

THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

Determination of Impacts of Drought on Pastoral Production System in Marsabit, Kenya

Jiddah Choke Chufe

Ph.D. Student, School of Environment and Earth Sciences,
Maseno University, Kenya

Boniface O. Oindo

Professor School of Environment and Earth Sciences,
Maseno University, Kenya

Dr. Paul Abuom

Senior Lecturer, School of Environment and Earth Sciences
Maseno University, Kenya

Abstract:

Pastoral communities in lands are faced with a number of challenges including recurrent droughts resulting in water shortages, loss of body condition of livestock, livestock deaths, human diseases and some severe cases human deaths. The drought frequency and severity of droughts have increased and is negatively impacting on households. However, the impacts of droughts on households are not well understood and documented. The objectives of this study is to determination impacts of drought on pastoral production system in Marsabit, Kenya. Simple cross-sectional random sampling was used for primary data collection through questionnaires. 384 households were randomly interviewed in a household population of about 19,000 households using the (Scott Smith, 2013) formula for deciding the sample size. Secondary data was obtained from relevant public reports, journals, agricultural reports, statistical abstracts and development partners. The study considered various biophysical and socio-economic factors to determine drought impacts on households. Drought impacts were determined through correlations of drought index and number of livestock owned, availability of pasture, number of water bodies, number of livestock species and livestock prices. Data analysis was done using frequencies, percentages, spearman correlation, cross tabulations and chi square tests. The results were presented using tables, bar graphs, pie charts and plates. The data was analysed through computer Excel and SPSS programmes. The presentation of results was done in form of narrative, graphs, tables, pie and bar charts. The results indicate positive and high correlations to the indicated parameters to drought impacts. This implies substantial support is required from within the community and external sources in order to mitigate the negative impacts of drought in the study area.

Keywords: Drought, impacts, pastoralists, arid lands

1. Introduction

Drought is the most complex of all natural hazards as it affects more people than any other hazard globally. According to EM/DAT data quoted in the World Disaster Report (2007), about 2.63 million people were affected by Hydro-metrological disasters globally during the period 1997-2006, about 41.82% are affected by drought, and 38.87% of them were affected during the year 2002. During 1997/2006, hydro-metrological disasters caused an estimated damage of US\$ 66.8 billion per year on average out of this 4.62% was caused by drought and average number of people reported killed by drought in million per year in Asia are (81.11), Africa (26.69), Americas (2.57), Europe (0.14) (World Disaster Report, 2007). Since drought is a global phenomenon, it is useful to understand the pattern of various drought-related characteristics and impacts worldwide from a global development perspective. According to the Global Drought Information System (GDIS, Global Drought Information System (2013), short-term global droughts remained relatively constant across the world in August 2013 affecting 44 million people while drought conditions, which eased in North America, Africa and Europe, remained intensive in Australia, constant in South America, and intensified in Asia. The global drought mapped by the University College of London shows 258 million people affected globally by exceptional drought in last 36 months (Miyan, 2014). The ability of many countries to deal with droughts impacts is constrained by the absence of reliable data, weak information networks as well as the lack of technical and institutional capacities (Erian, 2010). A Country like Syria is just beginning to establish relevant drought monitoring and management procedures and institutions, however existing drought monitoring and declaration procedures lag behind the development of drought events (Erian, 2010).

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 Steinfeld, 1996). This dependence on grasslands for livelihoods makes pastoralists in Africa highly impacted by drought. Similarly, a study conducted by Erian (2010) in Arab speaking countries including Sudan (southern area), Tunisia (northern area), Algeria (northern area Morocco (northern area) and Somalia (north eastern area) indicated severe impacts by drought on households. Most studies in Africa use large-scale drought impacts assessments which provide very little information that is of practical use for decision makers on the precise extent for specific locations (Nkomo *et al.*, 2006). It is acknowledged that making future predictions of future climate change in Africa is problematic due to lack of data on the current situation on drought impacts (Boko, 2007). Understanding the impact of Climate Change in Africa requires that we first understand Africa's existing non-climate vulnerabilities (Nkomo *et al.*, 2006). Boko (2007) states that Africa is one of the most highly drought impacted continent, climate change and climate variability, a situation aggravated by interaction of multiple stresses. Though drought impacts are claimed to be high, adequate studies on drought impacts have not been carried out.

In northern Kenya, about three million pastoralists were impacted on by severe droughts of 2006 and 2008/2009, which have been increasing in frequency and severity over time (Howden, 2009 and Lekapana 2013). The 2000 drought emergency affected the Central, Eastern, Rift Valley, Coast and North Eastern Provinces, with 4.4 million people requiring food and non-food assistance. The 2006 drought hit 37 out of 78 districts leaving a population of 3.5 million people in need of relief (GOK, 2008). The country also recognizes the fact that given the destruction and losses disasters (including drought) can cause and the high costs of helping out people to recover, sustainable development cannot be achieved without addressing issues of drought risk reduction in a comprehensive manner (GOK 2008). Droughts in Kenya, according to the AU (2010) affect adversely all sectors of the economy and the population as a whole. Speranza (2010) and Africa Union (2010) provide some of the impact of this drought to nomads to include a scarcity of water and pasture for herds, starvation and malnutrition, livestock deaths, altered herd structure, the deterioration of herds condition and a collapse of livestock markets (Mutu *et al.*, 2017). In Kenya, the vulnerable areas have increased and now cover five (5) provinces mainly in districts that are experiencing the highest level of poverty in the country. The intensity of drought has become more devastating in terms of the affected population (GoK, 2008). The most severe drought in recent years affected Central, Eastern, Rift Valley, Coast and North Eastern provinces, when 4.4 million people required emergency food and non-food assistance in 1999 - 2000. The more recent incidence of drought affected 37 out of 78 districts when 3.5 million people were in dire need of emergency food relief during the 2004 - 06 (ASAL, 2005). In Northern Kenya, where the dryness is most pronounced, 28 major droughts have been recorded in the past 100 years. The frequencies of droughts have increase as four of the major 28 droughts occurred in the last decade (schilling *et al* 2011). During the 1999-2001 drought in Kenya, over 2.3 million sheep / goats, 900,000 cattle and 14,000 camels valued at about US\$ 77.3 million were lost (Wekesa *et al* 2006). An assessment carried out by Oxfam following the 2005 drought in northern Kenya, revealed that over 70% of the livestock had been lost (Wekesa *et al* 2006).

Drought adversely affects the pastoral communities by reducing the availability of pasture and thereby resulting in death of livestock (Morton, 2005). It may also directly kill livestock through lack of drinking water. Livestock mortalities from starvation and disease outbreaks affected approximately 70 percent of livestock in most ASAL districts during the 2011 drought (RoK, 2011c and Lekapana 2013). In most parts of Marsabit County, recent droughts have resulted in livestock mortality and morbidity, depletion of water resources, household food insecurity, and acute malnutrition of up to 32% amongst the children with escalation of resource conflicts (ALRMP, 2011). Furthermore, the 2011 drought has severely emaciated livestock thus declining their market values (VSF, 2011). Additionally, during the same period, food prices in the County had increased drastically due to food shortage attributed to drought and unfavourable terms of trade (VSF, 2011). Pastoralists were worst hit since they comprise the majority of the population in Marsabit County (Lekapana, 2013). Pastoralist are forced to migrate, trekking long distances in search of pasture and water for their animals during periods of drought, migration often triggers conflict as well as upsurge in animal diseases. Drought results in loss of large numbers of livestock which leads to livelihood crisis among the population (Lekapana, 2013). Different publications have touched on impacts of drought on pastoralists' livelihood. Most studies provide an array of similar impacts across most pastoral groups. Little information is however available on impacts of drought on pastoralists in the study area.

2. Materials and Methods

2.1. Study Area

2.1.1. Location and Demographic Characteristics

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. Marsabit is the largest county in the country covering 70,961 sq. km. with a population density of 4 persons per sq km. Marsabit County has a population of 291,166 (2009) and a current estimated population of 310,000 persons. There are four parliamentary constituencies including Moyale, Sakuu, Laisamis and North Horr in the county. The study area covers the arid parts of Laisamis constituency including four electoral Wards including Laisamis, Loglogo, Korr and Ngurunet. The study area is in Laisamis Sub-County covering approximately 20,290. 5 sq. km with an estimated population of 65,000 persons

(Population Census, 2009). The study area ranges from 1°20'N to 3°15'N latitude and from 36°30'E to 38°E longitude, spanning lowland with an elevation of nearly 500 m above sea level (Figure 2).

The study area, Laisamis, in Marsabit County is isolated and undeveloped compared to the rest of the country, where the major populations live in the central highlands, Lake Victoria, and the Indian Ocean Coast. With low rainfall and few rivers, its deserts and mountains are inhabited mainly by nomadic pastoralists, including Turkana, Samburu, Rendille, Boran, Gabra, and Somali (Fratkin et al 2004). 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) is livestock rearing. The economy almost entirely revolves around livestock rearing i.e. camels, cattle, sheep, goats and donkeys. Almost each household keeps livestock and facets of livestock industry impact on all other economic and social segments. The main livestock kept in the study area include camels, cattle, sheep and goats while crop production is only limited to few areas with shallow wells and micro-irrigation facilities. The study area is mainly inhabited by Rendille, Samburu and Ariaal communities, who are considered to be the most efficient producers of livestock under nomadic pastoralism. Few ethnic Somali community members practicing trade in food commodities and livestock are found in the trading centres including Korr, Loglogo, Ngurunet and Laisamis Trading Centre.

2.1.2. Geophysical Characteristics

Most of the study area is generally extensive plains lying between 530-760 m a.s.l. Chalbi desert, an old saline lake bed, lying at altitude of 435-500m a.s.l is the lowest land surface in the study area. The Chalbi desert marks the northern boundary of the area, while Mt. Kulal (2355 m) marks the western boundary and the Ndoto Mountains (2885 m) and the Mathews Range (2688 m) mark the southwest boundary. The main landforms in the study area are sedimentary plains, volcanic plateaus, volcanic orgneissic ranges and hills. The rest of the study area consists of rocky, stony and rugged lava plains and sandy clay loams on alluvial plains and basement rock. The Chalbi area is completely devoid of plant life, due to its salinity, and in some other isolated areas the soils are too acidic to allow the growth of vegetation.

Rainfall is unreliable and bi-modally distributed (theoretically) with two seasons per year. Frequent rain failures occur leading to high risks of prolonged droughts. In Northern Kenya, droughts used to occur on average every five years but due to climatic variations, droughts occur more frequently and severely (Schwartz et al., 1991). Most of the Rendille and Samburu population live in the central lowland, which is known as the Kaisut Desert. The average high temperature in shade is 39°C and the average low is 22°C, with little annual variation (Sun, 2005). The extensive daily sunshine leads to a great deal of global radiation and low humidity. Rainfall patterns in the lowlands are both low and unpredictable, with an annual rainfall averaging less than 200 mm per annum. The rainfall figures for the study Sub-County, Laisamis, range from 200 mm – 750 mm per annum. 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 comprises mainly of two ecological zones i.e. Ecological Zone V and VI. Zone V area fall between 700m and 1000m, and covers Kaisut, Milgis and part of the slopes of Mt. Marsabit. The dominant vegetation consists of mixed acacia woodland on stony soils and acacia-cammiphora bushland on deeper soils. The grass consists of tufted annual grass that is suitable for cattle. Grazing in this zone starts at the onset of the dry season and lasts for 3 to 7 months, during which time the livestock herds gradually prepare to move to the permanent watering points. Ecological Zone VI covers areas lying below 700m. The annual grasses are poor and irregularly distributed. The high rates of evaporation and salt deposits inhibit the growth of grasses, particularly in Chalbi desert. The grazing season is short, lasting about 2 months after effective rains. When rains fail only camels and goats can graze in the area, (Njoroje, 2010). While over 30% of the study area is not fully utilized due to lack of water and insecurity, slow land adjudication process, conflict between communal land use and private ownership and wildlife conservation further inhibit full exploitation of the remaining land, and these problems also constrain conservation measures. If these constraints were overcome, more land would be available for both livestock and other economic activities. This would increase the overall study area livestock carrying capacity and reduce the rapid degradation of the fragile ecology.

The study area is characterised by wooded grassland, bushland and thicket, semi-desert grassland, and desert (Lind & Morrison, 1974; Sato, 1980; Sun, 2005). *Acacia tortilis* (*dahar*) is prominent in the upper strata, while the middle strata are fairly clear of vegetation, and grasses dominate the lower strata. Cattle and small stock (goats and sheep) are herded in the high elevation areas, but camels rarely come to these places owing to the high humidity, altitude, abundance of harmful insects that transmit livestock and human disease, such as ticks, tse tse flies and mosquitoes. The bushland and thicket zone extends from an elevation of 600 to 1200 m, and is found both at the foot of the mountains and in the lava area. *Acaciatortilis* and *Cordia sinensis* (*gaeer*) are conspicuous in the upper strata, while the lower strata are covered with shrubs such as *Sericocomopsis pallida* (*giib*) and *Duosperma eremophilum* (*yabah*). This vegetation zone covers approximately 40% of Rendille land, and is used by all species of livestock. Semi-desert grassland extends from an elevation of 400 to 600 m, and covers most of the central lowland of Rendille land. Trees more than 3 m high can be found only along the stream beds. Thorny trees less than 2 m (*Acacia* spp. or *Commiphora* spp.) are scattered throughout the middle and upper strata. The lower strata include sandy lands stippled by patches of bushes and herbs, such as *Sericocomopsis pallida*, *Duosperma eremophilum*, *Indigofera spinosa* (*kholo*) and *Blepharis linariifolia* (*Jemarak*). This vegetation zone accounts for approximately 40% of Rendille land, and is mainly exploited by camels and small stock. More than 80% of Rendille land is used for pasture. The vegetation species and quantities of plants are strongly influenced by topography and rainfall. Plant ecology is important for the Rendille's livestock management strategies.

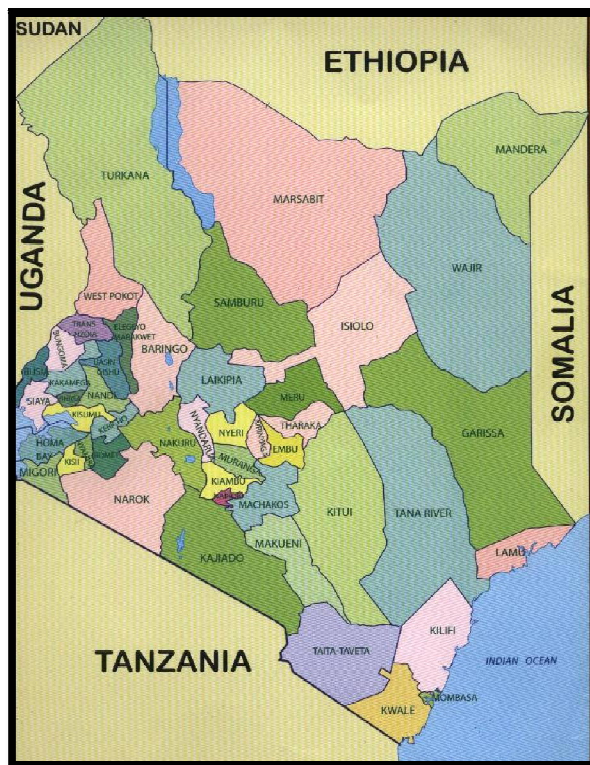


Figure 1: Map of Kenya Showing Marsabit County
Source: Kenya Maps, 2012

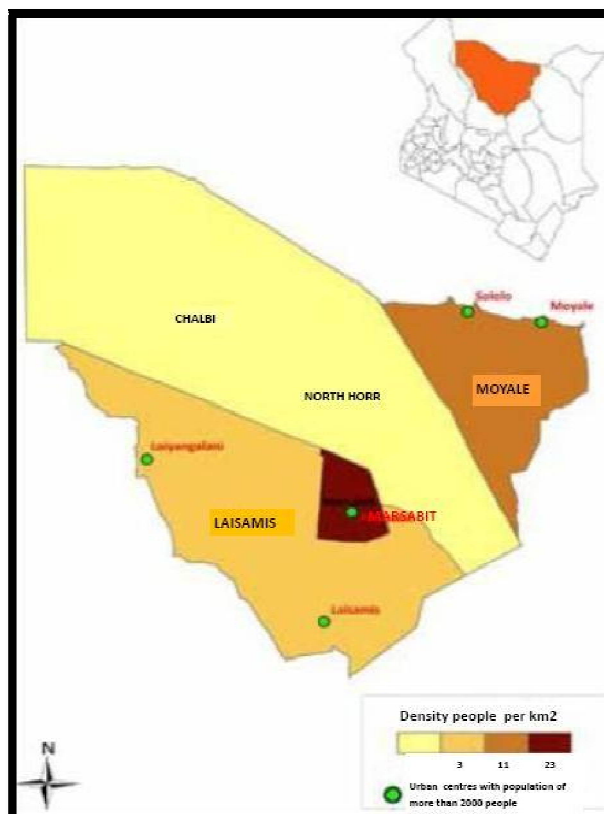


Figure 2: Marsabit County Map Showing the Location of Laisamis Sub-County
Source: County Maps, 2012

(KMS). Other key data collected include, demographic information, drought sensitivity on socio-economic systems, drought exposure, drought adaptive capacities, drought adaptation options and drought impacts.

2.6. Data Collection Process

Initial survey of the study area was conducted prior to the beginning of the study five months in advance. The objective was to identify the possible areas for the study and prepare for working relationship with the leadership of the relevant communities. This initial survey enabled a better understanding of the peculiarities of the study area, size of the sample, identification of local enumerators for the household interview. 16 local enumerators were identified i.e. four enumerators for each of the four villages. The enumerators were given one-day training to minimize bias and errors in data collection and to familiarize the enumerators with the objectives of the study. Pretesting of questionnaires was done on 15 households in Loglogo and the questions adjusted accordingly. The pretesting was done to check the suitability of the tools and also whether the enumerators could pose the questions without difficulty. The pretested questionnaires were not included in the final results analysis for the study area.

2.7. Primary Data Collection - Vulnerability Assessment

384 Household Questionnaire was administered to four villages through proportional allocation. The questions in the questionnaire are based on climate exposure, sensitivity and capacity gaps. 90 households in Loglogo, 108 households in Laisamis, 106 households in Korr and 80 households were interviewed in Ngurunet. The questions in the questionnaire include demographic information, drought *sensitivity* including diseases to humans and livestock, livestock and human deaths due to drought, natural resources (water, vegetation, wildlife), number of livestock owned, availability of pasture, number of water bodies, number of livestock species kept and livestock prices. Drought *exposure* questions include human, livestock and natural resources. To avoid misinterpretation, the household interviews were conducted in local languages including Rendille and Samburu.

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

2.8. Secondary Data Collection

Secondary data was collected from meteorological stations (Kenya Meteorological Services), Government of Kenya reports, NGOs' reports and County Government reports. Other data was collected through observations, listening and photography. The secondary data collected include rainfall and temperature from the meteorological stations in the study area and Marsabit Town. Records on frequencies of droughts and floods were obtained from the relevant GOK authorities in the Sub-County. Rainfall and temperature data over 30 - 50 years was collected. The data sets obtained include mean monthly rainfall averages together with minimum and maximum temperatures. However, there were some missing rainfall and temperature data for some centres in the study area including Korr, Ngurunet, Longlogo and Laisamis. Trends in temperature and rainfall deviations were recorded. Observations and photographic data and hearings were also used to enrich the secondary data. Additional secondary data were obtained from existing literature including published reports and other relevant sources.

2.9. Data Analysis

Primary data obtained was analysed through SPSS Version 20 and MS Excell programmes. Drought impact data including exposure and sensitivity was analysed through SPSS. Impact is calculated from exposure and sensitivity. Weighed indices ranging from 0 -1 were assigned to each variable within exposure and sensitivity. The maximum weight index was 1, while the minimum was 0. Data on rainfall and temperature was analysed from the study area over 10 - 50-year period depending on data availability from the various trading centres. The rainfall and temperature data was useful in providing indications of drought years in the study area over a long period of time.

3. Results and Discussions

3.1. Socio-Demographic Characteristics of Respondents

A total of 384 households we interviewed and the distribution is, 28.1 % (n=108) were from Laisamis Center; 23.4 % (n=90) from Loglogo; 27.6% (n=106) were from Korr and finally 20.8% (n=80) were from Ngurnet (figure 3.1). The percentages and numbers indicate the households interviewed out of the total 384. n represents the number of households interviewed per enumeration area.

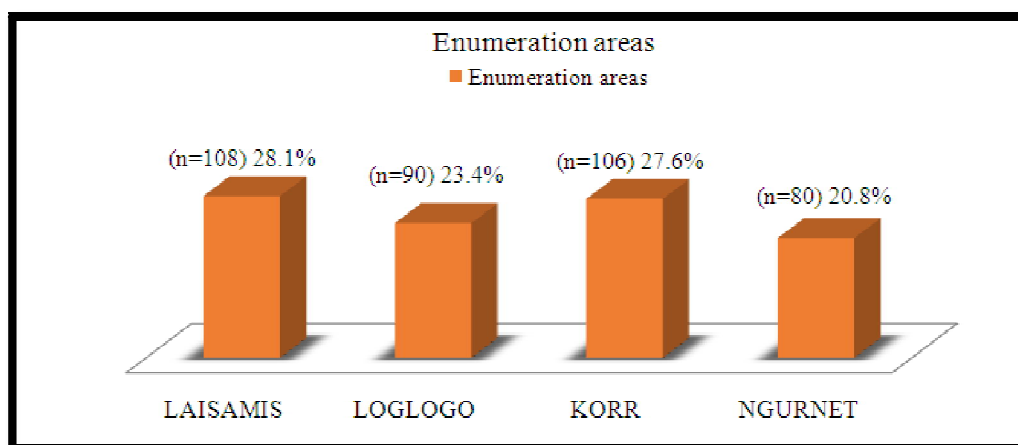


Figure 4: Enumeration Proportions

In Ngurunet 82.5 percent of the respondents were female while 17.5 per cent were male. In Korrr 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 percentages and numbers of households interviewed and gender representation is indicated in figure 4.2. 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 was heads of households. Some women were single mothers or widowed. The female headed households or widowed households are likely to be more vulnerable to drought related stresses. This is consistent with a study by Opiyo et al. (2014) conducted in Turkana County. The study has shown that female-headed households, divorced and widowed person's households with experience of less than 5 years in the area, are disproportionately likely to be affected by climate stresses and variability (Opiyo et al, 2014).

In times of climate stresses and shocks like drought, these categories of households tend to have fewer options to find other ways of making a living, because their very low levels of literacy reduce their opportunities in coping mechanisms such as wage employment. Similarly, female or divorced and widowed household heads are likely not to be empowered enough in pastoral communities to make household decisions and are frequently without access to credit services and adequate capital assets or not able to own large herds of livestock to manage households' daily requirements (Nabikolo et al, 2012). Similar observations have been made by Kakota et al. (2011) in Malawi and Tesso et al. (2012) in Ethiopia.

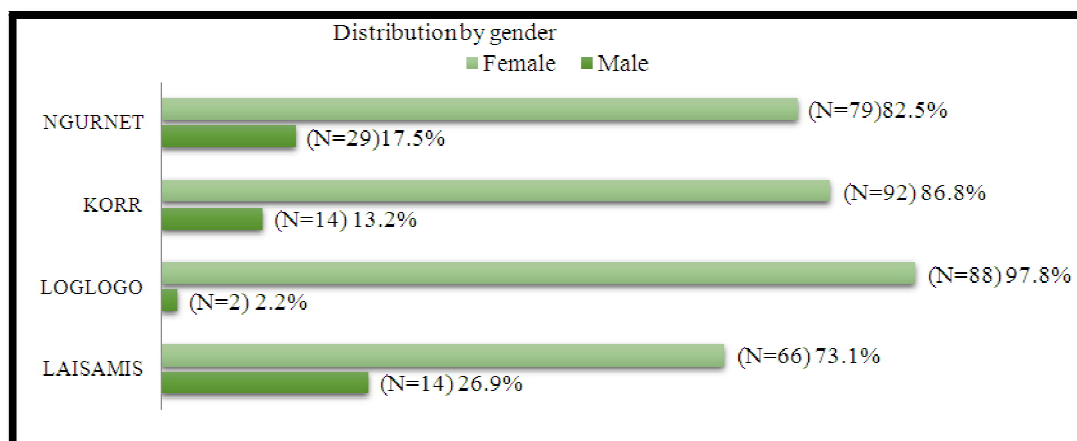


Figure 5: Distribution by Gender

The largest group from all the enumeration areas is between ages 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 (Figure 6).

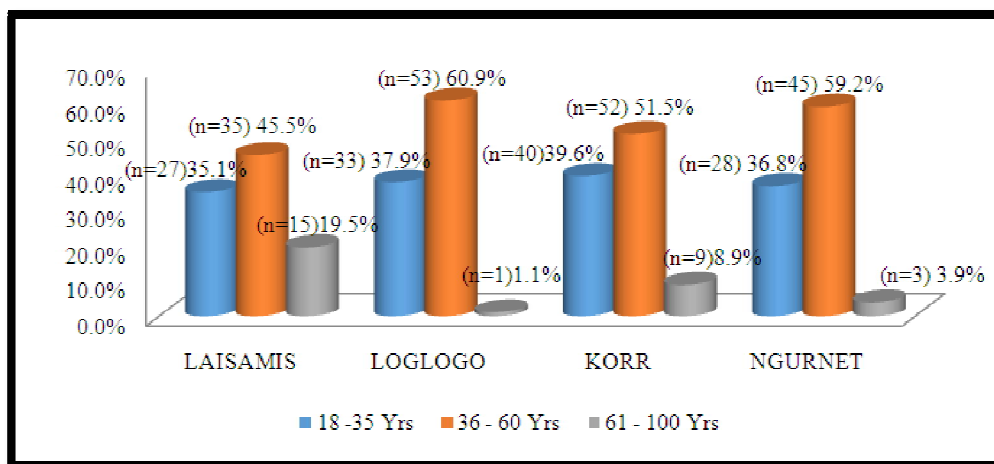


Figure 6: Age Distribution in the Study Area

Households with more dependents are more vulnerable than households with less dependents. In an urban set up, the existence of the dependents may enable the provider, such as a parent or guardian, to claim income tax relief deduction. However, in a pastoral set up, the dependents rely on individual household heads to provide food, shelter and other basic services, resulting in pressure on the household head and the entire household. In consistent with the study findings, Opiyo et al. (2014) found out that in Turkana, the determinants of households' vulnerability were found to be significantly influenced by size of the household, number of dependents, household head, marital status and social linkages. The results are also consistent with previous findings by Kakota et al. (2011) and Gebrehiwot and vander Veen (2013). The household size distribution for the study area is as indicated in figure 3.4.

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 communities comprise 52.3 % of 19 - 64 age groups, which is the most economically productive group. This implies that the community has adequate human resources to engage in economic activities. For example, households with more productive categories are less vulnerable than the categories with less productive ones. Less productive categories are more likely to be vulnerable compared with the productive category (Opiyo et al, 2014). Elderly household categories are probably worse off in terms of preparing strategies to cushion their families against adverse climatic stresses and impacts and are likely to be more vulnerable (Opiyo et al, 2014).

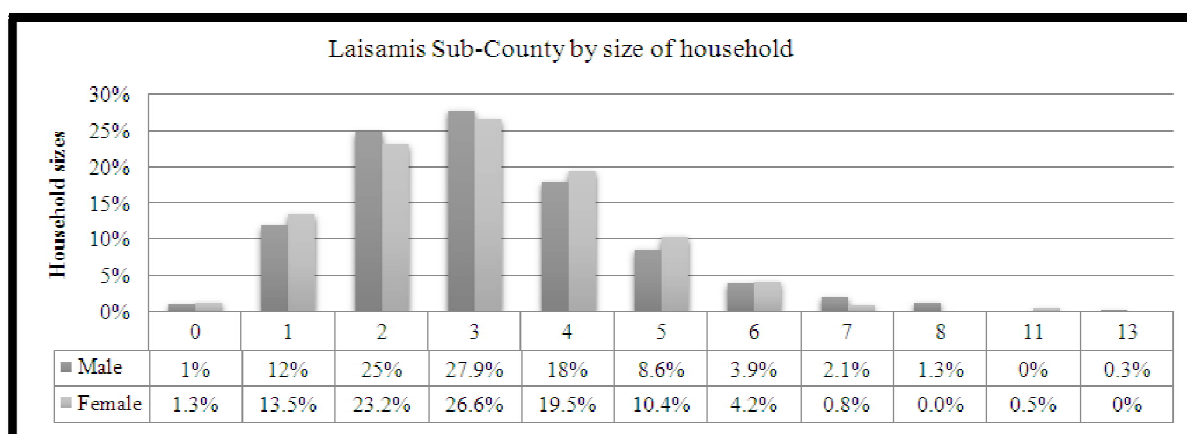


Figure 7: Household Sizes

From the bar graph above, male headed households with 2 dependents were 25 per cent of respondents, while with 3 dependents and above were 75 per cent for the study area. For female headed households, the households with 2 dependents were 23.2 per cent, while with 3 dependents were 76.8 per cent for the study area. We further went ahead and analysed the composition by the enumeration areas and the output was as below (Table 3.1). The table indicates the male and women headed households, the number of members in each household, the frequency, and the percentages of household members interviewed in each area including Laisamis, Loglogo, Korrr and Ngurunet. In Laisamis male headed households with 2 members were most frequent at 28.7 %, in Loglogo, male headed households with 3 members were most frequent at 34.4 %, in Korrr male headed households with 3 members were most frequent at 27.4 %, while in Ngurunet male headed households with 3 members were most frequent at 31.3 %. The male headed households with lowest frequency with 13 members in Laisamis was 0.9 %. In Loglogo male headed households with lowest frequency were 6 members at 2.9 %. In Korrr, male headed households with 8 members was least frequent at 0.9 %, while in Ngurunet male headed households with 5 members was least frequent at 8.8%.

Female headed households with highest number of members in Laisamis was 2 at 24 %, in Loglogo is 3 at 28.9 %, in Korrr is 3 at 34 %, while in Ngurunet is 2 members at 26.3 %. Female headed households with 11 members had lowest

frequency in Laisamis. In Loglogo female headed households with 6 members was least frequent at 1.1 %. While in Korr, female headed household with 7 members was less frequent at 0.9 %. In Ngurunet, female headed household with 5 members was the least frequent at 11.3 %.

Enumeration Area	Male headed household			Female headed household			
	Household size	Frequency (n)	Percent (%)	Size of Household	Frequency(n)	Percent (%)	
Laisamis	1	9	8.3				
	2	31	28.7	1	19	17.6	
	3	22	20.4	2	26	24.1	
	4	22	20.4	3	25	23.1	
	5	10	9.3	4	14	13.0	
	6	7	6.5	5	14	13.0	
	7	4	3.7	6	5	4.6	
	8	2	1.9	7	2	1.9	
	13	1	.9	11	2	1.9	
	Total	108	100.0	Total	108	100.0	
Loglogo	1	13	14.4				
	2	22	24.4	1	11	12.2	
	3	31	34.4	2	20	22.2	
	4	12	13.3	3	26	28.9	
	5	5	5.6	4	24	26.7	
	6	3	3.3	5	7	7.8	
	7	2	2.2	6	1	1.1	
	8	2	2.2				
		Total	90	100.0	Total	90	100.0
Korr	1	13	12.3	2	22	20.8	
	2	21	19.8	3	36	34.0	
	3	29	27.4	4	20	18.9	
	4	22	20.8	5	10	9.4	
	5	11	10.4	6	7	6.6	
	6	5	4.7	7	1	.9	
		Total	106	100.0	Total	106	100.0
		1	11	13.8	1	12	15.0
Ngurunet	2	22	27.5	2	21	26.3	
	3	25	31.3	3	15	18.8	
	4	13	16.3	4	17	21.3	
	5	7	8.8	5	9	11.3	
		Total	80	100.0	Total	80	100.0

Table 2: Laisamis Sub-County - Size of Households Headed by Males and Females

Generally, in Laisamis Sub-County, the dependents were as below in Figure 8 according to the size of the households and age groups. The vertical part of the graph indicates percentages of each age group in the households, while the horizontal part of the graph shows the number of members in each household. The color coded bar charts indicate under-fives, 6-18 year olds, 19 - 64 year olds and household members above 65 years of age. According to the data, the household with population of 2 appear to dominate, while households with 1 member follows. Households with 3 to 4 members are moderate, while households with 5 – 16 members are rare in age category (Figure 8).

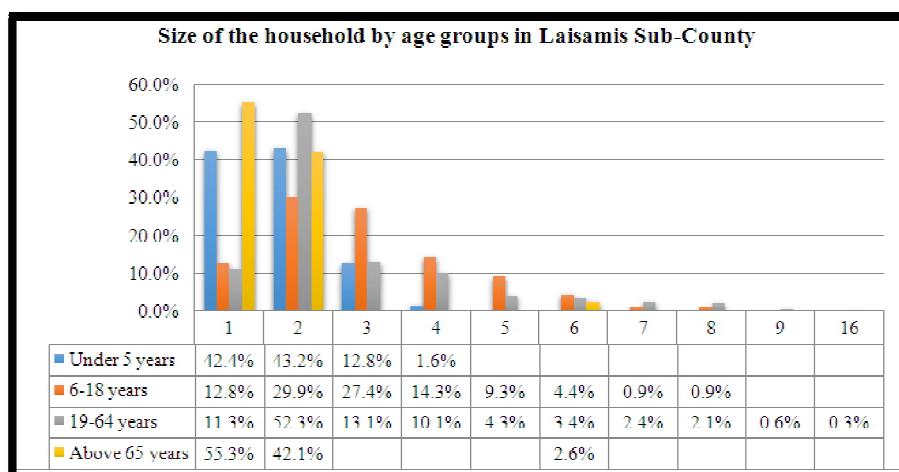


Figure 8: Size of Household by Age Group

From the study area, a greater percentage, 54 % of the pastoralists were unemployed with just 2 percent (2%) being employed. 93.8% of the households do not have formal education in the study area. Only 1.3 % has limited primary education and a negligible number had secondary education. The proportion with no formal education is the highest of all ranging from 85 - 90 %. This scenario implies that the target pastoralists are highly vulnerable to drought related stresses because they cannot access early warning information or read livestock extension materials. This finding is consistent with finding of a similar study by Opiyo et al (2014) in Turkana.

3.2. Impact of Drought on Pastoral Production Systems

Percent of Normal drought index which is defined by the UNEP (2011) as is a measurement of dryness based on recent precipitation and temperature was used for the study. Percent of Normal is a simple method to detect droughts. It is calculated by dividing actual (rainfall received in an area) precipitation by normal precipitation (average rainfall received in an area over time) typically a 30 - year mean and multiplied by 100 %. Thus the Drought Index for Korr was 64%, for Loglogo was 87%, for Ngurunet was 74 % and Laisamis was 53 %. The Drought Index for the study area was 53 %. This implies that, the study area is likely to experience drought about 53 % of the time.

3.2.1. Relationship between Drought Index and Number of Livestock Owned

Correlations		
		Drought Index
Livestock Unit	Pearson Correlation	-.093
	Sig. (2-tailed)	.095
	N	321

Table 3: Relationship between Drought Index and Number of Livestock Owned

There is a weak negative ($r=-0.093$, $p=0.095$) linear relationship between drought index and number of livestock owned, Table 3. This means that for every increase in drought index, there is a decrease in the number of livestock owned. This finding echoes literature by Seo and Mendelsohn (2016) who argued that the probability of owning livestock increases as annual temperature increases, but decreases as annual rainfall increases. Seo and Mendelsohn (2016) explained that as the temperature rises, pastoralists prefer to own goats and sheep rather than beef cattle, dairy cattle and sheep which all decrease as precipitation decreases. All three of these species are more productive in grasslands. In contrast, goats and chickens are more likely to be chosen as rain decreases.

The findings are also in support of findings by Kabubo-Mariara (2011) who established that the effect of drought on net animal revenue on those who own large number of livestock shows a linear increase. The weak linear relationship can be explained by the argument by Digambar (2011) that those who own a small number of livestock have no much effect during the drought season. The weak relationship is lined to the fact that during rainy season, farmers shift to crops since the grassland changes to forests as rain increases and this reduces the availability of natural grazing for most animals as well as increase in animal disease during rainy season as explained by during rainy season there is an increase in animal diseases (Seo and Mendelsohn, 2016). The weak relationship can also be explained from findings by FAO (2012) that as high temperatures and changes in rainfall patterns and these translate in an increased spread of existing vector-borne diseases and macro parasites of animals as well as the emergence and spread of new diseases.

From similar findings by Abate (2013) it was found that drought and delay in the onset of rain lead to poor regeneration of grass, water shortage and heat stress on livestock. The drought and delay of rainfall lead to increased mortality of livestock, vulnerability to diseases and physical deterioration due to long distance travel for water and pastures. As a result of severe drought, there was direct impact on the growth of palatable grass species and that regeneration of fodder species in pasture and forest fodder is decreasing because of less rainfall leading to a shortage in diversity and quality of livestock fodder (Digambar, 2011). Therefore, from the findings of this study, it can be argued that

increase in drought index leads to a decrease in livestock population which affects production of milk, milk products and meat and increases vulnerability of the population. The drought also affects livestock by drying wetlands, pasture land, water resources, streams and decreasing availability of drinking water for livestock.

3.2.2. Relationship between Drought Index and Availability of Pasture (Percentage Cover)

		Drought Index
Pasture	Pearson Chi-square	19.110
	Asymp. Sig. (2-sided)	0.002
	Cramer's V	0.134
	Df	1
	Cohen's Index(w)	0.134

Table 4: Relationship between Drought Index and Availability of Pasture (Percentage Cover)

The Chi square results indicated that there is a significant relationship between Vulnerability Index and availability of pasture. $X^2(1) = 19.110, p = 0.002$, Table 4.

With reference to the chi-square test it interpreted that the relationship between drought index and availability of pasture in the study area is low, $w = 0.134$.

The assessment of drought index and availability of pasture applied in this study, supports findings by Wilhite (2014) and Wilhelmi (2012) that drought reduces pasture availability due to exposure to the climatic hazard (e.g. low in-pasture growing rainfall) and the underlying dryness primarily leads to low pasture available. The significant relationship between drought index and availability of pasture reinforces findings by Smith (2016) in which he established that high drought index will decrease availability of pasture.

However, Semenza and Menne, (2009) established a different reason explaining the relationship between drought index and availability of pasture. In this regard, they indicated that alterations in pasture availability due to drought may be due to overgrazing. This can however be managed by taking actions such as planning and decision making on longer timeframes; aiming to enhance resilience by planning (risks & exposure), infrastructure and protection of strategic reserves and community; requiring community involvement and support as proposed by (AfriCAN Climate; 2015). Unfortunately, traditional pastoral mobility has been restricted by loss of pastoral lands to population pressures (of both humans and livestock), encroachment on important grazing areas by expanding agricultural or other pastoral groups, as well as the creation of commercial ranches and game parks. (Fratkin et al 2004).

3.2.3. Relationship between Drought Index and Number of Water Bodies

Correlations		
		Main Source of Water
Drought Index	Pearson Correlation	-.002
	Sig. (2-tailed)	.968
	N	310

Table 5: Relationship between Drought Index and Number of Water Bodies

There is a weak negative ($r = -0.002, p = 0.968$) linear relationship between drought index and number of sources of water, Table 5. This means that for every increase in drought index, there is a decrease in the number of sources of water. The weak negative relationship can be explained from available literature by Waggoner and Revelle, (2010) that drought is a major instrumental factor that affects water quality, both for surface as well as ground water. Waggoner and Revelle, (2010) continues to explain that drought reduces water quantity which results in changes in flow regimes influencing the chemistry, hydro-morphology and ecology of regulated water bodies. The weak relationship is linked to the fact that communities take measures to reduce the effects of drought by constructing new water sources such as dams, pans and boreholes as observe by (Whitehead, 2015). However, generally, the study findings show that water bodies that play an important role in water purification dry up during such heat events and longer evaporative seasons hence the negative relationship. Increased drought index as per Murdoch, Baron and Miller (2014) leads to lowering underground water table and hence lowers the number of water bodies available as it also leads to changes in water quality periods of elevated air temperature or drought can cause conditions that exceed thresholds leading to water quality degradation.

The study findings can also be associated to findings by Taylor (2013) who established that water quantity under climate extremes are affected through reductions in the water stored in glaciers and snow cover. These water sources keep on declining under extreme weather conditions. This trend reduces water availability especially during warm and dry periods (through a seasonal shift in stream flow, an increase in the ratio of winter to annual flows, and reductions in low flows) in regions supplied by this source (Taylor, 2013). Delpla (2011) adds that water availability from water bodies decreases further when storage capacities are not sufficient as much of the winter runoff will be lost to the oceans, and this will create regional water shortages hence the negative relationship. In many cases, access to large scale water

developments have turned out to be destructive of the environment as well as of social relations and has contributed to increased vulnerability of pastoralists to events such as drought (Manger, L., & Ahmed, A.G. M., 2000).

3.2.4. Relationship between Drought Index and Number of Livestock Species

		Correlations			
		Cattle	Camels	Goats	Sheep
Drought Index	Pearson Correlation	-.249	.023	.035	.056
	Sig. (2-tailed)	.000	.684	.538	.325
	N	312	312	312	312

Table 6: Relationship between Drought Index and Number of Livestock Species

There is a weak negative ($r=-0.2492$, $p= 0.968$) linear relationship between drought index and cattle, table 3.5. There was also weak positive linear relationship between drought index and camels ($r=0.23$) same as for goats ($r=0.35$) and for sheep ($r=0.56$). This means that for every increase in drought index, there is a decrease in the number cattle owned and little increase in number of other species being camels, goats and sheep.

These findings concur with findings by UNEP (2012) that generally population of livestock species decreases due to drought. The credence of the study findings can also be found from findings by Thomas (2014) that drought eliminates 15% to 37% of all species in the world. Steinfeld (2016) explains this by arguing that increase in temperature affects species reproduction, migration, mortality, and distribution.

The decrease of cattle in number as drought index increases is explained by literature by Thornton (2011) who states that that loss in livestock species is mainly because of the practices used in livestock production that emphasize yield and economic returns and marginalization of traditional production systems where other considerations are also important (such as ability to withstand extremes).

3.2.5. Relationship between Drought Index and Livestock Prices

		Correlations	
		Livestock Prices	
Drought Index	Pearson Correlation	-.148	
	Sig. (2-tailed)	.008	
	N	321	

Table 7: Relationship between Drought Index and Livestock Prices

There is a weak negative ($r=-0.148$, $p= 0.008$), Table 7. linear relationship between drought index and prices of the livestock. This means that for every increase in drought index, there is a decrease in the prices of the livestock. The findings augment argument by scholars like Paarlberg and Lee (2016) that effects of drought can persist for several years in the livestock industry and as feed costs rise, livestock producers typically increase livestock slaughter increasing supply thus lowering prices. The weak relationship can be attributed to the fact that the rise in supply of livestock causes the price of live livestock to decrease in the short-run and beef livestock inventories to decrease in the long-run. Livestock industries usually take longer to recover than crop industries do because of the drought-induced decrease in breeding stock. The study established from responses from key informants that livestock slaughter rises at the onset of a drought, but then diminishes below baseline levels and remains low until producers build up the breeding stock again. Conversely, the price of livestock declines as the market is flooded with low-weight livestock and culled livestock. After slaughter declines, the prices rise above baseline and slowly work back down as breeding stock and slaughter rise again.

The fluctuation of livestock prices as per the study findings have also been explained by Wilson (2017) when he explains drought is an important market factor in livestock markets. The findings can also be explained by findings by Wilson (2017) that with short supplies of hay available, cow herds get reduced, resulting in slaughter cow prices being the lowest. Cattle and sheep generally consume green grass as their main diet. Hay from wheat stems and other plant material is used as a nutritional supplement. As the drought persists, supplies of hay continue to run low and the prices of hay continue to rise. Consequently, farmers put a lot more cattle on the market as they could not feed them due to the drought and hence the cattle prices come down (Wilson, 2017).

Drought reduces crop production which increases commodity prices. Higher commodity prices increase feed costs which induce reductions in livestock breeding inventory. The drought also induces greater cattle slaughter which puts downward pressure on cattle prices and accelerates the breeding herd reduction. As forage prices rise, other crop prices rise as well (Sivakumar, 2011). Changes in crop prices alter input costs for livestock. Forage and pasture, along with grains, are the crops with the largest impact on costs in the beef sector as they comprise the largest percentage of beef cattle feed. Drought also led to added culling of breeding animals and further increased cattle slaughter. Increased slaughter affected cattle prices in the short run. Reduced cattle prices and higher feed costs reduce expected returns throughout the supply chain leading to a decrease in beef cattle inventory and a corresponding decrease in the supply of calves moving through the supply chain over time, which affects cattle prices in the long run.

4. Summary, Conclusions and Recommendations

4.1. Summary

Impact of drought on pastoral production systems was measured using the relationship between various factors in relation to the drought index in the study area. The factors considered in the study were, relationship between drought index and; number of livestock owned, availability of pasture, number of water bodies, number of livestock species as well as livestock prices. The study established that there is a weak negative ($r=-0.093$, $p= 0.095$) linear relationship between drought index and number of livestock owned. There was also there is a significant relationship between Vulnerability Index and availability of pasture $X^2(1) =19.110$, $p=0.002$ which was however low $w=0.134$.

The study determined that there is a weak negative ($r=-0.002$, $p= 0.968$) linear relationship between drought index and number of sources of water. There was however a differing relationships between drought index and livestock species indicating; a weak negative ($r=-0.2492$, $p= 0.968$) linear relationship between drought index and cattle, a weak positive linear relationship between drought index and camels ($r=0.23$) same as for goats ($r=0.35$) and for sheep ($r=0.56$). This means that for every increase in drought index, there is a decrease in the number cattle owned and little increase in number of other species being camels, goats and sheep.

4.2. Conclusion

Livestock in arid areas of Kenya plays a significant role in the local economies of such areas with many rural Kenyans deriving a range of financial benefits from livestock keeping. Livestock owners often 'cash in' their animals for particular purposes at a time of need and choice which highly determines the levels of impact of drought on households. Since pastoralists hold most of their wealth in the form of livestock, the impacts of drought and related challenges affect their entire livelihoods. Given the critical role livestock plays in the lives of the pastoralist communities, there still exists a myriad of constraints emanating from different areas of concern some of which have been highlighted in this study. From the data analysis the following conclusions are deduced i.e. the number of water bodies was also found to reduce the drought impact levels for communities though by a small margin, rearing of new breeds that are drought tolerant and consumes less pasture would reduce drought impact on communities in the study area including camels, donkeys and goats.

However, Semenza and Menne, (2009) established a different reason explaining the relationship between drought index and availability of pasture. In this regard, they indicated that alterations in pasture availability due to drought may be due to overgrazing. This can however be managed by taking actions such as planning and decision making on longer timeframes; aiming to enhance resilience by planning (risks & exposure), infrastructure and protection of strategic reserves and community; requiring community involvement and support as proposed by (AfriCAN Climate; 2015). Unfortunately, traditional pastoral mobility has been restricted by loss of pastoral lands to population pressures (of both humans and livestock), encroachment on important grazing areas by expanding agricultural or other pastoral groups, as well as the creation of commercial ranches and game parks. (Fratkin et al 2004). Waggoner and Revelle, (2010) explains that drought reduces water quantity which results in changes in flow regimes influencing the chemistry, hydro-morphology and ecology of regulated water bodies. The weak relationship is linked to the fact that communities take measures to reduce the impact of drought by constructing new water sources such as dams, pans and boreholes as observe by (Whitehead, 2015).

4.3. Recommendations

- Communities are exposed to frequent droughts situations. In order to cope with droughts situations households may keep more drought tolerant livestock like camels and engage in non-drought sensitive livelihoods where possible.
- Exposure to conflict is a major challenge and may result in displacement of populations and stressing the grazing land and water resources. There is need to begin peace building and conflicts resolution mechanism through establishment of peace committees.
- As short-term drought coping strategy in the study area, only 7 % came from external sources. 93 % of drought coping strategy originated from within household and community resources. This implies that, external supporters need to provide low inputs and take precautions not to undermine indigenous drought coping mechanism within the community.
- Key factors that contributed to high drought impacts on households include, low access to productive assets, low employment status, poor social networks, low access to extension services, poor access to drought early warning systems, poor remittances from relatives, poor access to credit facilities, low education and literacy levels and poor access to technology. If interventions are made in these key areas, drought resilience could be enhanced and impacts of droughts on households significantly reduced.

5. References

- i. Abate, T. (2013). Drought risk and livestock production in Southern Africa. *Journal of Asian Scientific Research*, 2013, 3 (10): 956 -973.
- ii. Abraham, J (2006). Assessing drought impacts and vulnerabilities for long-term planning and mitigation programs. Department of Geography and Regional Development. The University of Arizona, Dec. 6.

- iii. ACTED (2011). Rapid needs assessment in Mandera, Marsabit and Wajir counties. ACTED Assessment Report, Northern Kenya. July - August 2011.
- iv. Ajani, E. N., Mgbenka, R. N., Okeke, M, N (2013). Use of indigenous knowledge as a strategy for climate change adaptation among farmers in Sub-Saharan Africa: Implications for policy. *Asian Journal of Agricultural Extension, Economics and Sociology*. 2 (1): 23-40, 2013, Article no. AJAEES, 2013.
- v. Alam, K (2015). Farmers' adaptation to water scarcity in drought prone environments: A case study of Rajshahi District, Bangladesh. *Agriculture Water Management*. Volume 148, 31 January, pages 196 - 206.
- vi. Andargachew, K. & Brokken's, F. (1993). Intra-annual sheep price patterns and factors under lying price variations in the central highlands of Ethiopia. *International Journal of Agricultural economics* 8(2): 125-138.
- vii. Andreu J., Ferrer-Polo J., Pérez M.A., Solera A., Paredes-Arquiola J. (2013) Drought Planning and Management in the Júcar River Basin, Spain. In: Schwabe K., Albiac J., Connor J., Hassan R., Meza González L. (eds) *Drought in Arid and Semi-Arid Regions*. Springer, Dordrecht pp.237-249.
- viii. Augustine, A., Ayantunde, N., Matthew, D., Turner and Adamou, K. (2015). Participatory analysis of vulnerability to drought in three agro-pastoral communities in the West African Sahel. *Research Policy and Practice* (2015) 5:13.
- ix. ARGOS (2008). Common elements of pastoral farming systems as shown by causal mapping. ARGOS Research Note: Number 43, May.
- x. Barrett, A., Hannan, M., Alam, Z., Pritchard, M (2014). Impact of Chars Livelihood Programme on disaster resilience of Chars communities. Reducing extreme poverty on the Riverine Islands of North West Bangladesh.
- xi. Boko, M. I., Niang, A., Nyong, C., Vogel, A., Githeko, M., Medany, B., Osman-Elesha, R., Tabo & Yanda, P. (2007). *Africa Climate Change Impact 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge U.K, 433 – 467.
- xii. Brooks, N (2003). *Vulnerability, Risk and Adaptation: A concept Framework*. Tyridall Centre. Working Paper 38. September 2003.
- xiii. Baudoin, M., Henly-Shepard, S., Fernando, N., Sitali, Asha., Zommers, Z. (2016). From Top Down to "Community-Centric" approaches to Early Warning Systems Pathways to Improve Disaster Risk Reduction through community participation. *International Journal of Disaster Risk Science*. DoI 10.1007/s 13753-016-0085-6.
- xiv. Brown, J, R.; Kluck, D.; McNutt, C.; Hayes, M (2016). Assessing drought vulnerability using a socio-ecological framework. *Rangelands*. Volume 38, Issue 4, August 2016, pages 162 - 168.
- xv. Bett, D. (2017). *The assessment of drought preparedness measures in Kenya*. University of Nairobi.
- xvi. Catley, C., Lind, J., Scoons, I. (2013). *Pastoralism and Development in Africa: Dynamic change and the margins*. Research, policy and practice 2013, 3:19.
- xvii. Christiansen, L.J., & Subbarao, K. (2001). *Towards an understanding of vulnerability in rural Kenya*.
- xviii. Climate and Development Knowledge Network (2012). *Managing climate extremes and disasters in the agriculture sector. Lessons from the IPCC SREX report*.
- xix. Cordaid, (2007). *Building resilience to climate change. Experiences of Kenyan pastoralist communities in managing drought; Nairobi, Kenya*.
- xx. Colorado Water Conservation Board (2013). *Drought Vulnerability Assessment Technical Information*. Disaster Mitigation Act 2000 and Section 409, PL-93-288.
- xxi. Cohen, V. (2013) *Adaptive mechanisms and genomic plasticity for drought tolerance for pastoral Communities*.
- xxii. Coppock, B. (2014) *Increasing flexibility in rangeland management during drought*. *Ecosphere Journal Review*.
- xxiii. Delf University (1993). *Global Vulnerability Assessment. A global Vulnerability Assessment for populations, coastal wetlands and rice production on global scale*. Delft Hydraulics, The Netherlands. Second Edition.
- xxiv. Deka, S., Glakas, C., Olivier, M (2011). *Vulnerability to Climate Change: Assessing Climate Vulnerability in North Africa; A student working paper no. 3, CCAPS, USA*.
- xxv. Development Initiatives (2017). *Assessment of Kenya's preparedness to disasters caused by natural hazards: Floods, drought and disease outbreak Report*.
- xxvi. Dima, J (2011). *Assessment of pastoral resource management risks and conflicts among the Waso Boran of Northern Kenya*. Ph. D Thesis, Egerton University, Njoro, Kenya.
- xxvii. Dhanapal, G (2014). *Climate Change Vulnerability Assessment, Gaps and Challenges*.
- xxviii. *Economic and Political Weekly*. June 2014.
- xxix. Doll, P (2009). *Vulnerability to the impact of climate change on renewable groundwater resources: a global-scale assessment*. *Environment Research Letters* (2009) 035006 (12pp). Institute of Physical Geography, Goethe University Frankfurt, Frankfurt am Main, Germany.
- xxx. Davies, W. (2014) *Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa?*, *Ecological Economics*
- xxxi. Delpla, J. (2011) *The impact of drain blocking on an upland blanket bog during storm and drought events, and the importance of sampling-scale*. *Journal of Hydrology* volume 404, issues 3 – 4.

- xxxii. Elliot, F (2004). *Arial pastoralists of Kenya: Studying pastoralism, drought and development in Africa's Arid and Semi-Arid Lands*. Cultural survival studies in Ethnicity and change series. Order number, 0 - 205-26997-4.
- xxxiii. Erian, W (2010). *Drought vulnerability in the Arab Region: A case study - Drought in Syria*. Ten years of scarce water - 2000 - 2010.
- xxxiv. Fan, M., Zhang, C., Li, W (2013). *Adaptation of herders to droughts and privatisation of rangeland use rights in arid Alxa Left Banner of Inner Mongolia*. *Journal of Environment Management*. Volume 126: 182 - 90. Doi:/10.1016/j.jenvman. 2013.4.053.
- xxxv. Fussel, H.M. & Klein, R.J.T. (2014) *Assessing vulnerability and adaptation to climate change: An evolution of conceptual thinking*. In *Proceeding of the UNDP Expert Group Meeting on Integrating Disaster Reduction and Adaptation to Climate Change*, Havana, Cuba.
- xxxvi. Fratkin, E.M. and Colledge, S (2004). *Ariaal pastoralists of Kenya. Studying pastoralism, drought and development in Africa's Arid Lands*. Pearson Education Inc. 2 nd Edition No. 0 - 205-26997-4.
- xxxvii. Ford, J. D., Goldhar, C. (2012). *Climate change vulnerability and adaptation in resource dependent communities: a case study from West Greenland, Canada*. Vol.54: 181 - 196, 2012.
- xxxviii. Fussel, H.M. (2005). *Vulnerability in Climate Change Research: A Comprehensive Conceptual Framework*. Breslauer Symposium, University of California International and Area studies, UC Bekeley.
- xxxix. Fussel, H.M., and Klein, R.J. (2006). *Climate Change Vulnerability Assessment: An evolution of conceptual thinking*. *Climate Change* 75: 301- 329.
- xl. Gonzalez-Velosa (2012) "Choice of Functional Form for Hedonic Price Equations", *Journal of Urban Economics* volume 10, issue 1.
- xli. Gouro, M. (2014) *A decision support system for drinking water production integrating health risks assessment*. Center for Socio-Economic Documents: Tehran, Iran
- xl.ii. Gray, C. & Kinnear, D. (2012) "Livestock Marketing, Food Security and Related Issues in Ethiopia", Addis Ababa, Ethiopia.
- xl.iii. Gesare, H.M. (2012). *Assessment of climate change impacts on natural resources and the different gender among pastoral communities in Samburu, Kenya*. M.Sc thesis, School of Environmental Studies, Kenyatta University, Kenya.
- xl.iv. Graciela, M., Adrea, S., and Jason, S., (2014). *Climate change vulnerability, impact and adaptation assessment*. *International Journal of Climate Change Strategies and Management*, Vol.6 Iss. 4 pp. 442 - 476.
- xl.v. Goldman, M., Riosmena, F (2013). *Adaptive capacity in Tanzania Maasailand: Chnaging strategies to cope with drought in fragmented landscapes*. Vol. 23, Issue 3, June 2013, pp. 588 - 597.
- xl.vi. GOK (2005). *Draft National Disaster Management Policy for Sustained Development of Arid and Semi-Arid Lands (ASALs) of Kenya*. Ministry of State for Special Programmes, Office of the President.
- xl.vii. GOK (2008). *Review and analysis of existing drought risk reduction policies and programmes in Kenya*. National report on drought risk reduction policies and programmes. Ministry of state for special programmes, Office of the President.
- xl.viii. GOK (2010). *National Climate Change Response Strategy*; Government of Kenya, Nairobi.
- xl.ix. GOK (2014). *National Climate Change Framework Policy*, Government of Kenya, Ministry of Environment and Natural Resources, Nairobi.
- I. GIZ (2015). *The Vulnerability Sourcebook. Concepts and guidelines for standardised vulnerability assessments*. Federal Ministry of Economic Cooperation and Development.
- ii. Gleick, P.H (2014). *Water, drought, climate change and conflict in Syria*. *Weather, Climate and Sociey*. Volume 6. page 331-340. Doi: 10.1175/twcas-D-13-000591.
- iii. Hulufu, H (2011). *Cross border planning improves pastoralist resilience to drought in Kenya and Ethiopia*. *Disaster risk reduction in the drylands of the Horn of Africa*.
- iii. Hoffmann, L. (2009) *Drought discourse and vulnerability*. In *Drought: A Global Assessment, Natural Hazards and Disasters Series*; Routledge Publishers: London, UK.
- liv. ISDR (2012). *Disaster Reduction in Africa*. *Africa Informs; Special Issue on Drought Risk Reduction*.
- lv. IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Retrieved from http://ipcc_wg2.gov/ar5/report/final-draft.
- lv.ii. Jabbar, M.A. (1998) "Livestock Marketing, Food Security and Related Issues in Ethiopia", Addis Ababa, Ethiopia.
- lv.iii. Kaufmann, B., Nelson, W., Gudere, R., Canger, V., Golicha, D., Frank, M., Roba, H., Mwai, O., and Hulsebusch, C. (2012). *Identifying Local Innovations in Pastoral areas in Marsabit County, Kenya*, DITSL, University of Kassel, Germany.
- lv.iii. Kaufmann, B; Kratli, S; Huelsebuch, C; Brooks, S (2013). *Pastoralism: A critical asset for food security under global climate change*. *Animal Frontiers*. Vol. 3. No.1.
- lix. Kelly, P., and Adger, W. N. (2000). *Theory and practice in assessing vulnerability to climate change and facilitating adaptation*. *Climate Change* 47: 325-352.

- Ix. Kemal, F., Nmez, S., Ali, U., Mran, K., Scu, M., Ayan, E., Ertan, T. (2005). An Analysis of Spatial and Temporal Dimension of Drought Vulnerability in Turkey Using the Standardized Precipitation Index. *Natural Hazards* (2005) 35: 243–264.
- Ixi. Kellner, O., Niyogi, D. (2014). Forages and pasture symposium: Assessing drought vulnerability of agricultural production system in the context of the 2012 drought. *Journal of Animal Science*. Volume 92, Issue 7, 1 July 2014, pages 2811- 2822.
- Ixii. Khajuria, A. and Ravindranath, N.H (2012). Climate Change Vulnerability Assessment: Approaches DPSIR Framework and Vulnerability Index. *Journal of Earth Science and Climate Change*, 3:1.
- Ixiii. Kabubo-Mariara, F. (2011) "Heteroscedastic Hedonic Price Model for Cattle in the Rural Markets of Central Ethiopia", *Applied Economics*. Volume 43, Issue 24.
- Ixiv. Kwadwo, A. (2012) Climate risk management information, sources and responses in a pastoral region in East Africa. *Climate Risk Management Journal*. Volume 11, pages 1- 14.
- Ixv. Korb, K.A. (2013). Conducting Educational Research: Step 6 – Select sampling technique. Retrieved from www.koebedpsych.com.
- Ixvi. Lekapana, P. L (2013). Socioeconomic impacts of drought on pastoralists, their coping strategies, and government interventions in Marsabit County, Kenya. M.A. Thesis. Centre for Advanced Studies in Environmental Law (CASELAP), University of Nairobi, August 2013.
- Ixvii. Liu, X., Wang, Y., Peng, J., Brainoh, A, K., Yin, H (2013). Assessing vulnerability to drought based on exposure, sensitivity and adaptive capacity: A case study in middle Inner Mongolia of China. *Chinese Geographical Science*. Volume 23, Issue 1, pp. 13 - 25.
- Ixviii. Martin, R., Linstadler, A., Frank, K., Muller, B. (2014). Livelihoods security in the face of drought - assessing the vulnerability of pastoral households. Environmental Modeling and Software Society, Leipzig, Germany.
- Ixix. Manger, L., and Ahmed, A.G.M (2000). Pastoralists and environment. Experiences from the Greater Horn of Africa. Proceedings of the regional workshops on African drylands, Addis Abeba and Jinja. OSSREA, Addis Abeba.
- Ixx. McCarthy, J.J. (2001). Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of IPCC. Cambridge University Press, Cambridge, United Kingdom.
- Ixxi. Miller, S., Yoon, S. W., Yu, B. (2013). Vulnerability indicators of Adaptation to Climate Change and Policy Implications for IDB Projects. Policy Brief No. IDB-PB-184.
- Ixxii. MRC (2010). Review of climate change adaptation methods and tools. MRC Technical Paper No. 34.
- Ixxiii. Mude, A (2009). Index Based Livestock Insurance for Northern Kenya's Arid and Semi-Arid Lands. The Marsabit Pilot Project Report. ILRI January 2009.
- Ixxiv. Miyan, M. A (2014). Droughts in Asian Least Developed Countries: Vulnerability and Sustainability. *Weather and Climate Extremes*. Vol.7 (2014) pp. 8 - 23.
- Ixxv. Mutu, P. L., Akwee, P. E., Wakhungu J. W (2017). Environmental drought effects on human vulnerability to the Turkana Nomadic pastoral population of Elemi Triangle region, Turkana County, Kenya. *International Journal of innovation and research and advanced studies*. Volume 4, Issue 11, November, 2017. ISSN: 2394-4404.
- Ixxvi. Murdoch, P.S.; Baron, J.S.; Miller, T.L (2010) Potential effects of climate change on surface water quality in North America. *Water Resources Journal*. Volume 28, pp 67 – 82.
- Ixxvii. Notenbaert (2012) Dynamic effects of drought on U.S. Crop and livestock sectors. *International Journal of Agriculture*. Volume 47, Issue 2, pp. 261 – 284.
- Ixxviii. NDMA (2018). Marsabit County Drought Early Warning Bulletin. June, 2018.
- Ixxix. Ngugi, R.K.; Nyariki, D.M. (2002). A review of African pastoral production systems: Approach to their understanding and development. *Journal of Human Ecology*. 13(3): 237-250.
- Ixxx. Njoroje, B.N. (2010). Environmental and Social Impact Assessment (ESIA) Report for the proposed strengthening of Laisamis-South Horr - Loiyangalani Road. Vol IV. Lake Turkana Wind Power Limited.
- Ixxxi. Nkomo, J.C., Nyong, A.O. and Kulindwa, K. (2006). The impacts of climate change in Africa. The stern review on the economics of climate change.
- Ixxxii. Nkomo, J. C. (2006). The impacts of climate change in Africa, Ph.D Thesis, University of Cape Town, South Africa.
- Ixxxiii. Newsham, A., Naess, L.O. and Guthiga, P. (2011). Farmers' knowledge and Climate Change Adaptation: Insights from policy processes in Kenya and Namibia. Policy Brief 042.
- Ixxxiv. Oba, G., and Lusigi, W. (1987). An overview of drought strategies and land use in African pastoral systems; Kenya Arid Lands Research Station, Marsabit, Kenya.
- Ixxxv. ODI (2010). Pastoralism demographics, settlement and service provision in the Horn and East Africa. Transformation and opportunities. Regional Pastoral livelihoods and advocacy project.
- Ixxxvi. Ogwell, L (2011). The drought crisis in Kenya - will it ever end? Disaster risk reduction in the drylands of the Horn of Africa. Good practice examples from the ECHO drought cycle management partners and beyond.
- Ixxxvii. Oshita, G. (2010) Impacts of climate change on livestock husbandry and adaptation options in the arid Sahel belt of West Africa: Evidence from a baseline survey.

- lxxxviii. Omondi, P. A., Awange, L. J., Farootan, E., Ogolla, L. A. (2013). Changes in temperature and precipitation extremes over the Greater Horn of Africa from 1961 to 2010. *International Journal of Climatology*. DOI. 10. 1002/JOC.3763.
- lxxxix. Osano, P. M., Said, M. Y., Leeuw, J., Moiko, S.S., Kaelo, D.O., Schomers, S., Birner, R., Ogotu, J.O (2013). Pastoralism and Ecosystem-based adaptation in Kenyan Masailand. *International Journal of Climate Change Strategies and Management*. Vol. 5. No. 2, 2013, pp. 198 - 214.
- xc. Opiyo et al (2014). Measuring household vulnerability to climate-induced stresses in pastoral rangelands of Kenya: Implications for resilience programming. *Pastoralism: Research, Policy and Practice* 2014, 4:10.
- xc. Opiyo, F., Wasongo, O., Nyangito, M., Schilling, J. and Munang, R. (2015). Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya. *Int J Disaster Risk Sci* (2015) 6:295–309.
- xciii. PACIDA (2009). Drought situation report for Marsabit, Chalbi and Laisamis Districts, Northern Kenya. Development partners drought response action.
- xciv. Parannello, S. (2009). Pastoralists' vulnerability in the Horn of Africa: Exploring political marginalisation, donors' policies and cross-border issues. Humanitarian Policy Group, ODI, London, UK.
- xcv. Paarlberg & Lee (2016) "Risk and Social Change in an African Rural Economy: Livelihoods in Pastoralist Communities." Routledge.
- xcvi. Presser, S. and Krosnick, J.A. (2010). Question and Questionnaire Design. *Handbook of Survey Research*, Second Edition.
- xcvii. Scoones (2012) Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. *Weather Climate Extremes Assessment Report*.
- xcviii. Seo and Mendelsohn, (2016). An analysis of African livestock management by agro-ecological zones. *BE J. Econ. Anal. Policy*
- xcix. Sivakumar, Mannava V.K., Raymond P. Motha, Donald A. Wilhite, and John J. Qu (Eds.). 2011. Towards a Compendium on National Drought Policy. Proceedings of an Expert Meeting on the Preparation of a Compendium on National Drought Policy, July 14-15, 2011, Washington DC, USA: Geneva, Switzerland: World Meteorological Organization. AGM-12; WAOB-2011. 135 pp.
- c. Smith (2016) Climate change, drought and desertification. *Journal of Arid Environments* 34: 133-140.
- ci. Shiferaw, B., Tesfaye, K., Kassie, M., Abate, T., Prasana, B., Menkir, A. (2014). Managing vulnerability to drought and enhancing livelihoods resilience in Sub-Saharan Africa: Technological, Institutional and Policy Options. *Weather and Climate Extremes*. Vol. 3 (2014) pp. 67 - 79.
- cii. Schroter, D., Polsky, C., & Patt, A.G. (2004). Assessing Vulnerabilities to the effects of global change: An eight step approach; *Mitigation and Adaptation Strategies for Global Change* (2005) 10: 573-596.
- ciii. Schilling, J. and Remling, E. (2011). Local adaptation and national Climate Change policy in Kenya: Discrepancies, options, and the way forward. Research Group Climate Change, Institute for Geography, Hamburg University, Grindelberg, Germany.
- civ. Smith, S. (2013). Determining sample size: How to ensure you get the correct sample-size. *Insights*, April 08. Retrieved from www.qualtrics.com/blog/determining-sample-size.
- cv. Smit, B. and Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16 (2006) 282 – 292.
- cvi. Sun, X (2005). Dynamics of continuity and change in pastoral subsistence among the Rendille in Northern Kenya: With special reference to livestock management and response to socio-economic change. Graduate School of Asian and African Studies, Kyoto University. *Africa Study Monograph*. Suppl. 31:1 -94.
- cvii. Sperenza, M. (2010) A new approach for predicting drought-related vegetation stress: integrating satellite, climate and biophysical data over the US central plains. *ISPRS J Photogramm Remote Sens*. 2015;59(4):244–53. Cross Ref Google Scholar.
- cviii. Spies (2011). Establishing indices of genetic merit using hedonic pricing: an application to dairy bulls in Alberta. *Canadian journal of Agricultural Economics*. Volume 47, Issue 2, pp 261 -284.
- cix. Taylor, R.; Scanlon, B.; Döll, P.; Rodell, M.; van Beek, R.; Wada, Y.; Longuevergne, L.; Leblanc, M.; Famiglietti, J.; Edmunds, M.; et al. Ground water and climate change. *Nat. Clim. Chang*. 2013, 3, 322–329.
- cx. Thomas, J., Wheeler, T.R.; Reynolds, C. (2014) Predicting the risks from climate change to forage and crop production for animal feed. *Anim. Front*. 2013, 1, 36–41.
- cx. Thornton P.K., van de Steer, J., Notenbaert, A. and Herrero, M. (2009): The impacts of climate change on livestock and livestock systems in developing countries.
- cxii. Thornton P.K., Jones P.G., Owiyo T., Kruska R.L., Herrero M., Kristjanson P., Notenbaert A, Bekele N. and Omolo A.(2013):Mapping climate vulnerability and poverty in Africa. Report to the Department for International Development, ILRI, Kenya. pp 171.
- cxiii. Tambo, J, A. and Abdoulaye, T (2013). Smallholder farmers' perception of and adaptations to climate change in Nigerian Savanna. *Regional Environmental Change*. Vol. 13, Issue 2, pp. 375 - 388.

- cxiv. Thomalla, F., Downing, T., Spanger-Siegfried., Han, G., Rockstrom, J. (2006). Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation. *Disasters*, 2006, 30(1): 39 - 48.
- cxv. UNCCD (2015). Capacity development to support National Drought Management Policies. Regional Coordination Unit, UNCCD, Africa Region, Accra, Ghana.
- cxvi. UNDP (2007). The global drylands imperative. Implementing Millennium Development Goals in the drylands of the world. Nairobi, Kenya.
- cxvii. UNDP (2009). Improving market access to dryland commodities in East Africa. Synthesis Report.
- cxviii. Yehong, S., Hongjian, Z., Lingyun, Z., Qingwen, M., Weixia, Yin (2017). Adapting to droughts in Yuanyang Terrace of SW China: insight from disaster risk reduction. *Mitigation and Adaptation Strategic for global change*, 2017, Vol. 18, Issue 6, 759 - 771.
- cxx. Willinges, K., Mechler, R., Bowyer, P., Balkovic, J (2017). Towards and assessment of adaptive capacity of the European Agriculture Sector to droughts. *Climate Services*. Volume 7, August, 2017, pp. 47 - 63.
- cxxi. Wekesa, M. (2006). Drought, Livestock and Livelihoods: Lessons from 1999 - 2001 emergency response in Kenya. A consultancy report for Ministry of State for Special Programmes. Office of the President.
- cxxii. Western, D. and Nightingale, D. (2004). Environmental change and vulnerability of pastoralists to drought. A case study of the Masai in Amboseli, Kenya. Chapter 3, *The African Environment Outlook Report*.
- cxxiii. Wilhite, A.D. and Glantz, M. H. (1985). Understanding drought phenomenon: The role of definitions. *Water International*. 10 (3) 1985, pp. 111 - 120.
- cxxiv. Waggoner, P.; Revelle, R. Summary (2010). In *Climate Change and U.S. Water Resources*; Waggoner, P.E., Ed.; John Wiley and Sons: Toronto, ON, Canada, 2010.
- cxxv. Whitehead, P.G.; Wilby, R.L.; Battarbee, R.W.; Kernan, M.; Wade, A.J. (2011) A review of the potential impacts of climate change on surface water quality. *Hydrol. Sci. J.* 2011, 54, 101–123. [CrossRef]
- cxxvi. Wilhite DA, Svoboda MD, Hayes MJ. Understanding the complex impacts of drought: a key to enhancing drought mitigation and preparedness. *Water Resour Manag.* 2007;21(5):763–74. doi: 10.1007/s11269-006-0976-5. CrossRefGoogle Scholar
- cxxvii. Wilson, Sam. 2017. "12% of Montana is in exceptional drought—a once-in-century event, NOAA scientist says." *Billings Gazette*. August 1, 2017.
- cxxviii. Zarafshani, K., Sharafi, L., Azadi, H., Hosseininia, G.H., De Maeyer, P., Witlox, F. (2012). Drought Vulnerability Assessment: The Case of Wheat Farmers in Western Iran. *Global and Planetary Change*, vol. 98-99 (2012), 122-130.
- cxxix. Zewdu, A. and Jallela, T. (2011). Using a crisis modifier and contingency planning to respond rapidly to drought emergencies. *Disaster risk reduction in the drylands of the Horn of Africa*.