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CLIMATE CHANGE STRESS ON PASTORAL LIVELIHOODS IN NAROK COUNTY, KENYA

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Abstract:
The pastoral communities are groups of people who depend on livestock or the sale of livestock products for most of their livelihoods. In Kenya they inhabit mostly Arid and Semi-Arid Lands' (ASALs) and thus rely mainly on rainfall for water and pasture, lack of which poses greater challenges to their livelihoods. The conceptualization of this paper is based on the need to establish the impact of climate change on the livelihoods of the pastoral community of Narok County. Pastoralism in Narok County is adversely threatened by climate change related shocks despite its great potential in contributing to the community's livelihoods. The author, with an intention of conducting a face to face interview sampled 415 pastoralists by a multi stage sampling technique in Narok County. Data collection was done using both observation and questionnaire methods. The questionnaire administered to the participants pointed out such impacts as loss of livestock; livestock disease outbreak as well as famine as the main impacts of climate change in the study area. Notably, while pastoralists lease out land to private conservancies, paddock the land, reduce the size of livestock, and construct water harvesting schemes at the community level during extreme events; this has not made better the adversities faced. In giving hope to the community, this paper is intended to be an eye opener to policy makers and relevant institutions in establishing coping strategies to ensure food sustainability amidst climate change challenges.

Keywords: climate change, food insecurity, pastoral community, poverty, livelihoods

1. Introduction

According to Mwebeza (2009), East Africa would suffer some of the worst impacts of climate change which include successive poor rains, an increase in drought-related shocks, and more unpredictable and sometimes heavy rainfall events which in turn

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would cause human, economic, and environmental as well as biodiversity impacts. Closely related issues are observed in Kenya's Agricultural sector which indicates that climate change has already taken a toll on agriculture due to water scarcity, decline in soil fertility, soil erosion and landslides as well as increased incidence of pest and diseases.

In Kenya, climate change is having far reaching negative effects on the already precarious food security situation for both crop cultivators and pastoralists (Orindi *et al.,* 2007). The pastoral communities are specifically affected by the impacts of climate change besides other challenges that hinder their way of life and stifle their ability to adapt to changes in their external environment. These challenges have been grouped into four main categories: climate change, political and economic marginalization, inappropriate development policies, and increasing resource competition (Oxfam, 2008).

In Laikipia East sub-county, drought is ranked highest in severity among other climate change challenges and it is followed by livestock diseases, human diseases and conflicts over resources, (Kirimi *et al.,* 2013). Rainfall data and household surveys from Mandera and Turkana affirm that with climate change, droughts are more frequent and severe and therefore, pasture is not able to regenerate and rangelands remain bare even when erratic rainfall is recorded (Ogindo *et al.,* 2009). Documented evidence from a report at a workshop in Nakuru (NCCRS-ACTIONPLAN, 2012) on the impacts of climate change in the rift valley revealed that in Samburu County the impacts include; increased water scarcity caused by low rainfall and short lived water pans, increases in day time temperatures and decreases in night time temperatures.

Narok County also lying within the Arid and Semi-arid Lands of Kenya is inhabited by the Maasai pastoralists. The community has continued to face environmental stresses constantly navigating the hot and dry climate in search of pasture and water sources (Pavanello, 2009). The pastoralists in this place used to sell cows and goats in preparation for impending droughts in the past but due to unpredictable droughts currently, they have had to incur great losses and reduction in the cash income derived from the sale of livestock and its products. This is because their capacities to cope with these climate-related shocks are lower and dynamic due to lack of economic and natural resources, poor social networks, lack of entitlements, poor marketing institutions and governance, unskilled human resources, and low uptake of modern technology. It is further aggravated by the unpredictable rainfalls, which have resulted to torrential floods thus causing havoc particularly in eroding extensive bare surfaces of Mosiro, Ewaso Nyiro, Limanet and Mararianda areas (Nabutola 2010). The combined effects of siltation of rivers due to erosion and prolonged drought have reduced water levels and discharge in rivers such as Mara and Ewaso Nyiro. This has affected both the riverine ecosystem and the amount of water available for wildlife and humans, who are using it for their livelihoods downstream. Furthermore, this could have long term effects on the wild beasts' migration cycle that sustains Maasai-Mara tourism. The Maasai community, being the occupants of this region, earn their living directly from pastoralism and indirectly from tourism which are both threatened by the

effects of climate change related shocks. This largely impact on the livelihoods of the pastoral community.

2. Literature Review on Impact of Climate Change

According to Vinthagen (2013), the rising average temperature has far reaching consequences threatening human life such as increased firestorms, flooding, degradation of farming land, hurricanes, change of ocean streams, rising sea levels, and melting glaciers. He further argued that although these impacts affect the whole world and everyone in it, humans who live on the Earth today are not affected in the same way since the effects are distributed unequally among different parts of the world and again the ability to protect oneself is also distributed unequally. Mwebaza (2009) underlines that Africa's total greenhouse gas emission share is low compared to rich countries, yet Africa is projected to suffer some of the worst impacts of climate change. The worst affected are the poor especially in the ASALs since they live in the most dangerous areas, and yet they are unable to protect themselves through various available adaptation strategies.

It is also true that different experiences of effects of climate change will be felt in different parts of the world. Kamal (2011), observed that climate change is likely to bring particularly rapid temperature increases in Nepal, causing a serious retreat of glaciers and the glacial lakes hence impacting on water availability. The situation is different in Thailand which is one of the world's biggest rice exporters and food producers, where climate change effects such as drought and flooding have seriously threatened this economic sector and the overall food security of the country forcing the government to bear the burden of helping those afflicted (Marks, 2011).

Oli *et al*., (2007) presents another different scenario in Bangladesh, where the water levels have fallen, temperatures have risen, and the incidence of floods, dry spells and cyclones have all increased, thus affecting both people's lifestyle and their livelihoods.

The effects of climate change have already been felt in Kenya. The frequency of droughts, floods, and other extreme climatic events has increased in the recent years (RoK, 2013). These changes are believed to have direct impacts on agriculture, energy, water, health and the general economy. Such impacts have in one way or the other affected the lives of the people nationally and locally by subjecting them to increased levels of poverty and food insecurity (Downing, 1992). Reduction of poverty that was one of the millennium development goals was hard to achieve and most probably because the challenges of climate change may have had an upper hand in this. Iona (2011), pinpoints that in many ways there is a distinct correlation between poverty and vulnerability to climate change shocks, since the lack of resources which is a characteristic of poverty, impedes abilities to anticipate and deal with the effects of a natural hazard. But for Lelenguyah (2013), poverty reduction can only be achieved through a thorough understanding of the inter-linkages between climate change and

livelihood systems particularly among the inhabitants of the third world country like Kenya.

According to Ochieng *et al*., (2016), Climate variability and change have always presented a threat to food security in Kenya through their effect on rainfall, soil moisture and production and thus affecting mostly the people who are dependent on agricultural production for the largest proportion of their food requirements. Downing (1992) had estimated about 7 million Kenyans to be living in food poverty but of recent this number has increased to about fifty percent of the total population. The recurrent collapse of pastoralists' livelihoods brought about by frequent and severe droughts and other climate disasters is a striking evidence of this scenario, particularly in Kenya where pastoralists also appear to be becoming more vulnerable and in need for food-aid during these times, (Ochieng *et al*., 2016).

Climate change shocks will only worsen the situation that may lead to dire socio-economic challenges in the country since many households have been forced to overuse the available natural resources especially land which has lost most of its important nutritive elements that could boost crop farming and livestock production. Downing (1992) and Lelenguyah (2013) summarized the most likely groups of people be severely affected by climate change shocks in Kenya to include:

1) Nomadic pastoralists who practice no crop farming - 85% food risk;
2) Agro-pastoralist who often grow some crops - 33% food risk;
3) Migrant farmers who have permanent farmlands and keep livestock - 55% food risk;
4) Landless poor – farmer with little or no land and are perpetually food-insecure (85% food risk);
5) Squatters - farmers occupying large absentee-owned estates or public land with no legal claim to the land parcels - 33% food risk;
6) Smallholders (with less than 20 hectares), accounting for 50% of the farming population in each province - 29% food risk; and
7) Urban-poor – households with low incomes dwelling in metropolitan areas (40% food risk)

Table 1: Extreme Climatic Conditions in Kenya since Independence

Year	Event
1961	High equatorial rainfall experienced in East Africa which led to East African lakes rising in levels.
1977	Highest rainfall ever recorded in Kenya which caused severe gulley erosion, Lake level rise in semi - arid regions.
1984	Severe droughts in Kenya led to the introduction of "food queues" in supermarkets.
1991 - 1993	Severe droughts in most arid areas in Kenya led to the introduction of "food for work" programmes, and reduced surface areas of the lakes in the region e.g. Lake. Baringo.
1996-1998	Kenya experienced the worst floods in 36 years caused by El-nino which increased surface area of Lakes in the rift valley.
1999-2001	Affected not only the perennially drought-prone arid districts of northern Kenya, but also the marginal agricultural areas of Eastern, Coast and Rift Valley provinces, as well as high-rainfall areas such as the Central Province.
2009	A drought year in Kenya.

2013-2015	Elnino rains in Kenya that have seen all the Rift Valley Lakes increase in volume and depth, worst floods in Narok County that saw many people lose their lives.

Source: Adapted with expansion from Ngaira (2008).

The climate projection for the ASAL of Kenya includes longer and more frequent dry periods interspersed with intense but shorter and unpredictable periods of rainfall (GoK, 2007). However, since independence, Kenya has witnessed extreme climatic events of drought and floods as illustrated in Table 1 (Ngaira, 2008). In addition, it is reported that its effects were mostly felt by pastoralists in the present Counties of Garissa, Mandera, Tana River, Isiolo, Turkana, Baringo, Laikipia, Kajiado and Narok (Aklilu &Wekesa, 2002). Kenya's temperatures have risen by 1°C over the past 50 years (GoK, 2009) and warming is expected to accelerate with temperatures rising by nearly 3°C by 2050 (Intergovernmental Panel on Climate Change (IPCC), 2007). According to The Economist (2009), the cycles of drought in Kenya seem to have reduced from five to two years which imply higher evaporation and drier conditions. Such weather patterns are likely to deplete water and pasture resources, leading to natural resource scarcity, a situation that will make it difficult to acquire livelihoods in the already dry lands.

2.1 Vulnerability of livelihoods to climate change impacts

Vulnerability is a term that has multiple definitions and it has been used to make people understand the extent to which they may be subject to the impact of climate change. IPCC in its second report defines vulnerability as the extent to which climate change may damage or harm a system. Understanding vulnerability must involve understanding how institutions, class, gender and often social variables respond to climate change. Adger (2006) highlights that the people most vulnerable are those that are economically disadvantaged. Watson et al., (1996), envisaged that the vulnerability of a region depends largely on its wealth, and that poverty limits adaptive capabilities. Watson *et al*. (1996) argued that the level of economic development and institutions greatly determines vulnerability especially in developing countries where economic and institutional circumstances are less favorable. The report continues to emphasize that vulnerability is highest where there is the greatest sensitivity to climate change and the least adaptability but vulnerability will also increase with higher temperature increases.

Mwebaza (2009), affirms that the vulnerability of East Africa to impacts of climate change will be aggravated by the interaction of often stressors prevalent within the region such as extreme poverty, limited access to capital, ecosystem degradation and complex disasters. He further advises decision and policy makers to attempt to ascertain these conditions before providing policies of adaptation. FAO's (2004) report, indicates a triple increase in food crisis to a number of African countries attributed to effects of climate change.

2.2 Vulnerability of pastoral livelihoods to climate change impacts

Pastoral societies inhabit arid and semi-arid environments where the living conditions are harsh and challenging and where Pastoralism serves as the bedrock of livelihoods

and culture. Various studies have concluded that the largest population in ASALs will particularly be vulnerable to climate change impacts due to comparatively natural drier characteristics. Masika (2002) affirms that climate change is already intensifying the hazards that affect human livelihoods, settlements and infrastructure in ASALs, thus weakening the resilience of livelihood systems in the face of increasing uncertainty and frequent disasters.

Climate change will also impact the economy of arid and semi-arid regions due to increase in overall water stress caused by projected temperature increase and drier conditions that will notably alter vegetation cover as well as putting further stress on water resources. Thulani and Keith (2013) noted that the condition of grazing lands in Southern Zimbabwe deteriorated very quickly over the years due to the continuous seasons of drought that had made some of the pastures fail to recover. Moreover vegetation do not reach flowering period in north western Somaliland due consecutive droughts and a seasonal rains, thus leading to reduced biomass that exposes more soil erosion (Hartmann & Sugulle, 2009). This is also in line with the study by Silvia et al. (2012), which was done in 7 rural districts in Kenya, that reported that some livestock feeds which were available 10 years ago are no longer available, and on the other side, some new feed resources appeared in particular: "mathenge" (*Prosopisjuliflora*) and, napier grass (*Pennisetum purpureum*) because of increased dry conditions. This in turn has caused reduction in herd size during the last 10 years through death.

According to Fischlin *et al*. (2007), increased temperature and lower rainfall also increases vegetation flammability resulting in a shift in species composition as a result of increased dry soil. An extended drought can result in the mortality of perennial plants and the switch to an annual dominated flora (Hein & De Ridder, 2006). Such situations according to Iona (2011) jeopardize herd growth as there is insufficient time for herds to recover following a shock and thus furthering the vulnerability of pastoralist livelihoods. Although the direct effects of climate change on the animals are likely to be small as long as temperature increases do not exceed 3° C, livestock production is expected to be affected by changes in feed quality and availability, water availability and increased rates of disease and heat stress. Hoffmann (2010), affirms that climate change affect animals directly through physiological stress and thermoregulatory control, nutrition and disease stress. Consequently, these effects will potentially result *inter-alia* in community conflicts, loss of lives and livelihoods as well as migration (GoK 2010).

In Baringo, Lelanguyah (2013) found out that loss of crops, displacement of people, death of livestock and destruction of crops are some of the major effects of climate change related hazards on the livelihoods of the local people. Such effects led to loss of income sources for most of the local pastoralists as well as loss of residence. The end result is that such disasters increases dependence since the affected population eventually moves to the homes of close relatives and friends for shelter and food.

The climate-induced changes therefore reduce the pastoral resource flows that are critical for livelihood sustainability, by directly affecting their yields and changing ecosystem distributions and species ranges (Oxfam, 2008). Rembold *et al*. (2014), in their

research on food security found out that the aftermath of 2014 prolonged drought in Makueni and Narok counties were low cattle prices which went lower than the long-term average by -10.53% and -8.57% respectively and this had a huge impact on pastoralists who normally have to sell cattle in order to afford food. Such impacts will dramatically affect the livelihoods of many poor pastoralists, particularly through declining food security and problems with the viability of many livelihood activities, including livestock raising, fishing and the use of forest products as well as agricultural production (McDowell &Hess, 2012; Hertel & Rosch, 2010).

The high rise of poverty cases in the country may therefore be explained by the prevailing conditions of climate change and the out dated adaptive measures employed by the affected communities. This argument may be supported by the changes in livelihoods systems from pastoralism to agro-pastoralism as reflected in most County Integrated Development Plans (CIDPs) from the ASAL Counties including Narok (GoK, 2013). The changes in livelihood strategies are instigated by the ever changing climatic conditions that pose dynamic and unpredictable weather conditions. These wavering situations among the pastoral community in Kenya therefore prompted this study that sought to examine the impact of climate change to the livelihoods of the pastoral community.

3. Methodology

Narok County has two types of topography; the highland towards the forest in the west that rises up an altitude of 3,100 meters above the sea level and the lowland which extends up to the boundary with Tanzania in the South with an altitude of 460 meters above sea level. The highlands favor intensive agricultural production because of rich volcanic soils while the lowland area is inhabited by the nomadic pastoralists since the soils are poor and the rains are unreliable. The soils are diverse, ranging from mountain soils to those on the plains and seasonal swamps. A substantial part of the county is covered by fairly shallow soils which if not properly managed can be easily eroded (GoK, 2009).

Temperatures range from a minimum of 8 to a maximum of 28^0C. The county experiences two rainy seasons with short rains averaging 500mm while long rains average 1,800 mm per annum. Rainfall increases along a gradient from the dry southwest plains (500 mm/yr) to wet northern highlands (2000 mm/yr), with higher rainfall amounts being realized in higher altitude areas including the hills and escarpments. The rainfall of the region is partly related to the ITCZ, with local variations in topography playing a major role in the distribution patterns (Brown & Cochem, 1973). Floods are experienced in some parts of the county which are low lying and generally flat and of late in Narok town itself. However this only happens during the heavy rainy seasons. Farmers have constructed dams in some areas so as to prevent soil erosion and conserve some of the run off for agricultural purposes.

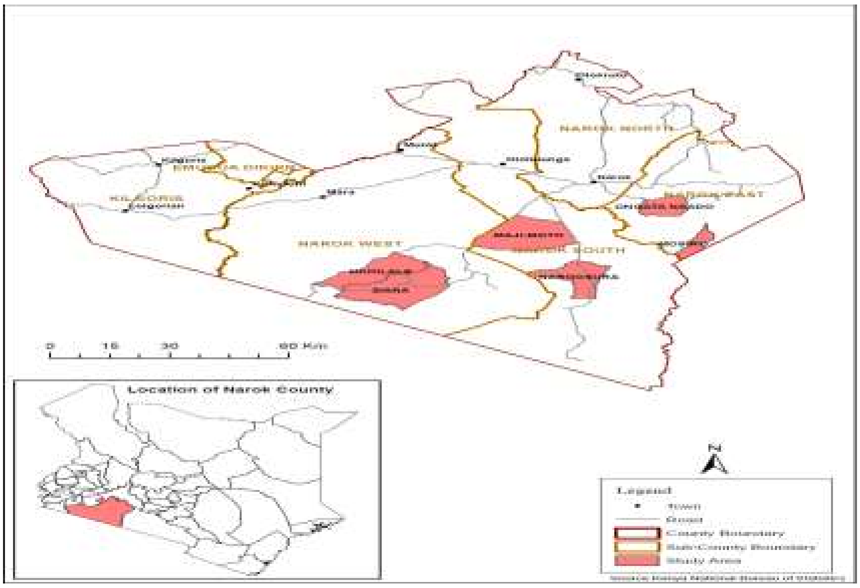

Figure 1: A map of the Study area (Narok County)
(Source: KNBS 2016)

The author used descriptive survey design which enabled analysis of the impact of climate change on the pastoral community in Narok County. Narok County formed the area of the study as it is one of the regions known to host pastoralist communities in Kenya. The target population constituted pastoralists' households in the County represented by Narok East (82,956), Narok South (181,905) and Narok West (135,939) sub-counties (KNBS, 2015).Using multi-stage cluster sampling, Krejcie sampling formula (1970) was used to compute the sample as shown below.

$$n = \frac{(\chi^2 Npq)}{((d^2(N-1) + (\chi^2 pq)))} \text{...}(1)$$

Where n is the desired sample size; N is the target population; p is the population proportion (0.5); d is the degree of accuracy reflected by the amount of error that can be tolerated in fluctuation of a size about a population and corresponds to the significance level with a standard error of the proportion at the corresponding confidence level (95%); χ^2 is the table chi square value for one degree of freedom relative to the desired level of confidence (χ^2 =3.841 at 95% confidence level); and q is 1-p. Using this formula, a total of 382 households were considered the appropriate study sample.

Questionnaires used to collect data from the pastoral community at household level. Both close-ended and open-ended items were incorporated in the tool in a self-administered questionnaire while key informant interviews were used to cross check the information and probe deeper into the real issues about climate change in the study area. This only applied to specific respondents who occupied some leadership position in the community as well as the representatives from government agencies, non-governmental organisations and County professionals like agricultural experts, environmental experts, and livestock department in the study area. The use of

interviews and focus group discussions on selected individuals were also aimed at achieving all the study objectives where questionnaires could not effectively apply on the basis of literacy levels and poor response rates. Direct field observations through transect walks were used to supplement the data on impacts of climate change and the data obtained from this tool were recorded using photographs taken using a camera. This helped to bridge the gap between what the respondents said and what was actually on the ground.

Collected data was descriptively analyzed using descriptive statistical tools of analysis. Its presentation was done in form of frequencies, percentages and means to test the impacts of climate change as reported by pastoralists in Narok County. The data was then presented in tables as shown in the next section.

4. Results and Discussion

The study sought to determine the impacts of climate change on the pastoral community livelihoods in Narok county of Kenya. The results (Table 2) indicated that loss of livestock together with livestock disease outbreak as well as famine were the main impacts of climate change in the study area. This was reported by 25.9%, 22.6%, and 41.5% of the respondents from Narok West, Narok East, and Narok South respectively. This was followed by the category which indicated loss of pasture and famine at (11.8%) as an impact of the climate change. Moreover, as indicated by the results, the reported impacts of climate change were significantly different across the three regions of the study area. Finally, the study findings indicated a small number of respondents who never felt any impact of climate change over the period of study, (3.7% and 1.2% of respondents from Narok West, and Narok South respectively).

Table 2 Summary of the impacts of climate change across the Pastoral regions

Impacts of climate change indicators/Variables	**Frequency. of Households**	**Sub-Counties**			
		Narok West	**Narok East**	**Narok South**	**Chi2(P-Value)**
		(%)	*(%)*	*(%)*	
No impacts at all	9	77.3	0.0	22.7	
Loss of livestock	36	61.1	8.4	30.5	
Flooding	3	0.0	0.0	100.0	
Human diseases	4	100.0	0.0	0.0	
Livestock disease outbreak	3	0.0	67.0	33.0	
Loss of pasture and famine	49	49.1	6.2	44.7	52.732
Migration to other places	11	82.0	0.0	18.0	**(0.000)****
Loss of pastures	3	68.9	0.0	31.1	*
Loss of livestock, livestock disease outbreak, and famine	239	35.9	22.6	41.5	
Loss of livestock, migration, and loss of pastures	46	60.9	10.9	28.2	
Loss of livestock and loss of pastures	12	50.1	0.0	49.9	
N	**415**	**188**	**67**	**160**	

*** (p<0.01)
Multiple responses were recorded.

These findings concurred with those given by the key informants from livestock production offices in the three sub-counties which indicated increased trend of loss of beef cattle between 2012 and 2016 due to droughts and famine as shown in Table 3.

Table 3: Number of cattle lost during drought between 2012 and 2016

	Narok West		Nork East		Narok South	
Years	**Population**	**No. Lost**	**Population**	**No. Lost**	**Population**	**No. Lost**
2016	90,312	1,264	285,567	4,283	177,890	2,313
2015	88,608	1,506	255,885	3,838	174,333	2,266
2014	86,904	1,304	229,288	3,439	170,776	2,220
2013	85,200	1,278	205,455	3,081	167,219	2,174
2012	83,496	1,252	184,100	2,761	163,662	2,128

Source: Sub- County livestock Production Office (2017)

According to the Key informant report from Regional Pastoral Livelihood Resilient Project (RPLRP), surveillance of disease outbreak done, also reported cases of Sheep and goat Pox outbreaks in Siana Location in Narok West sub-county and in Mosiro Location in Narok East and also Foot and Mouth Disease (FMD) together with the Contagious Bovine Pleuropneumonia (CBPP) and Lumpy Skin Disease (LSD) in other pastoral livelihood zones of Narok. All of these diseases according to the key informant were associated with climate change events in one way or another.

Furthermore, pastoral communities also faced varied challenges with different indicators of climate change. When their area was hit by heavy rains that caused floods the study findings revealed that, the respondents in the study area were faced with poor condition of roads and poor cattle market as shown in Figure 2, while during occurrence of prolonged drought the pastoral communities were majorly faced with food shortages, lack of pastures and water scarcity due to dry water sources as illustrated in Plate1.

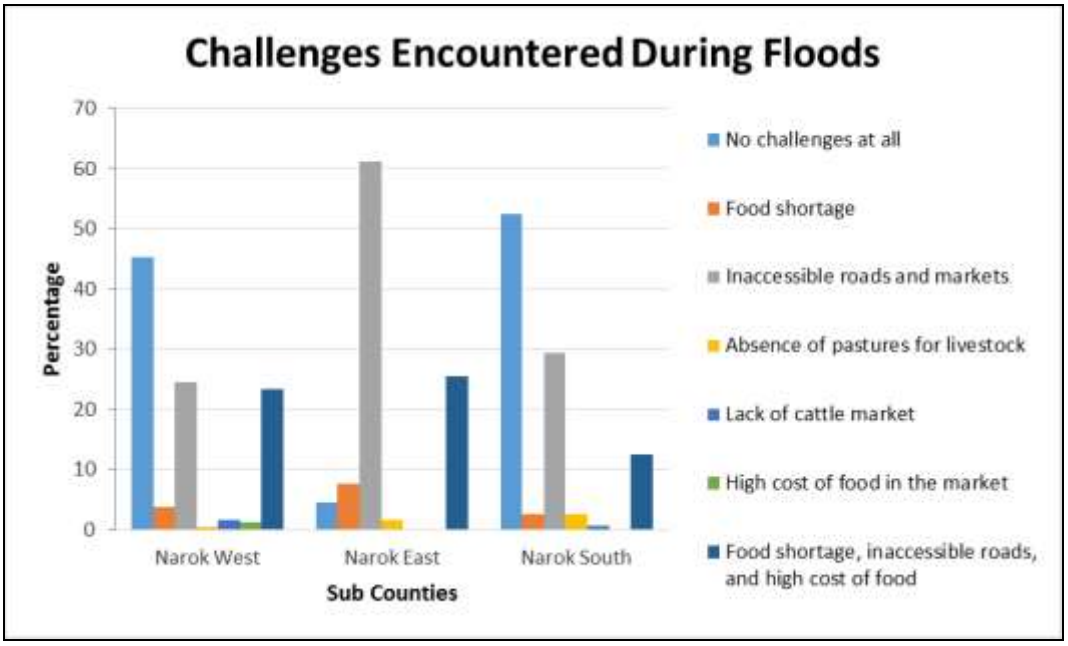

Figure 2: Main Challenges encountered during flood across sub-counties

The exciting revelation of the linkage between psychological threats and impacts of climate change is similar to the findings of Ndamani and Watanabe (2015). Furthermore, according to Nxumalo (2012), the impacts of climate change have led to low agricultural productivity in subsistence farming and hence negatively affecting the livelihoods of most households. The same was also cited by Barbieri *et al*. (2010) who pointed out that the impacts of climate change in Brazil were more likely to expose residence to extreme events with potential negative outcomes to food production and poverty. These results are also in agreement with Alinovi *et al*. (2010) who indicated that the vulnerability context of pastoralist towards pursuing their livelihoods can be heavily influenced by impacts of climate change, which have a direct impact on their assets and on the options available to them to pursue other beneficial livelihood option.

Plate 1: Dry water pan at Mosiro in Narok East Sub-County (2017).

In a study conducted by Little and McPeak (2014), two issues have majorly been identified to affect the pastoral communities and these are climate change and humanitarian crises. The climate change causes adverse effects on the environment and this is evident in loss of animals, human, starvation, lack of water, and pasture among others.

5. Conclusion

Climate change as found out in this study, has led to many challenges negatively impacting the livelihood of the Narok County pastoralists. Loss of livestock; livestock disease outbreak as well as famine were the main impacts of climate change in the study area. Specific challenges were mostly faced during prolonged drought and these included; food shortages, water scarcity and lack of pasture and animal market with poor condition of roads and poor cattle market being experienced during the few seasons of heavy rains and floods.

5.1 Recommendation

There is need for clear policies on how climate information can be effectively and appropriately disseminated at the local level so as to reach every part of pastoral areas to keep them abreast of climatic change possibilities and its impact so as to enable the community to salvage their livelihoods on time. This will also ensure that pastoralists get proper access to relevant and appropriate agricultural information from agricultural advisories and/or institutions, input providers, technical services, and markets at any time. Accordingly, mobile phone-based agricultural information access systems would also promote access to other services such as mobile banking and/or credit markets/services that can be channeled through such systems, and hence easing the credit challenges faced by pastoralist, especially in remote rural areas where formal financial services are limited. Market information like the knowledge, and prices for livestock can also be incorporated in these systems for ease of accessibility by pastoralist and other actors along the livestock value chains especially during drought periods.

This study focused on the pastoral community in Narok County. However, the author also recommends a similar study to be conducted in other pastoral regions in the country to allow comparison of the results.

About the Author

Dr. Janet Korir is a lecturer in the department of geography at Moi University in Kenya. She is a holder Doctor of Philosophy and Master of Philosophy Degrees in environmental studies from University of Eldoret and Moi University respectively. She also holds bachelors of education (arts) degree from Kenyatta University. Her area of specialization is Environmental studies with a bias toward environmental human ecology and environmental information systems. She has extensive research and teaching skills having taught Geography and environmental courses for over two decades in various high schools and universities. Among her previous research contributions include assessment of land use and land cover changes of Eldoret Town using remote sensing and Geographic Information techniques. Her current research interest includes climate change adaptation and food security among pastoral communities.

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