African Journal of Emerging Issues
Peer reviewed | Double blind | Interdisciplinary

African Journal of Emerging Issues (AJOEI)
Online ISSN: 2663 - 9335
Available at: https://ajoeijournals.org

CLIMATE CHANGE

IMPACT OF CLIMATE CHANGE ON LIVELIHOOD SUSTAINABILITY OF VULNERABLE PASTORAL COMMUNITIES IN KAJIADO, KENYA

[1]Dr. FCPA John Odhiambo Mudany, PhD.
United States International University-Africa
Member of Council, Management University of Africa

[2]Dr. Mildred Anyango Mudany, PhD.
Chairperson, Kisii University Council

[3]Prof. Martin Ogutu, PhD.
Professor, Strategic Management, Department of Business Administration, School of Business, University of Nairobi, Kenya

Publication Date: January 2024

ABSTRACT

Background: Climate Change is defined as a change in the state of average weather patterns attributed to both natural and human induced factors and which in addition to variability persists over long periods. It is a global problem that demands a global solution. The Paris Agreement, which aims to enhance the global response to the threat of climate change by keeping the global temperature rise this century well below 2°C over pre-industrial levels, now governs the worldwide response to climate change. Kenya's National commitment includes contribution for adaptation and mitigation, and outlines the nation's initiatives to help achieve the global objective outlined in the Paris Agreement.

Objectives: The objective of this paper was to identify climate change adaptation options for diverse pastoral groups in Kenya, with a particular focus on Kajiado County.

Methodology: Involved rigorous review of pertinent documents related to climate change and livelihood sustainability of vulnerable communities in Kajiado. These included documents on climate change conventions, national policies and strategies (including plans, programmes and legal documents), journal articles and published reports. The information drawn from these documents were critically skimmed, sorted and analyzed.

Results: The annual average range of precipitation received in Kajiado County is between 300 and 1300 mm with the lowlands receiving the lowest while elevated areas receive the highest precipitation. The temperature range varies between 20°C and 30°C throughout the year. Changes in climate significantly affect the pastoral production systems, with cattle being more affected compared to other species of livestock due to their feeding habit and being sensitive to heat stress. Livestock sector especially within ASALs, has suffered from recurrent droughts

with resultant loss of livestock body conditions, increase on livestock disease incidences and livestock deaths. In this review, at least 290,000 heads of cattle died in Kajiado County during the last drought season as at November 2022. Mechanisms have been established to comprehend and address the consequences of climate change. The government of Kenya has since developed various policy documents that are either directly or indirectly related to climate change, and there is strong backing from foreign partners. Since the residents of Kajiado County are not opposed to climate change, they have historically been able to adapt to it in a number of ways, such as migration, destocking, rain harvesting, and selling land to restock livestock fields or migrate. These adaptive mechanisms have the drawback of being more reactive than proactive.

Conclusion: This paper showed that the impact of climate change and its extremes is being felt by Maasai pastoralist living in Kajiado County of Kenya. The increase in drought occurrence has severe impact on pastoralist livelihood, food security, human and animal health, vegetation, and child education in the study area. The government is attempting to boost water capacity during dry years by sinking boreholes and water troughs in order to promote peaceful networks.

Key Words: *Climate Change, Livelihood Sustainability, Vulnerability, Adaptation*

Introduction

Globally, people are experiencing the fast-changing climate (Intergovernmental Panel on Climate Change (IPCC), 2014). The adverse effects on natural systems that the pastoral livelihood system depends on are what define these transformations (IFAD, 2009; Morrison et al. 2018). The IPCC (2014) report states that food and human security, including health, are natural systems. In addition to natural climatic change seen over comparable time periods, climate change is defined as alterations in the global atmosphere that are directly or indirectly caused by human activity (IPCC, 2014). According to the Intergovernmental Panel on Climate Change (IPCC, 2007), climate change is the state of average weather patterns that have changed due to both naturally occurring and man-made sources, and that have persisted for extended periods of time in addition to their variability. According to the IPCC (2013) and IPCC (2014), climate change is human-induced (anthropogenic), meaning that over time, changes in climatic systems are brought about by greenhouse gas emissions from human activity that are released into the atmosphere. Some writers have characterized climate change as the simple human modification of the Earth's climate system by burning fossil fuels, clearing forests, and other actions that raise the atmospheric concentration of greenhouse gases (Sexton, Rowell, Folland & Karoly, 2001; Weart, 2010; Trenberth, 2011; Curry, 2011).

The IPCC (2021) reports that the global surface temperature was 0.99 [0.84 to 1.10] °C higher in the first two decades of the twenty-first century (2001–2020) than it was in the 1850–1900 period. In comparison to 1850–1900, the global surface temperature increased by 1.09 [0.95 to 1.20] °C between 2011 and 2020. SPM increases over land were more (1.59 [1.34 to 1.83] °C) than over water (0.88 [0.68 to 1.01] °C). The primary cause of the estimated rise in global surface temperature since AR5 is additional warming from 2003 to 2012 (+0.19 [0.16 to 0.22] °C). New data sets and analytical developments have added around 0.1°C to the latest warming estimate in the Sixth Assessment Report (AR6). Due to their heavy reliance on rain-fed production systems, Africans are primarily negatively impacted by climate change (IPCC, 2007, 2014; World Bank, 2013; WHO, 2014; Filho, Nzengya, Muasya, Chemuliti & Kalungu, 2017). (Nobenbaert, Karanja, Herero, Felisberto & Moyo, 2013; Lopez-Carr & Burgdorfer, 2013). Due to the effects of climate change, food insecurity has been a problem throughout Africa over the past ten years (Marius, 2012; IPCC, 2014; FAO, 2010; FAO, 2016). Scientists

have been concerned about climate change as a worldwide issue since the 19th century, and its effects are still evident today. The mean annual temperature is predicted by Regional Circulation Models (RCM) to rise by 1.4°C by 2030, 2.8°C by 2060, and 4.7°C by 2090 (NCVST, 2009).

According to a 2014 report by the Intergovernmental Panel on Climate Change (IPCC), ecological degradation in the Asia-Pacific Area has been exacerbated by climate change. It is widely acknowledged that Africa is vulnerable to the beginning of climate change, with global temperatures expected to climb by 1°C to 2.5°C over the next 30 years (Boko et al., 2007). In a similar vein, the IPCC (2007) also noted rising temperatures and linked those increases to decreased yields, widespread food poverty, and biodiversity loss. This result is consistent with the UNDP (2013) Report, which said that individuals living in pastoral social-ecological systems are in such a terrible situation that they must make use of everything in their environment in order to survive.

Pastoralism has experienced processes of change over the past three decades on a global scale, which suggests that pastoral systems' capacity to withstand shocks and adapt to changes is deteriorating. Within the pastoral communities, there has been a rise in social inequality and differentiation due to growing impoverishment (FAO, 2016). The wealthy continue pastoralism and adopt increasingly commercialised methods, while the impoverished leave it and become penurious (Catley & Aklilu, 2013). Furthermore, the population of pastoralists is expected to increase by 2.5% to 3% year. People must therefore leave pastoralism because there is no long-term way of life and there are constant shocks (AU, 2010). These noted shifts among pastoralists increase the wealth gap between the affluent and poor portions of the movement and make it difficult to return to pastoralism in the future (Catley & Aklilu, 2013; Aklilu et al., 2016).

According to the IPCC (2014) and Niang et al. (2014), one of the regions of the world most susceptible to the effects of climate change is Africa. Livestock is often the sole resource available to the impoverished in rural communities, yet it is extremely sensitive to extreme weather events and climate change (FAO, 2007; IFAD, 2010). Rust and Rust (2013) predict that the following will have an impact on the production of dairy and beef: a decrease in the amount of fodder produced from irrigated pastures and dry land, which will raise feed costs; a decrease in milk production; a decrease in animal weight gain; a decrease in the rate of reproduction; a decrease in feed conversion efficiencies; a rise in the prevalence of internal parasite infestation; and a decrease in the prevalence of vector-borne diseases.

Pastoralists in Ethiopia work a limited amount of rangeland that is becoming more and more degraded and is currently experiencing an increase in the encroachment of shrubs. Numerous reasons, including as population development, agricultural encroachment, land degradation, obstructed migration routes, and conflict brought on by a lack of natural resources, are causing the rangelands to diminish (Eyasu & Feyera, 2010). Given these facts, an investigation of Ethiopia's pastoral livelihood system was started, with the particular goals of examining the main forms of economic activity that pastoral people engage in and the effects of climate change on these livelihoods.

Deteriorating security conditions, inadequate education and healthcare systems, and a lack of infrastructure all contribute to the growing impoverishment and falling standard of living. The resilience, adaptability, and viability of the pastoral livelihood system are all significantly impacted by this circumstance (Catley, 2017). A variety of strategies have been tried to support

pastoralists in Ethiopia in response to natural shocks like unpredictable rainfall patterns, droughts, floods, and conflicts, to which they are particularly vulnerable. These strategies include enhancing animal and human health, promoting and introducing diversification activities (often based on rangeland resources), creating and strengthening market access, enhancing access to natural resources (such as water), bolstering traditional institutions, and enhancing rangeland management (Berhanu et al., 2017). Despite those outstanding accomplishments, more work needs to be done to change their livelihood structure in a way that is sustainable.

According to research, by 2075, average daily temperatures in Tanzania are predicted to increase by 2-4°C and the mean annual temperature by 3-5°C due to climate change (Ehrhart & Twena, 2006). The months of June through August will see a higher temperature rise than the months of December through February. The study also indicates that temperature increases will be less pronounced in north-eastern parts, where warming may only reach 2.1°C, and more pronounced in central and western regions, where they may climb by as much as 4°C (Ndelolia, 2013). The amount of rainfall that has been seen has decreased significantly; since 1960, yearly rainfall has decreased by 2.8 mm per month on average (TCRA, 2015). The southernmost regions of Tanzania have had the biggest annual decline (McSweeney et al., 2010).

The Maasai community has continued to practice nomadic pastoralism in spite of changing climate patterns, but traditional seasonal cattle movements have been reduced as a result of altered land use patterns and sociocultural dynamics. Pastoralists mostly live in 29 of Kenya's 47 counties, which are classified as Arid and Semi-Arid Lands (ASALs) (MoD, 2018). At least 50% of the nation's livestock population is supported by these ASAL counties (KNBS, 2009). Kajiado County is no different, being one of the ASAL counties and home primarily to the Maasai people, whose primary source of income is pastoralism (CIDP). Over 70% of households are employed by livestock, which provides the majority of families with income (Kirimi et al., 2013). The County's natural resource base has been declining (Behnke, 2000), particularly the native grasslands that have withered and caused animals in the area to become emaciated or die (Lopez-Carr & Burgdorfer, 2013).

Soda ash in Magadi and marble in Kajiado Central are two more possible revenue streams (GoK, 2016). FAO (2010) stated that the ASALs' erratic and out-of-equilibrium climate conditions might have a negative impact on the livestock industry. This data is consistent with reports by Erickson (2010) and Said, Muhwanga, Bedelian, Moiko, and Abuya (2017), who noted that climate change has caused several production risks in Kajiado County (Kirimi et al., 2013; Pal and Eltahir, 2015; WHO, 2014). Determining past climatic trends was crucial in order to have a better understanding of the local climate system and maybe guide future preparations for the vulnerable Maasai community. The community has made an effort to adjust to the changing climate, but they still face a threat to their way of life from rising temperatures (Said et al., 2017), which cause high rates of evaporation and drier conditions that are insufficient to support the growth of new vegetation (Oxfam, 2008; Schwartz et al., 2005). Food insecurity levels in the County have increased as a result of the Maasai pastoralists' numerous struggles (Nori and Davies, 2007; Bobadoye, Ogara, Ouma, & Onono, 2016). In November of 2022, the Maasai pastoralists lost about 290,000 herds of cattle, according to a Citizen Digital Report. There is need to create awareness on the climate change adaptation options for diverse pastoral groups in Kenya hence the need for this paper.

Statement of the Problem

Global climate change has affected the climate on Earth over the last 30 years or more (Nasir et al. 2018). A decrease in rainfall volumes and distributions, coupled with an unexpectedly hot and protracted drought, are threatening pastoralist areas. The numbers of domestic herds have decreased as a result of these changes, and pasturelands, crops, surface and ground water, and other assets have failed or completely destroyed. Considering pastoral production systems rely on climate-dependent natural resources like pasture and water, they are currently experiencing a number of issues related to climate change on a worldwide scale. In instance, rainfall has becoming harder to forecast and has steadily decreased in quantity (Medhanit, 2014).

In pastoralist settings, the effects of climate change events are leading to a number of intricate issues that have chronically depleted resources (IPCC, 2014). This also applies to the situation in Kajiado County, where the Maasai pastoralists live in dense populations and rely heavily on natural resources (Oxfam, 2008; Said et al., 2017). Their predominant form of subsistence, pastoralism, is at jeopardy because of changing weather patterns. Temperatures in the region have been rising (New, 2015; Said et al., 2017), and the IPCC (2014) noted that a temperature increase of more than 1.5°C can result in a notable loss of terrestrial biomass. Moreover, Sharma et al. (2014) contend that drier conditions and landscape degradation are linked to temperature increases.

Kajiado County's aridity has grown, according to MoALF (2017). The report goes on to state that the area has seen more drought episodes in the past ten years and that the 2009 drought caused animal fatalities that exceeded 70% in the majority of the county. This data is comparable to that of Hugo and Mugalavai (2010), who reported that one of the greatest rates of cattle and shoat mortality—50% and 20%, respectively—was experienced during the 1999–2000 drought. Both Walker et al. (2004) and Lopez-Carr Burgdorfer (2013) agree that the region had significant animal losses and acute food shortages. Additionally, according to some writers, there have been more recent drought periods in the region (Nyariki et al., 2009; Kirimi et al., 2013). Kajiado County's aridity has grown, according to MoALF (2017). The report goes on to state that the area has seen more drought episodes in the past ten years and that the 2009 drought caused animal fatalities that exceeded 70% in the majority of the county. This data is comparable to that of Hugo and Mugalavai (2010), who reported that one of the greatest rates of cattle and shoat mortality—50% and 20%, respectively—was experienced during the 1999–2000 drought. Both Walker et al. (2004) and Lopez-Carr Burgdorfer (2013) agree that the region had significant animal losses and acute food shortages. Additionally, according to some writers, there have been more recent drought periods in the region (Nyariki et al., 2009; Kirimi et al., 2013).

According to UNDP (2013) and Campbell et al. (2005), developing sustainable coping and adaption techniques to meet changing climatic patterns overlaid by externalities such as land-use change patterns is necessary for the maintenance or restoration of the pastoral Social-Ecological System. In the pastoral Social-Ecological System, GECG suggests cultural perspectives as a crucial management component (Shiferaw, Takele & Hailemichael, 2017). Despite this, the detrimental effects of climate change are causing the Maasai community to experience blockages, dismantling long-established social networks.

Research at the community and family levels have examined and recorded pastoralists' adaptation and coping mechanisms to climate change (Silvestri, Bryan, Ringler, Herrero &

Okoba, 2012; Osano et al., 2013). In order to lower the risks associated with drought, policy makers should be informed about different adaptation and coping strategies at the local level, especially in light of the projections for increased drought impacts in pastoral areas. The Maasai community's inability to sustain pastoralism due to the depletion of natural resources (Kihila, 2015) is implied, but their solutions have been insufficient, inconsistent, and dispersed (Mussa et al., 2017). Thus, the need for this research to assist the Maasai community living within Kajiado County to identify sustainable intervention measures to enhance their resilience.

Livelihood Sustainability Among Pastoralists

In Sub-Saharan Africa's peripheral regions, pastoralism provides economic stability and a means of subsistence for a sizable population, but it is vulnerable to the effects of climate change (Nyariki et al., 2009; IUCN, 2010; Kirimi et al., 2013). Around 20 million pastoral households depend on this industry for their livelihood, and it generates money for a sizable portion of the global population. Furthermore, the cattle industry provides a living for about 200 million peasant farmers in Asia, Latin America, and Africa (World Bank, 2014). Since the production of cattle contributes significantly to the global food supply, any interruption in the form of altered climatic patterns may result in food insecurity in the majority of the world's population (World Bank, 2008). The majority of Kenyans depend on meat and milk, two essential animal proteins that are largely supplied by the country's livestock industry. Thus, achieving Kenya's Vision 2030 on increased food security depends heavily on a successful livestock enterprise.

A thorough understanding of the climatic system, including seasonal forecasting and prediction, is necessary for sustainable pastoralism (Said et al., 2017). Ostrom (2011) pointed out that a thorough grasp of the essential relationships within the natural resource system is necessary for the pastoral Social-Ecological System to survive. Although the Maasai community has made use of their traditional wisdom, this may not be sufficient given the rapidly evolving context of climate change (Shiferaw et al., 2017). Because it has disrupted the customary seasonal movement of livestock, the negative effects of an unpredictable climate pattern are thus cause for concern (Mukuna et al., 2015). Furthermore, the Maasai pastoralists have become increasingly vulnerable and perplexed as a result of their inability to comprehend seasonal patterns (Walker, Holling, Carpenter, & Kinzig, 2004).

Since pasture demand drives their mobility, seasonal failure has made it challenging for them to effectively adapt to some of the new hazards they face. Consequently, despite their wealth of traditional knowledge and insights, pastoral livelihoods are now under risk due to the climate system's capacity gap (UNDP, 2013). This data is consistent with those of (Xiao, Bilal, Gemechu, Gede, Yonas & Xiaadan, 2018), who found that pastoralists were able to achieve ecological and societal resilience through the use of traditional knowledge. Therefore, without traditional institutions, which have been essential to the survival of the dryland ecosystem, the quest for sustainable ecology cannot be fully realised. A community's long-established rights to steward their lands, waters, and natural resources, as dictated by their customary laws, require a cultural understanding of resource management (Bennette, 2015). The assertion made by Sharma et al. (2014) that indigenous institutions have preserved natural systems and shielded them from wanton devastation lends credence to this viewpoint. The Maasai pastoralists are now more vulnerable as a result of the region's increasing evidence of climate change. The system of pastoral subsistence is under danger, and human activities like land subdivision, rising private land ownership, and shifting land use patterns have made it worse (Mukuna et al., 2015).

Critical Review

In a changing and unpredictable environment, pastoralists strive to maintain a balance between themselves, their animals, and their pasture (Okoti, Kung'u, & Obando, 2014). This is known as pastoralism as a livelihood system. According to Catley et al. (2016), pastoralism is a way of life in which at least 50% of a population's food and income originate from raising livestock, and where the animals are seasonal migrants in search of pasture and water, particularly during dry spells. Pastoralism is a broad system of raising livestock in rangelands. It is distinguished by a number of characteristics, but two primary ones are the movement of cattle in search of pasture during dry spells and the collective management of natural resources (ASAL Policy, 2015).

The Maasai community's cultural, social, and spiritual well-being is greatly influenced by the livestock industry (League of Pastoral People, 2009). The Maasai community has very large livestock stocks, however Sinclair and Pech (1996) pointed out that these animals are in danger because of climatic change and changes in land-use patterns. Therefore, it is imperative that they implement immediate interventions aimed at doubling the current level of cattle output, lest their livestock herds begin to dwindle. This is happening at a time when the market for animal protein is expanding. According to Gregory, Ingram, and Brklacich (2005), in order to meet the growing demand for animal proteins, there need be greater interventions made in livestock operations. It is predicted that 8 billion individuals would consume animal protein by 2020 due to the ongoing global demand for this food (World Bank, 2014).

A thorough understanding of the climatic system, including seasonal forecasting and prediction, is necessary for sustainable pastoralism (Said et al., 2017). According to Ostrom (2009), comprehensive knowledge and comprehension of the essential relationships within the natural resource system are necessary for the pastoral Social-Ecological System to survive. Although the Maasai community has made use of their traditional wisdom, this may not be sufficient given the rapidly evolving context of climate change (Shiferaw et al., 2017). Because it has disrupted the customary seasonal movement of livestock, the negative effects of an unpredictable climate pattern are thus cause for concern (Mukuna et al., 2015). Additionally, it has made it harder for the Maasai pastoralists to comprehend seasonal patterns, leaving them more vulnerable and perplexed (Walker et al., 2004). Since pasture demand drives their mobility, seasonal failure has made it challenging for them to effectively adapt to some of the new hazards they face. Consequently, despite their wealth of traditional knowledge and insights, pastoral livelihoods are now under risk due to the climate system's capacity gap (UNDP, 2013). This data is consistent with that of (Xiao et al., 2018), who stated that pastoralists were able to achieve ecological and societal resilience through the use of traditional wisdom. Therefore, without traditional institutions, which have been essential to the survival of the dryland ecosystem, the quest for sustainable ecology cannot be fully realised.

Climate Trends

Humanity faces enormous challenges as a result of climate change. According to Climate Change 2021: Fundamentals of Natural Science, global surface temperatures will be 1.09 °C warmer in 2011–2020 than they were in 1850–1900. Over the following 20 years, it is expected that the average global temperature will rise further, surpassing the 1.5°C objective set in the Paris Agreement. Human development and survival are significantly impacted by global warming. The global water cycle will continue to be strengthened by climate change, leading to an increase in the frequency of floods, droughts, and heavy rainfall. Asia, though, is expected

to take the worst of the damage. Up to 758 million people worldwide may be affected by once-in-a-century floods by 2030.

There is a possibility that China would see an increase in natural disasters, with a 6% rise in the percentage of the country's population affected (Tellman et al., 2021). Between 1951 and 2019, China's annual mean temperature increased by 0.24 °C, a rate that was noticeably higher than the global average for the same time period (Blue Book of China on Climate Change 2020). Furthermore, 10–45 million people may be exposed to high heat in the future if emissions keep on their current rate. According to Coping with Climate Change: China's Response, the likelihood of heavy rainfall, which was once a once-in-50-year event in 1980, will likewise increase significantly, multiplying 2-3 times by 2030 and 3-6 times by 2050. Farmers, the population, and the availability of resources were all severely impacted by climate change (Liang et al., 2017).

High poverty indices are seen among pastoralists, and the fast-changing climate has made matters worse (World Bank, 2016; IPCC, 2014). Climate change has been blamed for the increased vulnerability of pastoralists, according to UNDP (2013). The MoALF (2017) Report states that Kajiado County's Maasai pastoralists are not an exception. The Report reaffirms that in order to better prepare the Maasai pastoralists in the area for the adverse effects of the quickly changing climatic patterns, they must have a better understanding of climate science. The Maasai community will be sufficiently prepared for climatic uncertainties that are projected to raise hazards and exacerbate the precarious situations in their regions if seasonal forecasts are accurate.

According to scientific consensus regarding climate predictions for the future, a significant portion of the ecosystem of drylands will face extreme episodes of drought and flooding, potentially endangering pastoralism (IPCC, 2007; Thornton, Jones, Ericksen & Challinor, 2011). Climate plays a significant role in cattle production because it affects the availability and spatial distribution of natural resources (Erickson et al., 2013). It is crucial to remember that pasture regeneration in the following season is impacted by the preceding producing season's precipitation. This viewpoint is similar to that of Erickson et al. (2013), who claimed that a seasonal decrease in precipitation is a sign of impending drought. According to Galvin et al. (2004), this suggests that in response to moisture stress, the vegetation cover shrinks, which causes animals to perish from limited pastures. This is the situation in Kajiado County, where climatic patterns have been unpredictable. Low livestock yields have resulted from those events' detrimental effects on pasture regeneration (Said et al., 2017).

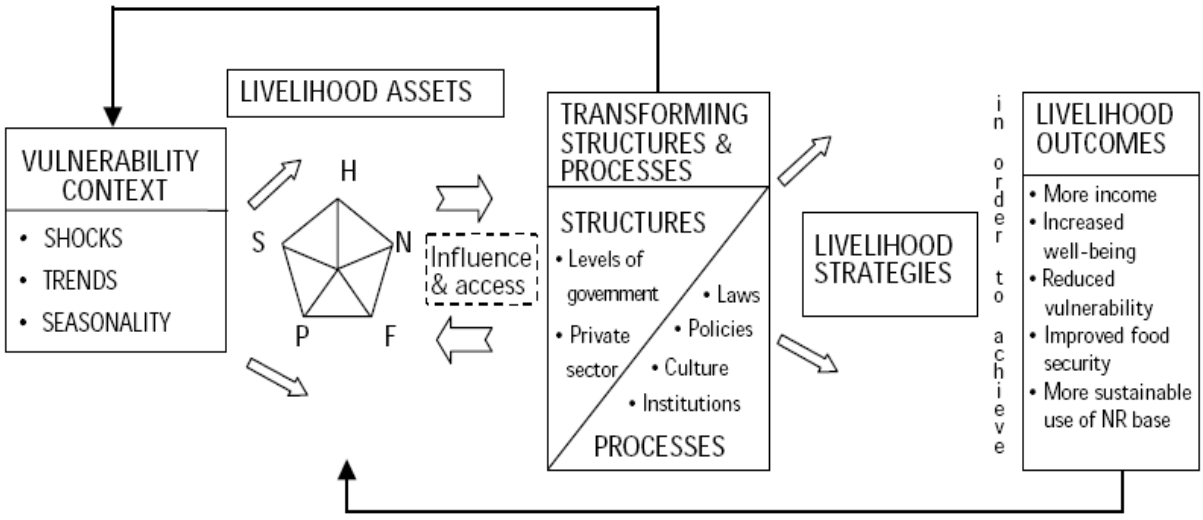
Africa has seen periods of extreme flooding and drought (Galvin et al., 2004). Given that the pastoral livelihood system is heavily dependent on a rain-fed agricultural system, such events have had a negative impact on pastoralism, the primary economic pillar of the ASALs (Nyariki et al., 2009). Livestock productivity has been adversely impacted by changes in climatic patterns (Markalis, 2004; Catley et al., 2013). For example, the decline in palatable pastures coupled with the shift in vegetation cover (Reynolds et al., 2007) has created multiple production risks, with some affected pastoralists facing the possibility of losing their means of subsistence if prompt intervention measures are not implemented (Birch & Grahn, 2007).

The Maasai pastoralists are now more vulnerable as a result of the region's increasing evidence of climate change. The system of pastoral subsistence is under danger, and human activities like land subdivision, rising private land ownership, and shifting land use patterns have made it worse (Mukuna et al., 2015). According to a 2014 report by the Intergovernmental Panel on

Climate Change (IPCC), ecological degradation in the Asia-Pacific Area has been exacerbated by climate change. It is widely acknowledged that Africa is vulnerable to the beginning of climate change, with global temperatures expected to climb by 1°C to 2.5°C over the next 30 years (Boko et al., 2007). In a similar vein, the IPCC (2007) also noted rising temperatures and linked those increases to decreased yields, widespread food poverty, and biodiversity loss. This result is consistent with the UNDP (2013) Report, which said that individuals living in pastoral social-ecological systems are in such a terrible situation that they must make use of everything in their environment in order to survive.

There is cause for alarm given how quickly these climate fluctuations are occurring. Following the extinction of some species, Kajiado County, like other ASALs worldwide, is witnessing a transformation of its key landscape features (Opiyo, Ekaya, Nyariki, & Murithi, 2011). However, those species have been used in the context of indigenous knowledge to accurately influence the prediction of the weather or seasons. Consequently, in their absence, climate-related uncertainties may become prevalent, endangering the pastoral livelihood system's sustainability. According to Ozor, Urama, and Mwangi (2012), Kajiado County is not an exception to the general food insecurity in the ASALs caused by erratic weather trends. The Maasai population, who were previously believed to be food secure, are now food insecure and are more susceptible to new production hazards, according to Osano et al. (2013) (Nori & Davies, 2007). Different opinions have been expressed about the effects of climate change as a result of these disasters. Meanwhile, outsiders continue to misunderstand the community, viewing pastoralism as a subpar land use strategy with little economic benefit (Folke et al., 2010).

In Kajiado County, the average yearly precipitation ranges from 300 to 1300 mm, with the lowlands receiving the least amount of precipitation and the hilly hills receiving the most. Throughout the year, the temperature ranges between 20°C and 30°C. But temperature fluctuates with height and season; Loitokitok, near the eastern slopes of Mount Kilimanjaro, reported the lowest temperature of 10°C, while Lake Magadi recorded the highest temperature of 34°C (MoALF, 2017).



The Sustainable Livelihood Framework (DFID 1999)

Methodology

This paper is based on rigorous review of pertinent documents and empirical reviews brought forth related to climate change and livelihood sustainability of vulnerable communities in Kajiado. Documents on climate change conventions, national policies and strategies (including plans, programmes and legal documents), journal articles and published reports. The information drawn from these documents were critically skimmed, sorted and analyzed. This paper seeks to understand the drought pattern in Kajiado County using participatory methods and information from the meteorological station. The study also documented their coping and adaptation strategies and identified viable adaptation strategies that will enhance livelihood sustainability of the Maasai pastoralist communities to climate change.

Impact of Climate Change

Despite the challenges faced by pastoral production systems when it comes to economic growth, environmental protection, and climate change adaptation, pastoralism is practiced worldwide, in both developed and developing nations. Pastoralists in these nations face different social and economic challenges, but their vulnerability to rapidly changing climate conditions is still increasing, even with the availability and accessibility of information on changing climatic conditions and the shift from mobile to sedentary pastoralism in some pastoral areas through the provision of water and pasture (Muchuru &Nhamo, 2017).The challenges of development in pastoral areas is partly being contributed by the fact that pastoralists have not developed appropriate adaptation strategies that could support livestock productivity under the changing climate as they continue to experience low livestock productivity due to livestock losses and poor productivity with the risk of food insecurity and increased poverty levels.

Climate change may be more severe in Africa due to the marginalized environment and water stress (Hassan, 2010). The ASALs may be negatively impacted by the unquestionably unprecedented rate of climatic change (Huang, Mingxia. Yongkun, Shanshan, Yongli & Jinjiang, 2016; Adhikari, U.A., Pouyan N & Sean, 2015; IPCC; 2013). The current impact of climate change on Africa as a continent is being compounded by numerous causes and is connected with variability in rainfall patterns, recurring droughts, flooding, and stormy winds (IPCC, 2007; IPCC, 2013). The anticipated adverse consequences may lessen Africa's capacity to adapt to changing climate conditions. Africa's poor health care system, high rate of poverty, low literacy, restricted access to resources, armed conflicts, inadequate infrastructure, and weak institutions all make it more difficult for the continent to cope. Average climatic conditions have an impact on natural systems, the economy, and human health. These effects are the outcome of climate change (IPCC, 2007). Climate change would have a more severe and varied impact on ASALs and the vulnerability of pastoral communities residing in these areas, necessitating swift and ongoing intervention (Herrero et al., 2016).

Changes in climate are predicted to have an impact on pastoralism as a livestock production system, with cattle being more affected than other livestock species because of their eating habits and sensitivity to heat stress (Toulmin, 2009; Nardone et al., 2010). Since East African ASALs lack robust institutional governance frameworks to address climate-related concerns, the impact of climate change on these entities is deemed to be quite severe. Most pastoralists and other rural inhabitants in both Tanzania and Kenya are impacted by climate change, with over 50% of their land mass covered by ASALs and 80% of Kenya's land mass covered by ASALs (Filho et al. 2017). Because developing countries have less resources available for

financial, social, and technological adaptations, their vulnerability to the effects of climate change is deemed to be more severe than that of rich countries.

Climate change is expected to have a significant impact on pastoralists and sustainable development in developing nations (UN, 2007). While Patt and Schröter (2007) and Adger et al. (2009) reported that people's perception of climate risk, both individually and collectively, could influence the actions taken to mitigate the effects of climate change, Egeru (2016) reported the importance of having climate risk information to help shape those actions. When deciding whether to adopt an adaptation plan, perceptions of a danger to climate change appear to be more important than hazards related to the changes. Consequently, a community's perspective of climate change must be thoroughly understood in order to execute adaptation methods in an effective and suitable manner (Ernoul, Vareltzidou, Charpentier, & Muryanyi-Kovacs, 2020).

Photo File: Mass Livestock Loss from The Prolonged Drought in Kajiado

Photo File: A Resident of Kajiado County Fetching Muddy Water for Home Use

Photo File: Prolonged Drought Experienced in Kajiado County

Response to The Effect of Climate Changes

Kenya actively participates in international efforts to address climate change, a global issue that need an international solution. The global response to climate change is currently governed by the Paris Agreement, which aims to strengthen the response to the threat of climate change by keeping the global temperature rise this century well below 2°C over pre-industrial levels. Kenya's national commitment describes the country's efforts to assist in achieving the global goal specified in the Paris Agreement and includes contributions for adaptation and mitigation. Article 2(6) of Kenya's 2010 Constitution states that as of January 27, 2017, Kenyan legislation incorporates the terms of the Paris Agreement. Global climate change is one of the most challenging and complex environmental concerns that humanity is currently confronting. It is considered one of the biggest threats to development efforts because of its detrimental effects on the environment, human health, food security, economic activity, natural resource management, and physical infrastructure.

The major piece of legislation guiding Kenya's response to climate change through mainstreaming climate change into sector functions is the Climate Change Act (2016), which provides the NCCAP with legal foundation. The National Climate Change Response Strategy (2010), First NCCAP (2013-2017), National Adaptation Plan (2015-2030), Kenya Climate Smart Agriculture Strategy (2017-2026), Climate Risk Management Framework (2017), National Climate Change Policy (2018), and National Climate Finance Policy (2018) are just a few of the sector-specific plans and policies that Kenya has developed to address various aspects of climate change. This research sought to identify options for various pastoral tribes in Kenya to adapt to climate change, with a specific emphasis on Kajiado County.

Essentially, it helps those pastoral communities spread the word about the benefits and suitability of new adaptation and mitigation methods and how to improve the way existing measures in place are implemented. Therefore, the loss of human and livestock life, wind-related building damage, decreased production and productivity, additional medical costs, inappropriate activity, and disruption of the pastoral community's overall activities can all be minimised by spreading important information about the likelihood of disasters in the future. One of the main goals is to increase pastoralists' capacity to diversify their sources of income by providing training in water management and conservation. Information on extra measures, such as using hay and destocking animals as the dry seasons approach, is provided to the pastoral communities.

The weather in Kajiado County has been characterised as chaotic and erratic. Previously, livestock accounted for 73% of livelihoods, off-farm employment for 17%, and agricultural production for around 10%. The farming of livestock is very important to the area. Most homes have cattle, goats, and sheep. In urban regions like Nairobi, off-farm activities usually involve jobs both inside and outside the community, as well as small-scale entrepreneurship such as making jewellery for tourists or other cultural artefacts.

An imbalance between these populations and the resources they need to survive has been brought about by increasing pressures from both natural and man-made shocks, and continuing climate change is predicted to increase rainfall unpredictability, which will increase the frequency of droughts and floods (Smith et al., 2015). These elements made it more difficult for pastoralists to make a living because it is difficult to comprehend their system of subsistence without natural resources. This demonstrates how closely pastoralists' livelihoods depend on natural resources, and that the continued destruction of those resources due to climate change

will make it more difficult for pastoralists to support themselves by undermining their primary source of income.

Misunderstanding the threats posed by climate change may lead to maladaptation or a failure to adapt. While the effects of climate change vary from place to place, it is expected that pastoralism will be more negatively impacted on rangelands used for pastoral activities than in high-potential locations. According to Wassie and Fekadu (2014), researchers should focus more on rangelands with pastoral production methods and their findings should be able to advise policy makers on the best course of action for pastoral areas. Morton et al. (2016), however, pointed out that the debate among scholars over how pastoralism is impacted by climate change has been oversimplified and divisive, with some expecting dire repercussions for pastoralists in the future. Although there has never been any research to determine how pastoralism affects greenhouse gas emissions, some scholars continue to believe that pastoralists can adapt as long as rules are in place that permit the production of greenhouse gases.

Climate variations have a big impact on the systems used for pastoral production. This necessitates inclusive talks on climate change that take pastoralists' capacity for adaptation and their susceptibility to its effects into consideration. According to Anderson et al. (2009), pastoralists might be included in conversations on climate issues if information gaps were filled and they were given guidance on what to do when adjusting to the effects of climate change. This would aid in the search for remedies that could assist the pastoralists in the ASALs in lessening the effects of climate change. Among the economic sectors that rely on the climate in the ASALs and high-potential areas are agriculture and cattle (Speranza, 2010).

The livestock industry, particularly in ASALs, has experienced frequent droughts, which have led to a decline in livestock health, a rise in the prevalence of livestock diseases, and an increase in livestock mortality. Temperature variability may not have a significant impact on livestock and pasture productivity in high potential areas, but in ASALs, the effects of climate change may be felt negatively in many localised places (Herrero et al. 2016).

Changes in the climate have the power to modify the prevalence of diseases, which in turn impacts both human and animal health (Raninowitz & Conti, 2013). Changes in climate factors like rainfall and temperature lead to the effects of climate change, which can be direct or indirect (Lacetera, 2018). As a result of harsh weather, there may be direct consequences in the form of clinical sickness or mortality, and indirect effects in the form of increased incidence and spread of pathogens that cause disease (Lacetera, et al. 2013). According to Gardner (2012), livestock diseases have an impact on animal health, the livestock market, and ultimately the livelihoods of people whose rural economies depend on the production of animals.

According to Kimaro et al. (2013), a number of studies have been conducted on the relationship between climate change and human health in the East African region, but less research has been done on the effects of these changes on animal health, taking into account the region's economic reliance on agriculture and livestock. This has led to a knowledge vacuum that is influencing the growth of livestock projects in the area as well as the management of livestock as a business. This has had a negative impact on food security, biodiversity, and ecosystems as well as the socioeconomic, water, and environmental sectors. According to Sejian (2013), climate extremes combined with seasonal variations may lead to a decrease in the amount and quality of pasture, which would have an impact on animal reproduction and productivity,

ultimately impacting pastoralism as a system of production. Climate change will impact the production of meat, milk, and dairy products in the ASALs, according to UNFCCC (2007) and WSPA (2012). These production systems are crucial for sustaining livelihoods and nutrition. According to Vitali et al. (2009) and Vitali et al. (2016), there is a higher chance of cattle losses and mortality during hot weather.

Forastiere (2010) states that a community's migration patterns, socioeconomic interests, and environmental conditions are some of the aspects that may influence how climatic changes affect an animal's health. According to Robinson et al. (2013) and Coffey (2008), rising temperatures may induce stress and warming in animals, which would reduce their intake of feed and, as a result, slow down their development, reproduction, and occasionally even cause their death. Reproduction and the quality of feed and pasture are the main effects of climate change on cattle (IFAD (2010); Chapman et al. 2012; Polley et al. 2013). The impact of climate change on cattle illnesses is contingent upon various factors such as land use, regional geography, disease behaviour, and animal susceptibility (Thornton et al., 2009).

Nardone et al. (2010) state that while climate change may have a direct or indirect impact on animal health, an increase in temperature will have a greater detrimental effect. Temperature increases have a direct impact on animal health because they increase disease morbidity and even death (Tubiello et al. 2008). Indirect effects include increased disease pathogens or parasites, the spread of vector-borne diseases, water scarcity, and decreased and low-quality feed and forage. According to Thornton et al. (2009), climate change may trigger significant outbreaks of certain diseases, introduce new livestock diseases, or change the pattern of disease incidence, all of which could have a negative impact on livestock. Changes in climate parameters, according to Desalegn et al. (2018), would have a significant impact on livestock output, either directly or indirectly, through increased incidence of animal diseases, decreased productivity, and production losses.

The pastoralists in Kajiado County are becoming more vulnerable as a result of the changing climate. While they are attempting to lessen the effects of these changes by altering the way they feed their animals, there is still a knowledge gap that prevents them from taking appropriate action (Mukuna et al. 2015). Since the effects of climate change are already being felt on pastoralism, this is cause for concern regarding the options currently available to pastoralists for adapting to the changing climate. Interventions that would increase pastoralists' resilience in the short term and their capacity for adaptation in the long term are therefore needed. It is important to find adaptation strategies that can lessen vulnerability and increase resilience in the communities of pastoralists residing in ASALs (Drucker et al., 2007). The dynamics and structures of livestock production, important indigenous breeding techniques, and indigenous knowledge on how to manage the pastoralists' climate-sensitive natural resources should all be considered in the adaptation intervention methods.

Increasing the diversity of livelihood possibilities is more a matter of survival than choice, given the frequent and severe consequences of climate change on pastoralist communities who rely primarily on livestock. Diversification is a tried-and-true way to increase household resilience by spreading risk. Crop farming, handicrafts, petty trade, labour sales, seasonal labour migration, saving, and other activities are examples of diversifying your sources of income. One way to address food volatility and economic diversification is through agropastoralism.

Several researchers suggest that the primary source of income for pastoralists should be the sale of livestock and the goods it generates in order to reduce the susceptibility of the rural poor to the water scarcity and health issues. to improve the marketing and market information systems by forming regional marketing cooperatives. Legislators and other interested parties can also encourage a process of acknowledgment and introspection, which can aid in local adaptation. In order to introduce and implement these tactics to their own situation, local pastoralists may benefit from learning about the adaptation strategies being used by other pastoralists in response to climate change.

The intensity of climate change in Kajiado is influenced by a number of factors, including low living standards due to poor building designs, seasonal production in agriculture, food insecurity and low income, deforestation, the traditional solid waste management system, a lack of adaptive capacity, limited financial resources, and a lack of skills and technologies, among others. Pastoral communities face more issues than agrarian (crop producing communities) communities because they are disproportionately more exposed to the confusing effects of poor infrastructure, poverty, a lack of alternative sources of income, inadequate public awareness of disease risks, illiteracy, and other issues. Using renewable energy sources (apart from firewood and charcoal), improving human health (sanitation) and clean water supply, developing and improving markets and infrastructure, employing integrated natural resource management, and destocking and restocking livestock (depending on weather conditions) are all necessary for pastoral communities of Kajiado in order to maintain or improve animal health.

Discussion

The Maasai pastoralists used to have access to extensive communal territory, but due to restrictions, their mobility has been severely limited. The shaky system of land tenure, which is vulnerable to land grabbing, has made this worse. As a result, substantial portions of land that were formerly recognised as belonging to a communal entity have been transferred to private ownership (Raleigh & Urdal, 2007). Private landholding has reduced mobility, an intervention that helped Maasai pastoralists adapt to changing climate patterns (Krisjanson et al., 2002; Mwangi and Dohrn, 2006; Lesorogol, 2008). Despite this, the Maasai community still exclusively depends on natural systems, including open space, for their needs in terms of production and provisions (ILRI, 2006; KNBS, 2009; Mwang'ombe et al., 2011; NEMA, 2011).

The pastoralist Maasai people have persisted in selling their land for fast money. Large areas of land are being divided, which has led to an immediate reward from land sales, as stated by Krisjanson et al. (2002) and Mwangi (2006). This has produced a need for money. Land sales are a temporary coping strategy since they are less reversible and deprive households of essential resources, making them more vulnerable (Gichangi & Gatheri, 2018). In addition, Molua and Kagwanja (2015) and Kinyenze and Irungu (2016) observed that the issue of land squatters is linked to a drive for land subdivision.

According to some research, the County's per capita acreage of land per family has decreased recently as a result of competition for resources from the fast expanding population (Homewood et al., 2004; Burnsilver, 2007; Leserogol, 2008; Silvestri et al., 2012 and Nkedianye et al., 2009). Resource-based disputes have increased in the area due to the decrease in the amount of land acreage per household and the exclusivity of land usage (Galvin, 2009; Morara et al., 2014; Molua and Kagwanja, 2015). The Maasai people depend on open space to

adapt to climate change, although Bobadoye et al. (2016), Swamy (2013), and Ozor et al. (2012) noted that the evolving land tenure regimes may change the Maasai people's pastoral Social-Ecological System to the point of losing important biophysical elements.

The County has also been subject to uncertainty and ongoing disequilibrium in its natural resource base, according to Ozor et al. (2012) and Sharma et al. (2014). However, prior research has not comprehensively addressed changes in this pastoral Social-Ecological System, so mapping natural resources is necessary to fill in the gaps in our knowledge. The Maasai community has always prospered in an environment of communal land because it allows for flexibility, movement, and opportunistic grazing. Due to their mobility, they have been able to relocate with their herds to other areas during drought episodes that have underutilised forage (Hobbs et al., 2008; Little et al., 2001; Galvin, 2009). This mobility has also made it possible for them to implement interventions that have allowed them to manage and utilise important natural resources within their territory in a sustainable manner (Reid et al., 2008).

Conclusion

The livelihood of the Maasai Pastoralist Community in Kajiado is negatively impacted by climate change, which is an inevitable consequence. The vulnerability in society is impacted by climate change because of the shocks they face, like unusually high floods, droughts, and landslides. Long-term patterns in socioeconomic and environmental processes have the power to change a society's level of vulnerability. A tendency of more frequent occurrences of the climatic shocks that impact susceptibility is established by enhanced climate change. Although there is no denying that climate change has a significant impact on adaptability, its detrimental effects are often overlooked or written off as accidents. In reality, major meteorological calamities are not accidental given the backdrop of an increasingly warming environment. Climate is the primary exogenous element influencing farmers' income levels and sustainable livelihoods if the trajectory of climate change is not significantly altered.

Skillful integration is also shown in the adaptation to the drought's direct and indirect impacts. There have been documented effects of drought on the Maasai pastoral system, both directly and indirectly. This skillful integration also shows itself in the way that conventional coping methods are applied simultaneously during dry spells. In order to handle climate change on a national and local level, a strong regulatory framework made up of laws, policies, programmes, and institutions is gradually being built. Because of this, the influence of climate change on the sustainability of farmers' livelihoods was evaluated in this paper using it as a shock variable. This study demonstrated how Maasai pastoralists in Kenya's Kajiado County are affected by climate change and its extremes. The study area's pastoralist livelihood, food security, human and animal health, vegetation, and educational opportunities are all severely impacted by the rising frequency of droughts.

This report discusses the array of techniques that the Maasai pastoralists in Kajiado County have consistently employed in response to climate change. The review did reveal, however, that the majority of the adaption techniques used by pastoralists are essentially autonomous and are not expected to increase the resilience of pastoralist ecosystems and livelihoods to the anticipated severity and scope of climate change in the twenty-first century. Furthermore, the combination of "multiple stresses" such as poverty, changing land use, and a limited capacity for adaptation makes Maasai pastoralists more vulnerable (Maito et al., 2013). Planned adaptation measures are therefore required to address the effects of climate change that pastoralists in Kenya's dry and semi-arid regions are currently experiencing as well as those

that are predicted. Even though they have a variety of sources of income, a number of obstacles, including a lack of finance, a lack of entrepreneurial spirit, and market accessibility, limit how much they can participate. Furthermore, variations in meteorological parameters like temperature, precipitation, and the frequency and intensity of extreme occurrences like droughts have a direct impact on pastoral areas' cattle output.

As Maasai poverty rises, strategies such as reduced household consumption may be extended beyond dry seasons to become normal coping mechanisms for dealing with the immediate effects of drought. This means that adaptation to the direct and indirect effects of drought may converge, blurring the lines between them. The Maasai people's varied and integrated use of drought-adaptation is indicative of their adaptive attempts to changing circumstances. The types and attributes, sustainability and viability, usage rates, and preferences of drought-adaptation strategies used in Maasai pastoralism are shaped by various and changing local and non-local, as well as place-specific and non-place-specific social, economic, political, and ecological factors, processes, contexts, and their interactions, according to the empirical data that is currently available.

Lastly, the diversification of livestock into pigs, poultry, sheep, and goats (shoats) can be understood as an adaptation to the readily available and accessible resource base, land, as these small-stocks only need very small spaces. The accessibility and availability of resources (such as land, water, and ecosystems) for Maasai pastoralists are impacted both directly and indirectly by the various social forces and phenomena (such as macroeconomic policies, cross-scale economic inequality, and gender disparities) that cause land-use change in this region. As a result, the adaptations associated with the same.

Recommendation

The influence of climate change on Kenya's socioeconomic sectors is recognised in NCCAP 2018–2022. Recognising that climate change is likely to restrict the achievement of these pillars, it highlights seven crucial areas where climate action is connected to the Big Four Agenda. Maasai pastoralists in Kajiado County may find that implementing an efficient early warning system, seasonal climate forecasting, and information sharing might be a successful planned adaptation strategy against drought. Communities must have access to a greater range of resources in order for early warning systems to be more than only forecast events and help them prepare for impending catastrophes. Thus, focus should be placed on enhancing the diversity of pastoralists' sources of income by training in entrepreneurship, teaching them how to pool capital to finance their ventures, and guaranteeing them access to capital and markets. Since they reside in regions with low levels of moisture, the emphasis should be on promoting soil and water conservation as well as watershed management. In light of this, pastoralists should diversify their sources of income to offset their reliance on raising cattle. These activities include crop farming, small-scale trading, handicrafts, the sale of wood and charcoal, and temporary labour.

Early warning system content and services can be shaped by a thorough grasp of community knowledge and experience, allowing important information to be delivered at the local level. Seasonal climate and disease risk forecasts, timely information on the prices of major commodities across major markets, and information on the geographic distribution of forage and water availability are all examples of early warning information. It should also provide guidance on practical risk mitigation techniques and the best ways to react in the event of a shock. One excellent example of a community-based early warning system is the use of

community radios to inform pastoralists about the drought. The majority of Maasai communities are large landholders with little infrastructure, which supports the adoption of community radio as an efficient early warning system in pastoralist groups. In conclusion, planned adaptation techniques that would increase pastoralists' resistance to climate change are necessary given the expected impact of climate change in Kenya's arid and semi-arid regions. To improve pastoralists' ability to adapt to climate change, a variety of stakeholders, including the government, communities, non-governmental organisations, and the corporate sector, have significant responsibilities to play.

Examining a suitable assessment index scheme ought to promote the sustained growth of farmers' incomes. The comprehension of farmers' livelihoods, the combination and flow of livelihood assets, the effect of climate change, and other dangers should all form the foundation of a solid and scientific index system. We should create a sustainable developmental assessment index based on the principles of the unity of scientificity and practicability, systematisation and hierarchy, comparability and quantification, guidance and pertinence, and combining quantitative assessments with qualitative assessments. This will help us identify vulnerable groups, provide them with targeted training on sustainable livelihood capacity-building, and increase their adaptability. In order to quantify the sustainability of farmers' livelihoods, it is necessary to go beyond the limitations of the conventional single evaluation of the governance effect of the post-livelihood state and include the evaluation of components like early warning systems for poverty risk and precise defense capabilities.

Follow-up assessment of external climate risk early warning, should focus on evaluating how sensitive and vulnerable farmers and impoverished areas are to natural catastrophes and climate change. The execution of policies involves the government. To ensure the resilience of ASAL lands, for example, the Kenya Arid and Semi-Arid Lands Policy is essential. The policy could work wonders for Kajiado County and other counties with comparable problems if it is effectively put into practise. In a similar vein, the Kenya Climate Change Act of 2016 needs to be closely monitored and put into practise in order to provide institutional and legal frameworks for climate change adaptation and mitigation in Kenya. It would be crucial to handle climate change resilience and adaptation plans in a way that is as unique and region-specific as feasible. Climate factors and rainfall vary, and the consequences of either are experienced differently by area or sub-county.

The assessment of farmers' endogenous resilience, encompassing psychological endurance, adaptability, resilience, and other attributes, is the second recommendation. The sustainability of farmers' livelihoods should be evaluated using a dynamic, multifaceted, integrated index system. In order to ensure farmers' sustainable development and rural revitalization, the evaluation system for farmers' sustainable livelihoods should therefore emphasise the value orientation of sustainable development in addition to efficiency and equity. Using technology will help systems adapt to climate change by enhancing techniques for gathering water and finding feed, making it easier to replace species, and allowing the development of diverse livestock breeds that can withstand varying environmental conditions or disease outbreaks.

References

Adhikari, U.A., Pouyan N & Sean A. W (2015): Climate change and eastern Africa: A review of impact on major crops. Food and Energy Security 4 (2): 110–132.

Aklilu, Y., Lemma, G., Deng, L., & Abdullahi, S. (2016). The impact of conflict on the livestock sector in South Sudan. Juba, South Sudan: Food and Agriculture Organization of the United Nations

ASAL Policy of Kenya (2015): Draft National Policy for the Sustainable Development of Northern Kenya and other Arid Lands. Unlocking Our Full Potential for Realization of the Kenya Vision 2030'.

Ashton, P.J. (2002). Avoiding conflicts over Africa's water resources. Journal of Human Environment, 31(3): 236-242.

Bennete, T. (2015) Cultural studies and the cultural concept. Cultural Studies, 29(4): 546-568. http://doi.1080109502386.2014.1000605

Birch, I., & Grahn, R. (2007). Pastoralism–managing multiple stressors and the threat of climate variability and change. *Human development report, 2008*, 2007.

Bobadoye, A.O., Ogara, W.O., Ouma, G.O. & Onono, J.O. (2016) Assessing climate change adaptation strategies among rural Maasai pastoralists in Kenya. American Journal of Rural Development, 4(6): 120-128.

Boko, M., Niang, A., Nyong, A., Vogel, C., Githeko, A., Mendany, B., Osman, E., Tabo, R. and Yanda, P. (2007) Africa: Impacts, Adaptation and Vulnerability. Contribution of Working Group ii to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: Parry, M., Canziani, F., Palutikof, P., Van der, L. and Hanson, C. (Eds.), Cambridge University Press, Cambridge UK pp. 433-467.

Cambridge UK and New York, USA: Cambridge University Press.

Catley, A., & Aklilu, Y. (2013). Moving Up or Moving Out?: Commercialization, growth and destitution in pastoralist areas. In *Pastoralism and Development in Africa* (pp. 85-97). Routledge.

Catley, A., Lind, J & Scoones, I (2016): The futures of pastoralism in the Horn of Africa: Pathways of growth and change. Review of Scientific Techniques. 35(2):389-403.

Curry, J. (2011). Nullifying the climate null hypothesis. WIREs Climate Change, vol. 2, pp. 919-924.

Egeru, A (2016): Climate risk management information, sources and responses in a pastoral region in East Africa: Climate Risk Management 11: 1–14

Ericksen, P., De Leeuw, J., Thornton, P.K., Said, M., Herrero, M. and Nobenbaert, A. (2013) Climate change in sub-Saharan Africa: what consequences for pastoralism?. In: Catley. A., Lind, J. and Scoones, I. (Eds.), Pastoralism and Development in Africa Dynamic Change at the Margins. Routledge, London, pp.77-81 .23884.

Erickson, P. (2010) Livestock Drought Management Tool. Final Report for Project OSRO/RAF/915/RFF/PR 44865. Submitted by ILRI to FAO Sub-Regional Emergency and Rehabilitation Officer to East and Central Africa.

Ernoul, L., Vareltzidou, S., Charpentier, M and Muryanyi-Kovacs, C (2020): Perception of climate change and mitigation strategies in two European Mediterranean deltas. AIMS Geosciences 6(4): 561-576

Eyasu E., Feyera A. (2010), Putting Pastoralists on the Policy Agenda: Land Alienation in Southern Ethiopia, *Gatekeeper Series*, IIED, London, pp 14–19.

FAO (2010). Weather and Agriculture in Kenya. Government Printers, Nairobi.

FAO (2016). The State of Food Security and agriculture, Climate Change, Agriculture and Food Security. Rome, Italy. A report accessed on 18.11.2023 from www.fao.org/pubication.

Filho W. L., Nzengya D., Muasya G., Chemuliti J & Kalungu J. W (2017): Climate Change Responses among the Maasai Community in Kenya. Climate Change.145(1):6-83

Galvin, K.A. (2009) Transitions: pastoralists living with change. Annual Review of Anthropology, 38(1): 185-198.

Galvin, K.A., Thornton, P.K., Boone, R.B. & Sunderland, J. (2004). Climate variability and impacts on East Africa livestock herders: the Maasai of Ngorongoro conservation area, Tanzania. Journal of Range and Forage Sciences, 21: 183-189.

GoK (2016) Kajiado County Statistical Abstract Government of Kenya, Nairobi. Accessed on 20.11.2023 from https://books.google.co.ke/books/about/County_Statistical_Abstract_Kajiado_Coun.html?id=uPTPzAEACAAJ&redir_esc=y

Gregory, P.J., Ingram, J.S. & Brklacich, M (2005). Climate change and food security. The Royal Society, 360(1463): 2139-2148.

Herrero, M., Addison, J., Bedelian, C., Carabine, E., Havlík, P., Henderson, B., van de Steeg, J & Thornton, P (2016): Climate change and pastoralism: impacts, consequences and adaptation Herrero, Rev. Sci. Tech. Off. Int. Epiz., 35 (2), 417–433.

Huang, J., Mingxia. J., Yongkun, X., Shanshan, W., Yongli, H & Jinjiang, R (2016): Global semi-arid climate change over last 60 years. Climate Dynamics 46 (3): 11311150.

Hugo, J.M. and Mugalavai, E.M. (2010). The effects of droughts on food security in Kenya. International Journal of Climate Change Impacts Response 2(2): 61-71.

IFAD (2009) Livestock and Climate Change. Rome, Italy. Accessed on 18.11.2023 from https://www.uncclearn.org/sites/default/files/inventory/ifad81.pdf.

IPCC (2007) Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: Parry, M.L. Canziani, O.F Palutikof J.P., van der Linden P.J and Hanson, C.E. (Eds.), Cambridge University Press, Cambridge, UK, 976p.

IPCC (2014) Summary of Policymakers. In: Climate Change 2014. Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge UK and New York, USA: Cambridge University Press.

Kirimi, J., Mwangi, G. & Nkurumwa, A. (2013). Climate change challenges and adaptation strategies among the pastoralists of Laikipia County, Kenya. International Journal of Agricultural Extension, 1(1): 20-30.

League of Pastoral People (2009) Indigenous Livestock Development. Annual Report. http//www.pastoralpeople.org/wp-content/Accessed on 04.09.2017.

Liang, X. Z., Wu, Y., Chambers, R. G., Schmoldt, D. L., Gao, W., Liu, C., ... & Kennedy, J. A. (2017). Determining climate effects on US total agricultural productivity. *Proceedings of the National Academy of Sciences*, 114(12), E2285-E2292.

López-Carr, D., & Burgdorfer, J. (2013). Deforestation drivers: population, migration, and tropical land use. *Environment: Science and Policy for Sustainable Development*, *55*(1), 3-11.

Marius, W.N. (2012). Tibetan nomads facing an uncertain future: impacts of climate change on the Qinghai-Tibetan plateau, in Armando Lamadrid, Ilan Kelman. Community. Environment and Disaster Risk Management, 11: 95-118.

McSweeney, C., New, M., Lizcano, G. and Lu, X. (2010). The UNDP Climate Change Country Profiles Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries. Bulletin of the American Meteorological Society 91: 157 – 166.

Milly, P.C., Betancourt, J., Falkenmark, M., Hirsch, R.M., Kundzewicz, Z.W. and Lettenmaier, D.P. (2008) climate change-stationarity is dead: whither water management. Science, 319 (5863): 573-574.

MoALF (2017) Climate Risk Profile for Kajiado County. Ministry of Agriculture, Livestock and Fisheries, Government of Kenya, Nairobi, Kenya. Accessed on 20.11.2023 from http://www.nafis.go.ke/wp-content/uploads/2018/02/Programme-Document-ASDSP-II2017-05-09-PD.pdf.

Muchuru, S., & Nhamo, G. (2017). Climate change and the African livestock sector: emerging adaptation measures from UNFCCC national communications. *International Journal of Climate Change Strategies and Management*, *9*(2), 241-260.

Mukuna, G.J., Muthoni, K.S. & Omedo, B.B. (2015). Influences of changes in rainfall patterns on livestock feeding in Kajiado. British Journal of Applied Science, 7(2): 134-140.

Nardone, A., Ronchi, B., Lacetera, N., Ranieri, M.S and Bernabucci, U. (2010): Effects of climate change on animal production and sustainability of livestock systems. Livestock Science. 130: 57–69.

New, M. (2015) Are Semi-Arid Regions Climate Change Hot-Spots? Evidence from Southern Africa. Adaptation at scale in semi-arid regions. University of Cape Town.

Nobenbaert, A., Karanja, S.N., Herero, M., Felisberto, M. and Moyo, S. (2013). Derivation of household-level vulnerability index for empirically testing measures of adaptive capacity and vulnerability. *Regional Environmental Change*, 13(2): 459-470.

Nori, M. and Davies, J. (2007) Change of Wind or Wind of Change? Climate Change, Adaptation and Pastoralism. WISP working paper prepared by IUCN, Nairobi. Accessed on 20.11.2023 from www.iucn.org/WISP/documents_english/wsp-CCAP-final-en.pdf

Nori, M., & Davies, J. (2007). Change of wind or wind of change. *Climate change, adaptation and pastoralism, WISP, IUCN: Nairobi*.

Nyariki, D.M., Mwang'ombe, A. & Thompson, D.M. (2009) Land use change and livestock production challenges in the integrated system: the Maasai Mara ecosystem Kenya. *Journal of Human Ecology*, 26(3): 163-173.

Okoti, M., Kung'u, J & Obando J (2014). Impact of climate variability on pastoral households and adaptation strategies in Garissa County, Northern Kenya. Journal of Human Ecology, Delhi, India. 45(3):243-249.

Opiyo, F.E.O., Ekaya, W.N., Nyariki, D.M. and Murithi, S.M. (2011) Seedbed preparation influence on morphometric characteristics of perennial grasses of semi-arid pastoral in Kenya. African Journal of Plant Science, 5(8): 460-468.

Osano, P. M., Said, M. Y., de Leeuw, J., Moiko, S. S., Kaelo, D. O., Schomers, S., ... & Ogutu, J. O. (2013). Pastoralism and ecosystem-based adaptation in Kenyan Masailand. *International Journal of Climate Change Strategies and Management*. 5 (2), 198-214.

Ostrom, E. (2011) Background of the institutional analysis and development framework. Policy Studies Journal, 39(1): 7-27.

Oxfam (2008). Survival for the Fittest: Pastoralism and Climate Change in East Africa (Vol. 16). Oxfam International. Accessed on 20.11.2023 from https://policy-practice.oxfam.org.uk/publications/survival-of-the-fittest-pastoralism-and-climatechange-in-east-africa-114607.

Ozor, N., Urama, K. & Mwangi, W. (2012) Climate change vulnerability and the use of indigenous technologies for adaptation among smallholder farming communities in sub-Saharan Africa. Journal of Agricultural Extension, 16, 2: 161-182.

Pal, J.S. and Eltahir, E.A (2015) Future Temperature in Southwest Asia Projected to Exceed a Threshold for Human Adaptability. Accessed on 20.11.2023 from http://doi.org/10.1007/978-3-642-12194.4-1.

Patt, G & Schröter. D (2007): Perceptions of environmental risks in Mozambique: Implications for the success of adaptation and coping strategies. The World Bank Development Research Group. Sustainable Rural and Urban Development Team. Policy Research Working Paper, 4417.

Raleigh, C., & Urdal, H. (2007). Climate change, environmental degradation and armed conflict. *Political geography*, *26*(6), 674-694.

Raninowitz, P & Conti, L (2013). Links among human health, animal health and ecosystem

Rust, J. M., & Rust, T. (2013). Climate change and livestock production: A review with emphasis on Africa. *South African Journal of Animal Science*, *43*(3), 255-267.

Said, M.Y., Muhwanga, J., Bedelian, C., Moiko, S. and Abuya, R. (2017) Climate Projections for Arid and Semi-Arid Land of Kenya Based on RCP 2.6, RCP4.5 and 8.5. PRISE report. Kenya Markets Trust, Nairobi, Kenya.

Sexton D.M.H., Rowell, D.P., Folland, C.K. & Karoly, D.J. (2001). Detection of anthropogenic climate change using an atmospheric GCM. Climate Dynamics, vol. 17, pp. 669–685.

Sharma, V., Orindi, V., Hesse, C., Pattison, J. and Anderson, S. (2014) Supporting Local Climate Adaptation Planning Implementation Through Governance and Decentralized Finance Provision. 24 (4): 579-590.

Shiferaw, D., Takele, S.and Hailemichael, A. (2017) Indigenous practices of the Ganta community in protecting natural resources, Gamo, Gofa Zone, Ethiopia. International Journal of Environmental Protection and Policy, 5(5): 74-83.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M., & Okoba, B. (2012). Climate change perception and adaptation of agro-pastoral communities in Kenya. *Regional Environmental Change*, *12*(4), 791-802.

Sinclair, A. R. E., & Pech, R. P. (1996). Density dependence, stochasticity, compensation and predator regulation. *Oikos*, 164-173.

TCAR (2016). Climate Policy. Irish Aid, Dar es Salaam, Tanzania. 17pp.

Tellman, B., Sullivan, J. A., Kuhn, C., Kettner, A. J., Doyle, C. S., Brakenridge, G. R., ... & Slayback, D. A. (2021). Satellite imaging reveals increased proportion of population exposed to floods. *Nature*, *596*(7870), 80-86.

Thornton, P.K., Jones, P.G., Ericksen, P.J. & Challinor. A.J. (2011) Agriculture and food systems in sub-Saharan Africa, Philosophical Transactions of the Royal Society, 369: 117-136.

Toulmin, C (2009): Climate change in Africa. Climate change is a major challenge for us all, but for African countries it represents a particular threat. Impact that Climate change has on Africa's development prospects. Zed books.

UNDP (2013) Combating Desertification in Kenya; Emerging Lessons from Empowering Local Communities, Nairobi.

University Press, Cambridge, UK, 976p

Walker, B., Holling, C. S., Carpenter, S. R. & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. Ecology and Society, 9(2):5-9.

Washington, D.C Accessed on 20.11.2023 from https://www.gfdrr.org/sites/default/files/publication/Urban%20Resilience%20Flagship% 20Report%20FINAL%20(10%2012%2016).pdf.

Wassie, B., & Fekadu, B. (2014). The impact of climate change on pastoral production systems: a study of climate variability and household adaptation strategies in southern Ethiopian rangelands. *WIDER Working Papers*, (028).

Weart, S.R. (2010). The idea of anthropogenic global climate change in the 20th century. *WIREs Climate Change*, vol. 1, pp. 67-81.

WHO (2014). Climate Change and Health. http://www.int/media centre/factsheets/fs266/en/ accessed on 18.11.2023.

World Bank (2008). Agriculture for Development. World Development Report. ISBN 139780821368084. Accessed on 20.11.2023 from https://openknowledge.worldbank.org/handle/10986/5990.

World Bank (2013). Africa Development Indicators 2012/13. Washington DC Accessed on 20.11.2023 from http://openknowledge.worldbank.org/bitstream/handle/10986/13504/978082139662.pdf?sequence=1)

World Bank (2014) An Expanded Approach to Urban Resilience: Making Cities Stronger.

Xiao, W., Bilal, A., Gemechu, S, Gede, K., Yonas, T. and Xiaadan, L. (2018) Does participatory forest management save the remnant forest in Ethiopia. Proceedings of the National Academy of Sciences, 88(1): 1-14.