

Animal Health

Journal
(AHJ)



CARI
Journals

The impact of climate change and variability on livestock production in pastoral communities and the sustainable coping mechanisms employed: A critical literature review

By

Dr. Yvonne Moegi

Abstract

Purpose: Global climate change is a major threat facing humanity. The livestock production sector as a livelihood option is one key sector which will bore the brunt of these changes in climatic conditions. This paper aims to identify the impact of climate change and variability on livestock production among pastoral communities and the coping mechanisms adopted.

Methodology: This paper adopted a desk study review methodology where relevant empirical literature was reviewed to identify main the themes.

Findings: The changes in these parameters (reducing rainfall and increasing temperature) have conspired to have negatively impacted on pasture quality and availability thus reducing livestock production in the area. Some of the coping mechanisms employed include seeking food relief, buying food on credit payable after droughts and selling herds, diversification of livestock species, increased mobility of livestock herd, seeking casual employment around the trading centers and engaging in petty trade.

Recommendations: Creating awareness on the changing parameters of weather is necessary in providing the communities with relevant information to prepare and develop sustainable coping mechanisms.

Keywords: Climate change, Climate variability, sustainable, livestock,

1.0 INTRODUCTION

1.1 Background of the Study

Climate change has been defined as a significant variation of the mean state of climate relevant variables such as temperature, precipitation and wind over a period of time, mostly to be taken as over 30 years (IPCC, 2007). Global climate change is a major threat facing humanity. According to Intergovernmental Panel on Climate Change (IPCC, 2007), climate change has led to an increase in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea level. At continental and regional levels, numerous long term changes in climate have been observed and include the widespread changes in precipitation amounts and distribution, ocean salinity, wind patterns and aspects of extreme weather resulting to droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. These changes threaten community livelihoods, ecosystems and social groups. Agriculture/Livestock production sector as a livelihood option is one key sector which will bore the brunt of these changes in climatic conditions.

One region of the world where the effects of climate change are being felt particularly hard is Africa (Shackleton *et al*, 2015). Because of the lack of economic, development, and institutional capacity, African countries are likely to be among the most vulnerable to the impacts of climate change. Thus, climate change impacts have the potential to undermine and even, undo progress made in improving the socio-economic well-being of Africans including East Africans (Cobbinah, P. B. (2019) The negative impacts associated with climate change are also compounded by many factors, including widespread poverty, human diseases, and high population density. The increasing population pressure is estimated to double the demand for food, water, and livestock forage within the next 30 years.

Arid and Semi-Arid Lands (ASALs) and the poor in society are the most vulnerable and likely to be hardest hit by climate change due to their low adaptive capacity (IPCC, 2000). The risks threaten approximately 70% of rural people living in extreme poverty around the world (Clark *et al*, 2020). Developing countries are experiencing the adverse impacts of climate change despite their low contribution to the greenhouse gases.

Therefore, climate change poses a serious threat to livelihoods and food security of millions of people living in the arid and semi-arid lands in Africa. This is because the agricultural systems and food production in the entire Sub-Saharan Africa (SSA) primarily rely on rainfall that is climate sensitive (Chivenge *et al*, 2015). Analysis of climatic data in the region shows that the coefficient of variation of rainfall in semiarid tropics can be as high as 50% while most of the annual rainfall often falls in few rainfall events within three to five months of the year. Predictions indicate a more severe crop production decline is expected in many parts of Africa leading to hunger, malnutrition, insecurity and migrations (Chivenge *et al*, 2015).

In Kenya, over 80% of the country's landmass is classified as ASALs. The ASAL areas are prone to drought and unpredictable rainfall as well as other natural disasters. The region is home to about 10 million people and supports about 60% of Kenya's livestock population estimated at 60 million. Indeed, the livestock sub-sector in the ASAL accounts for 90% of the employment and more than 95% of the family incomes (Government of Kenya 2010) hence the sub-sector is the major enterprise in these ASALs. The subsector contributes 40% of the agricultural Gross Domestic Product (GDP) and 12% of Kenya's total GDP (Government of Kenya 2010).

However, the ASAL areas face a number of challenges, including impacts of climate change. One of the main challenges facing the ASALs ecosystem is how to enhance communities' resilience whose livelihoods depend entirely on climate-sensitive resource (Njoka, 2016). The vulnerability of pastoralists is escalating due to recurrent natural disasters joined with the increasing population growth and declining carrying capacity of the land. Climate change impact has pushed many of the households in the ASALs resort to a number of coping strategies. It is evident that many pastoral households have resorted to settling near trading centers and water points to access relief food, water without burdening their beast of burdens and to seek for casual employment and also to allow easy movement of their herds. However, failure of such coping strategies might endanger the very own survival of the pastoralists and there is already some fear that pastoral livelihoods, especially in East Africa, are fast becoming unsustainable more rapidly than other forms of rural livelihood (Wato M., 2016). The pastoralist might therefore be in danger of being the first environmental refugees. The pastoral system, therefore, needs more research on the impact of

climate change. This study is thus an effort aimed at reducing this gap by looking at the specific impact climate change has on the livelihoods of the pastoralists and what they do to cope as well as analyzing the effect of those coping mechanisms.

1.2 Statement of the Problem

Many researchers assert that pastoralism is the most resilient form of land use for Arid and Semi-Arid areas and has evolved over time with adaptation strategies for survival (Geutjes, L. (2015). This resilience is now challenged by climate change impacts mainly through recurrent droughts. As pastoralists fight to survive, they are employing coping strategies which might see them exist or abandon the pastoral form of livelihood all together. Failure of such coping strategies might endanger the very own survival of the pastoralists and pastoralism as a form of livelihood.

There is therefore need for more research into the impact of climate change on the pastoral system and possibly the nature of the coping strategies the pastoralists are employing to survive. This study therefore aims at filling part of this gap by assessing the climate change impacts and specific coping strategies the pastoral communities employ.

1.3 Objectives of the Study

The main objective of this study was to identify the effects of climate change on livestock production and the sustainable coping mechanisms employed.

1.4 Justification of the study

The study will inform the pastoral development stakeholders and policy makers on the current status of climate change impacts on livestock production in the study area. The study results will thus guide the policy options, interventions and essential support necessary for sustainability of the nomadic pastoralists. Development actors like the Ministry of Agriculture, Livestock and Fisheries, National Drought Management Authority (NDMA) and Non-Governmental Organizations (NGOs) will utilize the findings and recommendation of the study to improve their interventions. Government agencies and other development actors can utilize the findings of the study to formulate and target awareness and sensitization programs aimed at influencing the appropriate coping strategies for the pastoral communities. Interventions can be developed to discourage and curtail unsustainable coping strategies adopted by the communities.

1.0 LITERATURE REVIEW

2.1 Introduction

There has been linear rising trend in temperature over the last 50 years from 1956-2005, an increase of about 0.130C per decade (IPCC, 2007) globally. Records on precipitation indicate that there are changes in precipitation pattern. Precipitation significantly increased in Eastern parts of North and South America, Northern Europe and Northern and Central Asia. However, it declined in the Sahel, the Mediterranean region, South Africa and parts of South Asia. Generally on global level, drought is likely to extend further (IPCC, 2007)

These variabilities are expected to impact livelihood globally either positively or negatively but more the latter. Much of these negative impacts will be felt in Africa mainly due to decreased precipitation and increased temperatures predicted and being felt in the continent. As indicated in

the report of Working Group II of the IPCC, the developing countries will be hardest hit (IPCC, 2001). IPCC (2007) also depicted Africa as one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of multiple stresses occurring at various levels and low adaptive capacity. Africa and mainly Sub-Saharan Africa is thought to be more vulnerable to climate change because of its dependence on agriculture and natural resource, warmer baseline climates, low precipitation, and limited ability to adapt. The vulnerability is further aggravated by the fact that current climate is already severe, present information in poorest and technology change has been slowest in Sub Saharan Africa (Shackleton, 2015)

2.2 Impacts of climate change

Climate change is affecting rains, increase in frequency of drought and rise in temperatures, threatening the availability of fresh water for agricultural production and other uses (Shackleton, 2015). IPCC (2007) concluded that climate change may severely compromise food production and food security in many African countries. This is 10 mainly because farming in Africa is highly dependent on rain-fed agriculture (GECHS, 2008) either through crop production or livestock rearing.

2.2.1 Variability in precipitation patterns

In Sub-Sahara Africa, rainfall pattern is mainly influenced by El-Niño Southern Oscillation (ENSO) events. These often result into frequent extreme weather events such as droughts and floods which lead to reduced food production causing severe food shortages (Cobon *et al* 2016). According to observations, ENSO influences contrasting rainfall variability in Sahel, East Africa and South East Africa with Sahel becoming drier, East Africa being wetter and South East Africa being stable (Shackleton, 2015). Though the IPCC AR4 suggested potential increases in mean precipitation across East Africa, especially in summer, some recent work has contradicted this, suggesting the potential for decreased rainfall over Kenya in the future. Recent analysis has shown increasing drought and the country is exposed to a high water security threat. However, large uncertainties remain, and as such, knowledge is little improved beyond that reported in the Intergovernmental Panel on Climate Change Assessment Report 4(IPCC AR4).

2.2.2 Changes in Temperature

The continent of Africa is generally noted to be hot and dry with current trends showing warmer spells than it was 100 years ago (Marumbwe et al, 2019). Warming trend has been noted likewise since 1960s. The 21st century has been warming at about 0.5oC/century recorded 1987 and 1998 as the warmest years. Sub-Saharan Africa (SSA) is anticipated to warm as it lies in tropical and subtropical latitudes, where temperatures are high throughout the year In future, the whole of Africa is expected to warm across all seasons throughout the century (Marumbwe et al, 2019). In SSA, by 2100, the temperature rise will be about 2-4.5oC which is expected to be stronger than global average (Muller, 2009). High ambient temperature, relative humidity and radiant energy compromise the ability of animals to dissipate heat. As a result, there is an increase in body temperature, which in turn initiates compensatory and adaptive mechanisms to re-establish homeostasis. These re-adjustments, generally referred to as adaptation, may be favorable or unfavorable to economic interests of humans, but are essential for survival of the animal. For an

already hot area though, the adjustment are largely unfavorable. Thus, an increase in air temperature would affect directly animal performance by affecting animal heat balance. Therefore, when temperature rises above normal, for already hot areas, animal heat exchange is affected. They fail to dissipate the extra heat load accumulated during the day hence affecting the animal's thermoregulation and feeding behavior. The result is a significant decline in milk production and reproduction. Extreme events, may also affect beef animals.

2.3 Climate change and coping mechanisms among pastoralists communities

Of all the natural resource based land uses in the dry land, pastoralist functions better within the context of wide rainfall variability and unpredictability. This is because it presents a more logical adaptation route than other livelihood activities and land uses which do not have the advantage of mobility (Lovelie, 2015). Pastoralists therefore employ various coping strategies to deal with climate and non-climate stress. Some of the common coping strategies are migration to market centers, seeking casual employment, seeking refuge in education (GECHS, 2008)

One seemingly effective and probable strategy for the pastoralists in the long term is further diversification of their livelihood both within the pastoral system (i.e. increasing reliance on more drought-resistant species such as camel) and out of livestock production (UNCCD/UNDP/UNEP, 2009) However efforts to diversify out of livestock production are likely to be constrained by the difficult environment characterizing the pastoral areas especially in the harsh conditions similar to the study area. Moreover, in the face of unprecedented rainfall variability and shifts, the rich indigenous coping strategies might not be sufficient any more to reduce the negative impacts of climate change nor are such strategies adequately supported (GECHS, 2008). In absence of adaptation or any coping strategy, most of the pastoralists lack the skills, skilled labor or capital necessary to specialize in another activity as a reliable source of income. Instead, most have to resort to a range of opportunistic activities, including wild foods, producing charcoal and seeking casual employment. As drought situation intensifies, the options often dwindle and more people are pushed into these few activities of marginal and decreasing returns. When faced with severe and prolonged climatic events, some of the most vulnerable people have to sell key productive assets such as land, livestock, farm tools, roofs from their homes or even resort to prostitution, thereby endangering their lives and livelihood in the long term, which for many leads to destitution (GECHS, 2008).

2.4 Sustainable coping mechanisms of communities

Among the coping strategies observed to be commonly used by the pastoralists to cope with the main hazard of drought include; buying food (on credit), getting assistance from relatives, seeking for relief food, selling livestock and other household assets to buy food, borrow food, seek for casual work, reducing number of meals, skipping meals, engage in petty businesses, and moving to market centers (Rojas Downing, 2017). It is worth noting that a successful coping strategy usually develops to an adaptation mechanism. An example is the mobility of pastoralism. This was a coping strategy that developed and became a characteristic adaptation of pastoralists. In face of increased rainfall variability and scarcer resources of pasture and water, the pastoralists have intensified their mobility. Other strategies include separation of livestock herds and charcoal burning.

Because of the changing climatic conditions and socio-political factors, experts argue that the adaptive capacities of pastoralists have eroded, so that they have become more susceptible to climate change than ever before and that their coping mechanisms may no longer be considered as effective options for mitigating the adverse future climatic impacts (University for Peace, 2009). According to UNDP (2008), many of the coping strategies that have served drought affected communities well may become inadequate in light of the frequent occurrences of droughts, rapid socio-economic and long-term climatic changes. It is obvious that the increased frequency of drought events have challenged the effectiveness/sustainability of these coping strategies. With dwindling natural resources (water and forage), there is little the pastoralists can do to create access to such resources.

2.5 Empirical view

Molu Wato (2016) conducted an exploratory study sought to investigate the coping mechanisms that pastoral communities have employed in Maikona Location and their sustainability. The study employed both quantitative and qualitative methods, targeting 145 respondents including 127 Households respondents, 14 Youth and Women group members in FGDs and 4 technical/NGO representatives. Questionnaires, FGDs and key informant checklists were used as the main tools. Data were analyzed both descriptively and inferentially. It is envisioned that the study would give vital information to pastoral development stakeholders and policy makers on the actual impacts facing the pastoralists, the existing and appropriate coping mechanisms while guiding on the interventions and policy options. The study found out that there had been real and perceived changes both in the rainfall and temperature patterns. Field inquiries indicated a great change in rainfall patterns (94%) between 1980 and 2010 as well as a significant trend of decline from the data of the metrological department. These changes were established to be negatively impacting livestock production and the livelihood of the community in the study area. The results of the study showed that the local community was found seeking for relief food, buying food on credit and selling livestock asset as the common coping strategies. However, the sustainability of those strategies is in huge doubt since most of the respondents were not even sure of their longevity while others admitted they may not use them for long. Moreover, majority (84%) of the respondents could not tell the consequence of their strategies on the environment. The external supports provided to the communities were largely in response to emergencies and were not seen as sustainable in the long term.

Omar Boru (2013) conducted a study to investigate necessary adjustments in the strategies and innovations among the Boran in Merti Division of Isiolo County. Specific objectives were to investigate innovations by Boran pastoralist' in response to climate change, to find out the main drivers of innovation practices and to establish the relationships between herders' innovation practices, climate change and livelihood strategies. Qualitative and quantitative approaches were applied. The target population was 400 from which a random sample of 80 herders was drawn. The results of the study showed that. The results of the study showed that there were main drivers of innovations among Boran pastoralists in Merti Division. They include prolonged droughts, conflicts and invasive species which are linked to climatic changes. There were also response strategies which were found to be improvement in their usual drought coping strategies while others are newly emerging strategies. The innovation practices include agreement between herders

and ranchers, livelihood diversification, inter-community negotiations, change in mobility, among others. The study established that 53% of the pastoralists were aged over 40 years while 47% were aged below 40 years though there was no significant difference between the two groups ($p=0.092$). On the period the respondents had worked as pastoralist, the results showed that majority (52%) had worked for more than 9 years while the rest had worked for less than 9 years as pastoralists. Further, the results of the study established that climate change was a key driver of herders led innovation practices.

Geoffrey Lenyayon (2013) conducted a study on the effects of climate variability on pastoralist livelihoods in Marigat District, Baringo. The study adopted both descriptive and explanatory research design while data sampling involved stratified random sampling procedure (Stratum 1 being Marigat division and stratum 2 being Mukutani division). This study utilized household structured questionnaires administered through pure random sampling with 136 households participating in the study, institutional questionnaires as well as collection of secondary data from various sources as methods of data collection. A number of bivariate comparisons of variables related to pastoral livelihoods were done. These includes t-test to compare means of variable on pastoralists demographic such as age between the two strata, ANOVA analysis to compare for significant differences in the cases of Rift Valley Fever (RVF) disease between the four sub locations, correlation analysis to test the relationship between rainfall amounts with number of cases of vector-borne diseases, and Chi-square test (χ^2) to test cross-tabulated data on variables such as perception of pastoralists on trends of climatic variables and socio-economic variables between the 2 strata. The Chi-square test was used to assess for homogeneity or similarity on categorical response variables between the study strata. The results of this study indicated correlation that apart from Heartwater ($p=-0.403$, $\text{sig}=0.012$ and $N=38$), other veterinary diseases had no relationship with the rainfall amount {Trypanosomiasis ($p=-0.224$, $\text{sig}=0.189$ and $N=36$), Babesiosis ($p=-0.124$, $\text{sig}=0.457$ and $N=38$), Anaplasmosis ($p=-0.156$, $\text{sig}=0.351$ and $N=38$) and East Coast Fever ($p=-0.224$, $\text{sig}=0.176$ and $N=38$)}. However, graphical plots depict the existence of relationships with disease cases either increasing or decreasing in frequency with a corresponding increase or decrease in rainfall amount. Chi-square results showed a strong statistically significant difference between the responses in strata 1 and 2 on the perceived trend of rainfall and floods towards the future (rainfall: $\chi^2 = 41.230$, $\text{df}= 3$, $p= 0.000$ and floods: $\chi^2 = 24.903$, $\text{df}= 3$, $p= 0.000$). Also, there was no statistically significant difference between the perception of the respondents in Strata 1 and 2 on the trend of tsetse flies ($\chi^2 = 0.115$, $\text{df}= 3$, $p= 0.990$) and Stomoxys ($\chi^2 = 6.677$, $\text{df}= 3$, $p= 0.83$) while significant difference were observed on the trend of Tabanids ($\chi^2 = 20.240$, $\text{df}= 3$, $p= 0.000$), Culicoides ($\chi^2 = 23.863$, $\text{df}=3$, $p= 0.000$) and Sand flies ($\chi^2 = 15.429$, $\text{df}= 3$, $p= 0.001$).

Raphael P (2016) conducted a study on better understanding of climate change and variability on two climatic factors, rainfall and temperature, in order to provide insights on pastoralists risk management adaptations at a micro-level in West Pokot. Both primary and secondary data was used. Household questionnaire survey, focus group discussion and key informants interviews were used to collect primary data at household and community levels. Primary data (through questionnaires) was collected from a sample survey of 98 households taken from 5,596 households this was sampled using multi-stage sampling technique, and information obtained analyzed using inferential and descriptive statistics. The results of the study showed that 94% of the farmers still

use Indigenous knowledge. Coping strategies include: Sold livestock (90%), relief food (90%), cash/food-for-work (71%), Slaughter of old and weak livestock (58%), wild fruits (33%), bush products, (50%), off-farm employment (30%), and minimization of food for consumption (84%). Diversification of livelihood (92%), Livestock mobility (94%), sending children to school (56%), Strategic livestock feed (35%), Develop water sources (15%), Change in diet consumption (78%), Livestock off-take (25%), Storage of pasture (35%), were identified as some of the most commonly used adaptation strategies.

2.6 Research Gaps

The geographical gap is a knowledge gap that considers the untapped potential or missing research literature in the geographical area that has not yet been explored or is underexplored. For instance, Omar Boru (2013) conducted a study to investigate necessary adjustments in the strategies and innovations among the Boran in Merti Division of Isiolo County only. The results of the study showed that there were main drivers of innovations among Boran pastoralists in Merti Division. They include prolonged droughts, conflicts and invasive species which are linked to climatic changes whereas; this study was conducted on a broader perspective of pastoral communities all over.

Methodological gap is the gap that is presented as a result in limitations in the methods and techniques used in the research (explains the situation as it is, avoids bias, positivism, etc.). The studies presented a methodological gap as a number of reviewed articles used descriptive research design while our current study adopted a desktop literature review method.

3.0 METHODOLOGY

3.1 Introduction

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related the impact climate change has on livestock production on pastoralists' communities and the coping mechanisms employed. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on the impact climate change has on livestock production on pastoralists' communities and the coping mechanisms employed. The search was done generally by searching the articles in the article title, abstract, keywords. A second search involved fully available publications on the subject on impact climate change has on livestock production on pastoralists' communities and the coping mechanisms employed. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to impact climate change has on livestock production on pastoralists' communities and the coping mechanisms employed which was split into top key words. After an in-depth search into the top key words (Climate change, sustainability, pastoralism, coping mechanisms), the researcher arrived at 4 articles that were suitable for analysis.

Molu Wato (2016) conducted an exploratory study sought to investigate the coping mechanisms that pastoral communities have employed in Maikona Location and their sustainability. The study employed both quantitative and qualitative methods, targeting 145 respondents including 127

Households respondents. The results of the study showed that the local community was found seeking for relief food, buying food on credit and selling livestock asset as the common coping strategies. However, the sustainability of those strategies is in huge doubt since most of the respondents were not even sure of their longevity while others admitted they may not use them for long. Moreover, majority (84%) of the respondents could not tell the consequence of their strategies on the environment. The external supports provided to the communities were largely in response to emergencies and were not seen as sustainable in the long term.

Omar Boru (2013) conducted a study to investigate necessary adjustments in the strategies and innovations among the Boran in Merti Division of Isiolo County. Qualitative and quantitative approaches were applied. The results of the study showed that there were main drivers of innovations among Boran pastoralists in Merti Division. They include prolonged droughts, conflicts and invasive species which are linked to climatic changes. There were also response strategies which were found to be improvement in their usual drought coping strategies while others are newly emerging strategies. The innovation practices include agreement between herders and ranchers, livelihood diversification, inter-community negotiations, change in mobility, among others. Further, the results of the study established that climate change was a key driver of herders led innovation practices.

Geoffrey Lenyayon (2013) conducted a study on the effects of climate variability on pastoralist livelihoods in Marigat District, Baringo. The study adopted both descriptive and explanatory research design while data sampling involved stratified random sampling procedure. The results of this study indicated correlation that apart from Heartwater ($p=-0.403$, $\text{sig}=0.012$ and $N=38$), other veterinary diseases had no relationship with the rainfall amount {Trypanosomiasis ($p=-0.224$, $\text{sig}=0.189$ and $N=36$), Babesiosis ($p=-0.124$, $\text{sig}=0.457$ and $N=38$), Anaplasmosis ($p=-0.156$, $\text{sig}=0.351$ and $N=38$) and East Coast Fever ($p=-0.224$, $\text{sig}=0.176$ and $N=38$)}. However, graphical plots depict the existence of relationships with disease cases either increasing or decreasing in frequency with a corresponding increase or decrease in rainfall amount. Chi-square results showed a strong statistically significant difference between the responses in strata 1 and 2 on the perceived trend of rainfall and floods towards the future.

Raphael P (2016) conducted a study on better understanding of climate change and variability on two climatic factors, rainfall and temperature, in order to provide insights on pastoralists risk management adaptations at a micro-level in West Pokot. Both primary and secondary data was used. Household questionnaire survey, focus group discussion and key informants interviews were used to collect primary data at household and community levels. The results of the study showed that 94% of the farmers still use Indigenous knowledge. Coping strategies include: Sold livestock (90%), relief food (90%), cash/food-for-work (71%), Slaughter of old and weak livestock (58%), wild fruits (33%), bush products, (50%), off-farm employment (30%), and minimization of food for consumption (84%). Diversification of livelihood (92%), Livestock mobility (94%), sending children to school (56%), Strategic livestock feed (35%), Develop water sources (15%), Change in diet consumption (78%), Livestock off-take (25%), Storage of pasture (35%), were identified as some of the most commonly used adaptation strategies.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 Introduction

This section of the paper presents results based on the objectives of the study. The results are on the impacts of climate change and variability on livestock production and coping mechanisms employed by pastoralist communities.

4.2 Conclusion

Global climate change is a major threat facing humanity. According to Intergovernmental Panel on Climate Change (IPCC, 2007), climate change has led to an increase in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea level. These climatic changes threaten community livelihoods, ecosystems and social groups. Agriculture/Livestock production sector as a livelihood option is one key sector which will bore the brunt of these changes in climatic conditions. Therefore, climate change poses a serious threat to livelihoods and food security of millions of people living in the arid and semi-arid lands in Africa. The changes in these parameters (reducing rainfall and increasing temperature) have conspired to have negatively impacted on pasture quality and availability thus reducing livestock production in the area. Indeed the data from the ministry of livestock do support this conclusion as livestock numbers declined. It was inferred that as the livestock population decline so is the production. It can then be deduced that the quality of life of people in the study area has substantially decreased owing to the fact that the population is purely nomadic pastoralists depending on livestock. The households were found to have devised some coping strategies, the main ones being livestock including the lactating ones. Other significant strategies are separation of livestock seeking relief food, buying food on credit payable after droughts and selling herds, diversification of livestock species, increased mobility of livestock herd, seeking casual employment around the trading centers and engaging in petty trade. However, the sustainability of those strategies especially the three top ones mostly used is in huge doubt. Similarly, the community is oblivious of impact their actions had on the environment. It was concluded that some strategies were seen to be harmful to the environment indeed like charcoal burning and settlement around market and water points that caused degradation.

4.3 Recommendation

More extensive research that covers more pastoral areas for comparison and generalization should be conducted and information made accessible

Research should also be done to investigate the nature and sustainability of strategies including reliance on external support to ascertain their impact and to devise better ways of delivery.

This study also recommends that the metrological department shares rainfall data constantly with the pastoralists so that they could understand the dynamics of rainfall and temperature variations on livestock production as well as an elaborate awareness program on the whole issue of climate change, its impact and possible coping strategies customized for their situation.

There is also need to empower the communities and devise long-term strategies instead of damaging short term but easy interventions.

5.0 REFERENCES

- Addaney, M., & Cobbinah, P. B. (2019). Climate change, urban planning and sustainable development in Africa: the difference worth appreciating. In the geography of climate change adaptation in urban Africa (pp. 3-26). Palgrave Macmillan, Cham
- Chivenge, P., Mabhaudhi, T., Modi, A. T., & Mafongoya, P. (2015). The potential role of neglected and underutilised crop species as future crops under water scarce conditions in Sub-Saharan Africa. *International journal of environmental research and public health*, 12(6), 5685-5711
- Clark, H., Coll-Seck, A. M., Banerjee, A., Peterson, S., Dalglish, S. L., Ameratunga, S. & Costello, A. (2020). A future for the world's children? A WHO–UNICEF–Lancet Commission. *The Lancet*, 395(10224), 605-658.
- Cobon, D. H., Ewai, M., Inape, K., & Bourke, R. M. (2016). Food shortages are associated with droughts, floods, frosts and ENSO in Papua New Guinea. *Agricultural Systems*, 145, 150-164.
- Geutjes, L. (2015). Coping with climate variability in West Pokot, Kenya: The influences of land use on responses to climate variability, by pastoralist and agro-pastoralist communities in arid and semi-arid areas of West Pokot, Kenya.
- Marumbwa, F. M., Cho, M. A., & Chirwa, P. W. (2019). Analysis of spatio-temporal rainfall trends across southern African biomes between 1981 and 2016. *Physics and Chemistry of the Earth, Parts A/B/C*, 114, 102808.
- Njoka, J. T., Yanda, P., Maganga, F., Liwenga, E., Kateka, A., Henku, A., ... & Bavo, C. (2016). Kenya: Country situation assessment. *Pathways to Resilience in Semi-arid Economies (PRISE)*.
- Shackleton, S., Ziervogel, G., Sallu, S., Gill, T., & Tschakert, P. (2015). Why is socially- just climate change adaptation in sub Saharan Africa so challenging? A review of barriers identified from empirical cases. *Wiley Interdisciplinary Reviews: Climate Change*, 6(3), 321-344.
- Smucker, T. A., Wisner, B., Mascarenhas, A., Munishi, P., Wangui, E. E., Sinha, G., ... & Lovell, E. (2015). Differentiated livelihoods, local institutions, and the adaptation imperative: Assessing climate change adaptation policy in Tanzania. *Geoforum*, 59, 39-50.
- Wato, M.(2016). Effects of climate variability on livestock production and coping strategies in Maikona location, Marsabit county, Kenya (Doctoral dissertation, Kenyatta University).