Afforestation as a Climate Change Mitigation and Adaptation Strategy in Isiolo County, Kenya: Challenges and Opportunities

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ABSTRACT

The aim of this study was to examine afforestation as a climate change mitigation and adaptation strategy in Isiolo County, focusing on its evolution, the challenges limiting its implementation, and the opportunities that can be harnessed to improve its effectiveness. The study also sought to demonstrate how afforestation contributes to building resilience in arid and semi-arid lands (ASALs), where recurrent droughts, land degradation, and dependence on natural resources increase vulnerability to climate change. Over the past few years, afforestation programmes have been launched to curb climate impacts in ASALs. The study was guided by three objectives: to investigate the evolution of afforestation as a climate change mitigation strategy in Kenya; to assess challenges facing its implementation in ASALs; and to establish opportunities for enhancing its effectiveness. Anchored on Ecosystem Restoration Theory, a mixed-method research design was applied with a sample size of 80 participants. Data was collected through questionnaires, analyzed descriptively, and presented in tables. Findings show afforestation programmes have improved in ASALs; however, their main challenge is the frequency and intensity of natural hazards. Opportunities lie in proactive governance through climate-sensitive policies and legislation. The study concludes that afforestation has evolved as a key climate change response, but its impact is limited by environmental and institutional barriers. It recommends policies linking afforestation to economic outcomes for local communities and stresses the need for regular maintenance practices such as weeding, thinning, pruning, and fire prevention to strengthen sustainability.

Keywords: Afforestation, Climate Change, Mitigation, Adaptation, ASALs, Isiolo County, Kenya

INTRODUCTION

The concept of climate change has become among one of the most discussed issues of academia in recent times (Kibu, 2024). This is because the discovery in the rise of temperature has resulted in global warming due to increase of Green House Gases (GHGs), leading to frequent and intense droughts, melting glaciers, rising sea levels and warning oceans (Bunning, Hagen & Simonson, 2024). All these impacts have the potential to harm humans, crops and animals, destroying the places they live, wreaking havoc on people's livelihoods and communities. The climate is changing globally, nationally and locally, and this is having an effect on conservation and ecosystems together with people and their livelihoods, through flooding, landslides and drought (Mume, Turyasingura, Abdi, Umer & Uwimbabazi, 2024). Therefore, recently there has been growing scholarly interest on the severe impact of climate change that has led to global warming and other challenges with respect to the environment. Owojaiye, (2024) argues that climate change is a growing concern, the phenomenon refers change in the climatic condition of a place over a given time period, and it is usually characterized by shifts in average weather conditions and in the frequency, plus severity of extreme conditions. Therefore, changes in climate result in notably extreme weather events.

Climate change disproportionately affects the most vulnerable (Elliott, 2023). In the developing countries, a large part of the population depends on activities that are most affected by climate change, namely, rain-fed agriculture, forestry, subsistence crop production and fishery (Adom, 2024). In addition, desertification, oceans, shorelines and reefs all seem threatened, with catastrophic consequences on human security (Abbas, 2022). The increased water stress has security implications for people in the Horn of Africa, they have experienced water shortages, especially those dependent on farming in arid or semi-arid areas (Psistaki, Tsantopoulos, &

Paschalidou, 2024). The arid and semi-arid dry lands are characterized by biophysical constraints such as temperature rise, low annual mean precipitation, erratic rainfall, frequent droughts and substantial seasonal and inter-annual variations, making these lands particularly vulnerable to climatic variability and change (Kibu, 2024). In spite of these challenges, envisioned climate adaptation measures have been slow to yield the much-needed relief, particularly, afforestation programmes, planting drought resistant crop varieties, in addition to practicing regenerative agriculture, managing land to reduce wildfire and building stronger defenses against extreme weather have also been unforthcoming.

According to Mume, *et. al*., (2024), when it comes to climate change action there are two broad approaches, that is, adaptation and mitigation. Adaptation refers to any action taken to adjust to climate change. Moreover, mitigation that are actions taken to reduce, avoid or sequester greenhouse gas emissions (Forster, 2024). The climate mitigation measures are those actions that are undertaken to reduce and curb GHGs, while climate adaptation measures are aimed at reducing vulnerability to the effects of climate change (Wakaba & Athanase, 2024). According to Lutta, Mungo, Kehbila, Sunguti & Osano, (2023), there has been a growing concern as to which mitigation and adaptation actions could provide the relief against climate variability generally, and particularly in Arid and Semi-Arid Lands (ASAL). Therefore, mitigation attends to the causes of climate change, while adaptation addresses its impacts. The common types of adaptation actions are infrastructural, institutional, behavioural and nature-based options (Kibu, 2024). In response to its vulnerabilities and deficiencies, Kenya has implemented a number of methods to tackle climate change effectively. The nature-based activities generally involve planting forests and restoring damaged ecosystems. Afforestation enhances soil quality by boosting nutrient cycling and lowering erosion (Owojaiye, 2024). It is a crucial tactic for sustainable land management and climate change mitigation since it offers resources like wood and non-timber forest products and helps control local climates.

Isiolo County has in recent years become a focus of large-scale tree planting efforts. In December 2023, 1,200 native tree seedlings were planted in the Gambella Wetland through a partnership involving the Wyss Academy for Nature, the Water Resources Authority, the National Environment Management Authority (NEMA), the Kenya Forest Service, and county officials from Meru and Isiolo. In May 2024, the Centre for Training and Integrated Research in ASAL Development (CETRAD) planted more than 4,000 trees in the same wetland to restore degraded ecosystems and improve local livelihoods. The Ministry of Defence has also taken part, with the Kenya Defence Forces (KDF) planting 5,000 trees in Isiolo under the Environmental Soldier Programme. These activities show that tree planting is increasingly being used to restore ecosystems and build resilience against climate change in the county.

Although afforestation has been widely promoted as a strategy for climate change adaptation and mitigation, there is limited research on how it is being implemented in ASAL counties such as Isiolo. There is also little documentation of the specific challenges faced and the opportunities that can be leveraged to make these initiatives more effective. This study therefore seeks to investigate afforestation as a climate change response in Isiolo County, with the aim of highlighting the challenges and opportunities that shape its success in arid and semi-arid regions. The general objective of this study is to explore afforestation as a climate change mitigation and adaptation strategy in Kenya with specific reference to the challenges and opportunities. The specific objectives of this study include: i) To investigate the evolution of afforestation as a climate change mitigation strategy in Isiolo County; ii) To assess the primary challenges facing the implementation of afforestation as a climate change mitigation and adaptation strategy in Isiolo County; and iii) To examine the opportunities, exist for enhancing the effectiveness of afforestation as a climate change mitigation and adaptation strategy in Isiolo County.

LITERATURE REVIEW

Concept of Climate Change

Climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions. Burning fossil fuels, cutting down forests and farming livestock are increasingly influencing the climate and the earth's temperature (Elliott, 2023). This adds enormous

amounts of GHG to naturally occurring in the atmosphere, increasing the greenhouse effect and global warming. Climate change refers to long-term shifts in temperatures and weather patterns. Human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas.

Climate change according to Chigudu, (2024) affects human security elements in Sub Saharan Africa (SSA), by virtue of the fact that they increase droughts, which in turn contribute to the spread of diseases, food insecurity challenges, limited access to clean water, a high risk of waterborne diseases, heat stroke and increases mental health challenges. For example, the SSA is a region that is most affected by climate change, with the Sahel, Southern Africa and East Africa (EA) sub-regions, climate change has become a threat multiplier, exacerbating exiting problems that gradually contribute to disasters, social and economic challenges.

The impact of climate change in Africa is fraught with difficulties. While some of the impacts are known and relatively well understood, there is still great uncertainty about the key climate processes and their consequences (Elliott, 2023). Climate change is having substantial impacts on Kenya, successfully adapting to these impacts is crucial to achieving the continent's development objectives (Owojaiye, 2024). Both observational records and climate projections provide evidence that freshwater resources are vulnerable and have the potential to be strongly affected, leading to additional pressure on water availability, supply and demand in Kenya (Mushitsi, Naymin & Nsabimana, 2023). In the case of Kenya, droughts and floods have resulted in the loss of human and animal lives and have negatively impacted the country's economy.

The Evolution of Afforestation as a Climate Change Mitigation and Strategy

The concept of afforestation is mainly concerned with establishing a forest, especially on land not previously forested (Owojaiye, 2024). It remains one of the most effective means of tackling climate change, particularly when it is designed to rely on green energy. This natural climate solution reduces the impact of desertification, supports ecosystems, and removes carbon-dioxide from the atmosphere (Walko & Avissar, 2018). It is a countermeasure against deforestation, which has been contributing to climate change dramatically for the last few centuries.

The afforestation projects can contribute to reducing greenhouse gas emissions and the overall concentration of carbon dioxide in the atmosphere (Elliott, 2023). This can help to mitigate the effects of climate change and support the transition to a low-carbon economy (Walko & Avissar, 2018). In around 1945, the Republic of Kenya started the first systematic programme of compensatory forest establishment (that is, replacing indigenous forests with plantations of exotic species) and replanting of clear-felled industrial plantation areas.

Afforestation and Climate Change in ASALs

The difficult afforestation of steppes and desert border regions is cumbersome and prone to ecological and hydrological mistakes, and it can take decades to get established. Afforestation is an important approach to mitigate global warming (Walko & Avissar, 2018). In addition, it has a complex interaction with the climate system, however, makes it controversial.

According to Owojaiye, (2024), large scale afforestation may have high value as a direct climate factor, and in semi-arid and arid areas with annual precipitation of less than 600 mm and 300 mm, respectively. Simulations are showing strong precipitation inducing the effect of large-scale vegetation. Afforestation is expected to be effective in the tropics where biogeochemical and bio-geophysical effects act in concert; however, its potential in the large semi-arid regions remains insufficiently explored. According to Abbas, (2022) there is an increasing recognition of the roles of forests and trees in mitigation and adaptation strategies to global climate change. Tree planting can modify local climate through impacts on temperature, wind speed, and humidity; it can also influence the landscape-scale water balance, cloud cover and albedo, and contribute to global carbon sequestration.

The (sub-) tropical developing countries, re- and afforestation have been included in the portfolio of mitigation efforts as a cost-efficient strategy to reverse the degradation of forests and to increase their atmospheric carbon uptake (Kang & Seely, 2017). According to Adom, (2024), although trees are central to many climate change

adaptation and mitigation strategies, they are vulnerable (particularly in their early growth), to variation in solar radiation, rainfall, and temperature as determinants of potential evapotranspiration (ET~0~). Changes in these climatic variables, particularly temperature increases and precipitation shortages leading to higher frequencies of extreme weather events (that is, severe drought and intense rainfall), are expected to affect tree growth and challenge the sustainable management of forests and tree plantations.

Challenges Facing Implementation of Afforestation

Forestation actions are a major tool for both climate-change mitigation and biodiversity conservation. Wang & Huang, (2015) addresses two weaknesses in this approach: the little attention given to the negative effects of reduced albedo associated with forestation in many regions, and ignoring the potential of dry-lands that account for 40 per cent of the global potential land area for forestation. Adom, (2024) propose an approach to identify suitable land for forestation and quantify its 'net equivalent carbon stock change' over 80 years of forest lifetime, accounting for both carbon sequestration and albedo changes.

Wang & Huang, (2015) notes that the marginalized people in dry areas are likely to be most seriously hit by the shifts in moisture and temperature regimes as a result of the global climate change. To help them cope with the challenges, there is a need for a new paradigm in agricultural research and technology transfer that makes full use of modern science and technology in conjunction with traditional knowledge (Walko & Avissar, 2018). This necessitates more investment by international agencies and national governments for supporting the relevant integrated research and sustainable development efforts, with full participation of the target communities.

Opportunities for Enhancing Effectiveness of Afforestation

Chigudu, (2024) opines that climate change and forest ecosystems are connected, with climate mainly affecting the rate, frequency, intensity and timing of air temperature, solar radiation and rainfall. Climate change impacts can be both positive and negative on forest structure, growth patterns, composition, productivity and functioning, depending on the location and type of forest. According to Abbas, (2022) forests can act as carbon *sink;* they can accumulate atmospheric CO~2~ as carbon in vegetation and soils. However, human activities affecting land use and forestry characteristics can alter the carbon cycle between the atmosphere and the terrestrial ecosystems leading to more CO~2~ emissions. Since forests are able to act as carbon *sink*, they are included in international policies (Walko & Avissar, 2018) to address climate change both via mitigation and adaptation processes; linking these two aspects should be preferred.

Owojaiye, (2024) opines that afforestation and reforestation projects can pursue this double role for forest ecosystems. Afforestation (converting long-time non-forested land into forest) refers to the establishment of forests where previously there have been none, or where forests have been missing for a long time (50 years according to UNFCCC) while reforestation refers to the replanting of trees on more recently deforested land (i.e. converting recently non-forested land in forest). If these two approaches are viewed as complementary, they may enable "win-win" policy options.

Walko & Avissar, (2018) postulates that at international level, afforestation and reforestation have been initially recognized as mitigation approaches, and have been promoted for carbon sequestration goals. However, they can also help forests to adapt to climate change by decreasing human pressures (for example by reducing the destruction or degradation of habitats) and landscape connectivity and reducing fragmentation (facilitating species migration under climate change conditions). Afforestation and reforestation may also contribute preserving biodiversity hotspots, avoiding soil degradation and protecting other natural resources (water).

According to Bunning, *et. al*., (2024) The sustainable management of afforested or reforested land help in pursuing adaptation responses, since it maintains forests status and guarantees ecosystems services, especially at local scale, by reducing vulnerability to climate change and to biodiversity loss. Lithu, (2024) points-out that in case of crop failure due to climate change, forests can provide safety nets for local communities with their products (such as, with both wood or non-wood products, such as game animals, nuts, seeds, berries, mushrooms, medicinal plants). According to Mume, *et. al*., (2024) forests also help in regulating water flow and water resources through their hydrological-related ecosystem services (base flow conservation, storm flow regulation

and erosion control). In addition, planting trees can create new habitats for more tolerant species and enhance biodiversity, especially when multispecies plantations (choosing native species and avoiding invasive ones, less adapted to the habitat) are preferred.

Theoretical Framework

The study was anchored on two theories: Ecological Restoration Theory and Systems Theory.

The Ecosystem Restoration Theory aims to help damaged or destroyed natural areas recover by reintroducing native plants and animals, improving soil and water conditions, and involving local communities to create healthy, self-sustaining environments (Owojaiye, 2024). The relevance of this theory to the study lies in its direct connection to afforestation as a climate change mitigation and adaptation strategy in Isiolo County. Through ecological restoration, degraded landscapes can be rehabilitated, carbon sequestration enhanced, and biodiversity protected.

von Bertalanffy (1968) advanced systems theory that argues that we are not able to fully comprehend a phenomenon simply by breaking it up into elementary parts and then reforming it; we instead need to apply a global vision to underline its functioning. Later, Bronfenbrenner (1983) advanced the Ecological Systems theory that represents a convergence of biological, psychological, and social sciences. The relevance of Systems Theory to this study lies in its ability to show how afforestation is influenced by multiple layers of interaction, from individual actions to national policies. The integration of the two theories therefore ensures that the study captures both the ecological and the socio-institutional dimensions of afforestation. Ecological Restoration Theory explains the what and how of ecosystem rehabilitation, while Systems Theory explains the who, why, and under what conditions afforestation initiatives succeed or fail.

METHODOLOGY

Research Design

The study adopted mixed method research (MMR) that combines both quantitative and qualitative data in a single study (Sharma *et al.,* 2023). Out of these, the study adopted the that explanatory sequential design. Creswell (2014) describes it as a mixed methods approach that involves a two-phase project in which the researcher accumulates quantitative data in the first stage, analyzes the outcomes, and then uses the outcomes to plan or construct into the second qualitative stage.

Area of Study

The study area was in Isiolo County, both of which are is located in Northern Kenya. Isiolo County is a county in the former Eastern Province of Kenya. Its population is 268,002 (KNBS, 2019) and its capital and largest city is Isiolo. Isiolo County is to be the first county to be developed as part of the Kenya Vision 2030 program (Government of Kenya, 2007). Other upcoming urban centers are; Garbatulla, Modogashe, Kinna, Merti and Oldonyiro. The local topography is arid or semi-arid low plains. Ewaso Nyiro River flows through the county and partly bounds it.

Isiolo County, Kenya, along with other 19 ASAL counties, had been reported to be having a normal phase of drought by August 2023. In 2021, about 80-90 percent of the population in Isiolo County, Kenya were affected by the drought. Noticeably, there is a severe vegetation deficit, with communities walking distances to access water and food for their livestock (Kiecol, 2021).

Target Population and Sampling

The target population was climate experts, security practitioners and afforestation agencies and multi-stakeholders. The primary target population for the study included; academia, African Union (AU), Inter-Governmental Authority on Development (IGAD), Kenya Forest Service (KFS), Kenya Defence Forces (KDF), Kenya Journalist and Broadcasters, Kenya Revenue Authority (KRA), Ministry of Agriculture, National

Intelligence Service (NIS), State Department for Diaspora Affairs, County Government of Isiolo, State Department for Interior and National Administration, Non-governmental Organizations (NGOs) and community leaders.

Purposive sampling, also known as judgmental, selective, or subjective sampling, is a form of non-probability sampling in which researchers rely on their own judgment when choosing members of the population to participate in their surveys. In this research purposive sampling technique was used to produce maximum variation within a sample size.

Sample Size Determination

The sample size was estimated within 95% confidence interval (z=1.96) and a desired accuracy level of 0.05 as follows; $n = (1.96)^2 (0.019). (0.981)/ (0.05)^2 = 79.64$ (*approximately*) = 80. A total sample size of 80 participants was selected.

Research Instruments and Tools

The study was dependent on primary and secondary data sources. The primary data was harnessed through a questionnaire and Key Informant Interview (KII) guide. The questionnaire was administered to the 80 respondents to gather quantitative data. Out of the 80 respondents, the researcher selected eight respondents that participated in the qualitative component of the research by participating in KIIs. The secondary data of the study was from books, journals, periodicals and reports via desktop review.

Data Analysis

The study began the data analysis of quantitative data where the findings were coded and then entered into the Statistical Package for the Social Sciences (SPSS) Version 27. These data were then analysed using descriptive statistical procedures. One of these methods is the frequency distribution table that shows the different measurement categories and the number of observations in each category (Bakker, 2023). The main descriptive analysis done were frequency and count distributions.

To analyse qualitative data, thematic analysis (Braun & Clarke, 2006) was used to systematically explore patterns in participants' perspectives. The MAX Weber Qualitative Data Analysis (MAXQDA) software tool was used in organizing and managing the data.

RESULTS AND DISCUSSION

Response Rate and Background Information

There were 80 questionnaires administered and out of these, 73 questionnaires were returned and used for analysis indicating a response rate of 91.25% which is acceptable for academic research. There were slightly more male respondents than female respondents as they accounted for 53.4% and 46.6% respectively. More respondents belonged to the 41-50 years' age group and represented 38.4% of the sample. Slightly more respondents had a certificate level of education comprising 24.7% of the sample. In terms of professions, there were more respondents from academia and these represented 16.4% of the sample.

More than half indicated yes and representing 50.7% of the sample were familiar with climate change mitigation. There were 57.5% of respondents that possessed knowledge on the climate change adaptation strategy while 42.5% of the sample did not. There were slightly more respondents that did not believe that there was a connection between afforestation and climate change mitigation strategy and this represented 52.1% of the sample.

Evolution of Afforestation as a Climate Change Mitigation Strategy

The first objective of the study was to investigate the evolution of afforestation as a climate change mitigation strategy. In Table 4.9, most respondents answered excellent on afforestation being a climate change mitigation

change was experiencing challenges and this accounted for 27.4% of the sample. Table 4.10 shows that 53.4% of respondents did not feel that afforestation had gone through an evolution compared to 46.6% who felt that there was an evolution of afforestation.

Table 4.11 shows respondents agreed to a great extent that afforestation programmes have improved in the Kenyan context as shown by a mean value of 4.29. This supports the existing literature. For instance, Gwatiyap *et al.* (2023) in Nigeria revealed that afforestation programmes in land use have become more important in order to restore degraded land, support agriculture, strengthen food security, safeguard water reserves, and enhance the well-being of local populace.

The respondents were also in agreement to a great extent that Kenya adapted to climate impacts and mitigate growing emissions as shown by a mean value of 4.22. This finding provides support for previous literature that has shown that adaptation to climate change has been growing in Kenya. Musafiri *et al.* (2022) findings underscored that smallholder farmers had embraced several interventions of climate change adaptation in Kakamega.

The respondents were in agreement to a moderate extent that global hazards have become harsh for Africa than before as indicated by a mean score of 3.89 supporting earlier research. The sub-Saharan Africa (SSA) region, along with the rest of the African continent, is prone to a wide variety of natural hazards. The respondents were in agreement to a moderate extent that local communities are more prone to climate change challenges as indicated by a mean score of 3.88. This supports existing evidence on local communities' vulnerability to climate change.

The respondents showed agreement to a moderate extent that afforestation have evolved and become effective in storing carbon as shown by a mean score of 3.82. This implies that remains one of the most effective means of tackling climate change, particularly when it is designed to rely on green energy. The respondents were in agreement to a moderate extent that new policies, instruments and partners are needed to update afforestation as shown by a mean value of 3.75. Unlike in developed nations where afforestation continues to increase effectively, the African continent is still struggling with policies that make it difficult to fully implement afforestation programmes as a result of culture, politics, and lack of community involvement (Kithu, 2024).

Challenges Facing Implementation of Afforestation

The second objective of this study was to assess the primary challenges facing the implementation of afforestation as a climate change mitigation and adaptation strategy. The respondents that held the opinion that implementation of afforestation to climate change was good represented the most of the sample at 31.5%. This was followed by those who answered very poor (26.0%), poor (20.5%), and excellent (21.9%) as shown in Table 4.12.

Most respondents held the perception that there were challenges in implementation of afforestation as a climate change mitigation strategy as shown by 57.5% who answered yes in comparison to 42.5% who answered no as seen in Table 4.13. A county government official noted that:"Water scarcity remains the biggest challenge for us. Even when seedlings are provided, they hardly survive in the harsh climatic conditions of Isiolo. Funding is also irregular, with most projects depending on donors, and once they withdraw, communities are left without support. Coordination between government departments is also weak, which makes follow-up and monitoring difficult. In addition, planted areas are often destroyed by grazing animals, and many community members do not see the need to take care of the trees after planting."

There were more respondents that felt that there has not been an increase in primary challenges facing implementation of afforestation as a climate change mitigation and adaptation strategy in ASALs and this represented 57.5% of the sample. On the other hand, 43.5% felt that there was an increase in challenges facing afforestation as a climate change mitigation strategy in the ASAL region as seen in Table 4.14.

Table 4.15 shows respondents' perceptions towards climate change and the findings reveal that respondents agreed to a great extent that Africa has challenges to meet sustainable use of natural resources to enhance climate

resilience, mitigation, and adaptive capacity as indicated by a mean value of 4.21. One of these challenges is the access to financial resources for implementing climate change interventions. For instance, access to the climate fund has been very challenging as compared to the COVID-19 fund, especially in African countries (Ngare et al., 2022).

The respondents were in agreement to a great extent that Kenya has face been faced with severe drought which has become increasingly regular to the extent that it was declared a national disaster as shown by a mean score of 4.15. The arid and semi-arid lands (ASAL)s are more affected by drought due to their fragile ecosystems and unfavorable climate (Kithikii, 2023). The respondents were in agreement to a moderate extent that the county government has priorities as articulated through these, and other, instruments include: adaptation, reducing emissions from deforestation and forest degradation as shown by a mean value of 3.93.

The respondents agreed to a moderate extent that climate change is increasing frequency and intensity of extreme weather events as shown by a mean value of 3.62. Ongoma et al. (2018) agrees that the most frequent and disastrous extreme weather events in the region are droughts and floods. The two extreme events are associated with devastating socio-economic losses. The respondents agreed to a moderate extent that Kenya tree replanting campaign will find this research useful as they both aims at reducing greenhouse emissions, stopping, and reversing deforestation as shown by a mean value of 3.51.

Opportunities for Enhancing Effectiveness of Afforestation

The third objective of the study was to establish the opportunities exist for enhancing the effectiveness of afforestation as a climate change mitigation and adaptation strategy. There was a slight difference among respondents on the question whether climate change mitigation and strategy show impacts of climate change in Kenya's key sector as 49.3% answered yes while 50.7% answered no as shown in Table 4.16. This implies that there is growing awareness on the climate change adaptation strategy given the small differences between those answering yes and no to this question.

A media officer noted: "We have seen awareness campaigns on tree planting, water conservation, and land restoration, but the impacts are not always visible in sectors like agriculture and livestock. Farmers continue to lose crops to drought, and pastoralists are still struggling with livestock deaths. While the strategies are good on paper, many people feel the results are yet to be seen on the ground."

Table 4.17 shows respondents' perception on afforestation as a climate change adaptation strategy. The respondents agreed to a great extent that afforestation and reforestation control soil degradation, hydraulic, landslide risks and encourages agroforestry as shown by a mean score of 4.44. This outcome supports the findings of Kithu (2024) that success rates were also noted in the main areas of most EAC with Kenya's Kakamega Forest, Imenti Forest, and Mount Elgon Forest cited as key rural areas that were now excelling in pursuit of afforestation programs aimed at increasing forest cover while maintaining the little that still exists.

The respondents were in agreement to a great extent that climate change-sensitive urban governance requires proactive, integrated, and contextualized approaches as shown by a mean score of 4.34. Naeku (2020) explain that the climate change legal environment in Kenya is considered progressive, with the country being one of the first in the African continent to enact robust climate law and policies that guide national and local action.

The respondents agreed to a great extent that drought remains one of the leading courses of conflict in ASAL counties such as Isiolo and Marsabit County as indicated by a mean score of 4.22. Climate change has both a direct impact on development of climate-dependent activities such as infrastructure and agriculture and indirect consequences for social systems such as issues of poverty, conflict, health and education.

The results revealed respondents agreed to a great extent there is increasing recognition of the role forests and trees in mitigation and adaptation strategies to global climate change as indicated by a mean value of 4.14. this finding goes against previous research such as Saalu *et al.* (2020) in Uganda where there was a high level of awareness of climate variability and its related effects on livelihoods, yet, a majority of the Buyangu community still do not understand provision of forests to climate change.

The respondents were in agreement to a great extent that forestation actions are a major tool for both climate-change mitigation and biodiversity conservation as shown by a mean score of 3.93. Chisika and Yeom (2025) revealed that Kenya's public forests are mega-biodiverse and provide many ecological goods and services and there is evidence that there is an increasing coverage of key biodiversity areas and demarcation of crucial biodiversity hotspots in counties such as Nyandarua, Kilifi, Kwale, and Taita Taveta.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The first objective investigated evolution of afforestation as a climate change mitigation strategy in Kenya's ASALs. The evidence from findings indicate that respondents were in agreement to a great extent that afforestation programmes have improved in the region's context. Therefore, the study concludes that there has been an evolution of afforestation as a climate change adaptation strategy that has been embraced and supported in the ASAL region.

The second objective assessed the primary challenges facing the implementation of afforestation as a climate change mitigation and adaptation strategy in Kenya's ASAL region. The findings indicate the main challenges were the frequency and intensity of droughts and floods which became a hindrance to the implementation of afforestation. Therefore, this research concludes that frequency and intensity of natural hazards and disasters are a significant barrier to the implementation and effectiveness of afforestation as a climate change adaptation and mitigation strategy.

The third objective was to establish opportunities for enhancing effectiveness of afforestation as a climate change mitigation and adaptation strategy in Kenya's ASAL region. The findings revealed that there are proactive efforts in governance towards climate-change sensitive policies and legislation in the central and county governments. Therefore, this study concludes that the governments at both levels are proactively promoting climate-change mitigation and adaptation policies and legislation.

Recommendations

Based on the findings of this study, several action-oriented recommendations are proposed to enhance afforestation as a climate change mitigation and adaptation strategy in Isiolo County.

- Strengthen policy support for afforestation initiatives. The national and county governments should develop policies that provide economic benefits to local communities through sustainable timber harvesting, agroforestry, and non-timber forest products. This includes establishing clear tenure and user-right frameworks, promoting participatory decision-making, and forming community forest management committees that receive ongoing training on climate change and forest management.

- Conduct thorough site assessments before planting. The national and county governments should assess soil conditions, water availability, slope, existing vegetation, and local climate before implementing afforestation programs. Incorporate traditional and indigenous knowledge into afforestation plans by supporting intergenerational knowledge transfer, promoting cultural practices that sustain forests, and selecting tree species based on local ecological knowledge.

- Promote economic sustainability through partnerships. The national and county governments should encourage public-private partnerships (PPPs) to support afforestation initiatives. Leverage corporate social responsibility (CSR) investments and take advantage of regulatory frameworks, such as Environmental, Social, and Governance (ESG) reporting requirements enforced by the Capital Markets Authority, to mobilize private sector resources for sustainable forest projects.

- Engage actively in tree planting and maintenance. Community members should participate in planting, watering, and protecting trees to ensure seedlings grow successfully. This includes establishing local monitoring groups to guard against grazing and vandalism.

- Integrate indigenous knowledaage in afforestation efforts. The national and county governments should empower communities to use traditional ecological knowledge to select suitable tree species and adopt planting methods that are adapted to local soil and climate conditions. Elders and experienced farmers can mentor younger members to ensure knowledge transfer.

Areas for Further Research

1. Future research should examine the implementation of afforestation as a climate change adaptation strategy in ASALs, with emphasis on the level and extent of community participation in afforestation efforts.
2. Research should also focus on the implementation of afforestation as a climate change mitigation and adaptation strategy in the coastal region, where limited evidence exists, and explore the adaptation strategies being adopted in response to climate change impacts.
3. Further studies should investigate the socio-economic benefits of afforestation projects, including the economic trade-offs for rural communities engaging in large-scale afforestation programmes.

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