GSJ: Volume 13, Issue 2, February 2025, Online: ISSN 2320-9186
www.globalscientificjournal.com

Adaptive Strategies to Climate Change in ASAL Pastoral Communities of Northern Kenya

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Abstract

Climate change significantly impacts pastoral communities in Northern Kenya's arid and semi-arid lands (ASALs), particularly among the Turkana and Somali pastoralists. Rising temperatures, prolonged droughts, and erratic rainfall patterns threaten traditional livestock-dependent livelihoods, worsening food insecurity and economic stability. This study aims to assess the climate change adaptation strategies employed by these communities and evaluate the effectiveness of policy interventions in supporting resilience. A mixed-methods approach was used, including household surveys, focus group discussions, and key informant interviews with 200 pastoralist households. Results indicate that mobility, herd diversification, water conservation techniques, and alternative livelihoods are key adaptation strategies. However, challenges such as inadequate institutional support, weak policy implementation, and land tenure disputes hinder long-term resilience. The study concludes that strengthening community-based resource management, improving climate-resilient infrastructure, and integrating indigenous knowledge into policymaking are crucial for sustainable adaptation. Policy implications emphasise the need for tailored interventions that address socio-economic and cultural dynamics to enhance climate resilience in ASAL regions of Kenya.

Keywords:, Climate Change Adaptation, ASAL, Pastoralism, Northern Kenya

1. Introduction

Climate change poses significant challenges to pastoral communities in Kenya's arid and semi-arid lands (ASALs), particularly among the Turkana in the northwest and the Somali in the North Eastern Province. These regions are experiencing increased temperatures, prolonged droughts, and unpredictable rainfall patterns, which adversely affect traditional pastoral livelihoods. The Turkana and Somali pastoralists, who have historically relied on livestock rearing and mobility to adapt to environmental variability, now face heightened vulnerability due to the intensifying impacts of climate change. Studies have shown that these communities are disproportionately absorbing the effects of climate change, leading to the abandonment of

livelihood practices that hold deep cultural significance (Waila, 2018; Imana & Zenda, 2023; Omolo, 2010).

In Turkana County, recurrent droughts have led to significant livestock losses, diminishing the primary source of food and income for the community. The depletion of water sources and pasturelands has forced many pastoralists to migrate in search of resources, often leading to conflicts over the scarce remaining resources. Also, according to Hodbod et al., (2019), development projects such as the construction of the Gibe III Dam in Ethiopia have altered the flow of the Omo River, which supplies 90% of Lake Turkana's water, further threatening the livelihoods of those dependent on the lake.

The combination of climate-induced environmental changes and infrastructural developments has exacerbated the challenges faced by the Turkana pastoralists, making their traditional way of life increasingly untenable (Human Rights Watch, 2015; Opiyo, 2014).).Similarly, the Somali pastoral communities in Kenya's North Eastern Province are grappling with the adverse effects of climate change. The increasing frequency and severity of droughts have led to water scarcity and reduced pasture availability, resulting in weakened livestock health and decreased productivity.

These challenges are compounded by socio-economic factors, including limited access to markets, inadequate infrastructure, and historical marginalisation, which hinder the communities' capacity to adapt effectively to the changing climate. Research indicates that the Somali pastoralists are employing various adaptation strategies, such as migrating to better grazing areas, adopting drought-resistant livestock breeds, and diversifying their livelihoods to include alternative income-generating activities (Osman, 2015; Tenaw, 2021).

Despite these challenges, both the Turkana and Somali pastoralists have demonstrated resilience through various adaptive strategies. These include diversifying livelihoods, adopting controlled grazing practices, and engaging in community-based resource management initiatives. However, the escalating pace of climate change necessitates enhanced support from governmental and non-governmental entities to bolster these adaptive capacities and ensure the sustainability of pastoral livelihoods in Kenya's ASAL regions. Policy interventions aimed at improving access to water resources, providing climate-resilient infrastructure, and facilitating market access for pastoral products are crucial in enhancing the adaptive capacity of these communities (Njoka et al., 2018; Lutta et al., 2023).

This paper examines the impacts of climate change on the Turkana and Somali pastoral communities, analysing their adaptive strategies and the role of policy interventions in supporting sustainable livelihoods. Focusing on these two case studies, allows this research paper to contribute to a deeper understanding of the challenges and opportunities faced by pastoralists in Kenya amidst a changing climate. The findings underscore the need for comprehensive and context-specific approaches to climate adaptation that consider the unique socio-cultural and economic dynamics of pastoral communities.

2. Local Strategies for Climate Change Adaptation

2.1. Climate Variability in Turkana and North Eastern Kenya

An analysis of climate data from different weather stations across East Africa reveals significant changes in temperature and precipitation trends over recent decades. Studies indicate that the region has been experiencing increasing temperature extremes, rising at an average rate of 0.2°C to 0.3°C per decade (Nembilwi et al., 2021). These changes, coupled with declining rainfall patterns, have significantly impacted pastoral livelihoods.

The case studies described below present an analysis at the local level of the climate change adaptation strategies that people themselves are developing. Two specific places are analysed: in Kenya, the Turkana pastoral communities in the north western region; and in Kenya’s North

Eastern Province, the Somali pastoral communities. Table 1 presents key characteristics of both case studies, highlighting common features such as high poverty rates, pastoralism as the primary livelihood, and dependence on livestock for food security, communal land tenure systems, and exposure to extreme climatic conditions.

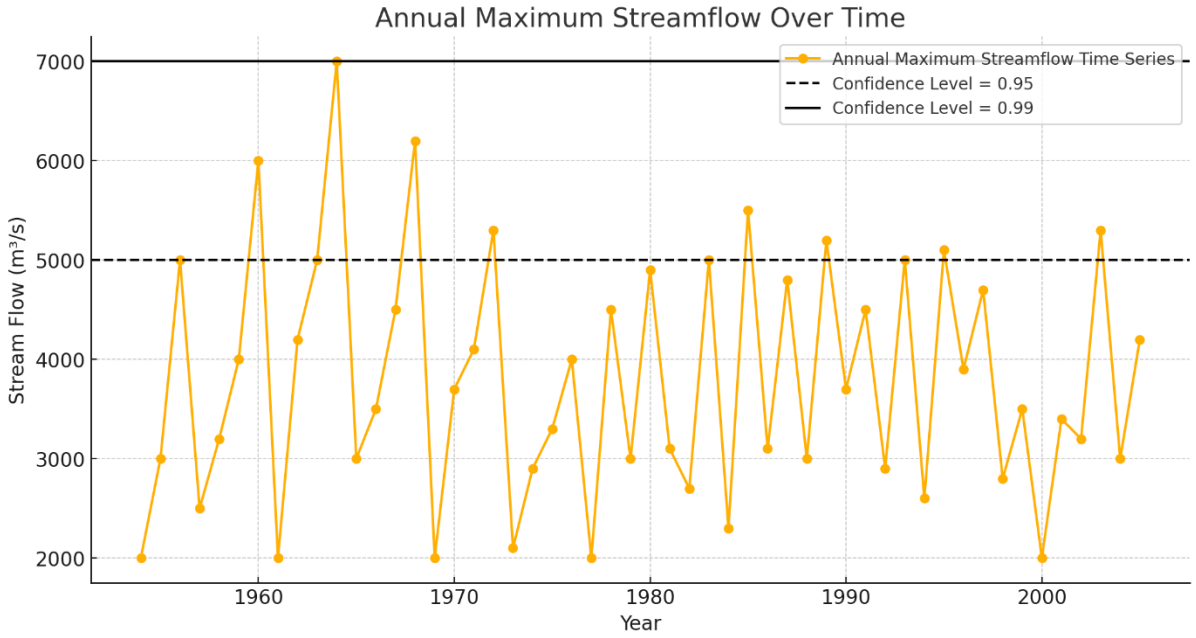
Table 1: Characterisation of the Study Areas

Features	Turkana Pastoralists (North Western Kenya)	Somali Pastoralists (North Eastern Kenya)
Region	North-western Kenya	North Eastern Kenya
Climate	Arid and semi-arid; frequent droughts	Arid and semi-arid; frequent droughts
Types of Vegetation	Acacia woodland, grasslands, shrubs	Grasslands, sparse acacia trees, shrubs
Main Livelihood	Pastoralism (livestock rearing)	Pastoralism (livestock rearing)
Poverty Rate	High	High
Land Tenure System	Communal grazing land	Communal grazing land
Climatic Challenges	Prolonged droughts, water scarcity, land degradation	Erratic rainfall, recurrent droughts, desertification
Adaptation Strategies	Mobility, livestock diversification, water conservation, alternative livelihoods	Mobility, herd splitting, livestock diversification, resource-sharing networks

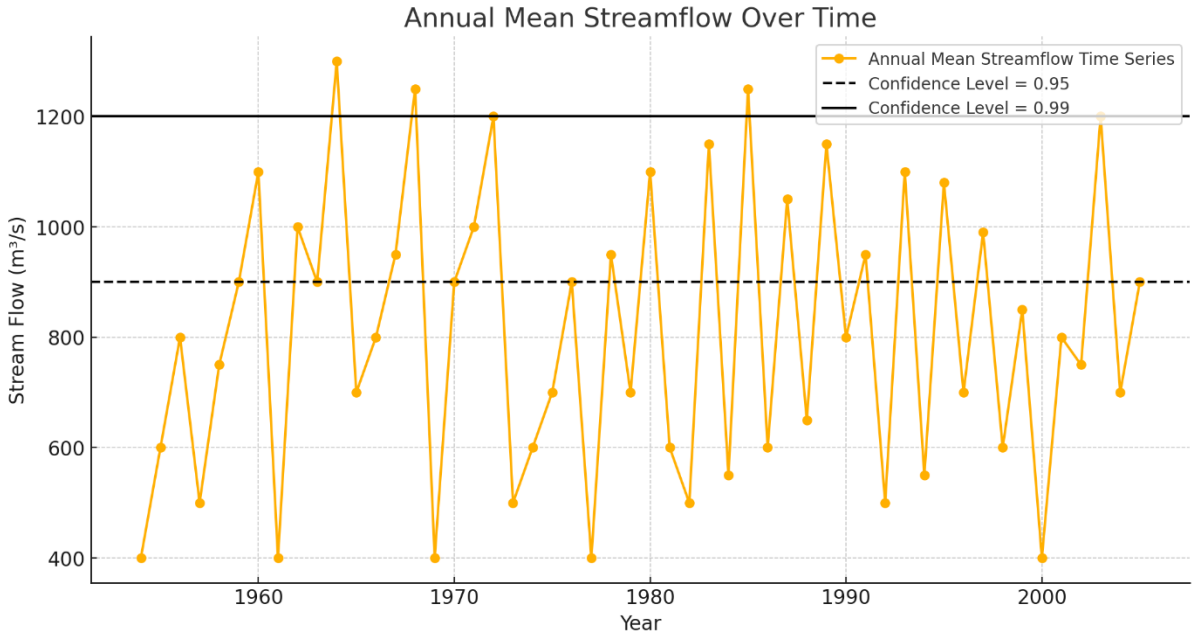
To illustrate these trends, Figure 1 presents the annual maximum and mean streamflow trends in Turkana. These fluctuations reflect the impacts of declining precipitation and increasing temperatures, which have led to prolonged drought conditions.

Figure 1: Annual Maximum and Mean Streamflow Trends in Turkana

(a)



(b)

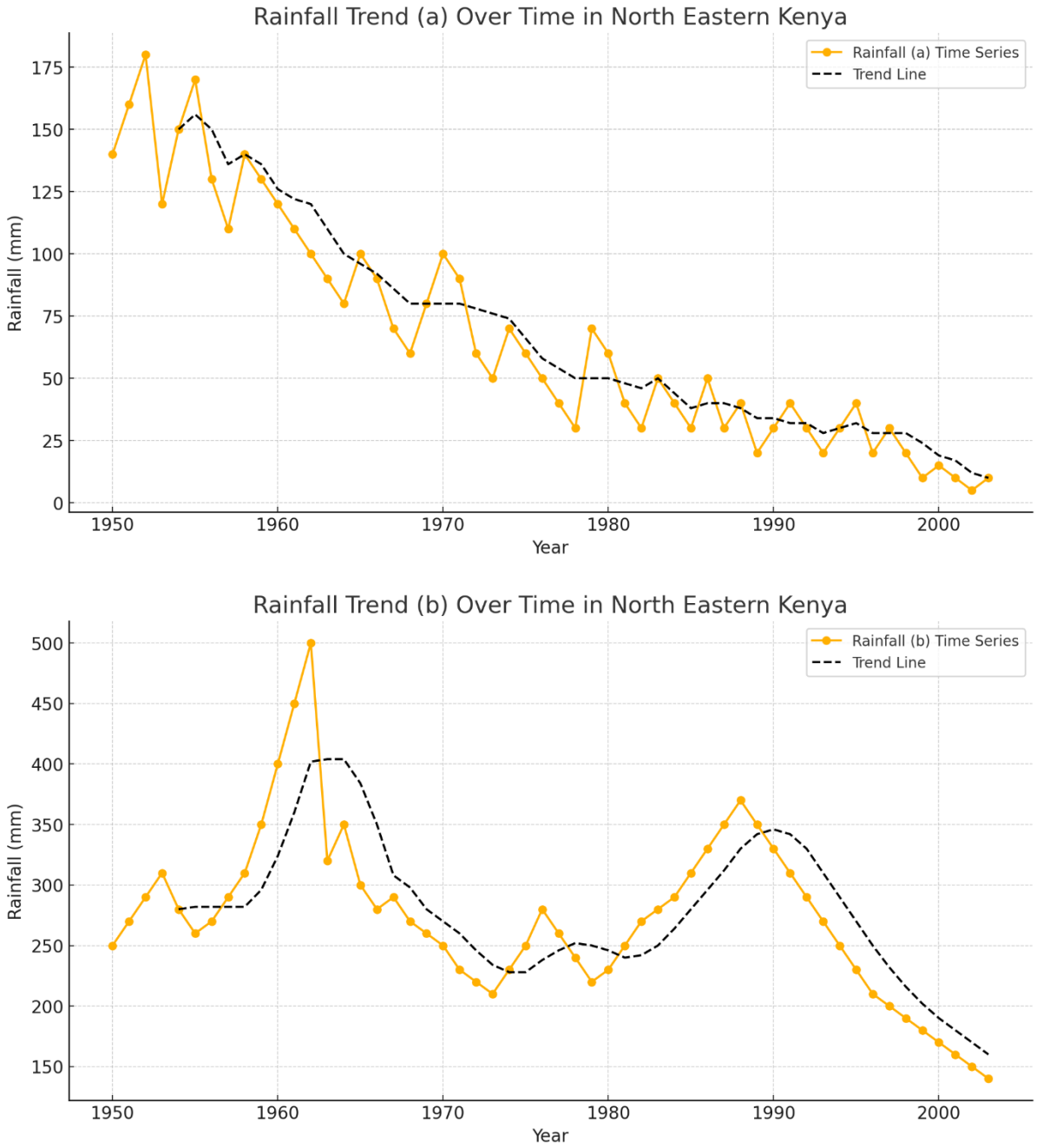


Source: (KMD, 2023)

In Turkana, climate data on precipitation and temperature for the last four decades from meteorological stations indicate a clear trend of increasing mean annual temperatures, averaging approximately 0.07°C per year. Concurrently, annual precipitation has been declining by an estimated 10-15 mm per year. This has led to frequent and prolonged droughts, reducing pasture availability and accelerating land degradation (KMD, 2023).

Figure 2 showcases rainfall trends in North Eastern Kenya, indicating the increasing variability in precipitation. The combination of extreme dry spells and short, intense rainfall events has aggravated land degradation and water scarcity, severely affecting pastoral livelihoods.

Figure 2: Rainfall Trends in North Eastern Kenya



Source: (KMD, 2023)

For the Somali pastoral communities in North Eastern Kenya, meteorological records show similar trends. Data from the Garissa Meteorological Station from 1980 to 2020 reveal a temperature increase of approximately 0.06°C per year, along with highly erratic and declining rainfall patterns. Unlike Turkana, which has seen a general decline in precipitation, North Eastern Kenya experiences increased variability, characterised by intense short-term rainfall events followed by prolonged dry spells. These patterns have contributed to unpredictable grazing conditions, increased livestock mortality, and heightened resource-based conflicts (KMD, 2023; Schilling et al., 2012; Opiyo et al., 2015).

2.2. Impacts on Livelihoods and Adaptation Strategies

In response to these climatic challenges, both communities have developed various adaptive strategies. In Turkana, pastoralists rely on mobility, moving livestock across vast areas to find pasture and water sources. They have also embraced livestock diversification, shifting from

cattle to more drought-resistant species such as camels and goats. Moreover, community-based water harvesting initiatives have gained prominence, allowing for better water conservation during dry periods (Alhamad et al., 2021; Mukarram et al., 2023).

Among Somali pastoralists, herd splitting is a widely used strategy, where parts of the livestock are sent to different locations to minimise losses during extreme droughts. The community also engages in resource-sharing agreements, allowing access to water points and grazing land during crises. Some households are diversifying into alternative income sources such as small-scale trade and remittances from family members working in urban centers (Desalegn et al., 2022; Kebede et al., 2024; Muse et al., 2023). Equally, both Turkana and Somali pastoral communities continue to demonstrate resilience in the face of climate change. However, increasing frequency and severity of climatic extremes require sustained support through policy interventions, infrastructure development, and improved access to climate information to enhance adaptive capacity.

3. Methods

3.1 Population and Sample

The study population consists of ASAL pastoral communities of northern Kenya, particularly, the Turkana and the Somali pastoralist households in north-western and north-eastern Kenya. These populations were selected due to their high vulnerability to climate change, reliance on pastoralism, and long history of indigenous adaptation strategies. The selection aimed to ensure that the study captured a broad spectrum of climate adaptation practices within arid and semi-arid regions.

A purposive sampling technique was employed to target pastoralist households actively engaged in climate adaptation efforts. The sample consisted of 200 households, with 100 from Turkana and 100 from the Somali pastoralist community. The selection criteria included active involvement in livestock rearing, direct exposure to climate variability impacts, and willingness to participate in the study. Households that had migrated outside the study regions during the data collection period were excluded to maintain consistency in responses.

Participants were identified through local community leaders and pastoralist associations, who facilitated initial contact. Snowball sampling was then used to reach additional respondents recommended by the initial participants. The study was conducted between December 2024 and January 2025. Interviews and focus group discussions took place at community centers, local administration offices, and designated pastoralist gathering points to ensure accessibility and participant comfort.

3.2 Sample Characteristics

The demographic characteristics of the study sample are summarised in Table 2, which includes variables such as gender, education level, income, and age distribution.

Table 2: Sample Characteristics

Characteristics	Turkana (%)	Somali (%)
Gender	Male (60%)	Male (55%)
	Female (40%)	Female (45%)

Age	18-35 (45%) 36-50 (35%) 51+ (20%)	18-35 (50%) 36-50 (30%) 51+ (20%)
Education	No formal education (40%) Primary (35%) Secondary+ (25%)	No formal education (50%) Primary (30%) Secondary+ (20%)
Income Level	Low (<$2/day, 70%) Middle ($2-$5/day, 25%) High (>$5/day, 5%)	Low (<$2/day, 75%) Middle ($2-$5/day, 20%) High (>$5/day, 5%)

The data indicate that both communities have a significant proportion of young adults (18-35 years) and a high prevalence of low-income households earning less than $2 per day. Additionally, a large segment of the population has little to no formal education, which can influence their adaptive capacity to climate change.

3.3 Data Collection Instrument and Validity

Data were collected through household surveys, focus group discussions, and key informant interviews. The study employed a mixed-methods approach to capture both quantitative and qualitative insights. Quantitative data were analysed using descriptive and inferential statistics, including chi-square tests and regression analysis, to determine relationships between socio-economic factors and adaptation measures.

For qualitative data, a structured interview guide was designed to explore in-depth experiences and perceptions of climate adaptation. The interview guide was categorised into key themes: (1) climate change perception, (2) adaptation strategies, (3) barriers to adaptation, and (4) policy and institutional support. Open-ended questions were used to encourage participants to elaborate on their experiences, such as "How have recent droughts affected your livestock and livelihoods?" and "What strategies have you adopted to cope with climate changes?" Probing techniques were applied to gain further insights into decision-making processes, indigenous knowledge use, and external support systems.

Focus group discussions were structured to facilitate community-based dialogue, where participants engaged in discussions on shared challenges and collective adaptation measures. Equally, to ensure validity, triangulation was achieved by cross-referencing household survey responses with focus group discussions and key informant interviews. The interview guide was pre-tested with a small sample to refine question clarity and ensure cultural sensitivity. Ethical considerations, including obtaining informed consent, ensuring voluntary participation, and maintaining anonymity, were strictly adhered to throughout the study.

4. Results

4.1. The Case of Turkana Pastoralists, North Western Kenya

Turkana County, located in north-western Kenya, is one of the most arid and impoverished regions of the country. The area is characterised by high levels of poverty, low literacy rates, and limited access to essential services, including education, healthcare, and infrastructure. The region experiences extreme climatic conditions, with high temperatures averaging 30-35°C and low annual rainfall between 150-500 mm. Droughts are frequent, and water scarcity remains a

significant challenge, severely impacting pastoral livelihoods. Livestock keeping, primarily of camels, goats, and cattle, is the predominant economic activity. However, frequent droughts have led to significant livestock losses, increasing food insecurity and economic vulnerability.

Beyond environmental constraints, socio-political dynamics also shape pastoralist vulnerabilities. The region's remoteness limits market access, restricting economic diversification opportunities. Additionally, conflicts over pasture and water resources frequently arise, particularly during prolonged droughts. Limited institutional presence exacerbates these issues, as many government interventions lack consistency or fail to align with local needs. Addressing these interwoven challenges requires a multi-faceted approach integrating both traditional and modern adaptation strategies.

A critical factor influencing Turkana pastoralists' resilience is the role of indigenous knowledge in environmental management. Many Turkana herders rely on traditional ecological knowledge to predict weather patterns and identify suitable grazing lands. This knowledge, passed down through generations, enables them to navigate harsh climatic conditions. However, climate change is increasingly undermining the reliability of these traditional indicators, forcing pastoralists to seek alternative coping strategies, such as engaging in small-scale irrigation farming along seasonal rivers.

4.1.1. Individual and Collective Strategies

To cope with climatic variability and ensure their survival, the Turkana pastoralists have developed multiple adaptation strategies. Given the unpredictability of rainfall, they rely on mobility, migrating with their livestock in search of pasture and water. This practice, deeply ingrained in their culture, helps mitigate the risks associated with drought. In response to decreasing pasture availability, there has been a shift towards keeping more drought-resistant species such as camels and goats.

A key strategy in Turkana is the implementation of social support systems that allow for the redistribution of resources among households. Families that lose their livestock due to drought or disease often receive support from wealthier members of the community, ensuring that they are not completely devastated by adverse climatic conditions. This informal social insurance system, though effective, is increasingly strained by prolonged droughts and increasing resource scarcity.

Another important adaptation measure is diversification of income sources. Many Turkana households engage in small-scale trade, selling livestock products such as milk, hides, and meat. Others engage in fishing along Lake Turkana, which has become an alternative livelihood source for communities living close to the water body. However, fishing is itself threatened by climate variability and changes in lake water levels.

Several Turkana pastoralists have also embraced agro-pastoralism, growing drought-tolerant crops such as millet and sorghum in small plots. While still a relatively minor livelihood strategy, agro-pastoralism is gaining traction as a means of supplementing food supply and reducing dependence on livestock. Government and NGO initiatives have supported this transition by providing seeds and training in conservation agriculture practices.

The impact of climate change on water availability has led to increased efforts in rainwater harvesting. Some households have constructed underground water storage systems to retain water during the rainy season. This practice is gradually being adopted at the community level, with shared water storage systems being established to ensure year-round access to water for both human and livestock consumption.

Livestock health management has also become a priority among Turkana pastoralists. Veterinary services, often provided through mobile clinics, have improved disease control among herds. Vaccination campaigns and access to basic animal health care are reducing livestock mortality rates, thereby helping to sustain pastoral livelihoods in the face of recurring droughts and food shortages.

Table 4.1: Adaptation strategies identified by Turkana pastoralists: origin of initiatives and existing interrelationships

Category	Individual	Collective	Institutional	Related to
Livestock mobility	Yes	Yes		Grazing management
Construction of shallow wells and boreholes	Yes	Yes		Water resource management
Rainwater harvesting	Yes	Yes		Water storage and conservation
Supplementary feeding	Yes			Drought resilience
Fodder cultivation	Yes	Yes	Yes	Livestock productivity
Establishment of social support networks		Yes		Economic resilience
Community grazing reserves		Yes	Yes	Rangeland conservation
Diversification of livelihoods	Yes		Yes	Economic diversification
Veterinary interventions and vaccinations		Yes	Yes	Livestock health
Conflict resolution mechanisms		Yes		Pastoral security

The findings reveal that Turkana pastoralists heavily rely on mobility as their primary coping mechanism, underscoring the fundamental role of flexible resource use in adapting to arid conditions. However, limited institutional support and ongoing land-use restrictions are progressively undermining this adaptation. Although individual strategies such as supplementary feeding and rainwater harvesting are emerging, their impact is constrained by financial and logistical challenges. Community-level interventions, such as grazing reserves and borehole drilling, illustrate a shift towards collective resilience, yet their sustainability remains questionable without robust institutional backing.

4.1.2. Perception of government policies and programmes

National policies and programs aimed at supporting Turkana pastoralists' adaptation to climate change have achieved mixed results. Early warning systems and drought response initiatives, facilitated by the NDMA, provide essential climate-related information, but their inconsistent implementation and inadequate funding limit their effectiveness. Likewise, the Hunger Safety Net Programme (HSNP) offers much-needed financial relief to drought-affected households, but concerns over dependency and limited coverage reduce its overall impact.

Water security remains a key challenge for Turkana pastoralists. Borehole drilling and water resource development initiatives have improved access to water, yet high maintenance costs and frequent mismanagement have led to inefficiencies. Many boreholes fall into disrepair due to a lack of technical capacity and long-term sustainability planning, undermining their potential as climate adaptation tools.

Table 4.2: Relevant Public Policies Aimed at Climate Change Adaptation for Turkana Pastoralists

Policy/Programme	Objectives	Challenges
National Drought Management Authority (NDMA)	Early warning systems and drought response	Inconsistent implementation, insufficient funding
Hunger Safety Net Programme (HSNP)	Cash transfers for drought-affected households	Coverage limitations, dependency concerns
Borehole Drilling and Water Resource Development	Provide water access for livestock and domestic use	High maintenance costs, mismanagement issues
Livestock Insurance Programmes	Financial protection against drought-related livestock losses	Low enrollment, limited awareness
Community Rangeland Management	Prevent land degradation and ensure sustainable grazing	Poor enforcement, land ownership conflicts
Pastoralist Resilience Building Programme	Enhance adaptive capacity through training and resource access	Coordination challenges, short-term focus
Market Development and Livelihood Diversification	Support trade networks and alternative incomes	Poor infrastructure, market volatility
Veterinary Services Expansion	Improve livestock health and prevent disease outbreaks	Inadequate funding, limited reach in remote areas

Livestock insurance programs were introduced as a buffer against drought-induced livestock losses, aiming to protect household incomes from catastrophic shocks. However, these programs suffer from low enrolment rates and a lack of awareness among pastoralists. Affordability also remains a barrier, as many herders struggle to pay the required premiums despite the long-term benefits of the schemes.

Efforts to promote sustainable land management through community-based rangeland management have faced difficulties due to poor enforcement and land tenure disputes. The communal nature of pastoral lands has made it challenging to implement structured grazing plans, often leading to overgrazing and resource depletion. Without clear land ownership rights, conflicts over pastureland persist, exacerbating vulnerabilities to drought.

Government and non-governmental organisations have sought to strengthen pastoralists' adaptive capacity through resilience-building programs. These initiatives focus on training, financial support, and knowledge dissemination. However, short-term funding cycles and poor coordination between agencies limit the scalability of such programs, making long-term impact difficult to sustain.

Economic diversification and improved market access are essential for reducing dependence on livestock, yet poor infrastructure and market volatility continue to limit these opportunities. The underdevelopment of road networks and trading hubs isolates many Turkana pastoralists from larger commercial centers, restricting their ability to engage in alternative livelihoods, such as trade and agro-pastoral farming.

Veterinary services play a crucial role in maintaining livestock health and ensuring the resilience of pastoral economies. However, inconsistent funding and limited accessibility hinder the expansion of these services. Inadequate vaccination programs and a lack of skilled

veterinary personnel result in high livestock mortality rates during disease outbreaks, compounding pastoralists' losses.

Addressing these policy shortcomings requires a multi-pronged approach that integrates both local and national governance structures. Strengthening institutional frameworks, improving coordination between agencies, and ensuring sustainable funding mechanisms will be vital for enhancing Turkana pastoralists' resilience to climate change. Investing in infrastructure development, capacity-building, and financial inclusion will further enable these communities to adapt to an increasingly volatile climate landscape.

While existing policies provide a foundation for adaptation, their success hinges on improving implementation efficiency, reducing bureaucratic inefficiencies, and prioritising long-term sustainability. Collaborative engagement between government institutions, international organisations, and local communities will be critical in ensuring that adaptation measures effectively meet the needs of Turkana pastoralists in the face of evolving climate challenges.

4.2. The Case of Somali Pastoralists, North Eastern Kenya

Somali pastoralists, primarily residing in North Eastern Kenya, operate in a vast and challenging arid environment with an average annual rainfall of 200-500 mm and high temperatures exceeding 35°C. The region is prone to recurrent droughts, making water scarcity and pasture depletion persistent challenges. Livestock rearing mainly camels, goats, and cattle forms the backbone of their economy. However, climatic variability, land tenure disputes, and socio-political instability have compounded their vulnerability, necessitating complex adaptation mechanisms.

The geographical positioning of Somali pastoralists offers both advantages and challenges. Their proximity to Somalia and Ethiopia has facilitated extensive cross-border trade, enabling them to engage in commerce beyond livestock. This economic adaptability, however, is offset by security risks linked to armed conflicts, inter-clan disputes, and sporadic restrictions on cross-border movement. Despite these barriers, the Somali pastoralists have demonstrated resilience through a blend of traditional knowledge and modern adaptation strategies.

4.2.1. Individual and Collective Strategies

Table 4.3: Adaptation Strategies Identified by Somali Pastoralists: Origin of Initiatives and Existing Interrelationships

Category	Individual	Collective	Institutional	Related to
Transhumance	Yes	Yes		Grazing management
Borehole construction	Yes	Yes	Yes	Water security
Destocking	Yes			Economic resilience
Fodder cultivation and storage	Yes	Yes		Livestock productivity
Clan-based rangeland governance		Yes	Yes	Land tenure
Livestock insurance	Yes		Yes	Risk mitigation
Diversification of income sources	Yes		Yes	Economic resilience
Establishment of fodder banks		Yes	Yes	Drought preparedness

Strengthening social networks		Yes		Information sharing
Veterinary support and disease surveillance		Yes	Yes	Animal health

Somali pastoralists employ multiple adaptation strategies to cope with the impacts of climate change, many of which are deeply embedded in traditional knowledge and collective governance. Transhumance, the practice of seasonal migration with livestock, remains a cornerstone of resilience, allowing herders to access distant pastures and avoid overgrazing in localized areas. However, increasing land fragmentation and conflicts over access to water sources are making this strategy less viable over time.

Another key adaptation measure is borehole construction, which ensures a stable water supply during prolonged dry seasons. While many boreholes are built through communal efforts, institutional support from non-governmental organisations (NGOs) and government agencies has played a crucial role in sustaining these water sources. However, the high costs of maintenance and frequent breakdowns pose challenges for long-term sustainability.

Destocking, or reducing herd sizes during droughts, is a widely used individual strategy to mitigate livestock losses. This approach helps herders secure immediate income while preventing overuse of limited resources. However, in times of economic downturn, the ability to sell livestock at profitable prices is constrained, leaving pastoralists vulnerable to further losses.

Fodder cultivation and storage initiatives have gained prominence as a means of improving livestock productivity. Some communities have begun growing drought-tolerant grasses, while others have invested in fodder storage facilities. These efforts help reduce reliance on natural pasture, particularly in periods of scarce rainfall, but adoption remains low due to financial constraints and lack of technical knowledge.

Traditional clan-based rangeland governance continues to regulate grazing patterns and prevent disputes over pastureland. This collective approach fosters cooperation among different pastoral groups, ensuring equitable access to resources. However, land tenure uncertainties and conflicts with governmental land policies have weakened traditional governance structures, reducing their overall effectiveness.

To safeguard against climate-induced livestock losses, livestock insurance schemes have been introduced as an institutional measure. While these programs provide financial compensation to herders in times of crisis, adoption remains limited due to affordability concerns and a lack of awareness. Expanding access to subsidised insurance schemes could enhance the resilience of Somali pastoralists to climate variability.

Economic diversification is becoming an increasingly popular adaptation strategy. Many pastoralists are engaging in alternative income-generating activities, including small-scale trade, agriculture, and cross-border commerce. Institutional support has facilitated this transition, but challenges such as market instability and poor infrastructure hinder its widespread success.

Some communities have established fodder banks, which store animal feed for use during dry periods. This collective initiative helps buffer against seasonal fluctuations in pasture availability. However, sustainability issues arise due to inadequate storage infrastructure and financial constraints.

Strengthening social networks and knowledge-sharing systems has proven invaluable in enabling Somali pastoralists to adapt to climate change. Community-based organisations and cooperative groups provide a platform for exchanging information about climate trends, best practices, and early warning systems. Expanding these networks could enhance resilience by fostering stronger communal support mechanisms.

Finally, veterinary services and disease surveillance have been critical in reducing livestock mortality rates. Collective and institutional efforts have expanded vaccination programs and improved animal healthcare. However, limited access to veterinary professionals in remote areas remains a significant challenge. Increased investment in mobile veterinary units and community-based animal health programs could bridge this gap.

4.2.2. Perception on public Policies aimed at Climate Change Adaptation

Table 4.4: Relevant Public Policies Aimed at Climate Change Adaptation for Somali Pastoralists

Policy/Programme	Objectives	Challenges
National Drought Management Authority (NDMA)	Early warning systems and drought response	Limited reach, slow response times
Hunger Safety Net Programme (HSNP)	Direct cash transfers to vulnerable pastoralists	Funding limitations, dependency risks
Borehole Drilling and Water Resource Management	Improve access to water for livestock and human consumption	Poor maintenance, high costs
Livestock Insurance Schemes	Provide financial compensation for drought-induced livestock losses	Limited uptake, affordability issues
Community-Based Rangeland Management	Promote sustainable land use and prevent overgrazing	Land tenure disputes, implementation challenges
Pastoralist Resilience Building Programme	Enhance adaptation strategies through training and resource provision	Limited scalability, coordination challenges
Cross-Border Livestock Trade Initiatives	Support economic diversification through regional trade	Political instability, fluctuating market access
Veterinary Services Expansion	Improve animal health through vaccinations and disease surveillance	Inconsistent funding, lack of accessibility in remote areas

National policies and programs play a crucial role in shaping Somali pastoralists' ability to cope with climate change. Early warning systems and drought response mechanisms under the NDMA provide vital information, but their limited reach and slow response times reduce their overall effectiveness. Similarly, direct cash transfers through the HSNP help vulnerable households during crises, yet funding limitations and dependency concerns hinder long-term sustainability.

Water resource management through borehole drilling is an essential adaptation measure, improving access to water for both livestock and human consumption. However, inadequate maintenance and high operational costs often render many boreholes non-functional. Mismanagement and lack of long-term investment in water infrastructure continue to limit their effectiveness as a sustainable adaptation measure.

Livestock insurance has been introduced as a financial safety net against drought-related livestock losses. While this initiative holds promise, low uptake and affordability issues prevent many pastoralists from benefiting. Awareness campaigns and subsidies could improve participation, making livestock insurance a more viable option for pastoralists facing extreme weather conditions.

Community-based rangeland management is another policy aimed at preventing overgrazing and promoting sustainable pasture use. However, its effectiveness has been undermined by land tenure disputes and difficulties in enforcing grazing regulations. Without clear and enforceable land rights, overgrazing remains a persistent issue, further degrading fragile rangelands.

Cross-border trade initiatives have allowed Somali pastoralists to integrate into regional markets, reducing reliance on subsistence pastoralism. However, fluctuating political stability and trade restrictions imposed by neighbouring governments frequently disrupt market access, making income streams unpredictable. Strengthening diplomatic efforts to support free trade zones could enhance the sustainability of this initiative.

Veterinary service expansion programs have improved livestock health through vaccinations and disease control, but funding inconsistencies and limited accessibility in remote areas hinder their widespread adoption. Increasing investment in mobile veterinary services and community-based animal health programs could address this challenge effectively.

Overall, these policies highlight the multi-faceted challenges facing Somali pastoralists in adapting to climate change. While government and non-governmental interventions have introduced valuable support mechanisms, their success depends on improving policy coordination, strengthening implementation, and ensuring long-term sustainability. Addressing structural inefficiencies, investing in community-led initiatives, and integrating local governance systems into formal adaptation frameworks will be essential for the long-term resilience of Somali pastoralists in North Eastern Kenya.

5. Discussion

It is clear that in the two case studies analysed here, local efforts are being made to mitigate impacts, although much remains to be done. Despite the fact that, although not homogeneously, in both countries there are numerous public policy instruments related to the implementation of decisions to adapt to climate change, the articulation between these instruments is weak or non-existent, and therefore their effectiveness and territorial expression, especially at the local level, is diffuse. Therefore, despite the fact that some policies or programmes include climate change adaptation among their objectives (most of them implicitly rather than explicitly), this is not yet expressed in rural localities in terms of reducing their vulnerability. So far, it seems that measures to prepare the population to cope and adapt to the new conditions have been insufficient and weakly incorporated into sectorial plans and policies (Schilling et al., 2012). The challenge, therefore, is to incorporate such adjustments and measures, in the contexts where they are needed.

The findings reveal significant climate-induced vulnerabilities among Turkana and Somali pastoralists in Kenya, highlighting both commonalities and divergences in their adaptation strategies. As presented in Table 4.1, mobility remains the cornerstone of adaptation for both communities, reinforcing the long-established practice of seasonal migration to counter pasture shortages. Similar observations have been made among Sahelian pastoralists in Niger and Mali, where transhumance remains vital for sustaining livestock despite increasing environmental pressures (Turner et al., 2016; Mortimore & Adams, 2015). However, unlike Turkana pastoralists, whose mobility is increasingly constrained by infrastructural projects such as the

Gibe III Dam, Somali pastoralists face additional socio-political barriers, including cross-border conflicts and restrictive land tenure policies (Opiyo et al., 2015; Schilling et al., 2012).

One striking finding from Table 4.1 is the diversification of livelihood strategies beyond pastoralism, particularly among Turkana households. While livestock rearing remains dominant, many have embraced agro-pastoralism and fishing as supplementary sources of income. This mirrors trends observed in Ethiopia's Borana pastoralists, who have also integrated farming into their livelihood portfolio to buffer against recurrent droughts (Tache & Oba, 2018). In contrast, Somali pastoralists have leaned heavily on cross-border trade and remittances, underscoring the significance of socio-economic networks in adaptation (Kagunyu & Wanjohi, 2014). These divergent strategies underscore the influence of geographic and economic positioning, as Turkana pastoralists' proximity to Lake Turkana provides alternative resources, whereas Somali pastoralists leverage trade links with Somalia and Ethiopia.

Water resource management emerges as a critical adaptation measure in both communities, yet challenges in sustainability persist. As indicated in Table 4.1, rainwater harvesting, borehole construction, and water-sharing networks are increasingly adopted. Similar patterns are documented in Rajasthan, India, where pastoralists have constructed traditional water reservoirs known as 'beris' to cope with erratic rainfall (Joshi et al., 2013). However, issues of high maintenance costs and mismanagement, as highlighted in both Turkana and Somali pastoralist contexts, mirror those faced by communities in Namibia's Kunene region, where borehole failures have worsened drought-related losses (Reid et al., 2014). These findings suggest that infrastructural interventions alone are insufficient unless coupled with sustainable governance mechanisms.

Grazing management and herd composition adjustments are evident across both communities, yet the emphasis differs. As detailed in Table 4.1, Turkana pastoralists have increasingly shifted towards camels and goats, which are more drought-resistant than cattle. This shift is well-documented in Mongolia, where herders have transitioned to cashmere goats due to their resilience to climate extremes (Fernández-Giménez et al., 2015). Conversely, Somali pastoralists have relied more on herd-splitting, sending livestock to different locations to mitigate localized resource scarcity. This strategy aligns with Maasai pastoralists in Tanzania, who practice 'olopololi' (rotational grazing) to optimise resource use and reduce livestock mortality (Galvin et al., 2016). These similarities indicate a strong reliance on indigenous knowledge in herd management, yet challenges remain in balancing adaptation with overgrazing concerns.

Economic diversification, as presented in Table 4.1, reveals an increasing shift toward non-pastoral income sources, particularly among Turkana households. The transition to small-scale trade, employment in urban centres, and engagement in safety-net programs mirror trends observed among Fulani herders in Nigeria, where urban migration has become a coping strategy against climate stress (Sarch & Birkett, 2020). Somali pastoralists, in contrast, exhibit a stronger reliance on remittances, reflecting patterns seen among Afghan nomadic communities, where diaspora support has become crucial in sustaining livelihoods (Azizi, 2021). This suggests that while economic diversification is a common adaptation response, its pathways are shaped by historical, geographic, and socio-political contexts.

The findings in Table 4.1 also highlight a persistent gap in institutional support, which continues to undermine adaptive capacity. While interventions such as drought early warning systems, market access programs, and financial instruments like livestock insurance have been introduced, their uptake remains limited due to affordability and logistical challenges. Similar constraints have been documented in Bolivia, where Andean pastoralists struggle with the high costs of climate insurance, leading to low enrolment rates (Valdivia et al., 2013). In Kenya,

limited access to veterinary services exacerbates livestock mortality, a challenge comparable to the experiences of Kazakh pastoralists who face barriers in accessing modern animal healthcare due to policy neglect (Behnke, 2018). Strengthening institutional frameworks and enhancing accessibility to adaptation resources remain key priorities for both Turkana and Somali communities.

An overarching theme emerging from these findings is the tension between traditional adaptation strategies and modern policy interventions. While indigenous knowledge systems continue to play a crucial role in climate adaptation, external interventions often fail to integrate local contexts effectively. Studies from Tuareg communities in the Sahara have shown that externally driven projects, such as sedentarisation programs, have disrupted pastoral mobility rather than enhancing resilience (Chatty, 2019). Similarly, Turkana and Somali pastoralists express concerns over poorly designed government interventions that fail to account for local realities, underscoring the need for participatory approaches in climate adaptation policymaking.

Overall, the results illustrate that while adaptation strategies among Turkana and Somali pastoralists align with global pastoralist responses, local socio-economic, political, and environmental factors shape their effectiveness. The cross-referencing of adaptation practices with those of pastoralists in Africa, Asia, and South America suggests that while there are universal elements in climate resilience strategies, tailored interventions that consider historical and socio-cultural dimensions are essential. Future policies should prioritise flexible and community-led adaptation frameworks that integrate both traditional and modern approaches to enhance resilience in Kenya's ASAL regions.

It is clear that in the two case studies analysed here, local efforts are being made to mitigate impacts, although much remains to be done. Despite the fact that, although not homogeneously, in both countries there are numerous public policy instruments related to the implementation of decisions to adapt to climate change, the articulation between these instruments is weak or non-existent, and therefore their effectiveness and territorial expression, especially at the local level, is diffuse. Therefore, despite the fact that some policies or programmes include climate change adaptation among their objectives (most of them implicitly rather than explicitly), this is not yet expressed in rural localities in terms of reducing their vulnerability. So far, it seems that measures to prepare the population to cope and adapt to the new conditions have been insufficient and weakly incorporated into sectorial plans and policies (Schilling et al., 2012). The challenge, therefore, is to incorporate such adjustments and measures, in the contexts where they are needed.

The findings reveal significant climate-induced vulnerabilities among Turkana and Somali pastoralists in Kenya, highlighting both commonalities and divergences in their adaptation strategies. As presented in Table 4.1, mobility remains the cornerstone of adaptation for both communities, reinforcing the long-established practice of seasonal migration to counter pasture shortages. Similar observations have been made among Sahelian pastoralists in Niger and Mali, where transhumance remains vital for sustaining livestock despite increasing environmental pressures (Turner et al., 2016; Mortimore & Adams, 2015). However, unlike Turkana pastoralists, whose mobility is increasingly constrained by infrastructural projects such as the Gibe III Dam, Somali pastoralists face additional socio-political barriers, including cross-border conflicts and restrictive land tenure policies (Opiyo et al., 2015; Schilling et al., 2012).

One striking finding from Table 4.1 is the diversification of livelihood strategies beyond pastoralism, particularly among Turkana households. While livestock rearing remains dominant, many have embraced agro-pastoralism and fishing as supplementary sources of income. This mirrors trends observed in Ethiopia's Borana pastoralists, who have also

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An overarching theme emerging from these findings is the tension between traditional adaptation strategies and modern policy interventions. While indigenous knowledge systems continue to play a crucial role in climate adaptation, external interventions often fail to integrate local contexts effectively. Studies from Tuareg communities in the Sahara have shown that externally driven projects, such as sedentarisation programs, have disrupted pastoral mobility rather than enhancing resilience (Chatty, 2019). Similarly, Turkana and Somali pastoralists express concerns over poorly designed government interventions that fail to account for local realities, underscoring the need for participatory approaches in climate adaptation policymaking.

Overall, the results illustrate that while adaptation strategies among Turkana and Somali pastoralists align with global pastoralist responses, local socio-economic, political, and environmental factors shape their effectiveness. The cross-referencing of adaptation practices with those of pastoralists in Africa, Asia, and South America suggests that while there are universal elements in climate resilience strategies, tailored interventions that consider historical and socio-cultural dimensions are essential. Future policies should prioritize flexible and community-led adaptation frameworks that integrate both traditional and modern approaches to enhance resilience in Kenya's ASAL regions.

6. Conclusions

The adaptation strategies employed by Turkana and Somali pastoralists underscore the fundamental role of indigenous knowledge, mobility, and economic diversification in responding to climate-induced vulnerabilities. While both communities exhibit resilience, the challenges they face demand a multifaceted approach that integrates traditional coping mechanisms with institutional support. The comparative analysis with other pastoralist communities globally reveals striking similarities in adaptation responses, reinforcing the universality of mobility, herd management, and resource-sharing networks. However, localised challenges such as land tenure disputes, restricted cross-border movement, and infrastructural deficits uniquely shape the adaptation pathways of Turkana and Somali pastoralists. Addressing these challenges requires targeted policy interventions that bridge the gap between traditional and modern adaptation strategies while fostering community-driven resilience initiatives.

Moving forward, sustainable climate adaptation for pastoralists must prioritise participatory approaches that involve local stakeholders in decision-making processes. Institutional frameworks should be strengthened to ensure equitable access to climate-resilient infrastructure, financial mechanisms, and market opportunities. Furthermore, long-term investments in water security, veterinary services, and alternative livelihood programs will be instrumental in enhancing the adaptive capacity of these communities. The insights from this study contribute to the broader discourse on climate adaptation in arid and semi-arid regions, emphasizing the need for context-specific solutions that respect cultural heritage while fostering sustainable development. By integrating local knowledge with evidence-based policy interventions, the resilience of Turkana and Somali pastoralists can be bolstered against the growing challenges of climate change.

Declaration of Conflict of Interest

The authors have no interest to declare

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