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Impacts of Climate Change Variability on Livestock Health in Arid and Semi-Arid Land in Kenya

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Abstract

Purpose: Livestock plays a critical role in the livelihood of the pastoralists who inhabit the arid and semi- arid lands (ASAL) areas of Kenya. ASALs experiences erratic and unreliable rainfall that is normally interspersed by long and frequent droughts. Loss of dependable livelihood assets impoverishes the communities in ASALs areas and exposes them to the vagaries of food insecurity. The main objective of this study is to establish the impacts of climate variability on livestock health in ASALs.

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: Climate change in ASALs is positively and significantly related to the occurrence of livestock diseases. Significance variations in certain weather elements may have modified the ecosystems of the diseases causing an increase in pathogens and vectors populations.

Unique Contribution to Theory, Policy and Practice: An early warning system, extension education, strategic disease management interventions, water provision and establishing a national pasture reserve for the pastoralists in ASALs in severe drought periods are ways in which cases of livestock diseases can be reduced.

Keywords: *Climate Variability, ASALs, Infectious Diseases*

1.0 INTRODUCTION

1.1 Background of the Study

Livestock plays a critical role in the livelihood of the pastoralists who inhabit the arid and semi-arid lands (ASAL) areas of Kenya. The ASALs constitute 80% of the country's land mass and carry over 60% of the livestock resources. Despite the enormous livestock potential, development in these areas has lagged behind the rest of the country and is usually characterized by low productivity, poor infrastructure for marketing of livestock and delivery of services, chronic food and water shortage and widespread animal diseases Strategy for revitalizing Agriculture

Arid and Semi-Arid Lands in Kenya have populations whose main economic activity is nomadic pastoralism. They experience erratic and unreliable rainfall that is interspersed with frequent droughts resulting in difficulties in accessing surface water for livestock and human consumption. The communities depend on ground water sources which include water pans, dams and shallow wells. In most parts of the district, the droughts are severe, resulting in complete loss of vegetation, death of livestock, frequent food shortages and high degree of poverty estimated at 51% (Republic of Kenya, 2001). Droughts frequently reach disaster levels due to climate variability/change that require the communities to spend many hours trekking in pursuit of pastures and water instead of concentrating on income generating activities. During these movements, vulnerable groups such as women, children and the old are left without food, which is mainly derived from livestock sales and products. The mass movement of livestock causes land degradation, massive erosion during floods, pasture scarcity and the attendant poor body condition and weakened immunity in the animals. During these periods, disease outbreaks are common especially when animals congregate and are moved from areas of low to high disease challenge. Thus, substantial livestock and livestock production losses occur, further worsening food security.

Climate comprises many factors including temperature, rainfall, humidity, winds and altitude. These factors can have both direct and indirect effects on animal production and health (Kim, M., & Sung, K. 2021). Climate can also affect the quantity and quality of feedstuffs such as pasture, forage and grain, and the severity and distribution of livestock diseases and parasites. Thornton (2012), argued that animal diseases contribute to poverty globally particularly in the developing world and that Climate change / global warming might be associated with these diseases.

In pastoral communities, livestock is very critical as source of food and livelihoods and is considered important as a source of wealth (bank account), for cultural functions, for draught power, as an indicator of social status, and as source of raw materials. This study investigated hypothesized associations between livestock disease occurrence and climatic variability/change. The findings of the study would generate information and packages that can assist the pastoralists, extension systems, and policy makers to make informed decisions on disease management in ASAL areas. The knowledge generated could be replicated in other ASAL areas in empowering the pastoralists to better deal with livestock diseases.

1.2 Statement of the Problem

ASALs experiences erratic and unreliable rainfall that is normally interspersed by long and frequent droughts. The inhabitants of the district are nomadic especially when animals congregate and are moved from areas of low to high disease challenge. Thus, substantial livestock and livestock production losses occur, further pastoralists whose livelihoods depend on livestock production. They practice communal grazing systems. As a result of climatic variability, the district experiences severe droughts. When these droughts reach disaster levels, communities trek with their livestock to distant places in search of pastures and water. This movement of livestock usually coincides with high incidences of livestock diseases that result in losses in productivity and increased mortalities. Loss of dependable livelihood assets impoverishes the communities in ASALs areas and exposes them to the vagaries of food insecurity.

1.3 Objectives of the Study

The main objective of this study is to establish the impacts of climate variability on livestock health in ASALs.

1.4 Significance of the Study

The results from the study will provide relevant information that will be used in the adoption of strategies and intervention measures on assessing the effects of climate variability on livestock health.

2.0 LITERATURE REVIEW

2.1 Infectious diseases

The impact of infectious animal diseases seems as great at the start of the 21st Century as it was at the start of the 20lh Century. In the developing world, these diseases continue to limit

productivity, constrain development and exacerbate poverty through financial loss as well as being zoonotic (Thornton, P. K. 2012).). Governments spend colossal sums of money in the control of these diseases.

The global impact of infectious animal diseases is likely to be affected by many factors that cannot be predicted with confidence including, changes to livestock management practices, changes to the physical environment, developments in animal genetics, new scientific or technological advances, and influence from climate change. There is widespread scientific agreement that the world's climate is warming at a faster rate than ever before owing to anthropogenic activities (Intergovernmental Panel for Climate Change (IPCC), 2001), with concomitant changes in precipitation, flooding, winds and the frequency of extreme events such as El Nino. How we should react to predicted changes in animal diseases ascribed to climate change depends on the relative impact of the disease, whether the disease changes in incidence or spatiotemporal distribution, on the direction of change, on the animal populations and human communities affected.

There is need to focus on the possible effects of climate variability/change, by the 2020s and the 2080s, on the diseases that 'matter most', i.e. diseases that cause the greatest economic losses thus impacting most on the poor. Domestic livestock play a central role in many African cultures. Cattle and camels, in particular, have an importance that goes beyond the production of meat in the ASALs. Their value is based on the full set of services they supply (milk, meat, blood, hides, draught power), their asset value as a form of savings, and their cultural symbolism. It would be difficult and damaging for these cultures to abandon pastoralism in the event that it becomes climatically, environmentally, or economically unviable.

2.2 Climate and animal diseases

Many important animal diseases are affected directly or indirectly by weather and climate. These links may be spatial, with climate affecting distribution, temporal with weather affecting the timing of an outbreak, or related to the intensity of an outbreak. Many animal diseases of significant impact are influenced by climate. Vector-borne diseases, certain directly transmitted diseases, food/water borne and aerosol-transmitted diseases are affected by climate variability or change. Non-vector-borne diseases affected by climate have the pathogen or parasite spending a period of time outside of the host, subject to environmental influence.

Examples of the diseases associated with climate variability include: Bacterial diseases- Anthrax is an infectious disease of warm-blooded animals, including humans, with worldwide distribution. Temperature, relative humidity and soil moisture all affect the successful germination of anthrax spores. Outbreaks are often associated with alternating heavy rainfall and drought, and high temperatures (Khan, S. J et al 2015). Blackleg, an acute infectious clostridial disease mainly affecting young cattle, which is also spore-forming, is associated with high temperature and heavy rainfall (Disasa, D. D. et al 2020). Certain bacterial infections such as dermatophilosis and hemorrhagic septicemia are associated with areas of high humidity and occur during rainy seasons (Ashraf, A et al 2017).

In addition to that is viral diseases whereby transmission is mainly by contact between infected and susceptible animals or contact with contaminated animal products or equipment. However, spread by wind occurs since the virus survives well at relative humidity which makes wind-borne spread favorable in humid, cold weather. In warmer drier regions, wind-borne spread of FMD is considered unimportant (Baylis, M., & Risley, C. 2013)

Peste des Petits Ruminants (PPR) is an acute, contagious, viral disease of small ruminants, of great economic importance in parts of Africa. It is transmitted mostly by aerosol droplets between animals in close contact. Appearance of clinical PPR is often associated with the onset of the rainy season or dry cold periods, a pattern that may be related to viral survival.

Rift Valley Fever (RVF) is a zoonotic viral disease transmitted by Aedes and Culex mosquitoes. Epizootics of RVF are associated with periods of heavy rainfall and flooding (Linthicum, K. J. et al 2016) or, in East Africa, with the combination of heavy rainfall following drought associated with El Nino Southern Oscillation (ENSO). Bluetongue, is a viral infection of ruminants transmitted by a vector (Culicoides biting midges) (Maclachlan, N. J., & Mayo, C. E. 2013) whose distributions are largely dependent on environmental variables such as temperature, moisture and wind.

2.3 How climate change affects the health of livestock

Many processes have been proposed by which climate change might affect infectious diseases. These processes range from the clear and quantifiable to the imprecise and hypothetical (Baylis, M., & Risley, C. 2013). They may affect pathogens/parasites directly or indirectly, the hosts, the

vectors (if there is an intermediate host), epidemiological dynamics or the natural environment. Only some of these processes can be expected to apply to any single infectious disease.

2.3.1 Effects on pathogens

Higher temperatures resulting from climate change may increase the rate of development of certain pathogens or parasites that have one or more life cycle stages outside their animal host. This happens through shortened generation times and, increased number of generations per year (Mitchell, M. et al 2013). Conversely, some pathogens are sensitive to high temperatures and their survival may decrease with climate warming. Some pathogens/parasites and many vectors experience significant mortality during cold winter conditions (Abdela, N., & Jilo, K. 2016). Pathogens and parasites that are sensitive to moist or dry conditions may be affected by changes to precipitation, soil moisture and the frequency of floods. Changes to winds could affect the spread of certain pathogens and vectors.

2.3.2 Effects on host

Mammalian cellular immunity can be suppressed following heightened exposure to ultraviolet B (UV-B) radiation - an expected outcome of stratospheric ozone depletion (Aucamp, 2003). There is depression of the immune response to intracellular pathogens (viruses, rickettsia such as Cowdria and Anaplasma, and some bacteria, such as Brucella). Many animals have evolved a level of genetic resistance to some of the diseases to which they are commonly exposed. Local breeds of Zebu cattle, show some degree of trypan tolerance whereas recently introduced European cattle breeds are highly susceptible. Certain tick-borne diseases of livestock, such as anaplasmosis, babesiosis and cowdriosis, show a degree of endemic stability (Jonsson, N. N. et al 2012). If climate change drives such diseases to new areas, non-immune individuals of all ages in these new regions will be exposed, and severe disease outbreaks could follow.

2.3.3 Effects on the vectors

Biting midges, brachyceran flies (e.g., tabanids, muscids, myiasis flies, hippoboscids), ticks and tsetse all dominate as vectors of livestock diseases (Bowman, D. D. 2020). There are several processes by which climate change might affect disease vectors.

2.3.4 Effects on epidemiology

Climate change may alter transmission rates between hosts by affecting the survival of the pathogen/parasite or the intermediate vector, but also by other, indirect, forces that may be hard to

predict with accuracy (Abdela, N., & Jilo, K. 2016). Climate change will lead to changes in future patterns of international trade, local animal transportation and farm size - all of which may affect the chances of an infected animal coming into contact with a susceptible one. For example, a series of droughts in East Africa between 1993 and 1997 resulted in pastoral communities moving their cattle to graze in areas normally reserved for wildlife. This resulted in cattle infected with a mild lineage of Rinderpest transmitting disease both to other cattle and to susceptible wildlife, causing severe disease, in buffalo, lesser kudu and impala. (Kimaro, E. G., & Chibinga, O. C. 2013)

2.4 Empirical review

Gikaba (2014), conducted a study on the influence of drought variability on livestock feeding practices by Maasai pastoralists in Kajiado County, Kenya. All the regions of the world are vulnerable to climate change where droughts have become more unpredictable due to climate change. Effects droughts are felt most severely by the livestock-based economies and livelihoods in the Kenyan Arid and Semi-Arid Lands (ASALs) where rainfall amounts are low, erratic and unreliable. Pastoralism is a key production system in ASAL areas using extensive grazing for livestock production. While pastoralists in ASAL areas have adjusted their livestock feeding practices to cope with changes in droughts, their characteristic responses are less understood. There was need therefore, to establish the influence of drought variability on livestock feeding practices by Maasai pastoralists in Mailwa sub-location of Kajiado County. This area was purposively selected as it is inhabited mainly by the Maasai practicing pure pastoralism. The study used a descriptive research design. Population of the study consisted of 437 male and female household heads. Proportionate random sampling technique was used to select136 household heads comprising of both male and female. Data was collected using a semi-structured interview schedule and analyzed using descriptive and inferential statistics with SPSS software (version 17). Chi-square was applied to test the hypotheses at 0.05 confidence level. Rainfall data from Maasai Rural Training Centre (MRTC) Isinya was analyzed using Microsoft Excel to give a general pattern of rainfall in the area for the last five decades. The results of the study showed that 87.5% of pastoralists traditionally used seasonal movement of livestock as a response to cope with drought in addition to herd splitting and livestock mix. On current livestock feeding practices, 97.8% practiced seasonal movement of livestock in addition to purchasing of commercial feeds and hay. On frequency of droughts, 98.5% had noticed an increase in frequency where droughts

have become an annual occurrence. On duration of droughts, 97.8% had noticed an increase in the duration where droughts lasted for a period of 7-12 after onset. On changes in rainfall patterns, 99.3% had noted changes in rainfall patterns where onset of rainfall was no longer predictable.

Watto (2016), conducted a study on the effects of climate variability on livestock production and coping strategies in Maikona Location, Marsabit County in Kenya. Climate change is viewed as one of the greatest challenges facing humanity manifested in form of variation in amount and distribution of precipitation, ocean salinity, wind patterns and aspects of extreme weather leading to droughts and flooding, among others. These changes threaten community livelihoods, economy, ecosystems and social cohesion. Among the conspicuous threats are decline in crop production, livestock deaths due to droughts, malnutrition, resource-based conflicts and migration. Pastoral community in Maikona location (Marsabit County) is one such community. The existence of effective coping mechanisms is vital for the survival of these communities. This 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. The results of the study showed 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 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.

Onyango (2021), conducted a study on climate variability on vector-borne diseases in Narok County, Kenya. Variability in climate has in recent decades caused adverse impacts on natural and

human systems all over the world. The study assessed the effect of climate variability and the associated vector-borne diseases on livestock in Narok South Sub-County from 1980 to 2010. The study period was associated with high prevalence of vector-borne diseases hence the need to understand the cause and impacts. Objectives of the study were: to analyze the trends of droughts and floods in Narok County; to assess the relationship between rainfall patterns and vector-borne livestock diseases and to analyze the perceived impacts of climate variability by pastoral communities in Narok South Sub-County from 1980 to 2010. The study worked with the hypothesis that the cases of selected vector-borne diseases had no significant relationship with rainfall patterns over the study period. It adopted a descriptive research design and used stratified random sampling. Structured questionnaires were administered to 397 households while 36 key informants from relevant institutions were interviewed. The results of the study showed that other than Heartwater ($p= 0.402$), $r=0.011$ and $N=38$), other vector-borne diseases had a weak relationship with the amount of rainfall received. Nonetheless, there was some small relationship between graphical plots with cases of diseases either decreasing or increasing with corresponding decrease or increase of rainfall. According to the Chi-square analysis, there was a strong statistically significant difference between the two strata on the impact of floods and rainfall (floods: $\chi2= 24.902$, $df=3$, $p=0.000$ and rainfall $\chi2=41.230$, $df= 3$, $p=0.000$). The study revealed an increase in cases of most of the vector-borne diseases over the study period and attributes the increase to climate variability.

Elema (2018), conducted a study on the effects of climate variability on water and pasture availability in Turbi Division of Marsabit Cpunty, Kenya. Indigenous systems such as pastoralism have for centuries been flexible to harsh conditions of water and pasture scarcity but exogenous factors like climate change render them fragile. Currently, severe and abrupt changes in climatic conditions have caused serious negative impacts on availability of water and pasture. The overall objective of the study was to establish pastoralist adaptation strategies to the impact of climate change on water and pasture scarcity in Turbi Division of Marsabit County. Primary data was collected using empirical tools. Survey questionnaires were used to collect data from two hundred and three (203) households. These were selected through stratified and simple systematic sampling methods. Additionally, interview schedules with nine key informants, four Focus Group Discussions (FDGs) and field observations were done. Data was analyzed both quantitatively and

qualitatively using Statistical Package for Social Sciences (SPSS). Data is presented using graphs, tables and pie charts. The results of the study showed that climatic changes including rainfall patterns 55%, temperatures 21%, sunshine intensity 15% and 9% through changes in cloud cover had been witnessed by 78.3% of the residents through a number of indicators like increased distances to watering points 24%, degraded pasturelands 22%, loss of livestock 18% inter alia as well as extreme conditions like severe droughts 66%, moderate rainfalls 23%, and floods 7% among others. The study established that 4% result to social issues mainly hunger, conflicts and displacement at a ratio of 20:7:4 subsequently influencing adaptation strategies. Using cluster analyses dependent variables showed that there were adaptation strategies clustered as traditional $Y1 < 1.975$; conventional $Y2 < 1.403$; challenges in adaptation $Y3 < 0.759$; intervention from external forces $Y4 < 1.065$ and therefore that ($Y1, Y2, Y3$ and $Y4 \neq 0$).

2.5 Research Gaps

A knowledge gap occurs when desired research findings provide a different perspective on the context of the matter discussed in the paper. For instance, Onyango (2021), conducted a study on climate variability on vector-borne diseases in Narok County, Kenya. The study assessed the effect of climate variability and the associated vector-borne diseases on livestock in Narok South Sub-County from 1980 to 2010. The study worked with the hypothesis that the cases of selected vector-borne diseases had no significant relationship with rainfall patterns over the study period. It adopted a descriptive research design and used stratified random sampling. Structured questionnaires were administered to 397 households while 36 key informants from relevant institutions were interviewed. The results of the study showed that other than Heartwater ($p= 0.402$), $r=0.011$ and $N=38$), other vector-borne diseases had a weak relationship with the amount of rainfall received. Nonetheless, there was some small relationship between graphical plots with cases of diseases either decreasing or increasing with corresponding decrease or increase of rainfall. On the other hand, our current study focused on the impacts of climate variability on livestock in ASALs.

In addition to that, a methodological gap can be identified as the above researchers for example Watto (2016), conducted a study on the effects of climate variability on livestock production and coping strategies in Maikona Location, Marsabit County in Kenya. 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. The results of the study showed 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. Our current study adopted a desktop literature review method.

3.0 METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to the impacts of climate variability on livestock health in ASALs. 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 impacts of climate variability on livestock health in ASALs. 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 the impacts of climate variability on livestock health in ASALs. 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 the impacts of climate variability on livestock health in ASALs which was split into top key words. After an in- depth search into the top key words (climate variability, ASALs, infectious diseases), the researcher arrived at 4 articles that were suitable for analysis. These findings were from Gikaba (2014), who conducted a study on the influence of drought variability on livestock feeding practices by Maasai pastoralists in Kajiado County, Kenya. The study used a descriptive research design. Population of the study consisted of 437 male and female household heads. Proportionate random sampling technique was used to select136 household heads comprising of both male and female. The results of the study showed that 87.5% of pastoralists traditionally used seasonal movement of livestock as a response to cope with drought in addition to herd splitting and livestock mix. On current livestock feeding practices, 97.8% practiced seasonal movement of livestock in addition to purchasing of commercial feeds and hay. On frequency of droughts, 98.5% had noticed an increase in frequency where droughts have become an annual occurrence. On duration of droughts, 97.8% had noticed an increase in the

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extreme conditions like severe droughts 66%, moderate rainfalls 23%, and floods 7% among others.

4.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Communities in the ASALs are recognize livestock diseases as a constraint in their livelihood. In addition to that, veterinary diseases are inadequate and not timely in the control of these diseases. The main livelihood for these pastoralist communities is livestock that they sell to raise cash for food among other family obligations. Climate variability leads to loss of livestock due to inadequate pasture and water; and this leads to food insecurity among pastoralists. Droughts cause inadequacy of pastures for the livestock and water for human and livestock consumption. Tick borne diseases are a major constraint in these areas. Climate variations influence the tick vectors and limit control of the vectors due to shortage of water. Climate change in ASALs is positively and significantly related to the occurrence of livestock diseases. Significance variations in certain weather elements may have modified the ecosystems of the diseases causing an increase in pathogens and vectors populations.

4.2 Recommendations

An early warning system should be developed to predict climate changes in ASALs and generate information that pastoralists can use to manage possible occurrences of livestock diseases. Targeted and strategic disease management interventions should be developed to moderate the multiplication of disease- causing pathogens and their vectors as a result of climate variability. Extension education should be undertaken to enlighten the pastoralists on the importance of strategic disease control, stocking density of animals and environmental conservation in order to mitigate climate variability. Water should be provided by constructing more boreholes and water pans in the pastoral areas as it is the most important commodity for the sustenance of their livelihood for humans and livestock during drought. The government should also create a national pasture reserve for provision to pastoralists in ASALs during severe droughts.

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