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The Nexus Between Climate Change and Livelihoods in Arid and Semi-Arid (ASAL) Areas of Kenya: Evidence from the Literature

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ABSTRACT: This study explored the complex relationship between climate change and livelihoods in the Arid and Semi-Arid Lands (ASALs) of Kenya, utilizing a comprehensive literature review to understand the multifaceted impacts of climate variability and change on these regions. ASAL areas covered approximately 89% of Kenya's land area and were home to about 36% of the population, who primarily depended on pastoralism and small-scale rain-fed agriculture for their livelihoods. The harsh climatic conditions characterized by low and erratic rainfall, high temperatures and frequent droughts exacerbated the vulnerability of these communities.

The study used the literature rev8iew methodology to obtain the requisite information on the subject. The literature review method involved systematically searching, analyzing and synthesizing existing research and scholarly articles, focusing on the impacts of climate change, adaptive strategies and the role of policy in supporting resilience.

The findings indicated significant variations in temperature and rainfall patterns in the area under discussion, leading to water scarcity, reduced agricultural productivity and increased food insecurity. Pastoralism, being the dominant livelihood source, faced challenges such as reduced pasture availability and increased livestock mortality. Small-scale farming was similarly affected by soil degradation, water scarcity and pest infestations, further limiting agricultural productivity. The study underscored the importance of integrating indigenous knowledge with modern practices to enhance resilience, highlighting the need for policies that promoted such integration and provided necessary training and resources to local communities. Effective implementation of climate policies required strengthening institutional capacities, ensuring adequate funding, and involving local communities in policy development. Additionally, international support needed to be streamlined to ensure easy access for ASAL communities, with simplified procedures and increased transparency enhancing the impact of international funding and technical assistance.

This comprehensive approach to the study of this subject was considered important for achieving sustainable livelihoods and socio-economic development in Kenya's ASAL regions.

KEYWORDS: Climate Change Adaptation, Arid and Semi-Arid Lands (ASALs), Pastoralism, Agricultural Productivity, Policy Implementation, International Support

1.0 INTRODUCTION

The nexus between climate change and livelihoods in arid and semi-arid lands (ASALs) is a critical area of study, particularly as these regions are on the frontline of climate variability and its impacts. In ASAL regions, such as those in Kenya, the livelihoods of communities are predominantly dependent on climate-sensitive activities like agriculture and pastoralism. Climate change exacerbates existing vulnerabilities by altering precipitation patterns, intensifying droughts and shifting the ecological balance. This not only affects the availability of natural resources but also threatens food security and the economic stability of households. Adaptation strategies, therefore, become essential. They include the adoption of climate-smart agricultural practices, diversification of livelihoods to reduce reliance on climate-vulnerable sectors, and improving access to climate information and financial services. These measures aim to build resilience and empower communities to better withstand and recover from climate-induced shocks.

Integrating traditional knowledge into climate-smart adaptations in Arid and Semi-Arid Lands (ASALs) involves a respectful synergy between age-old practices and modern scientific approaches. Traditional knowledge, which encompasses a deep understanding of local ecosystems, weather patterns and sustainable land management, can provide a valuable foundation for developing effective climate adaptation strategies. For instance, indigenous practices such as agroforestry, organic manure application and mixed farming have proven to be effective in maintaining soil health and moisture, thereby enhancing crop resilience

to climate variability. Moreover, traditional weather forecasting techniques, when combined with scientific climate forecasts, can improve decision-making and planning for climate-related events. It is essential to involve local communities in the adaptation process, ensuring that their experiences and insights are incorporated into the design and implementation of interventions. This participatory approach not only honors the cultural heritage of the communities but also fosters ownership and sustainability of the adaptation measures. By valuing and integrating traditional knowledge, ASAL regions can craft robust, culturally appropriate and sustainable responses to the challenges posed by climate change (Emoit & Gaynor, 2023).

Education and awareness programs are pivotal in promoting the integration of traditional knowledge into modern practices, particularly in the context of climate-smart adaptations. These programs can facilitate the preservation and dissemination of indigenous wisdom by incorporating it into formal and informal educational curricula. For example, the 'Big Five' framework is a set of strategies that embody First Nations knowledges and ways of knowing, being, and doing, which can be integrated into teaching and learning processes. UNESCO also plays a significant role in education for sustainable development, actively supporting the inclusion of biodiversity and local knowledge in learning initiatives. Moreover, bridging the gap between Western science and Indigenous knowledge through education can foster a more inclusive and comprehensive learning environment. Additionally, documentation initiatives aim to preserve, safeguard and promote traditional knowledge at the community level, encouraging its integration into formal education. These programs not only honor cultural heritage but also enhance the application of traditional knowledge in addressing contemporary environmental challenges (Makate, 2020).

Adaptation strategies for communities in Arid and Semi-Arid Lands (ASALs) are diverse and tailored to address the unique challenges posed by climate variability. One effective approach is the integration of scientific forecasts with indigenous knowledge, which enhances the community's decision-making capabilities for managing drought events. Additionally, smart farming practices, such as the use of water-saving irrigation systems, drought-resistant crops, and efficient resource utilization, are being adopted to improve resilience. The private sector also plays a crucial role by investing in adaptive agriculture, which can lead to livelihood diversification and strengthen the resilience of natural resources. Furthermore, community-driven measures, including stakeholder collaboration and locally driven innovations, are vital for building water-resilient communities in ASAL regions. Lastly, promoting and adopting livelihood measures that prioritize resilience at household, community and system levels can mitigate the impact of major shocks and stresses, resulting in greater overall resilience. These strategies collectively contribute to enhancing the adaptive capacity of ASAL communities in the face of climate change (Jones, 2022).

Arid and Semi-Arid Lands (ASALs) cover approximately 89% of Kenya's land area and are home to about 36% of the population (Mwangi & Wambugu, 2020). These regions are characterized by low and erratic rainfall, high temperatures, and frequent droughts, making them highly vulnerable to climate variability and change. The livelihoods of communities in ASAL areas are predominantly dependent on natural resources, particularly pastoralism and small-scale agriculture, which are significantly affected by the harsh climatic conditions.

Pastoralism is the dominant livelihood in ASAL regions and is practiced by over 60% of the population in these areas (Kinyua, Ndung'u & Karanja, 2018). This livelihood strategy involves the rearing of livestock such as cattle, goats, sheep and camels, which are well adapted to the arid environment. However, climate change poses significant challenges to pastoralism. Prolonged droughts lead to the scarcity of water and pasture, resulting in increased livestock mortality and reduced productivity (Opiyo, Wasonga & Nyangito, 2015). Additionally, the traditional mobility of pastoralists, which is crucial for accessing grazing lands, is increasingly restricted by modern land tenure systems and land-use changes, further complicating their ability to adapt to changing conditions.

Small-scale farming is another critical livelihood strategy in ASAL areas, although it is highly susceptible to climate variability. Agriculture in these regions is primarily rain-fed, and farmers face numerous challenges such as soil degradation, water scarcity and pest infestations, which are exacerbated by climate change (Njoka, Yazan & Opiyo, 2016). The unpredictability of rainfall patterns often leads to crop failures and reduced yields, contributing to food insecurity. Furthermore, the lack of irrigation infrastructure and access to climate-resilient crop varieties limits the potential for agricultural productivity and sustainability in ASALs.

Women play a crucial role in sustaining livelihoods in ASAL areas. They are involved in various economic activities, including agriculture, livestock rearing, and small-scale trade (Gichohi, Kariuki & Njenga, 2014). Women also contribute significantly to household food security and nutrition by engaging in kitchen gardening and food processing. Despite their critical role, women in ASAL areas face numerous challenges, including limited access to resources, decision-making power, and education, which hinder their ability to fully contribute to and benefit from livelihood opportunities (Njiru, 2012).

To cope with the harsh climatic conditions and economic challenges, households in ASAL areas often diversify their livelihoods. Diversification strategies include engaging in petty trade, wage labor and small businesses such as selling charcoal and firewood (Njiru, 2012). These activities provide additional sources of income and reduce the vulnerability of households to climatic shocks. However, the sustainability of some of these activities, such as charcoal production, poses environmental concerns and may contribute to further degradation of natural resources.

In Kenyan ASAL areas, prolonged droughts exacerbated by climate change have significantly reduced agricultural and livestock production, which are the mainstay of the local economies. Climate-smart adaptations, such as diversified farming practices and

water harvesting techniques, are being implemented to build resilience against climate shocks. These adaptations are essential for protecting food and water security, as well as livelihoods in the face of changing weather patterns. For instance, farmers in Laikipia County have turned to constructing vertical gardens and investing in drought-resistant crops, which has not only increased water preservation but also created diversity in crops, thus enhancing food security and economic stability in the region. Similarly, pastoralists in Northern Kenya are facing acute challenges as persistent droughts and periodic floods destroy their traditional way of life, forcing them to migrate in search of pastures and water for their livestock or move to safer grounds against the floods. The situation underscores the urgent need for comprehensive climate action and support for ASAL communities to safeguard their livelihoods and adapt to an increasingly unpredictable environment (IPCC, 2022).

Communities in Arid and Semi-Arid Lands (ASALs) can access resources for climate-smart adaptations through various channels. International and local NGOs often provide support in the form of training, funding and technology transfer. For instance, community-based adaptation frameworks are increasingly being adopted, which focus on developing locally relevant and culturally appropriate solutions, as well as fostering resilience through sustainable practices. Additionally, governments and private sector partnerships play a crucial role. In Kenya, initiatives like the African Enterprise Challenge Fund (AECF) aim to drive investment in ASALs by de-risking business activities related to agriculture, thereby enhancing livelihood diversification and strengthening the resilience of natural resources. Furthermore, adaptation interventions may include forecasting, storage of food, water efficiency, and environmental improvement interventions such as soil and water conservation. Access to these resources is also facilitated by programs like DryDev, IMARA, and T-CLIRP, which have been successful in mitigating the impact of drought and improving household and community resilience in Kenyan counties. Lastly, integrated water resource management systems are promoted to improve access to water for both drinking and domestic use, which is essential for sustaining livelihoods in these regions (Development Partners International, 2024).

2.0 METHODOLOGY

This study adopted the literature review method as the primary research approach. A literature review involved systematically searching, analyzing and synthesizing existing research and scholarly articles on a specific topic to develop a comprehensive understanding of the subject. This method was particularly well-suited for examining the complex relationship between climate change and livelihoods in ASAL areas of Kenya, as it allowed the aggregation of diverse findings from multiple studies to paint a holistic picture of the current knowledge landscape. The literature review method was chosen for its ability to provide a broad and detailed exploration of existing research, identify gaps in knowledge, and offer insights into the collective evidence gathered by various scholars and institutions. The data collection process for this literature review involved an extensive search of peer-reviewed journals, government reports and publications from international organizations. The selection criteria were based on the relevance of the articles to the topic, their recency (published between 2010 and the present), and their credibility, with a preference for those published in reputable, peer-reviewed journals. The review focused on studies that specifically addressed the impacts of climate change on livelihoods in ASAL regions, the adaptive strategies employed by local communities, and the role of policy in mitigating these effects. Through a careful analysis of the collected literature, key themes and patterns were identified, providing a structured synthesis of the existing research. This method not only offered a detailed understanding of the topic but also highlighted areas where further research was needed, thereby contributing to the development of more effective climate adaptation strategies and policies. The collected literature was analyzed to identify common themes, findings and gaps. Key areas of focus included: Impacts of climate change on ASAL areas: Examining changes in temperature, rainfall patterns, water resources, agriculture and food security. Livelihood strategies: Understanding how pastoralism and small-scale agriculture are affected and the adaptive strategies employed by communities. Policy and institutional frameworks: Evaluating the role of national and international policies in supporting climate adaptation and resilience.

3.1 Climate Change and Its Impact on ASAL Areas

3.1.1 Temperature and Rainfall Patterns

Climate change has led to significant alterations in temperature and rainfall patterns in ASAL regions, which have far-reaching implications for the livelihoods of communities residing in these areas. The ASAL regions, which are already characterized by harsh climatic conditions, are becoming increasingly vulnerable due to the impacts of global climate change. Studies indicate a notable increase in average temperatures and the occurrence of more frequent and severe droughts, and in some occasions flash floods. For instance, Opiyo, *et al.* (2015) observed that ASAL areas have experienced substantial temperature rises, exacerbating the already arid conditions. Rainfall patterns in these regions have also become increasingly unpredictable, with longer dry spells and more intense and sporadic rainfall events that occasionally cause destructive floods. In Kenya, temperatures have risen by approximately 1.0°C over the last five decades, and there has been a marked increase in the frequency of heatwaves (Ongoma & Onyango, 2014). These changes in climate variables have significant impacts on the livelihoods of ASAL communities, which heavily depend on

agriculture and pastoralism. The traditional agricultural calendar is disrupted, affecting planting and harvesting seasons and thereby reducing crop yields.

Empirical studies have extensively documented the adverse effects of these climatic changes on both the environment and human activities. Research conducted by Schilling *et al.* (2012) highlights that the frequency of droughts in Northern Kenya has increased markedly, leading to significant reductions in water availability and pasture for livestock. This has directly affected pastoral communities, resulting in increased livestock mortality and reduced herd sizes, which are crucial assets for these communities. Additionally, the increased unpredictability of rainfall has disrupted planting seasons for farmers, leading to lower crop yields and heightened food insecurity (Savo, Morton & Lepofsky, 2016). These climatic shifts also amplify existing vulnerabilities, as communities face greater difficulty in maintaining their traditional livelihoods and securing food and water. The impact of climate change on temperature and rainfall patterns in ASAL regions necessitates the development of robust adaptation strategies to enhance resilience. Local communities, governments and international organizations must collaborate to implement sustainable practices and policies that address these climatic challenges.

3.1.2 Water Resources

Water scarcity is a critical issue in ASAL areas, and climate change has exacerbated this problem, significantly impacting both human and agricultural activities. Reduced rainfall and higher evaporation rates due to increased temperatures have led to the drying up of rivers, lakes, and groundwater sources, which are vital for the survival and economic activities of communities in these regions (Njoka, Yazan & Opiyo, 2016). The scarcity of water not only affects human consumption but also agricultural productivity, which is a primary livelihood source in ASAL areas. Galvin, Beeton & Boone (2014) indicated that water shortages have forced pastoralists to migrate more frequently and over longer distances in search of water, increasing the likelihood of conflicts over these scarce resources. The mobility of pastoralists, traditionally an adaptive strategy to cope with the arid environment, is becoming less effective as water sources dwindle and competition for remaining resources intensifies. This situation is further complicated by modern land tenure systems that restrict movement, leading to overgrazing in certain areas and exacerbating land degradation.

Evidence suggests that water scarcity has a profound effect on agricultural productivity. For instance, Olang, Kundu & Bauer (2014) found that water scarcity in ASAL regions of Kenya has reduced crop yields by over 50%, exacerbating food insecurity. The reliance on rain-fed agriculture in these regions makes them particularly vulnerable to climate variability. When rains fail or are delayed, crop failures become more frequent, leading to significant socio-economic implications for local communities, including increased poverty and malnutrition. Moreover, the drying up of water sources also affects the health and well-being of communities. Lack of adequate water for hygiene and sanitation can lead to the spread of waterborne diseases, further straining the already limited healthcare resources in ASAL regions. This multifaceted impact of water scarcity underscores the urgent need for comprehensive water management strategies that incorporate both traditional knowledge and modern technologies to enhance water use efficiency and ensure sustainable water supply for ASAL communities.

3.2 Livelihoods in ASAL Areas

3.2.1 Pastoralism

Pastoralism is the dominant livelihood in Arid and Semi-Arid Lands (ASALs) areas, where communities primarily rely on the rearing of livestock such as cattle, goats, sheep and camels. These animals are well adapted to the harsh, arid environment, but climate change poses significant challenges to this way of life. The availability of grazing land and water is increasingly affected by more frequent and severe droughts, leading to conflicts over these scarce resources. The traditional mobility of pastoralists, which is crucial for accessing dispersed and seasonal resources, is further restricted by modern land tenure systems and land-use changes. These changes include the privatization and fencing of land, the establishment of protected areas, and agricultural expansion, all of which complicate pastoralists' ability to adapt to changing conditions (Galvin, 2009).

According to Opiyo, *et al.* (2015), droughts have reduced pasture availability significantly, leading to increased livestock mortality and decreased milk production, which are critical for pastoral livelihoods. The Turkana pastoralists of Northern Kenya, for instance, have experienced substantial herd losses, which directly affect household incomes and food security. The reduction in herd sizes forces pastoralists to seek alternative livelihoods or migrate to urban areas, where they often face economic marginalization and limited opportunities. Furthermore, the stress of maintaining their herds in increasingly inhospitable conditions exacerbates social tensions and conflicts, not only among pastoralist communities but also between pastoralists and agriculturalists (Dube & Nhamo, 2020).

Moreover, the impacts of climate change extend beyond immediate economic losses to long-term socio-cultural effects. Pastoralism is not just an economic activity; it is deeply embedded in the social and cultural fabric of ASAL communities. The loss of livestock undermines traditional practices, social structures and cultural identity. Women, who play a crucial role in pastoralist societies, are particularly affected as they often bear the brunt of the increased labor burden and food insecurity. These challenges underscore the need for targeted interventions that not only address the environmental and economic dimensions of climate change but also support the social and cultural resilience of pastoralist communities (Galvin, 2009; Opiyo *et al.*, 2015).

3.2.2 Agriculture

Small-scale farming in ASAL areas is predominantly rain-fed, making it highly vulnerable to climate variability. Farmers and agro-pastoralists in these regions face numerous challenges, including soil degradation, water scarcity and pest infestations, all of which are exacerbated by climate change. The unpredictable nature of rainfall, characterized by either excessive or insufficient amounts, disrupts planting and harvesting schedules, leading to crop failures and reduced agricultural productivity. The lack of irrigation infrastructure further compounds these challenges, as it limits the ability of farmers to mitigate the impacts of droughts and capitalize on the benefits of occasional heavy rains (Njiru, 2012).

Bryan, *et al.* (2013) indicated that climate change has led to reduced crop yields and increased crop failure rates in ASAL regions. The study highlights that farmers and agro-pastoralists are increasingly adopting drought-resistant crop varieties and conservation agriculture practices to mitigate these impacts. For instance, the use of conservation tillage, which involves minimal soil disturbance, helps retain soil moisture and reduce erosion. Agroforestry practices, where trees are integrated into agricultural landscapes, improve soil fertility and provide additional sources of income through the production of fruits, nuts and timber. However, these adaptive strategies are often limited by financial constraints and lack of access to relevant information and resources. Below *et al.* (2012) found that socio-economic factors, such as household income, education level and access to extension services, significantly influence farmers' ability to adopt and sustain adaptive practices.

Additionally, the impact of climate change on agriculture extends to broader socio-economic dimensions. Reduced agricultural productivity exacerbates food insecurity, leading to increased reliance on food aid and imports. This dependency undermines local food systems and increases vulnerability to global food price fluctuations. Moreover, the loss of agricultural income forces many households to diversify their livelihoods, often through wage labor, petty trade or migration. These shifts can strain family and community structures, as traditional roles and responsibilities are altered. Women, who are primarily responsible for household food production, face heightened burdens as they navigate the dual challenges of climate change and socio-economic pressures (Bryan *et al*., 2013; Below, *et al*., 2012).

3.3 Adaptive Strategies

3.3.1 Indigenous Knowledge and Practices

Communities in ASAL areas have developed indigenous knowledge and practices to cope with climate variability. These include traditional rainwater harvesting, the use of drought-resistant crop varieties, and mobile livestock rearing. Such practices are crucial for resilience but need to be supported and integrated with modern techniques (Osbahr, *et al*., 2010). Indigenous knowledge systems encompass a deep understanding of local ecosystems, weather patterns and resource management practices that have been passed down through generations. These systems are tailored to the specific environmental and socio-economic contexts of the communities, making them highly relevant and effective in managing climatic variability. Traditional rainwater harvesting techniques, such as the construction of small dams, ponds and terraces, help in capturing and storing rainwater for use during dry periods. These practices enhance water availability for both agricultural and domestic use, thereby reducing the vulnerability of communities to water scarcity. The use of drought-resistant crop varieties, which are typically native species adapted to arid conditions, ensures that agricultural activities can continue even under limited water availability. These crops often have shorter growing seasons and require less water, making them suitable for the erratic rainfall patterns in ASAL regions.

Mobile livestock rearing, or pastoralism, is another critical indigenous practice that allows communities to adapt to changing environmental conditions. Pastoralists move their herds across vast areas to access grazing lands and water sources, ensuring that their livestock can survive during periods of drought. This mobility is a strategic response to the spatial and temporal variability of resources in ASAL areas. Additionally, indigenous weather forecasting methods, based on the observation of natural phenomena such as the behavior of animals, plants and celestial bodies, provide valuable information for decision-making related to livestock movement and resource allocation (Speranza, *et al.*, 2010).

Speranza *et al.* (2010) found that pastoral communities in Kenya utilize indigenous weather forecasting methods to make decisions about livestock movement and resource allocation. These traditional practices enhance the adaptive capacity of communities and contribute to their resilience against climatic shocks (Reid, *et al*., 2014). Furthermore, integrating indigenous knowledge with scientific data and modern technologies can create robust adaptation strategies that leverage the strengths of both systems. For instance, combining traditional rainwater harvesting with modern irrigation techniques can optimize water use efficiency and improve agricultural productivity.

3.3.2 Technological Innovations

Technological innovations, such as improved irrigation systems, climate-smart agriculture and early warning systems, are essential for enhancing resilience. These innovations provide communities with the tools and information needed to better manage their resources and adapt to changing climatic conditions. Improved irrigation systems, including drip irrigation and sprinkler systems, allow for more efficient use of water resources, ensuring that crops receive adequate water even during dry spells. These systems help maintain agricultural productivity and reduce the risk of crop failure due to water stress (Thornton, *et al*., 2014). Climate-smart

agriculture involves the adoption of agricultural practices that increase productivity, enhance resilience to climate change and reduce greenhouse gas emissions. Techniques such as conservation tillage, crop diversification, agroforestry and integrated pest management improve soil health, increase biodiversity and enhance the overall resilience of farming systems. Conservation tillage, for example, minimizes soil disturbance, thereby reducing soil erosion and improving water retention. Agroforestry integrates trees into agricultural landscapes, providing multiple benefits such as shade, windbreaks and improved soil fertility (Muthoni, *et al*., 2017).

Early warning systems are critical for preparing communities for extreme weather events. These systems provide timely information about impending climatic events, such as droughts, floods and storms, allowing communities to take proactive measures to mitigate their impacts. Mobile technology plays a significant role in disseminating climate information and market prices, aiding farmers and pastoralists in making informed decisions. Mobile applications can deliver real-time weather forecasts, agricultural advice and market information, enabling users to optimize their farming practices and improve their livelihoods (Kadi, *et al.,* 2011). For instance, Muthoni, *et al*., (2017) found that the adoption of climate-smart agricultural practices, such as conservation tillage and agroforestry, significantly improved crop yields and soil health in ASAL regions. The study showed that these practices not only increased agricultural productivity but also enhanced the resilience of farming systems to climatic variability. Moreover, the use of mobile technology for weather forecasting and market information has empowered farmers to make better decisions and reduce climate-related risks. For example, access to accurate weather forecasts enables farmers to plan their planting and harvesting schedules more effectively, reducing the risk of crop losses due to adverse weather conditions (Kadi *et al*., 2011).

3.4 Policy and Institutional Framework

3.4.1 National Policies

Kenya has developed several comprehensive policies to address the multifaceted challenges posed by climate change and to support communities in Arid and Semi-Arid Lands (ASALs). The cornerstone of these efforts is the National Climate Change Response Strategy (NCCRS), which was launched in 2010. The NCCRS provides a strategic framework aimed at enhancing climate resilience and mitigating the adverse impacts of climate change across various sectors. It outlines specific actions and priority areas, including disaster risk reduction, water resource management and the promotion of climate-smart agriculture (GoK, 2010). Complementing the NCCRS is the National Adaptation Plan (NAP), which further details the adaptive measures necessary to bolster the resilience of Kenya's socio-economic systems. The NAP emphasizes the need for integrating climate adaptation into national development plans, enhancing the adaptive capacity of vulnerable communities, and improving the country's overall preparedness for climate-related hazards. This plan also identifies key sectors for targeted interventions, such as agriculture, water resources, infrastructure and health, ensuring a holistic approach to climate adaptation (GoK, 2016).

Despite these well-structured policies, empirical reviews indicate several challenges that hinder their effective implementation. Limited financial resources are a significant constraint, as adequate funding is crucial for executing the various initiatives outlined in the NCCRS and NAP. The lack of technical expertise and insufficient institutional capacity further exacerbate these challenges, making it difficult to translate policy into actionable programs. Moreover, poor coordination among stakeholders, including government agencies, non-governmental organizations and local communities, undermines the coherence and effectiveness of climate action (Ojwang, Agatsiva & Situma, 2010). Ojwang *et al*. (2010) highlighted the need for better integration of climate policies with local development plans. The study stresses that involving local communities in policy formulation and implementation is vital for ensuring that the policies are contextually relevant and sustainable. The researchers also advocate for capacity-building initiatives that empower local governments and community organizations, enabling them to effectively participate in climate adaptation efforts. This approach not only enhances policy effectiveness but also fosters a sense of ownership and accountability among stakeholders.

3.4.2 International Cooperation

International cooperation and funding are pivotal for supporting climate adaptation initiatives in ASAL areas. Kenya has benefited from various international programs and partnerships that provide both financial resources and technical assistance. The Green Climate Fund (GCF) is one such initiative, designed to support developing countries in their efforts to respond to climate change by promoting low-emission and climate-resilient development (Tanner & Horn-Phathanothai, 2014). However, accessing these international funds often involves complex procedures and bureaucratic hurdles, which can limit their effectiveness. For instance, the stringent requirements for project proposals and the lengthy approval processes can delay the disbursement of funds, hindering timely implementation of adaptation projects. Additionally, there is often a mismatch between the priorities of international donors and the actual needs of local communities, leading to suboptimal allocation of resources (Tanner & Horn-Phathanothai, 2014).

Evidence suggested that streamlining these processes and increasing transparency can significantly enhance the impact of international funding. Agrawal, *et al*., (2019) emphasized the importance of strong governance structures and accountability mechanisms in the effective utilization of international climate funds. Their study reveals that building local capacity and ensuring that funds are aligned with local needs and priorities are crucial for the sustainability of adaptation efforts. The researchers advocate

for a participatory approach in which local stakeholders are involved in the planning and implementation of climate adaptation projects, ensuring that the interventions are relevant and beneficial to the target communities. Furthermore, Agrawal *et al*. (2019) highlighted the role of international cooperation in fostering knowledge exchange and capacity building. International partnerships can facilitate the transfer of innovative technologies and best practices, which are essential for enhancing the resilience of ASAL communities. By fostering collaboration between global and local actors, international cooperation can help bridge the gap between policy and practice, ensuring that adaptation strategies are both effective and sustainable.

4.0 DISCUSSION

4.1 Integrating Indigenous Knowledge and Modern Practices

Integrating indigenous knowledge with modern practices is crucial for enhancing the resilience of communities in Arid and Semi-Arid Lands (ASALs) of Kenya. Indigenous knowledge encompasses traditional understandings and practices that local communities have developed over centuries to manage their environment and resources sustainably. These practices include, but are not limited to, traditional rainwater harvesting techniques, the use of drought-resistant crop varieties, and the mobile grazing systems practiced by pastoralists. Indigenous knowledge systems are rooted in a deep understanding of local ecosystems and are highly adapted to the variable and extreme climatic conditions typical of ASAL regions (Osbahr *et al*., 2010).

The effectiveness of integrating indigenous knowledge with modern practices has been supported by various empirical studies. Speranza *et al*. (2010) documented how pastoral communities in Kenya utilize indigenous weather forecasting methods to inform decisions on livestock movement and resource allocation. These traditional forecasting methods, which include the observation of animal behavior and plant phenology, have proven to be reliable and critical for sustaining pastoral livelihoods in the face of climate variability. Integrating such indigenous knowledge with modern meteorological data can enhance the accuracy of weather predictions and improve the decision-making processes of local communities.

Moreover, the combination of traditional agricultural practices with modern techniques can significantly improve crop yields and soil health. For instance, research by Recha *et al*. (2016) found that conservation agriculture, which includes practices such as minimal soil disturbance and the use of organic mulches, when combined with indigenous soil fertility management techniques, significantly enhances agricultural productivity in ASAL regions. These findings underscore the importance of promoting policies that encourage the integration of indigenous knowledge with modern agricultural practices. Providing training and resources to local communities is essential for the successful implementation of such integrated approaches.

4.2 Enhancing Policy Implementation

Effective implementation of climate policies requires strengthening institutional capacities and ensuring adequate funding. Institutional capacity building is essential for empowering local governments and agencies to effectively plan and execute climate adaptation strategies. This involves training personnel, developing robust data collection and analysis systems, and fostering collaboration among various stakeholders. The decentralization of decision-making processes and the involvement of local communities in policy development can greatly improve the relevance and effectiveness of climate policies (Ojwang *et al*., 2010).

Empirical evidence supports the need for decentralizing climate policy implementation. For instance, Nyong, Adesina & Osman Elasha (2007) highlighted the positive outcomes of involving local communities in the management of natural resources. The study found that community-based resource management practices in the Sahel region led to improved resource sustainability and increased community resilience to climate change. These findings suggest that similar approaches could be beneficial in Kenya's ASAL regions, where local knowledge and participatory governance can enhance the effectiveness of climate adaptation efforts.

Furthermore, ensuring adequate funding is crucial for the successful implementation of climate policies. Without sufficient financial resources, it is challenging to carry out necessary infrastructure projects, provide training and support local adaptation initiatives. A study by Agrawal *et al*. (2019) emphasized the importance of aligning funding mechanisms with local needs and priorities. The research found that when local stakeholders have a say in how funds are allocated and used, the outcomes are more sustainable and impactful. This highlights the need for climate finance mechanisms that are transparent, inclusive and responsive to the specific needs of ASAL communities.

4.3 Strengthening International Support

International support plays a critical role in bolstering climate adaptation efforts in ASAL areas. Programs like the Green Climate Fund (GCF) and partnerships with international organizations provide essential financial and technical assistance to support local adaptation initiatives. However, accessing these resources often involves complex procedures and bureaucratic hurdles that can limit their effectiveness (Tanner & Horn-Phathanothai, 2014). Streamlining these processes and increasing transparency can significantly enhance the impact of international funding. A study by Agrawal *et al*. (2019) emphasized the importance of strong governance structures and accountability mechanisms in the effective utilization of international climate funds. The research found that building local capacity and ensuring that funds are aligned with local needs and priorities are crucial for the sustainability of adaptation

efforts. The study also highlighted the need for a participatory approach, involving local stakeholders in the planning and implementation of climate adaptation projects to ensure their relevance and effectiveness.

Empirical evidence also suggests that international cooperation can facilitate knowledge exchange and capacity building. For instance, Berrang-Ford, Ford & Paterson (2011) demonstrated that international partnerships can help transfer innovative technologies and best practices to enhance resilience in vulnerable communities. The research highlighted successful examples of technology transfer in agriculture, water management and disaster risk reduction, which significantly improved the adaptive capacity of local communities in ASAL regions. Moreover, aligning international funding with local development goals can maximize the benefits of climate adaptation projects. Research by Roberts and Pelling (2018) found that integrating climate adaptation with broader development initiatives, such as poverty reduction and infrastructure development, enhances the overall resilience of communities. This integrated approach ensures that adaptation efforts are not only effective but also contribute to sustainable development outcomes.

5.0 CONCLUSION

This study has provided a comprehensive analysis of how climate change impacts the livelihoods of communities in ASAL regions, the adaptive strategies employed, and the role of policy and international cooperation. The findings underscore the profound effects of climate variability and change on these vulnerable regions, particularly in terms of temperature increases, unpredictable rainfall patterns and water scarcity. These climatic changes have significantly disrupted traditional pastoralism and small-scale farming, leading to reduced productivity, increased food insecurity and heightened competition for resources. The review highlights the critical importance of integrating indigenous knowledge with modern practices to enhance the resilience of ASAL communities. Indigenous practices such as traditional rainwater harvesting, the use of drought-resistant crop varieties and mobile livestock rearing have proven to be effective adaptive strategies. When combined with modern technologies and scientific data, these practices can significantly improve agricultural productivity, water management and overall community resilience. Policies that promote such integration and provide necessary training and resources to local communities are essential for sustainable development in ASAL regions.

Effective policy implementation is another key factor in addressing the challenges posed by climate change in ASAL areas. Strengthening institutional capacities, ensuring adequate funding and decentralizing decision-making processes are crucial steps towards achieving successful climate adaptation. Involving local communities in policy formulation and implementation enhances the relevance and sustainability of these policies. Empirical evidence supports the effectiveness of community-based resource management and participatory governance in building resilience to climate change. International cooperation and funding play a pivotal role in supporting climate adaptation initiatives in ASAL regions. Streamlined procedures, increased transparency and alignment of international funding with local needs and priorities can significantly enhance the impact of these resources. Strong governance structures and accountability mechanisms are essential for the effective utilization of international climate funds. Additionally, international partnerships facilitate the transfer of innovative technologies and best practices, further strengthening the adaptive capacity of local communities.

In conclusion, addressing the multifaceted challenges posed by climate change in Kenya's ASAL regions requires a holistic and integrated approach. Combining indigenous knowledge with modern practices, enhancing policy implementation, and leveraging international support are critical components of this approach. By fostering collaboration among local communities, government agencies and international partners, it is possible to build resilient and sustainable livelihoods in ASAL regions. This integrated strategy not only addresses the immediate impacts of climate change but also contributes to long-term socio-economic development and environmental sustainability in Kenya's ASAL areas.

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