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THE EFFECTS OF CLIMATE CHANGE ON PASTORALISM IN EAST AFRICA: A CASE STUDY OF SOUTH SUDAN

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ABSTRACT: *Climate change is a significant threat to pastoralism in East Africa, particularly in South Sudan, where rising temperatures and increasingly frequent extreme weather events such as prolonged droughts and severe floods have disrupted traditional livelihood systems. Increased g rainfall variability has made it difficult for pastoralists to predict seasonal patterns, undermining livestock production, worsening food insecurity, and intensifying socio-economic vulnerabilities. This study examines the impacts of climate change on pastoralist livelihoods in South Sudan. A mixed-method research design was applied, integrating quantitative climate data analysis with qualitative evidence drawn from peer-reviewed literature, humanitarian agency reports, government documents, and meteorological records. Climatic trends were assessed through temperature and rainfall variability, while insights from organizations such as FAO, UNDP, and other UN agencies highlighted the consequences of recurrent climate shocks, including livestock mortality, displacement, and reduced access to food and grazing resources. A comparative analysis spanning approximately a decade (2010–2024) was conducted to trace evolving patterns of climate stress and their implications for pastoralist resilience. Findings reveal increasing climatic unpredictability across the region. Higher-than-average rainfall has triggered flooding that destroyed grazing land and forced widespread displacement. In South Sudan alone, floods between 2019 and 2024 affected more than 1.4 million people, with Jonglei, Lakes, and Unity states most severely impacted. In 2019, approximately 800,000 cattle, sheep, and goats were lost, and subsequent years saw continued livestock deaths due to persistent flooding and disease outbreaks. Diminished milk production, shrinking pastureland, and heightened competition for elevated grazing areas have further intensified food insecurity and resource-based conflicts. The study concludes that pastoral systems must adapt rapidly to ensure long-term sustainability. Key recommendations include diversifying household income sources, strengthening water and rangeland management, and improving conflict-resolution mechanisms. As climate pressures intensify, pastoralist communities require coordinated support from local, state, and national institutions to safeguard their livelihoods and cultural heritage.*

KEYWORDS: Climate Change, Pastoralism, Livestock, East Africa, South Sudan.

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INTRODUCTION

Climate change refers to long-term alterations in temperature and weather patterns, primarily driven by anthropogenic greenhouse gas emissions (Wright et al., 2014). There are many studies looking at how climate change impacts pastoralism and how people all over the world, notably in East Africa, are slowly changing to deal with it. The Intergovernmental Panel on Climate Change (IPCC, 2019) says that subsistence pastoralism and farming are two types of human activity that depend on resources sensitive to climate change, which makes them exceptionally vulnerable to it. This means that herders who depend on natural rainfall and rangelands for their livestock are more likely to be affected by changes in the weather and temperature. Thornton et al. (2014) and Herrero et al. (2016) assert that pastoral and agro-pastoral systems are likely to experience diminished livestock productivity and increased animal mortality due to climate change, jeopardizing the food security and livelihoods of millions of pastoralists globally. This is especially essential in East Africa, where it has already caused a lot of loss and suffering more than the rest of the world (CDKN, 2021). The temperature in East Africa has been about 0.7 to 1.0°C warmer during the previous few decades, and the rain has not been as steady (CDKN, 2021). As a result, extreme weather events such as floods and droughts have become more frequent and severe. Since 2005, East Africa has suffered around twice as many droughts, going from one every six years to one every three years (CDKN, 2021). These changes in the weather and temperature have already harmed many agro-pastoralists in the region. There are more than 1.5 million dead animals on the ground in East Africa because of a string of particularly terrible wet seasons. These losses have contributed to heightened food insecurity and poverty, affecting an estimated 13 million people (ILRI, 2025). Climate change in East Africa isn't just something to worry about in the future; it is a problem that is happening right now and is impacting the economy, food security, and ways of life all over the continent. South Sudan is a unique example of how perilous the area is. According to OBI (2022), climate variability in South Sudan has intensified in recent years, with rainfall patterns becoming increasingly unpredictable across much of the country. This variability has resulted in the occurrence of both prolonged droughts and severe flooding. In 2021 and 2022, South Sudan and other parts of the Horn of Africa had two disasters at the same time. Some locations had droughts that lasted a long time, while others saw floods that broke records. During this period, an estimated 10 million livestock were lost across East Africa, with economic losses exceeding USD 1 billion (World Bank, 2025). These losses emphasize the necessity to comprehend and mitigate the effects of climate change on pastoral systems. This study examines the impacts of climate change on pastoralism system in South Sudan as a case study to elucidate these issues and propose adaptive solutions.

Background to the Study

Pastoralism is a big component of South Sudan's way of life and culture. It is very important for the economy and society of most of the local people and the country. According to OBI (2022), about 78% of families in South Sudan receive most of their food from farming, fishing, or herding. There are a lot of people in South Sudan who spend a lot of time caring for cows and other animals. The Dinka and the Nuer are two of the main ethnic groups that have been herding cattle for a long time (OBI, 2022). The Dinka alone constitute roughly 40% of the population, and for these communities, livestock are not only a source of income but also a symbol of social status, cultural identity, and economic security (Gregory I, and Abdallah, R.,2022); Jok, M., 2018; Sebit Martin, 2017). FAO (1977, 2026) reports that livestock populations in South Sudan, comprising approximately 12 million cattle and 24 million sheep

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and goats, outnumber the human population of roughly 11 million. This emphasizes the centrality of pastoralism to both livelihoods and the socio-economic structure of the country. Livestock provide pastoralist households with essential food sources, including milk and meat, and serve as assets that can be sold or saved to generate income (DEFRA, 2003). Cattle are traditionally used in marriage dowries, as compensation in court rulings, and to settle fines, thereby strengthening ties between clans and families. This creates robust social networks where everyone has a role to play. Social support networks are based on livestock, enabling individuals in communities to get through tough times by sharing animals (DEFRA, 2003). In other words, cows make people in most pastoralist communities feel protected, loved, and respected (FAO, 1977). Based on all this, pastoralism is very much related to cultural identity and how people think about many things in life.

In short, pastoralism is good for the economy. It lets most people in rural areas make a living, good for society because it makes people feel safe and like they belong, and good for culture since cows are a sign of lineage and social pride. The consequences, therefore, of climate change on pastoralism are particularly essential for pastoralists' survival and stability in South Sudan.

Statement of the Research Problem

In South Sudan and all of East Africa, pastoralism is a very important way of life, as elucidated above earlier. It helps millions of people who live in places that are usually dry or only a little bit wet (FAO, 2018). However, climate change has increasingly disrupted these systems by raising temperatures, altering precipitation patterns, prolonging droughts, and intensifying flood events. It has become harder to procure pasture, water, and keep animals healthy. Moreover, competition over scarce natural resources has exacerbated conflicts among pastoralist communities (IPCC, 2022; UNEP, 2021). These climatic stressors threaten food security and economic stability, while eroding social cohesion within pastoral communities (Catley et al., 2013; Ndung'u et al., 2019).

Pastoralism is important, but it's only a small part of South Sudan's plans and talks about how to deal with the climate change that affects it. Most national and regional climate change plans in East African region are too general and don't take into account the specific strengths and weaknesses of mobile pastoral systems that have been proposed as strategies to cope with the problem (Morton, 2021; Davies & Bennett, 2007). Moreover, there is a notable deficiency of localized empirical research investigating the socio-ecological dynamics of pastoralism under shifting climatic conditions, especially in South Sudan (Opiyo et al., 2015; Deng, 2018).

This study, therefore, aims to investigate the various effects of climate change on pastoralism in South Sudan, serving as a case study within the larger East African framework. The study seeks to deliver evidence-based insights through the examination of environmental, social, economic, and institutional factors to guide policy, bolster community resilience, and foster sustainable pastoral livelihoods in a changing climate (Herrero et al., 2016; Scoones, 2021).

Objectives of the Study

The study's main objective is to study how climate change affects the livelihoods of pastoralists in South Sudan and suggest ways to make pastoral systems in the country and East Africa more resilient.

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Specific Objectives:

A. To evaluate the principal climate change-related environmental stressors impacting pastoralism in South Sudan.

B. To assess how climate change affects the health, mobility, access to resources, income, and food security of pastoralist groups.

C. To examine the adaptation strategies employed by pastoralists and other rural communities in response to climatic and soil-related changes

D. To analyze laws and regulations governing climate change and pastoralism in South Sudan and determine how to enhance their synergy.

. To develop evidence-based recommendations for strengthening the resilience and sustainability of pastoral systems in South Sudan and the broader East African region.T**1.4.2 Research Questions**

A. What are the principal climate change-related environmental stressors impacting pastoralism in South Sudan?

B. How has climate change affected the socioeconomic conditions of pastoralist communities in South Sudan, particularly regarding livestock health, mobility, resource accessibility, income, and food security?

C. How can pastoralists in South Sudan employ traditional and local practices to adapt to climatic and environmental changes?

D. How do the current rules and policies in South Sudan support or hurt pastoralism and the ability to adapt to climate change? What are the chances of change and the gaps?
E. What specific, evidence-based measures can be suggested to improve climate resilience and encourage sustainable development in pastoral communities in South Sudan and the larger East African region?

Significance of the Study

There are many reasons why this study is important. First, it addresses a critical knowledge gapin our understanding of how climate change affects pastoralism in South Sudan, where pastoral livelihoods are important for social identity, economic stability, and cultural continuity (Deng, 2018; FAO, 2018). Many studies have looked at how climate and pastoralism affect each other in East Africa. However, there isn't much real-world information about how vulnerable South Sudanese pastoralist tribes are to social and ecological problems such as climate change (Opiyo et al., 2015; Ndung'u et al., 2019).

Second, the studycontributes to the evidence base about how to deal with climate change by showing how pastoralists have dealt with it, what problems they have faced, and how they have changed. Pastoralists are typically underrepresented in national policy and climate planning frameworks (Morton, 2021; Davies & Bennett, 2007). To develop effective, community-oriented resilience strategies that honor indigenous knowledge, mobility, and traditional governance frameworks (Catley et al., 2013; Scoones, 2021), it is essential to comprehend how pastoralists address climate-related challenges.

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Third, the study is advantageous for legislators, development organizations, and humanitarian groups. The study examines the environmental, economic, and institutional aspects of climate change's effects on pastoralism, providing practical suggestions for focused initiatives and evidence-based policies in South Sudan and other pastoral areas in East Africa (Herrero et al., 2016; UNEP, 2021).

The results will show that it is important to include climate resilience in pastoral livelihood systems to ensure long-term peace, food security, and rural development. This is especially true given the continuing recovery and reconstruction activities in the country (IPCC, 2022; Tiller et al., 2020).

Lastly, the study encourages trans-disciplinary research by adopting a socio-ecological systems (SES) framework to examine the dynamic interconnections among climate, ecosystems, institutions, and livelihoods. This enhances understanding of community resilience and adaptive capacity in regions affected by climate change and provides a foundation for comparative research across East African contexts and beyond (Folke et al., 2010; Ostrom, 2009).

THEORETICAL FRAMEWORKS

The Socio-Ecological Systems (SES) framework, often employed in conjunction with the Vulnerability and Adaptation (V&A) paradigm, elucidates the impact of climate change on pastoralism. These frameworks stress how cultures and their settings interact in a changing way. This is important to know because it helps us understand how pastoralism relies on ecosystems that can change quickly when the weather changes. The SES paradigm emphasizes the interdependence of social and ecological components within a system. It acknowledges that climate change directly impacts rangelands, water resources, and cattle health, subsequently influencing the livelihoods of pastoralists and the welfare of their communities (Herrero et al., 2016). As a result, it makes it easier to conduct a comprehensive analysis of social systems, including food security, income, and social structures.

In this case, vulnerability is a very crucial idea. This includes the ability to adapt (via mobility, diversification, or institutional support), the threat of disasters caused by climate change, and the vulnerability of pastoral systems, which are characterized by a lack of water or fodder (Adger, 2006). The V and A approach aids SES by examining how pastoralists think about, deal with, and respond to climate change. It also reveals how social, economic, and political issues affect how people change (Nelson et al., 2007). These frameworks also look at things that cause stress that have nothing to do with the weather, like war, changes in land ownership, and market pressures. These stressors, along with the weather, change how strong and weak pastoralists are (Scoones, 1999). They also back the idea of using both indigenous knowledge and scientific data to make things more adaptable (Reid et al., 2009).

Researchers and policymakers can learn more about how climate change affects pastoralism by using the SES and V and A frameworks. This lets us develop rules that fit the situation and help people get stronger and make a living without destroying the environment.

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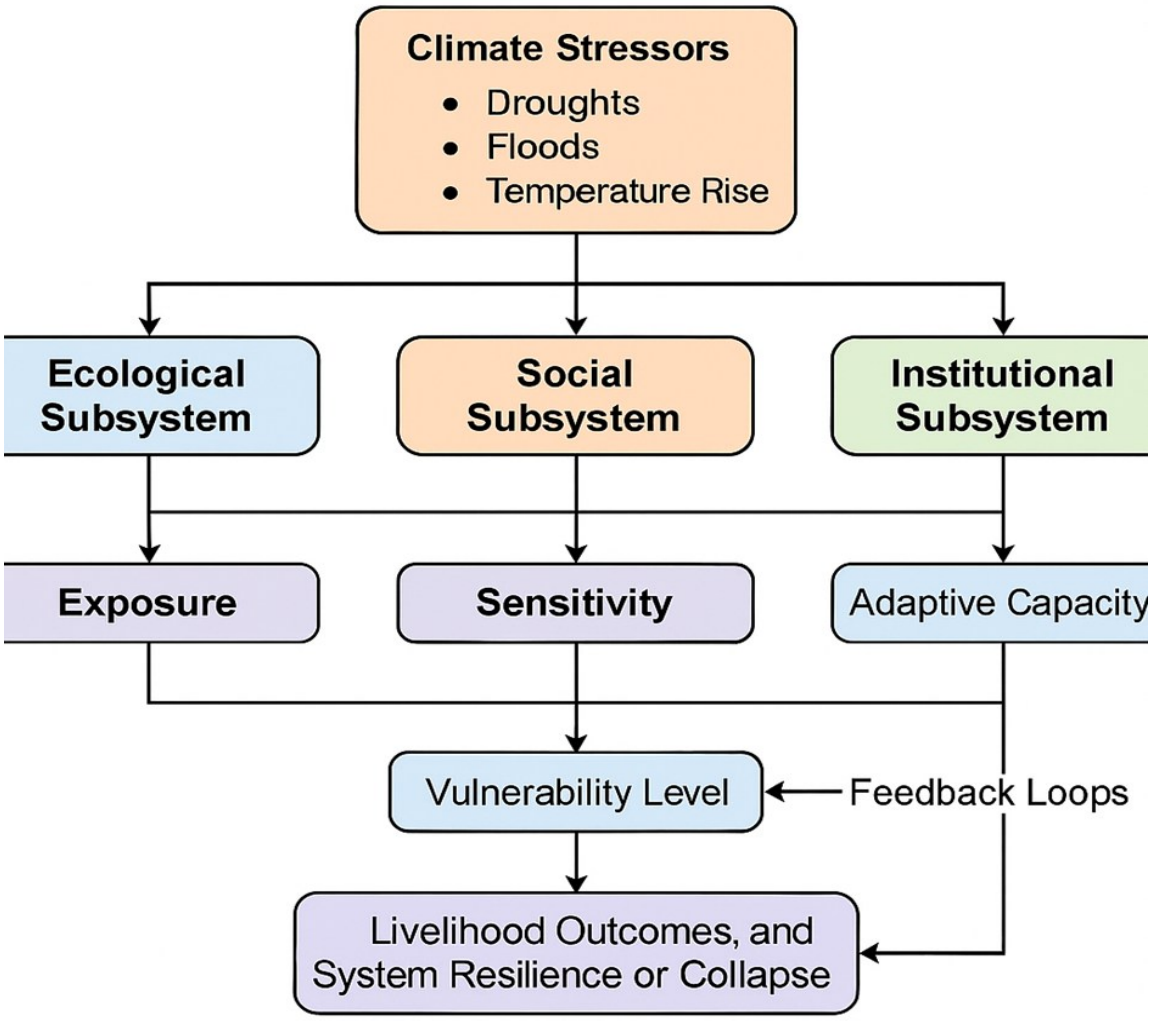
Conceptual frameworks

The socio-ecological systems (SES) approach, along with the Vulnerability and Adaptation (V and A) framework, provides a thorough conceptual framework for studying the intricate and ever-changing relationships between human societies and their natural surroundings (Berkes and Folke, 1998; Ostrom, 2009). This conceptual framework underscores the profound interconnections and co-evolution of natural and social systems across time. Individuals and nature are not perceived as distinct components of a larger whole. Their resilience depends on adaptive governance, feedback systems, institutional flexibility, and epistemic frameworks (Folke et al., 2005; Ostrom, 2009).
This strategy works really well in rural locations, especially in arid and semi-arid countries where the weather, the rangelands, how people get around, and the rules that govern them affect their traditional economies (Homewood et al., 2009). The SES viewpoint enables a comprehensive analysis of the relationships between climate change and the biophysical, cultural, economic, and political aspects of pastoralism.

Figure 1. Conceptual Frameworks of SES and V&A for the explanation of the impacts of Climate Change on Pastoralism in East Africa and South Sudan.



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The conceptual model elucidates the direct and indirect impacts of climate change on pastoralism in South Sudan, for that matter. It also shows where changes to the legislation and improvements made by the community can have the most effect.

Explanation of the key concepts in the conceptual frameworks

To understand the integrated conceptual framework for analyzing the effects of climate change on pastoralism in East Africa, particularly through a case study of South Sudan, it is crucial to delineate the fundamental elements that define the socio-ecological and vulnerability dynamics within this system.

Climate stressors

These stressors are the things that happen outside in the environment that modify the weather and put stress on both social and ecological systems. In East Africa, the most important stressors are: (a) Droughts, which are long periods of time when there isn't enough rainand water, and the grazing lands and water points dry up; (b) Floods, which happen at certain times of the year that damage and destroy the infrastructure, pasture, causing people to move or die; and (c) Temperature rise, which is a slow rise in ambient temperatures that lowers livestock productivity, causes disease outbreaks, and changes ecosystems.

Ecological Subsystem

This is the part of the environment that contains everything that sustains pastoral livelihoods within the socio-ecological system. This comprises (a) floodplains, grazing grounds, and seasonal pastures; (b) water sources such as rivers, boreholes, and wetlands; and (c) biodiversity, which includes both wild and domesticated species. The health of this subsystem directly affects how many resources are accessible and how quickly the ecosystem can bounce back.

Social subsystem

his includes the Dinka, Nuer, Mundari, and Toposa pastoral groups in South Sudan, whose livelihoods are predominantly based on livestock rearing and seasonal mobility. It also includes the gender roles and how chores are divided in the home, and traditional knowledge and customs for predicting the weather and taking care of herds.

Institutional subsystem

Institutions are groups that decide who can use resources, work together to fix issues, and make things better during normal and abnormal conditions. There are four types of organizations in this regard: (a) traditional structures like clan elders and local chiefs; (b) government institutions like the Ministry of Livestock and state governments; (c) non-governmental organizations (NGOs), funders, and humanitarian agencies; and (d) places where people can settle disputes and make grazing agreements.

Exposure

This shows how likely it is that climate change could trigger disasters that hurt a system. Pastoralists' susceptibility is influenced by geographical factors, such as floodplains and

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drought-prone regions, as well as seasonal aspects, including dependence on grazing during the rainy season.

Sensitivity

This means that the system in place isn't very strong because it relies too much on animals for food and money, doesn't get enough food during dry seasons because there isn't enough milk, and doesn't have enough veterinary infrastructure.

Adaptive capacity

Adaptive capacity is a system's ability to handle climate change, change with it, and get back up again. This means having different kinds of animals and ways to make money, moving around with the seasons, using social networks to get support and information, and groups that aim to make peace and create bargains for shared grazing.

Vulnerability Level

Vulnerability is a measure of three things: (a) being open to climate risks, (b) knowing how they affect us, and (c) being able to change to make them less bad or get rid of them. People who live in societies that are very open and sensitive but not very adaptable are the most likely to get hurt.

Feedback loops

These feedback loops refer to interactions that happen over and over again, and when one element of the system changes, it has an effect on other elements. For example, (a) losing livestock can make food insecure, which can make people move and fight over resources, which makes the system even less stable; (b) on the other hand, successful adaptation strategies (like rainwater harvesting or conflict resolution mechanisms) can make the system more stable and less likely to fail in the future.

Livelihood outcomes and system resilience or collapse

Results for people and how well the system may work or not work right, is how well the pastoral system is handling the stress of the weather. Strong systems work because they learn, adapt, and change. People lose their practices, run out of food, and have to move when systems break down, and they can't adapt.

METHODOLOGY

This study adopted a mixed-methods research design, integrating qualitative and quantitative approaches through an extensive literature review and comparative case study analysis. The selection of this approach was informed by the complex and multidimensional relationship between climate change and pastoralism, as well as the practical constraints associated with collecting primary field data within the timeframe of the study. Consequently, the research relied on the triangulation of multiple secondary data sources to ensure analytical depth and contextual accuracy.

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Data Sources and Literature Search Strategy

The primary data sources comprised peer-reviewed journal articles, books, institutional reports, and policy documents addressing climate change and pastoral systems in East Africa. Particular emphasis was placed on publications from recognized international organizations, including the Intergovernmental Panel on Climate Change (IPCC), especially the Sixth Assessment Report (AR6), which provided authoritative insights into global and regional climate dynamics. Additional data were obtained from reports published by the Food and Agriculture Organization (FAO), the World Food Programme (WFP), and the United Nations High Commissioner for Refugees (UNHCR), which offered up-to-date humanitarian and food security assessments relevant to pastoral communities in South Sudan and the wider East African region.

A systematic search was conducted across academic databases and reputable online repositories using key terms such as "climate change and pastoralism in East Africa," "climate impacts on cattle in South Sudan," and "pastoral adaptation strategies." To ensure relevance and contemporaneity, the review primarily included literature published within the last 10–15 years. However, earlier foundational works were consulted where necessary to support theoretical framing.

In addition to peer-reviewed sources, the study incorporated gray literature, including NGO case studies, conference proceedings, and government policy documents. The inclusion of gray literature was intended to capture context-specific insights, indigenous knowledge systems, and field-based observations that are often underrepresented in formal academic publications.

Case Study Approach: South Sudan

South Sudan was selected as a focal case study to contextualize regional climate–pastoralism interactions within a highly climate-vulnerable and conflict-affected setting. Specific climatic events were examined, including the 2017 drought and the prolonged flooding episodes between 2019 and 2021. These events were analyzed in relation to livestock mortality, displacement, damage to infrastructure, and food security outcomes. Where available, quantitative indicators—such as livestock losses, household displacement figures, and extent of flood damage—were incorporated to assess the magnitude of impacts.

The South Sudan case was further examined in comparison with pastoral regions in Kenya, Ethiopia, and Somalia. This cross-regional comparison enabled the identification of convergent and divergent patterns in climate impacts and adaptive responses across East Africa. Such comparative analysis strengthened the external validity of the findings and ensured that interpretations were not isolated from broader regional trends.

Data Analysis

The collected materials were subjected to thematic analysis. Key themes were identified inductively and deductively, guided by the study's research objectives. The principal thematic categories included:

1. Observed climate trends in East Africa (e.g., temperature increases, rainfall variability, drought frequency, and flooding patterns);
2. Impacts on livestock health and productivity;

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3. Socioeconomic consequences, including food insecurity, displacement, and resource-based conflict; and

4. Adaptation and resilience strategies among pastoral communities.

Qualitative data—such as pastoralists' narratives, indigenous coping mechanisms, and community-level adaptation practices—were analyzed to enrich quantitative findings and provide contextual depth. Quantitative information, including reported livestock losses and damage estimates, was used to assess the scale and severity of climate-related impacts.

Conceptual Framework and Analytical Tools

The study was guided by Social-Ecological Systems (SES) and Vulnerability and Adaptation (V&A) frameworks to analyze the interconnected relationships between climate stressors, ecological subsystems, and pastoral livelihoods. These frameworks facilitated the development of an integrated conceptual model linking climatic hazards, livestock systems, socioeconomic vulnerability, and adaptive capacity within East African pastoral contexts.

Generative artificial intelligence tools, including ChatGPT, were employed solely to support the synthesis of conceptual frameworks and the organization of literature-based insights. These tools were not used as primary data sources. All factual content and empirical evidence were derived from verifiable scholarly and institutional publications.

Ethical Considerations

As the study relied exclusively on secondary data sources, no direct human subjects were involved, and formal ethical clearance was not required. Nonetheless, all sources were properly cited to maintain academic integrity and avoid plagiarism.

Reliability and limitations.

The study checked data from many sources wherever it could to make sure it was correct. Scientists used climate data, IPCC regional summaries (CDKN, 2021), and other sources to learn how losing livestock affects people (World Bank, 2024; ILRI, 2022). But we were aware of some of the limits. For example, we don't have a lot of meteorological data for the most remote portions of South Sudan, so we have to fill in the gaps or use climate models for larger areas in the region. Climate change or natural changes may have caused some disasters, such as floods and droughts. But the analysis is based on simple trends that climate scientists have seen. Another concern is that the outcomes of certain adaptations depend on the context. Due to differences in culture, politics, or the environment, it must be admitted that what works for one group may not work for others. The report acknowledges the uncertainty and the necessity for additional investigation in areas marked by inadequate data. There are some of the same issues; hence, looking at information from many different places is a good way to understand more about how climate change and pastoralists are connected in South Sudan and other countries in the region.

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LITERATURE REVIEW

Conceptual and theoretical frameworks

In East Africa, pastoralism is closely linked to intricate Socio-Ecological Systems (SES), wherein climate change intersects with social, economic, and political challenges, rendering populations more susceptible and altering their responses. The Vulnerability and Adaptation (V&A) Framework enhances the SES by assessing individuals' exposure, sensitivity, and adaptability. This review compiles theoretical perspectives on the impact of climate change on pastoralism in East Africa, utilizing South Sudan as a case study.

The SES framework (Ostrom, 2009) looks at how the social and ecological parts of a system operate together, focusing on feedback loops, resilience, and governance. The four essential aspects of the SES are: resource systems (grazing grounds, water sources), resource units (livestock, vegetation), governance systems (traditional institutions, state legislation), and users (pastoralist communities). Robinson and Berkes (2011) examined the impact of climatic variations on grazing patterns and the interplay between social and ecological systems (SES) in East Africa. Mwangi and Ostrom (2009) argued that traditional institutions, such as Xeer in Somalia and Dedha in Kenya, govern resource access but are undermined by state policy. The Vulnerability and Adaptation (V&A) framework examines exposure (the frequency of floods and droughts), sensitivity (the number of animals required), and adaptive capacity (the ease of movement and diversification). The IPCC (2014) notes that pastoralists in East Africa, especially in dry areas like Karamoja and Turkana, are quite sensitive because they rely on livestock. Eriksen et al. (2013) and Schilling et al. (2012) discovered that political constraints impeded their adaptation, despite the option of relocating to another nation. Some areas of East Africa, particularly South Sudan, are demonstrating signs of ecological instability. Thornton et al. (2009) stated that the grasslands in East Africa are becoming less fertile, which is causing pastoralists and their herds to move to other places. People in certain areas have had to change the way they regularly graze since there isn't enough water (Adano et al., 2012). Indigenous understanding of seasonal forecasts has enhanced resilience in social and institutional responses; nevertheless, it is being undermined by modernization (Ayal et al., 2018). As more farmers and investors go to Ethiopia's Afar region, more and more people are fighting over who owns the land there (Tache & Oba, 2010). Some of the countries in the area are experiencing trouble with their laws and how they do things. The Tanzanian government's actions are making it tougher for pastoralists to move around, which puts them in more risk (Brockington, 2006). This indicates that these fragile institutions are unable to incorporate the requirements of pastoralists in their strategies for addressing climate change (Nassef et al., 2009).

With elaboration, this study provides and adds significant insights into the co-evolution of environmental changes and human reactions in South Sudan, a nation marked by frail institutions, intricate livelihood networks, and ecological susceptibility. Pastoralism, prevalent in South Sudan's Jonglei, Warrap, Unity, Northern Bahr el Ghazal, parts of the central equatorial State, and Eastern Equatoria States, is intricately connected to the natural environment and is highly responsive to climatic variations (FAO, 2019; UNEP, 2018). The SES and V&A lenses demonstrate that the resource and institution systems in South Sudan are weaker or do not function. Because of flooding from 2020 to 2023, grazing meadows have been ruined in most of the aforementioned states (FAO, 2023), thus herders have always to move to other people’s places. The government can't prohibit people from committing crimes

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during a conflict, which leads to new fights, such as stealing animals (Young, 2019). This means that floods and droughts that are worse are more likely to hurt pastoralists (UNEP, 2022). They are more prone to getting wounded because 80% of their livelihoods are derived from animals (Leff, 2009). It is also hard to get used to such a situation because there isn't enough infrastructure, leading to more violence, followed by poverty (Pantuliano, 2010). This illustrates that the violence and state of poverty make it hard for the pastoralists to become habituated to the new situations. Every season, people still try to relocate from one part of the country to another to solve these difficulties, but the violence is making this tougher (WFP, 2021). Fodder banks get aid from groups outside of the bank, such as NGOs, although they have trouble staying open for a long time (UNDP, 2021).

The preceding SES investigation of pastoralists indicates deficiencies in the research concerning SES resilience, vulnerability, adaptive inter-sectionalism, and policy coherence. It is essential to examine the reconfiguration of pastoralist socio-ecological systems in response to climate shocks within the context of socio-ecological resilience. In the framework of the intersectionality of vulnerability and age, there is an impact of vulnerability on gender and age. The V&A framework tells us which categories of people are most likely to get hurt. The scenario in South Sudan shows how war makes climate problems worse and makes it harder to deal with them. Future research ought to investigate institutional adjustments to advance sustainable pastoralism.

Review of empirical studies

Many researchers are looking into how climate change affects pastoralism and ways to adapt, especially in East Africa and around the world. The Intergovernmental Panel on Climate Change (IPCC) has done research around the world that shows that subsistence farming and pastoralism are two of the most susceptible ways of making a living that depend on resources that are affected by climate change (IPCC, 2019). Pastoralists, who depend on natural rainfall and rangelands for their animals, are at increasing risk as the weather changes and temperatures rise. Thornton et al. (2014) and Herrero et al. (2016) assert that pastoral and agro-pastoral systems are anticipated to face diminished cattle availability. Pastoralists in this study reported significant livestock losses during previous drought periods, corroborating empirical climate data with experiential evidence. Research in Turkana, Kenya, found that temperatures were rising and drought cycles were getting shorter, which forced people to find other ways to make a living (Imana and Zenda, 2023). The Maasai herders in Kenya and Tanzania have had to move farther out or live in peri-urban areas more often since their grazing meadows can't support their livestock all year round. There is a trend of pastoralists in these countries (O'Loughlin et al., 2014). People in Jonglei, Lakes, and Unity States in South Sudan are upset about the floods that have killed several cows. According to ACAPS (2025), the floods in South Sudan killed more than 800,000 animals, including cows, goats, and sheep, from 2019 to 2021. In 2020 and 2021, the losses were the worst. Animals who dwell in places that have been flooded for a long time go sick and hungry. According to a report from Jonglei State in the middle of 2020, the floods killed or drowned more than 6,000 cattle and 36,150 goats in just two months (June–July 2020) (CLiMIS, 2025). The floods in Jonglei State killed more than 355,000 animals in 2021, including more than 251,000 farm animals (FAO, 2021). Floods in the Unity State killed about 795,558 animals of all kinds in 2021.

Lakes State also lost a lot of animals, although not as many as Unity and Jonglei did in 2021. A lot of people assumed there were more than 745,000 cows in the lakes when they overflowed,

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and about 2,160 of them died. 874,000 goats got sick, and 7,896 of them perished (Moro, 2023). At that time, 3,890 sheep also passed away in Lakes State. The findings show that goats are more likely to die than other animals from flooding. This is probably because little ruminants can't stay in standing water for very long and don't have adequate food. Cows grow sick when they are shifted to dry pastures, and a lot of cows perish when the grazing area floods. In 2022 and 2023, Aid groups said that animals were still dying and that households in these areas needed food and medical care for their animals right away. Since 2019, the weather has gotten worse and worse for farming. Every year, floods and heavy rains injure more cows and crops (ACAPS, 2025). This was bad news for the economy of a country where cows and goats are vital for food, money, and culture. Over time, the effect on cows has been worse. The floods have gotten worse, and the herds haven't had much time to get better because they've been flooding for years. This is why people in Jonglei, Lakes, and Unity States still believe that it rains a lot and floods come all the time.

Empirical literature underscores that pastoralism possesses intrinsic adaptive characteristics, albeit with some adverse effects. Nassef (2024) asserts that historical evidence illustrates that African dry land pastoralism developed as a lifestyle proficient at adapting to significant climatic fluctuations. Pastoralists have always changed the quantity and kinds of animals in their herds, moved around, and created social networks to share resources in order to adapt to changing conditions. Hesse and Cotula (2006) and Nassef (2024) characterize pastoralism as the "invisible asset of dry lands," emphasizing that mobility facilitates the sustainable utilization of scarce resources and should be encouraged rather than hindered. Recent research indicates that pastoralists exhibit reduced adaptability due to factors unrelated to the environment. Pastoralists may have problems going around and getting to their usual grazing sites because of farms or fences that divide the land, water, and a growing population. This indicates that individuals are more susceptible to unforeseen meteorological fluctuations (Nassef, 2024). Catley et al. (2019) discovered that measures restricting herd mobility or fragmenting nomadic groups typically diminish the resilience of pastoral systems to drought.

To sum up, our research reveals that climate change is already having a substantial impact on the lives of East African pastoralists. It also shows that policymakers should take advantage of the adaptability of pastoralism. We still don't know much about how to find out what the effects are, since there isn't a lot of weather data in remote rangelands, and it's hard to create changes that work on a larger scale. This study enhances the existing literature by utilizing South Sudan as a case study to amalgamate many elements, evaluating concrete outcomes, community reactions, and policy interventions in a distinctly susceptible pastoral context.

RESULTS AND DISCUSSION

This study's results show a clear trend: climate change is affecting pastoralism in East African region and South Sudan, and pastoral groups are responding in different ways, though not without some problems. Here are the main outcomes, sorted by where they happened and how they changed people:

Climate trends and resources for pastoralists

The literature shows that the weather in South Sudan has become harsher and less predictable, and it has been happening for so long now. It has gotten a lot hotter. People who herd animals

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in the area say that summers are hotter now than they used to be and that it doesn't rain as much as it used to. A case study showed that people in Awerial County, Lakes State, could see clear signs of climate change. They said that the weather was getting hotter, that it rained when they didn't expect it to, and that floods and droughts were happening more often than they remembered (Ndebele and Zenda, 2023). This means that there are fewer resources for pastures. When there is a drought, the grasses in the rangelands die, and the rivers and ponds dry up faster. This means that the livestock don't have enough grass to eat. During the wet season, there are a lot of flash floods. They hurt meadows and make pools of water that make it hard for grass to grow back. People who have lived in the area for a long time say that places where animals used to graze are either dry or flooded for months at a time. This means that herders can't rely on the typical seasonal grazing cycle that they need (Ndebele and Zenda, 2023).

Effects on the health and productivity of livestock

Because of the weather patterns indicated above, some herds of cattle have lost animals. People and animals perish when they don't have enough food or water. For instance, El Niño induced droughts in South Sudan from 2015 to 2016 that made people sick and malnourished and killed 20–30% of the pastoralists' livestock herds (FAO, 2024). In 2019, 2020, and 2021, floods in the Sudd wetlands area killed animals or made them sick with infections that made their eyes watery. The UNHCR in 2021 says that the floods killed hundreds of thousands of animals. In East Africa, bad weather has killed millions of animals in the last ten years. People who herd animals in South Sudan have been hit the worst since they dwell in river basins that flood a lot and savannas that dry out quickly (World Bank, 2025). Animals that live through still have to deal with stress, which makes them less productive. Cows lose weight, have less milk, and produce fewer offspring when they stay in dry areas for a long time. Herders report that cows that used to give milk for much of the year quit delivering it rapidly when there isn't enough food. Floods spread diseases through water, and droughts make animals weaker and more susceptible to getting sick. In the past few years, the number of animals in herds has gone down a lot more (World Bank, 2025).

People feel the effects of these losses right away. Families that don't have as many healthy animals don't have as much milk, meat, or cows to sell to feed their kids. This makes it harder for them to get enough food. The study showed that those who depend on cattle have had to contend with extreme hunger after natural disasters. For example, during the drought in 2017, the number of malnourished children in some pastoral counties increased over what was believed to be an emergency threshold. This caused the deaths of many animals. A pastoralist quoted in a SIPRI briefing (2025) said, "When you don't have enough to eat, you have to raid your neighbors to get cattle for survival." This shows how far people will go when they don't have enough livestock (FAO, 2024).

Livelihood disruption and food insecurity

Studies show that getting grass and water is tougher because there are droughts that happen over and over again, and rain that isn't always expected. This has killed animals and made them less useful for milk and meat. That's why many families throughout the East African region are running out of food and money. For example, 97.5% of pastoralists in Ethiopia's Somali Region claimed they didn't have enough food because their animals perished in droughts, and 90% said

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they lost money (Abdi et al., 2022). Climate shocks might make people in East African pastoral areas more vulnerable and make it difficult for them to get food (Herrero et al., 2016).

Socio-economic and cultural effects

The erosion of pastoral livelihoods has profound socio-economic and cultural consequences and contributes to the intensification of conflict. In South Sudan, as in much of East Africa, livestock function not merely as productive assets but also as stores of wealth, mechanisms of social protection, and powerful symbols of identity and social status. Cattle, in particular, underpin systems of reciprocity, alliance formation, and marriage transactions. Consequently, repeated climate-induced livestock losses resulting from droughts, floods, and disease outbreaks have far-reaching implications beyond immediate economic deprivation.

Recent climate shocks have pushed many pastoral households into chronic poverty. Evidence suggests a widening socio-economic gap within pastoral communities across East Africa, including South Sudan. Wealthier households, often possessing larger herds or benefiting from external support networks, are better positioned to restock and recover following climatic shocks. In contrast, poorer households frequently lack the capital and social resources required to rebuild herds after successive losses, leading to a downward spiral of asset depletion and vulnerability. This growing inequality weakens traditional redistribution mechanisms and undermines the resilience of pastoral systems as a whole.

Livestock losses also disrupt social institutions, particularly marriage systems that rely on cattle as bride wealth. In many South Sudanese communities, the inability of young men to accumulate sufficient cattle for marriage has generated intergenerational tensions and social anxiety. Elders express concern that prolonged herd depletion is undermining established cultural norms and delaying or preventing marriage, thereby affecting family formation, lineage continuity, and community cohesion. Such pressures place considerable psychological and social strain on young people and challenge the stability of customary institutions.

Resource scarcity linked to recurrent drought further exacerbates inter-communal tensions. As pasture and water become increasingly limited, competition intensifies between pastoralists and agricultural communities. Reports and field interviews indicate that during recent droughts in parts of the Equatoria region, livestock migrated into cultivated areas in search of forage and water, resulting in crop destruction and disputes between nomadic herders and farming populations. Similarly, pastoral groups have competed for access to relatively resource-secure areas in northern regions where grazing conditions remain more favorable during dry periods.

Heightened resource competition has also been associated with increased cattle raiding and livestock theft, practices that are often framed as survival strategies under conditions of acute scarcity. However, such actions frequently trigger cycles of retaliation, revenge killings, and prolonged insecurity (FAO, 2024). These dynamics contribute to the militarization of pastoral communities and the breakdown of local conflict-resolution mechanisms.

The cumulative effect of these pressures is the progressive destabilization of pastoral areas. Insecurity not only constrains herd mobility, a cornerstone of pastoral adaptation, but also discourages investment in livestock production. In extreme cases, persistent violence and repeated asset losses compel households to abandon herding altogether or migrate in search of alternative livelihoods. Thus, climate-induced disruptions to pastoral systems generate a

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complex interplay of economic decline, social fragmentation, and escalating conflict, threatening both local stability and long-term livelihood sustainability.

Community-level adaptation and coping strategies

Pastoralists in South Sudan are doing everything they can to adapt, even when things are really bad. This study shows that pastoral groups used several techniques to deal with climate change-related problems, such as:

Mobility and migration

Mobility is still the most essential adaptation since herders move their animal's large distances to new sites to find food and water (SPARC, 2023; Bak, 2025). Some South Sudanese pastoralists travel to wetter areas, including the Nile and Sobat rivers, or even over the border into Uganda and Kenya when there is a drought. During the floods in 2021, a lot of people in Jonglei did the opposite. They moved their cows to higher ground in the middle and east of Equatoria (Muorwel, et al., 2023). But their migrations are increasingly tougher to sustain. Crossing national and international boundaries can be hard, and entering onto someone else's property without permission can lead to battles, like the one that happened in Mogwi County, Eastern Equatoria State, not too long ago. Pastoralists still need to travel about to keep alive, and a lot of individuals report that when the weather is poor, it's much more vital for them to do so, leading to more conflicts and poverty.

Diversifying and destocking herds

Pastoralists are altering how they care for their animals by adding new species and carefully removing animals from their herds. Some cow herders are introducing additional goats and sheep to their herds since these smaller animals can survive dry weather better and eat more sorts of grasses (FAO, 2018; Gebru, et al., 2018; World Bank, 2024). People in South Sudan don't commonly rear camels, but some are now starting to do so. Camels also perform well when it's dry. Families have already started to destock, which means they sell their livestock so they don't lose everything if there is a drought or flooding. For instance, ranchers who know that the dry season is coming can sell some of their cattle, usually the less productive males, while they are still healthy. This makes things easy for the pasture and offers them money to buy food or hay later (UNEP, 2018; World Bank, 2021; World Bank, 2024). This is something that people in eastern Africa used to do when they were afraid of droughts, and it's becoming more and more prevalent as a way to deal with the climatic variations in South Sudan. They might also move groups of animals around and separate the herds for a short time. This is an old way to spread out danger, and they hope that some of the smaller herds will be able to locate food.

Livelihood diversification

Several pastoral families are looking into agro-pastoralism or other ways to get money so they don't have to rely on animals as much. Some people in South Sudan have started small-scale gardening to make money and get food. This means adding grains, sorghum, or vegetables. It's not safe to work in fields in dry places, but it demonstrates that people are trying to find new ways to get stronger. Some people work for a few months at a time, fishing particularly when the land is flooded, or do little casual jobs when herding isn't enough to support them. The Awerial County survey in Lakes State indicated that many households had taken steps to

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decrease their risk, like planting trees, keeping bees, and even raising livestock and crops together (Ndebele and Zenda, 2023). They declared that if the cows don't give us enough milk or money, and the other activities are just good for acquiring money.

Community natural resource management

Local groups and pastoralists are also making communities better by agreeing to share land and water for grazing. In some areas, the heads of clans and cattle camp chiefs have made arrangements with their neighbors on where their animals can graze. These deals let their herds travel around or use other pastures when the weather is poor (Ndebele and Zenda, 2023). During the rainy season, herders would dig shallow wells or hafirs (water ponds) to catch rainfall. When it doesn't rain, they use this water for their herd's consumption. These communal projects show that these people understand that the environment is growing worse and are trying to make it better for a living.

Harvesting of wild foods as emergency practices

When pastoralists don't have any regular food due to cows lost to flooding and droughts, they eat wild fruits and plants, such as water lilies during the rainy season (UNHCR, 2024). People only use their emergency plans when they have to, and they show how much people may change when they have to deal with two calamities in succession.

External and institutional responses

The data also show how aid from the United Nations and national agencies might or might not help with certain problems related to flooding or droughts. It was shown that humanitarian operations are becoming more common in rural areas that have been hit by disasters caused by climate change, during the drought in 2017 and floods in 2020. The United Nations agencies and non-governmental organizations (NGOs) made plans to provide food and medical care to cows in case of an emergency to protect important breeding animals. But these fixes were not lasting long. The government of South Sudan has just started a big project to help farmers and herders deal with climate change better. This project has people from a lot of different NGOs working on it (UNDP, 2024). This project is going to create early warning weather stations, rehabilitate damaged rangelands, and teach farmers and ranchers how to graze and raise food in ways that are favorable for the environment from 2023 to 2028. These kinds of programs are highly vital, but the poll showed that many small-scale farmers don't know about them or can't access them. People who reside in rural areas may have trouble making the changeover since they don't have access to a lot of resources, such as markets, money, or agricultural extension. The people who took part in the Awerial study said it was hard for them to alter their lives since they couldn't acquire loans, information, or farming tools (Ndebele and Zenda, 2023). This shows that the goals of the national plan do not matching up with what really happens in the country. Although the pastoralists are losing more animals and their occupations are less secure, they still use traditional methods like migrating and trying new things. If these methods are supported and improved by the government plans, they could form the basis for a strong framework for adaptation.

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CONCLUSION AND RECOMMENDATIONS

Conclusion

Climate change is a serious problem for pastoralism in East Africa. This problem is exceedingly terrible and hard to fix, as the case of South Sudan shows. The study demonstrates that pastoralists' natural resources are in danger because temperatures are rising, rainfall patterns are changing, and disasters are happening more regularly. In South Sudan, the repercussions are already clear: cow herds are dying, herder households are getting poorer, battles over resources are getting worse, and traditional herding ways are eroding. Pastoral communities have demonstrated incredible resilience by surviving through tough times by migrating, meeting new people, and finding new methods to sustain a living. Yet, still, climate change is making things too hard for them. Weather projections claim that there will be more droughts and more floods. People may have to adapt slowly to pastoralism operating within a fluctuating climate in the next few decades. In other words, pastoralism can be a long-lasting and flexible way of life with the right assistance from the government. To protect these systems from climate change, local and national governments need to take care of them and make them operate better. Countries like South Sudan can keep the pastoralists' jobs, lessen the likelihood of conflicts, and keep their distinctive cultural heritage alive by investing in their livelihood's resilience. This will also help with the bigger goals of achieving the Sustainable Development Agenda.

Recommendations

To deal with how climate change is affecting pastoralism in South Sudan and other East African countries, the following reforms and policy efforts are suggested for remedy and adaptation:
Improve early warning and climate services

As soon as possible, people should learn about floods, droughts, and diseases. The government might partner with other groups to keep a watch on the weather in faraway regions and make sure that people get warnings fast, like through cell phones and radios. A big step forward is the new early warning system in South Sudan that can handle a lot of threats. It needs better weather stations and climate models that can work on their own. As this is being planned, think about what the herders need. For example, it should be able to identify when there will be enough food and water for herders to move their animals or sell them before some bad weather happens.

Make sure the water and pastures are managed safely

The government needs to spend money in the rural areas to harvest and secure fodder and water. This includes putting in and maintaining items like ponds, wells, and boreholes where animals may drink when it's dry. It also involves making it easy to get to rivers and ponds in a way that will last. The government also needs to come up with new ways to take care of rangeland or bring back old ones. For example, it can build pasture banks to use during dry and resee,d as well as conduct controlled burning to restore land that has been devastated. The project that is restoring any land to make it more resilient to climate change is an ecosystem-based adaptation strategy that helps stabilize the pastoral resource base and bring back grazing land.

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Help pastoralists move and share resources

Moving around is one of the most important strategies that pastoralists undertake to adapt to climate change. Policymakers should make it legal to use community grazing pastures and seasonal migration routes. This could include striking deals with other countries in the area to make it simpler for people to traverse borders. For instance, people who raise animals in South Sudan often go to Ethiopia, Sudan, or Uganda to gather grass. It is very important to precisely define and observe the typical grazing rights and corridors when selecting how to manage land in a given area. Governments and development programs shouldn't force pastoralists to stay in one place. Instead, they should let people move about to fit in. The African Union and IGAD have asked for help writing laws that make it simpler for pastoralists to move around. South Sudan should make these ideas part of its plans for land and peace. If there are mediation committees and plans for how to share resources, pastoralists and farmers can get along well.

Diversify livelihoods and income Sources

Pastoral families need to find new ways to make money so that the economy stays stable. Agro-pastoral programs can help communities grow some of their own food if they can. People who live in the country, especially women and young people, should learn how to make money in different ways. Some examples are keeping bees, rearing poultry, manufacturing crafts, or trading. This implies you won't have to rely on animals as much. Setting up value chains for animal products, such as creating cheese from milk or leather items, could also help smaller herds make more money. People should use and retain these kinds of projects as long as they fit with the culture and are focused on the community.

Improve veterinary services and animal health

Climate change makes diseases more widespread, thus people who live in rural areas require better veterinary care. In faraway cattle camps, community animal health workers and mobile veterinary clinics can give animals shots, get rid of parasites, and treat sick animals. We need to be careful of Rift Valley disease because of climate change. It can happen after a lot of rain. We also need to bring extra medical supplies for our dogs in case of an emergency. Animals that are healthier and less likely to get sick will be better able to handle the stress of bad weather. Long-term plans might also include finding ways to breed animals that can handle drought better, like strong native cow breeds or cross-breeding with tougher animals like camels.

Establish social safety nets and insurance

Pastoralists often lose everything, so it's really important to have social safety nets in place to make sure they don't lose everything when a natural disaster happens. The government and the groups that help should make sure that cows are either insured or paid for. For example, index-based insurance that pays out when drought indicators hit a certain threshold can benefit people when their animals die. Pastoral communities should also be able to get food or money when it is very dry or very wet, so that people don't starve or sell their goods too quickly. These safety nets can function alongside "build back better" programs that help people get their lives back on track or get their pets back after a disaster. In this manner, communities won't get worse every time something bad happens.

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Finding ways to make peace and settle disagreements

People can feel offended quite easily; adaptation efforts need to bear that in mind. When people are moving because of a drought, it's especially crucial to help local peace committees deal with difficulties with water and pasture. Elders and chiefs can be given more power to end fights, and steps can be taken to stop the violence. In places where raids happen a lot, people may need to have their guns taken away, and the police may need to be tighter. But it's just as important to tackle the conditions that generate them. For instance, giving them additional means to make money so that raiding isn't the only choice they have. It will be easier to stop fights if the region works together through IGAD to manage resources. If farmers and pastoralists talk to each other and make fair plans for how to share resources, they are less likely to fight over them.

Institutional support and extension services

Governments and development partners should help groups aid individuals who live in rural areas. This includes agricultural extension services for pastoralism that might teach people how to store fodder (make hay for dry seasons), care for animals better, and use weather information. Microcredit and savings clubs are two kinds of banks that can help individuals who live in pastoral communities buy goods like water pumps or extra food to help them get used to their new lives. For instance, teaching pastoralists how to read and write or how to take care of animals could help them get adjusted to a world that is continually changing. Pastoralists must be included in the planning and implementation of adaptation programs (a participatory approach) to make sure that the adjustments are based on what people in the area know and that they address real needs. The University of Juba, for instance, wants to construct a center to help people deal with climate change. This institute might focus on research and outreach that directly affects rural areas and gets people in the community involved.

Long-term planning and policy coordination

Last but not least, the government of South Sudan should make climate adaptation for pastoral systems one of its national development priorities. The National Adaptation Plan (NAP) should clearly include pastoralism and create a long-term plan for managing rangelands that is both sustainable and able to handle droughts and support different ways of living in pastoral areas. The ministries of Conflict Resolution and Peace Building, Agriculture/Livestock, Water, and the Environment must all work together to carry out a complete strategy. Fixing water infrastructure and restoring rangelands are two significant adaptation projects that foreign countries can help pay for. They can do this via climate finance choices like the Least Developed Countries Fund or the Green Climate Fund. We should always watch pilot initiatives and provide them with comments so that we may learn from them and make them better. Policymakers ought to regard pastoralists as significant collaborators in enhancing communities. They need to provide kids the rights and resources they need to do well in a world that is continuously changing, and they also need to know that kids may change.

These approaches can help South Sudan and the countries around it be more flexible. There are a lot of problems. Climate change will keep placing stress on traditional systems, but pastoralism can still be a good way to make a living for a long time with aid from others. Even though the climate is changing, the area can protect not only the jobs of millions of people, but also the unique cultural landscape that pastoralism symbolizes.

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