. 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 contribution of formal education to adaptation options for the target community and the county at large.

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. Apart from isolated studies conducted in Kajiado and Turkana, there are no comprehensive studies on options for adaptation to climate change by pastoralists. Knowledge on adaptation options and adaptation capacity gaps are limited for pastoral livestock production systems.

Pastoralists and subsistence farmers are more vulnerable to climate change and it is difficult for them to cope with climatic variability because of small farm sizes and lack of modern technology. Therefore, there is need to apply rapidly growing scientific knowledge to enhance the adaptive capacity of pastoralists argues Mirza (2003). Adaptation to climate change is not accomplished in a single intervention. Rather, it is a continuum requiring overarching approach that incorporates that range from those that address underlying drivers of vulnerability to those designed exclusively to respond to climate change impacts (ODI, 2010). Adaptation process and strategies need to be location and context–specific, integrated and flexible to focus on the needs of the study target group.

Since the communities in the study area live in and Arid Area, their livelihoods are highly exposed to climate stimuli including temperature, rainfall, high velocity winds and frequent droughts. The target community relies mainly on climate sensitive livelihoods including livestock, pasture and water supply systems. The stimuli including rainfall and temperature for livestock production and sustained water supply for domestic and livestock use, significantly contribute towards vulnerability. However, the significant and contributions of the sensitivities of livestock, humans and the natural resources including water and pasture has not been adequately researched in the study area and at national level.

Other vulnerabilities exacerbate the already highly vulnerable communities due to socio-economic and biophysical factors. However, the levels of vulnerability have not been assessed and highlighted and fully shared among stakeholders. Thus, this study has attempted to assess vulnerability levels in pastoral production systems.

The purpose of the study is to assess the magnitude of vulnerability levels among pastoralists households. The study aimed at providing information on drought vulnerability levels to be used for proper targeting in rural development interventions.

384 householder questionnaires were conducted among four villages in the study area. Random sampling was done and the questions were based on parameters contribution to drought vulnerability including exposure, sensitivity and adaptation. Weights were allocated to each Principal Component and Indices worked out through a formula described in the text.

1.4. Justification of the Study

Climate change is a major challenge for agriculture, food security and rural livelihoods for billions of people including the poor in the sub-Saharan Africa region. Pastoral production system is the sub-sector most vulnerable to climate change due to its high dependence on climatic variables including rainfall, temperatures, humidity and wind speeds. Studies by Kabubo-Mariara (2009) and Silvestri et al (2012) in Opiyo et al (2014) reveal that extreme weather events such as prolonged dry spells and intense rainfall are already affecting rural communities in parts of arid and semi-arid lands (ASALs) of Kenya. At present, nearly 30% of the total Kenya's human population resides in the ASALs, which cover approximately 88% of the total land mass, and hold almost 70 % of the total livestock herd.

Large proportions of pastoralists who reside in ASALs are believed to be at risk of food production deficit, declines in pasture and water availability, all exacerbated by extreme climate events such as drought, Opiyo (2014).

This calls for efforts to carry out a comprehensive study to assess vulnerability levels, identify capacity gaps and recommend adaptation options. Otherwise communities in ASALs may become environmental refugees, conflicts over resources may arise and in the extreme cases livestock deaths and human deaths may occur.

Disasters in East Africa are having a lot of negative impact in terms of both human and economic loss because of high vulnerability of the region's people and institutions. Climate Change and variability have compounded the challenges to the extent that indigenous knowledge can no longer provide solutions to address new challenges (ISDR 2012). It has resulted in more severe disasters in the region particularly resulting in droughts and floods. It is only through a comprehensive study of vulnerability and capacity gaps assessment that can inform decisions on interventions.

Disasters induced by drought account for about 90 per cent of all disasters in the Horn of Africa. Drought sets off a vicious cycle of socio-economic impacts beginning with crop failure, low crop yields, unemployment, erosion of assets, decrease in income, worsening of living conditions, poor nutrition, and subsequent decrease in coping capacity thus increasing vulnerability to drought (ISDR 2012). The proposed study will carry out comprehensive study to analyse the vulnerability levels and adaptive capacity gaps with a view to giving a clear recommendation on how communities' can reduce their vulnerability and improve on their capacities to cope with drought.

Climate Change has become more threatening not only to the sustainable development of socio-economic and agricultural activities of any nation but to the totality of human existence mentions Adejuwon, (2004). Studies have shown that about 90% of all natural disasters afflicting the world are related to extreme climatic changes. Negative impacts of climate change affect various development sectors including agriculture, environment, human health, economic activities and physical infrastructure (IPCC, 2007). The impacts of climate change combined with inadequate adaptive capacity results in high vulnerability.

Pastoralists face a number of challenges including changes in rainfall patterns, increased frequency and severity of droughts, increased sedentarisation taking up valuable grazing land, rapid population growth, decreased fodder availability particularly during the dry seasons, low milk and meat productivity, poor marketing infrastructure among others, Kaufman (2012).

Exposure to drought prone areas and sensitivity of the livelihood systems to climate change makes pastoralists highly vulnerable. However, the levels of vulnerability are not well understood by development workers and intervention planners.

The analysis of vulnerability levels will assist development planners for better targeting of their efforts in long term development interventions or during emergencies related to climate change. There is limited information regarding Kenya's vulnerability to the Climate Change and the level of knowledge and understanding is still more general according to a report of GOK (2010).

The country's vulnerability differs depending on the area. This therefore calls for specific vulnerability assessment for each area (GOK 2010). In addition, knowledge on adaptive capacity gaps and strategies for adaptation are not well understood and documented both for Kenya and the study area.

This study will contribute to an expanding knowledge on vulnerabilities and adaptation in pastoral systems and help broaden our understanding of how global climate change is playing out in the local places. Comparing the findings of the research with other pastoral systems in the world, conclusions may be drawn concerning vulnerability levels, adaptation capacity gaps and options for adaptation be developed and implemented.

2. Materials and Methods

2.1. Introduction

This section describes the study area (figure 1), research design, study population and sampling, data collection methods, primary data collection, secondary data, data analysis and results presentation, reliability and validity, and finally research ethics.

2.2. Study Area

Marsabit County 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 310,000 persons. The County covers a vast area of 70,961 sq. km. with a population density of 4 persons per sq km. The county has four constituencies including Moyale, Sakuu, Laisamis and North Horr. The study area will cover the arid parts of Laisamis constituency including four electoral Wards including Laisamis, Loglogo, Korr and Ngurunet. 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 Laisamis Constituency (the study area - figure 1) is livestock rearing. 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. 85 per cent of Lake Turkana lies in Laisamis Constituency and is a major source of income from tourism and fishing. 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 ethnic communities. Turkana people mainly live around Lake Turkana, with few ethnic Somali community members practicing trade in food commodities and livestock around the trading centres. The rainfall figures for the study constituency ranges from 200 mm – 1,000 mm. 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. Details on levels of vulnerabilities, adaptive capacities and adaptation options are not well understood by development partners and researchers in order to propose effective interventions on sustainable basis. This scenario has resulted in poor targeting by the Government of Kenya and development partners.

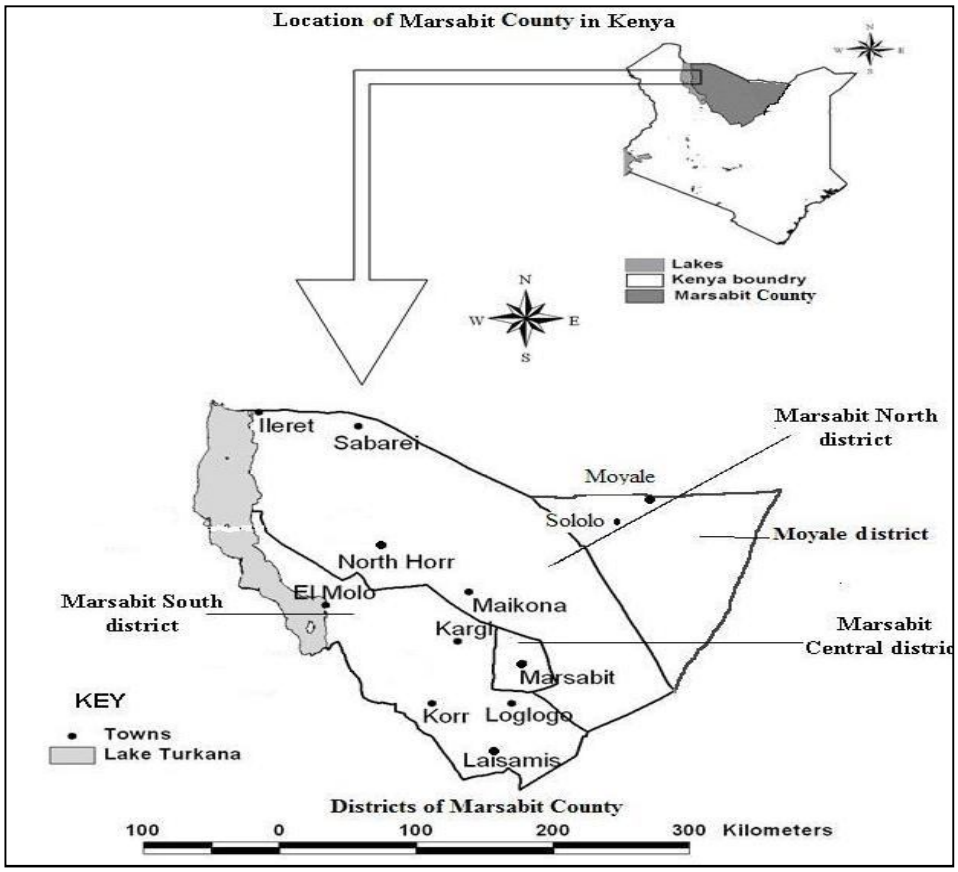


Figure 1: The map of Kenya indicating the Study Area.
Source: Marsabit County Maps, 2012

3. Research Design

The research used exploratory and cross sectional survey. This method was used because the research topic is relatively new and has previously scarcely been studied in the study area and Kenya. 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 (Non-Governmental Organisations), relevant GOK (Government of Kenya) departments and other key stakeholders.

3.1. 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 *exposure, sensitivity* and *adaptive capacity* 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. Nevertheless, households are connected to the wider community, which can greatly influence their decision- making processes in relation to use of particular productive resources (Opiyo et al 2014).

The Sample Size was identified through the formula described below derived from Scott Smith, (2013):
Necessary Sample Size is = (Z-Score) squared X Standard Deviation (1-Std. Deviation)/ (Margin of error) squared Margin of Error (Confidence Interval) chosen is - + 5 %, Confidence Level is 95 %, and the Standard Deviation of 0.5 to ensure that the sample size is large enough. Z-Score for 95% Confidence Level from Z-Score Table is 1.96. Therefore, the formula for my sample size is:
Used Z-Score for: 95 % accuracy – i.e. 1.96
90% '' - 0.645
99% '' - 2.326
Sample Size = (1.96) Squared X Standard Deviation (1- Standard Deviation)/ (Margin of Error) Squared
=3.8416 x 0.25/0.0025
=384 Respondents

Secondary rainfall and temperature data for the last 30-52 years was analysed and plotted in graphs from the main trading centres including Laisamis, Loglogo, Korr and Ngurunet. The data was plotted on a graph to show the trends in rainfall and temperatures changes.
Experts' and decision makers were interviewed on the relevant questions to the study including questions on exposure, sensitivity, adaptive capacities, adaptation capacity gaps and adaptation options. This was done to get the generic expert and decision makers perspectives.

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 are based on climate *exposure, sensitivity* and *capacity gaps*. Interviews were held with experts and decision makers to get their perspectives on vulnerabilities and adaptive gaps. 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
Secondary data collected include rainfall and temperature from the meteorological stations. Evidence of interventions to climate change related disasters including droughts and floods were recorded. Records on frequencies of droughts and floods was obtained from the relevant GOK authorities in the Sub-County. Rainfall and temperature data over 30 - 52years was collected. Trends in temperature and rainfall and deviations from means was plotted. Relationships between the trends in climate change and climate related disasters including drought was shown. Other secondary data was collected from NGOs, published and unpublished reports and any other relevant sources.

5. Data Analyses and Results Presentation

5.1. Qualitative Data Analyses
This was done because identification of adaptive capacity gaps required 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, charts and photographs.

5.2. Quantitative Data Analyses

This study used an integrated vulnerability 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. However, this is the first attempt for the approach to be applied in a pastoral production system in Northern Kenya.

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) under three broad themes i.e. climate *exposure,* climate *sensitivity* and *adaptive capacity* gaps. The main determinants of vulnerability were used to obtain Vulnerability Index. Vulnerability Index was calculated based on indices for each response under *exposure, sensitivity* and *adaptive capacity*.

Based on the Vulnerability Index formula, this was achieved through addition of exposure and sensitivity indices and obtaining the means. This calculation resulted in Impact. The final Vulnerability Index was obtained by subtracting Adaptive Capacity from the Impact.

SPSS and MS Excell computer programmes were used to work out the calculations. The results are presented in form of tables, percentage, bar graphs and pie charts.

5.3. Computation of Vulnerability Index

According to the IPCC (2001) Third Assessment Report, Vulnerability is defined as "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of variation to which a system is exposed, its sensitivity, and its adaptive capacity'', McCarthy et al (2001). Thus, as per this definition, vulnerability has three components*: exposure, sensitivity*, and *adaptive capacity*. These components are described as follows:

- *Exposure* can be interpreted as the direct danger (i.e., the stressor), and the nature and extend of changes to a region's climate variables (e.g. temperature, precipitation, extreme weather events).
- *Sensitivity* describes the human-environmental conditions than can worsen the hazard, ameliorate the hazard or trigger an impact.
- *Adaptive Capacity* represents the potential to implement adaptation measures that help avert potential impacts.

The first two components together represent the *potential impact* and the *adaptive capacity* is the extent to which these impacts can be averted. Thus

Exposure + Sensitivity= Potential Impact (I)

The values for Exposure is obtaining by normalising using the mean. Sensitivity values are also obtained by normalising using the mean.

Thus, vulnerability is potential impact (I) minus adaptive capacity (AC).

This leads to the formula V= f (I – AC)

For exposure, sensitivity and adaptive capacities, Principal Component Analysis method was used to allocate values to various variables. All the variables under *exposure* were summed and means established. The same was done for variables under *sensitivity*. The same procedure was applied for *adaptive capacity.* The above indicated formula was used to calculate the *vulnerability index* for each household.

In creating indices, the scale of analysis is important as noted by Tesso et al (2012), Derese et al (2008) from Opiyo (2014). Vulnerability analysis may range from household level to global level, Brooks et al (2005) from Opiyo (2014). The choice of scale is dictated by the objectives, methodology and data availability. In this case the objective is to obtain household vulnerability, village level vulnerability and Sub-County level vulnerability.

In this study, the households were classified into three categories based in the value of their vulnerability index, which puts households into highly vulnerable, vulnerable and less vulnerable. These fractile intervals were used to characterise the various stages of vulnerability i.e.

1. Less Vulnerable if the value is 0.0 – 0.49
2. Moderately vulnerable is value is 0.5 – 0.69
3. Highly Vulnerable is value is 0.7 – 1.0.

The higher the value, the higher the vulnerability and vice versa. The values presented are not absolute. The value represents relative measure, representing the household vulnerabilities.

5.4. Factors Influencing Household Vulnerability

The ability of human systems to adapt to and cope with climate change depends on such factors as wealth, technology, education, information, skills, infrastructure, access to resources and management capabilities, McCarthy et al (2001). Notenbaert et al (2013) from Opiyo (2014) noted that many factors contribute to vulnerability, and these factors undermine capacity for self-protection, block or diminish access to social protection, delay recovery or expose some households to greater or more frequent hazards than other households.

The factors that were analysed in this study under *exposure* were frequency of droughts, duration of long and short rainy seasons, flood, hail stones, fire, conflicts and the topography of the area. Factors considered under *sensitivity* include livestock and human

sicknesses due to drought, livestock and human deaths due to droughts, livestock and human sicknesses due to floods, livestock and human deaths due to floods, soil susceptibility to wind and water erosion, land degradability and attacks from wildlife.

Under *adaptive capacity,* the factors considered 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.

The analysis was performed using ordinal logistic analysis. This method is used when the outcome variables is categorised in an ordinal scale as is the case where vulnerability is categorised as (1) highly Vulnerable which implies for households for whom the difference between *adaptive capacity and impact (exposure+sensitivity)* is significantly high, tending towards 1. (2) moderately vulnerable, which means that households for whom the difference between adaptive capacity and impact are about mid way of 0 and 1 i.e. around 0.5; and (3) less vulnerable which means that the difference between adaptive capacity and impact is very low, i.e. tending towards 0.

In this study, *sensitivity* of households to climate change is indicated by human and livestock sickness; and human and livestock deaths, loss of water and pasture. *Exposure v*ariables considered include drought, floods, hailstones, fires, terrain and conflicts. Rainfall variabilities for the four villages are plotted. Rainfall and temperature variability for Marsabit town is also indicated, as it has influence on the micro climate of the study area. Adaptive capacity variables considered were described above.

In addition to vulnerability analysis, other information obtained from the research include adaptation capacity gaps and options for adaptation to drought as an indicator of climate change.

6. Results

6.1. Household Structure

In Ngurunet 82.5 percent of the respondents were female while 17.5 per cent were male. In Korr 86.8 per cent were female while 13.2 per cent were male. In Log Logo 97.8 per cent were female while 2.2 per cent were male. In Laisamis, 73.1 per cent of respondents were female while 26.9 per cent were males. The gender distribution does not necessarily represent the head of household; rather it represents the gender of the household who was available to be interviewed. However, in some cases, the female gender were heads of households. Some women were single mothers or widowed.

The largest group from all the enumeration areas is between age 36-60 years with the least being the age groups above 61 years. The age group of 36–60 years is the most active and productive age among the respondents. Categories in age group above 61 are more vulnerable because they have no adequate energy to engage in economic activities. The household with population of 2 under all age groups is the largest, Under 5 years (43.2%), 6-18 years (29.9%), 19-64 years (52.3%) except for those above 65 years (55.3%) with the highest population of size.

6.2. Rainfall and Temperature in Marsabit Mountain

In Marsabit, temperature figures were apparently constant over a period of 38 years, from 1975 - 2013, where the average maximum temperature was 25 degrees centigrade. The minimum average temperature was 15.8 degrees centigrade and was consistent. There was no significant variability in temperatures over the 38-year period. The average annual rainfall for Marsabit is 713.5 mm per year. Rainfall figures obtained for 52 years, from 1960 - 2012 indicate, severe drought in 1968, 1973, 1974, 1976, 1980, 1984, 1992, 1996, 2000 and 2010. The years when rainfall was highest was in 1962, 1982, 1997 and 2003.

Floods may have occurred in these years. Out of the 52-year period, 28 years received less than average rainfall, while 24 years received the average or more than average rainfall.

6.3. The Study area: - Exposure to drought

In 1981, 1983, 1987, 1989, 1990, 1991, 1993, 1994 Korr experienced severe droughts. Over a period of 13 years, Korr experienced eight droughts indicating high *exposure* to drought. This high exposure significantly contributes towards community vulnerability. Highest rainfalls were recorded in 1982 and 1988. A major challenge for the analyses is the availability of data for only 13 years.

In Log Logo, there is much variations in rainfall figures and apparently, there are more years with less than 300 mm of rainfall including 1973, 1974, 1975, 1979, 1980, 1983, 1986, 1991, 1993, 1996, 1997, 1998, 2001 and 2004. The rainfall pattern for Log Logo indicates that the area experienced 14 major droughts over a 31-year period. This is an indication of the local's high *exposure* to drought.

The average Annual average rainfall for Ngurunet is 600 mm per annum. However, significantly low rainfalls in 1980, 1981, 1983, 1993, 1994, 1995, 1999 were recorded. Severe droughts were experienced in 1980, 1983 and 1995. Highest rainfall was received in 1982, 1987, 1988, 1989, 1990 and 1992. From the 19-year rainfall records, it is clear that less than average rainfall was received exposing the community to droughts resulting in increased community vulnerabilities.

The average Annual average rainfall for Laisamis is 400 mm per annum. However, from the 31-year record, 24 severe droughts were experienced in 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1978, 1980, 1981, 1983, 1984, 1985, 1986, 1987, 1988, 1991, 1992, 1993, 1994, 1995, 1996 and 1999. Highest rainfall was recorded in 1968, 1977, 1979, 1982, 1989, 1990 and 1997 and 1998. The Laisamis community is more *exposed* to frequent and severe drought than the other study sites. This implies that drought exposure significantly contributes towards vulnerability.

From the analysis above, Laisamis community is the most exposed to drought at 77.42 per cent. The Laisamis community experienced 24 years of drought in 31 years. Korr community is exposed 61.54 per cent. Korr community was exposed to 8 droughts over only a period of 13 years. Log Logo community is 45.17 per cent exposed. Log Logo community were exposed to 14 droughts over a period of 31 years. while Ngurunet community is 36.85 per cent exposed. Ngurunet community were exposed to 7 droughts over a 19-year period. The percentages were used to allocate *exposure index* for the various locations i.e. *exposure index* for Laisamis is 0.8, Korr 0.6, Log Logo 0.5 and Ngurunet 0.4. The lowest exposure index is 0, while the highest is 1.

Exposure to conflicts

Korr had the least exposure to conflicts while, while Ngurunet had 6.3 per cent, Log Logo had 38.9 per cent and Laisamis had 4.6 per cent exposure to conflicts.

6.4. Sensitivity to Drought

Households lost between 1 to 10 cattle (47.7%) whereas for camels, the households lost between 1 to 5 camels (37.2%). Households lost between 1 to 20 goats (65.4%) whereas for sheep, majority of the households lost between 1 to 20 sheep (64.3%). For donkeys, a greater proportion of households have not lost the donkeys i.e. 79.9%, whereas those who have lost between 1 to 3 donkeys were 17.7%. These results indicate that the households with cattle and sheep/goats are more vulnerable to drought than households rearing camels and donkeys. Camels and donkeys are more tolerant to drought that cattle and sheep due to the browsing grazing habits giving them wider varieties on livestock food plants.

6.5. Adaptive Capacity

The data shows that most of the pastoralists are members of just one social network (55%). Similarly, it is quite discouraging that a few belong to no social network (20%) making them highly vulnerable in case of disaster they have may not access contributions from the larger community members. Higher proportion of pastoralists (47.1%) belong to Women's groups with the least (1.5%) belonging to community Cooperatives. For Laisamis a high proportion have No Access (74.10%) to Extension Services, unlike Loglogo (80.7%), Korr (90.5%) and Ngurunet (55.8%) where they have moderate access. 60.1% have no access to climate related disaster Early Warning Systems and 47.9% have moderate access in the study area. For Laisamis and Ngurnet , there is a wide difference with a high fraction for those who have No access (88.9%) and (83.7%) respectively to climate related disaster Early Warning Systems and a lower fraction (11.1%) and (16.3%) respectively have moderate access unlike for Loglogo and Korr where there is a narrow gap with those who have No access being (56.7%) and (50.9%) respectively and a lower fraction (43.3%) and (49.1%) respectively have moderate access.

The pastoralists in study area have a high proportion (82%) who don't have any productive assets with just a handful percentage (18%) who have these productive assets. This is alarming since it exposes the community and makes them highly vulnerable to drought and other disasters. For Laisamis and Loglogo those who have productive assets are so alarming with 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.

55.7% of pastoralists in the study area receive remittances, whereas 44.3% did not receive. Pastoralists from Ngurnet received the highest proportion (82.5%) of remittances, whereas Laisamis pastoralists receive the least (42.6%) of the remittances coming to the Sub- County.

95.5% of Ngurnet households received remittances of less than Ksh 5000 whereas the households with lowest proportion (71.7%) were from Laisamis received less than Ksh 5000. However, the highest proportion (28.3%) of Laisamis households received remittances between Ksh 5001-10000 whereas the households with lowest proportion (4.5%) were from Ngurnet who received remittances of between Ksh 5001-10000

From Marsabit County, a greater percentage (54%) of the pastoralists were unemployed with just a small percentage (2%) being employed. From Ngurnet the highest proportion of the households (46.3%) were unemployed. For Korr the highest proportion (78.3%) were unemployed. However, for Loglogo and Laisamis, 93.3% and 95.3% respectively were self employed.

Higher fraction (63.8%) have moderate accessed to credit facilities and just a fraction less than half (35.7%) have No access to credit facilities and a negligible fraction of 0.5% had adequate access in the study area. For Laisamis there was a small difference between those who have No access (52.8%) and those with moderate access (47.2%) unlike Ngurnet with a wide difference between those who have No access (17.5%) and those with moderate access (80%).

The highest proportion (93.8%) do not have any formal education while a few have primary education and a negligible fraction (1.3%) with secondary education in the study area. A high percentage (62%) have no access to technology. A higher proportion of the population have access to M-Pesa (36.2%) money transfer, with the least practicing dipping and tattooing on livestock being 1.3% in the study area.

Most of the household's own cattle between of 1 to 20 cattle (63.8%) whereas for camels most of the households own between 1 to 20 camels (65.1%). Most of household's own goats between of 1 to 40. Most of the households own between 1 to 40 sheep (81.5%). For donkeys, greater proportions have the donkeys between 1 to 3 (52.1%).

6.6. Vulnerability Index Computation

Vulnerability Index is computed by subtracting adaptive ***capacity*** **(*AC*)** *from* ***potential impact*** **(*I*)** as described below:

$VI = f(I - AC)$

Where VI= Vulnerability Index

I= Exposure + Sensitivity

AC= Adaptive Capacity

In calculating *Vulnerability Index,* all the weighed values from (0 - 1) for *Exposure* and *Sensitivity* were added and mean calculated. The weighed values for *Adaptive Capacity* were also summed and the means calculated. The mean for *Adaptive Capacity* was deducted from the mean sums of *Exposure* and *Sensitivity* to arrive at *Vulnerability Index.*

6.7. Interpretation of the Indices

The Vulnerability Index ranges from 0 to 1. In order to identify different level of vulnerabilities, three categories were identified i.e. Less Vulnerable will be households and enumeration areas with 0 - 0.49 Vulnerability Index. Households and areas with 0.5 - 0.69 were classified as Moderately Vulnerable, while areas and households with 0.7 - 1.0 were classified as Highly Vulnerable i.e.

1. Less vulnerable if ***0-0.49***
2. Moderately vulnerable if ***0.5-0.69***
3. Highly vulnerable if ***0.7-1.0***

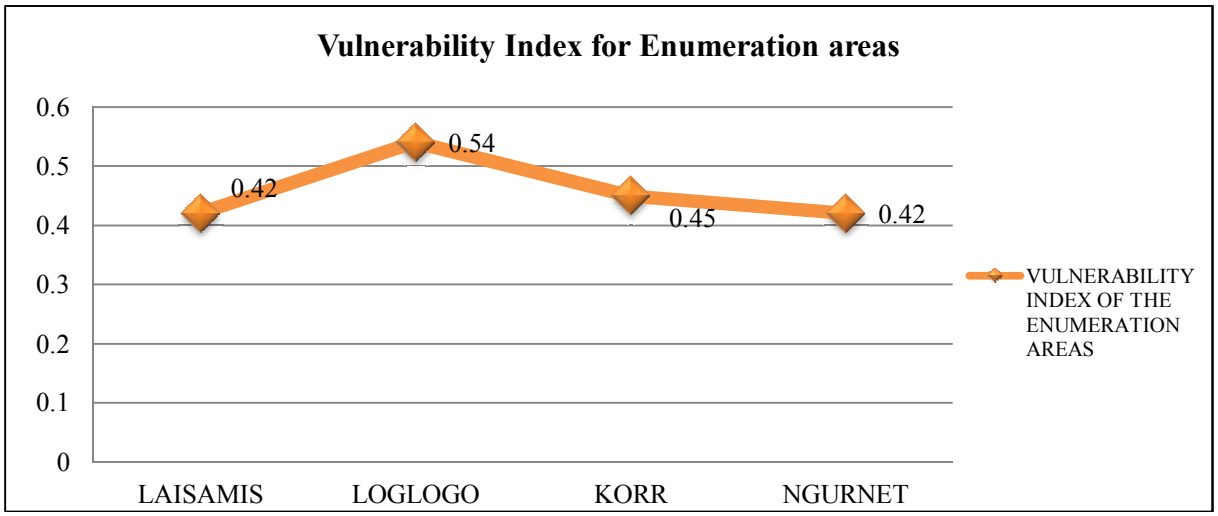
A high proportion of the households in the study area, 65.1% are Less Vulnerable with the vulnerability index being between (0.0 to 0.49). 32 .6 % of the households were Moderately Vulnerable with 0.5 -0 .69 Vulnerability Index. Whereas 2.3% are Highly Vulnerable with Vulnerability Index of 0.7 - 1.0.

6.8. Vulnerability Index per Enumeration Area (figure 2)

In Laisamis enumeration area, 75.9% of households are Less Vulnerable with an index of between (0.0 to 0.49) and just 1.9 % of the households are Highly Vulnerable. While 22.2 % of the households were Moderately Vulnerable. For Loglogo, 62.2 % of the households were Moderately Vulnerable with an index of between (0.50 to 0.69) with 4.4% being very Highly Vulnerable. 33.3 % households were Less Vulnerable in Log Logo. In Korr enumeration area, 69.8 % of the households were Less Vulnerable with an index of between (0.0 to 0.49), 28.3 % of households were Moderately Vulnerable while 1.9 % of households were Highly Vulnerable.

In Ngurnet enumeration area, 80 % of the households were Less Vulnerable with an index of between (0.0 to 0.49), 18.8 % of the households were Moderately Vulnerable. While 1.3 % of the households were Highly Vulnerable.

In regards to the enumeration areas, the vulnerabilities varied as indicated below:



Vulnerability Index, line graph

Figure 2: Vulnerability Index for enumeration areas

For Laisamis, Korr and Korr the Vulnerability Index was 0.42, 0.45 and 0.42 respectively, which implies that households in the areas are Less Vulnerable. Whereas for Loglogo the index is 0.54 implying that it is Moderately Vulnerable.

Finally, for Laisamis Sub-County the Vulnerability Index is: (Table 2)

SUB-COUNTY	VULNERABILITY INDEX
Laisamis Sub-County	0.46

Table 2: Final Vulnerability Index for the study area

From the above findings, it clearly shows that Laisamis Sub-county, is Less vulnerable with 0.46 Vulnerability Index.

7. Discussions

Women play significant role in the household decision making among the pastoralists. There were 82 - 98 % women respondents in the four enumeration areas. The study community comprise 52.3 % of 19 - 64 age group, which is the most economically productive group. This implies that the community has adequate human resources to engage in economic activities.

Temperature figures for Marsabit which provides micro catchment for the study area remained at 15 degrees centigrade for minimum and an average of 25 degrees at maximum over a period of 52 years. However, 28 years experienced below average rainfall. This may be attributed to climate variability. Due to sustained average temperature figure, it cannot be concluded that the area has experienced climate change.

In the enumeration areas, i.e. Ngurunet, Log Logo, Laisamis and Korr, there are no manned meteorological stations and this has presented a challenge of obtaining consistent data over a long period. The temperature figures for the enumeration areas are not available. However, the from the analysis, Laisamis community is the most exposed to drought at 77.42 per cent. Korr community is exposed 61.54 per cent. Log Logo community is 45.17 per cent exposed, while Ngurunet community is 36.85 per cent exposed. The *exposure index* for the various locations i.e. *exposure index* for Laisamis is 0.8, Korr 0.6, Log Logo 0.5 and Ngurunet 0.4. Except for Ngurunet, the other three areas, have significant exposure to drought that requires timely mitigation interventions.

The households with cattle lost 47.7%, households with camels lost 37.2 %, households with goats lost 65.4%, household with sheep lost 64.3 % while only households with donkeys lost 17.7 %. These results indicate that the households with cattle and sheep/goats are more vulnerable to drought than households rearing camels and donkeys. Camels and donkeys are more tolerant to drought that cattle and sheep due to the browsing grazing habits giving them wider varieties on livestock food plants. For targeting for drought mitigation interventions, households with cattle, sheep and goats need to be prioritised.

Other factors that contribute to vulnerability include adaptation capacities i.e. membership to social networks, access to extension services, access to disaster early warning information, ownership of productive assets including livestock and other economic assets, employment, levels of formal education, access to credit facilities and access to technologies. In the study area, the community exhibited low access in majority of the cases, making the households significantly vulnerable. Efforts should be made to build the community capacity in order to reduce their vulnerability to drought.

A high proportion of the households in the study area, 65.1% are Less Vulnerable with the Vulnerability Index being between (0.0 to 0.49). 32 .6 % of the households were Moderately Vulnerable with 0.5 -0 .69 Vulnerability Index. Whereas 2.3% are Highly Vulnerable with Vulnerability Index of 0.7 - 1.0. For drought mitigation purpose, the 32.6 % and the 2.3 % of the households need to be targeted for intervention.

Because of remoteness, there are no similar studies conducted in the study area. Researchers and development organisastions need to be proactive in conducting similar research to validate or provide additional new information on drought vulnerability.

The challenges faced by the study include limited rainfall and temperature data to conclusively describe climate variability or climate change. This reserach attempt will encourage researchers to embark on more detailed study on *exposure, sensitivity* and *adaptive capacity*.

The research findings may be applied for use as a base for other researchers and by development partners for drought mitigation planning, contingency planning and setting up of drought contingency funds for interventions during emergencies.

8. Conclusion

The pastoralists experience various challenges in vulnerability to drought including exposure to drought because of the physical nature of the environment they live in, their livelihood based on livestock including camels, cattle, sheep, goats and donkeys are highly sensitive to drought. The vulnerability of pastoralists is exacerbated by adaptive capacity factors. Weak adaptive capacity implies high vulnerability to drought. Therefore, in order to reduce vulnerability, efforts should be made to build the adaptive capacities of pastoralists by development partners.

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