

Case Report

Mangrove Forest Rehabilitation in Kilifi County, Kenya

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Abstract

Mangrove ecosystems face numerous conservation challenges due to human-induced pressures, climate change, and natural disruptions. This paper discusses the restoration initiatives and obstacles encountered in conserving mangroves in Kilifi County, Kenya. Between 2019 and 2024, significant progress was recorded in various restoration sites across the county, with the planting of over 16 million propagules and seedlings. The main species targeted for restoration included *Ceriops tagal*, *Rhizophora mucronata*, and *Avicennia marina*, with efforts largely centered on mangrove rehabilitation. Restoration activities were carried out in key areas such as Kanagoni, Ngomeni, Kilifi Creek, and Mida Creek. The adoption of innovative techniques, such as enrichment planting, contributed to the overall success of these initiatives. Despite these positive outcomes, several challenges emerged. Environmental pressures, including damage by crabs and grazing animals, negatively affected seedling survival. Limited resources hindered the expansion of restoration efforts, while poor access to remote areas posed difficulties for consistent monitoring. Additionally, the lack of structured collaboration frameworks often delayed stakeholder coordination, and illegal practices such as unregulated logging continued to threaten long-term sustainability. The paper recommends establishing clear and effective collaboration frameworks that outline stakeholder roles and responsibilities. This would improve coordination, and support timely execution of projects. Strengthening partnerships with local communities is also encouraged, as their involvement in sourcing planting materials and participating in restoration activities can foster a sense of ownership and motivate sustained engagement.

Keywords

Mangrove Restoration, Mangrove Degradation, Forest Restoration, Forest Conservation, Kilifi County, Kenya

1. Introduction

Mangrove ecosystems occur in coastal zones at the interface between land and sea, primarily in tropical and subtropical regions across the globe. Significant mangrove areas are located

in Africa, Asia, and South America [1, 2]. These ecosystems are distributed across 118 countries and territories, covering a total estimated area of 147,000 km² globally [3]. Mangroves are

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uniquely adapted to intertidal environments characterized by high salinity and fluctuating conditions. Their ecological significance stems from the wide array of ecosystem services they provide, including blue carbon sequestration, biodiversity conservation, habitat provision for fish and wildlife, support for coastal fisheries, shoreline protection, and tourism [4, 5]. In addition, mangrove forests support local livelihoods through aquaculture, agriculture, provision of fuelwood, building materials, and traditional medicines [6, 7]. Despite their importance, mangrove ecosystems face mounting ecological pressure. It is estimated that one-third of global mangrove cover has been lost over the past fifty years [8]. The main threats include habitat loss and degradation caused by human activities such as conversion for aquaculture and agriculture, coastal development, industrial and domestic waste discharge, and poor management practices [9].

In Kenya, mangroves are found in protected deltas, bays, creeks, river estuaries, and lagoons along the country's 600 km coastline [10]. These ecosystems are located within five coastal counties: Lamu, Tana River, Kilifi, Mombasa, and Kwale, collectively covering approximately 61,271 hectares across 18 forest formations [11]. Kenya hosts nine mangrove species, with *Rhizophora mucronata* and *Ceriops tagal* being the most dominant, accounting for over 70% of the formations. The zonation pattern typically includes a *Sonneratia-Rhizophora-Avicennia* community on the seaward edge, followed by *Rhizophora-Bruguiera-Ceriops* in the middle zone, and a dwarf *Avicennia-Lumnitzera-Xylocarpus* complex on the landward side [10].

Kenya's mangrove forests are increasingly under threat, mainly due to human activities such as overharvesting for timber and fuelwood, salt production, and land conversion for urban development, agriculture, aquaculture, and tourism [12-14]. Unsustainable harvesting, especially in densely populated areas, further accelerates degradation [15]. Furthermore, inadequate legal protection and enforcement have rendered some mangrove areas vulnerable to exploitation.

Recognizing these threats, Kenya has intensified mangrove conservation and restoration efforts, particularly through community-based initiatives [16, 17]. These initiatives aim to restore degraded mangrove areas by engaging local communities in planting and sustainable management, as well as promoting the sale of carbon credits from sequestered carbon. Public awareness campaigns and capacity-building programs are also underway to promote sustainable mangrove practices and highlight their ecological importance [18]. Key focus areas include preventing further degradation, promoting natural regeneration, and establishing mangrove nurseries. Traditional ecological restoration approaches often involve restoring environmental conditions to support natural regeneration. Engaging and empowering local communities with knowledge, skills, and alternative livelihoods is seen as a crucial strategy for the long-term success of restoration projects. Among the coastal counties, Kilifi has emerged as a focal point for restoration activities [19]. These efforts are crucial

for achieving both national and global commitments to sustainable forest management and ecosystem restoration. However, the current status and effectiveness of mangrove restoration efforts in Kilifi County remain poorly documented. Therefore, the aim of this paper is to explore and assess the conservation and restoration of mangrove ecosystems in Kilifi County, located on the Kenyan coast.

2. Methodology

2.1. The Study Area

The study was carried out in Kilifi County (Figure 1). Kilifi County, located in the Coastal region of Kenya, is characterized by a diverse landscape, ranging from coastal plains and highlands to the Nyika Plateau. The county stretches along 65 km of coastline and extends 90 km inland, offering a variety of ecological zones. Its unique features include the Arabuko Sokoke Forest, Dakacha woodlands, and several creeks like Mtwapa, Kilifi, and Mida Creeks.

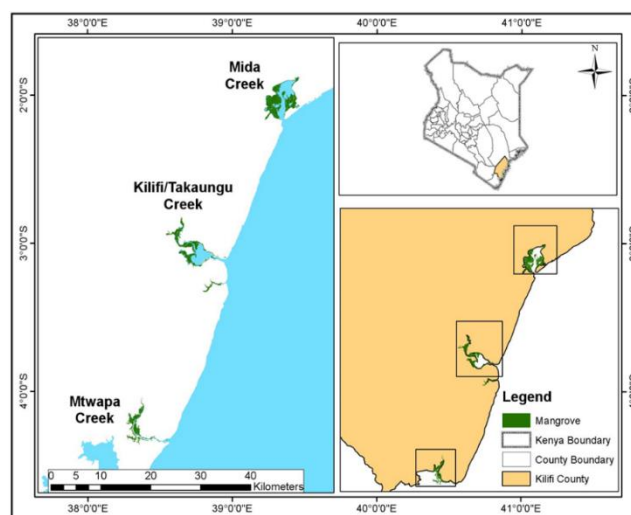


Figure 1. Distribution of mangroves in Kilifi County with the different patches highlighted.

2.2. Mangrove Ecosystem Analysis

The analysis exercise was designed to provide a comprehensive evaluation of mangrove and terrestrial forest restoration efforts in Kilifi County. The exercise combined geospatial technologies, field-based assessments, stakeholder consultations, and community participation to ensure a detailed, data-driven, and participatory approach.

This analysis exercise initially planned to cover both Kwale and Kilifi counties. However, due to budgetary constraints, Kilifi County was selected as the pilot area, as it hosts the majority of ongoing restorative work. Key restoration sites, including Ngomeni, Kanagoni, Mida Creek, and Kilifi Creek,

were selected for their ecological significance, extent of restoration activities, and stakeholder involvement.

Each site was assessed based on several key factors: Restoration Methods: The techniques employed, such as enrichment planting or direct seeding, were evaluated for their appropriateness and effectiveness; Success: Survival rates of restored species and observed ecological recovery were analyzed to gauge restoration outcomes; Extent: The size of the area under restoration, measured in hectares, was documented to establish the scale of interventions; Challenges: Issues such as environmental stressors, logistical constraints, and socio-economic conflicts were identified to understand barriers to success and Community Engagement: The extent to which local communities participated in restoration activities was assessed, including their roles in sourcing propagules, planting, and monitoring, as well as the benefits they accrued from these efforts.

2.3. Data Collection Techniques

A mixed-methods approach was employed, utilizing both qualitative and quantitative data collection methods to capture the full scope of restoration efforts:

- 1) Geospatial Tools: Advanced tools such as Survey123, high-resolution satellite imagery, and GPS-enabled systems were used to monitor and map restoration activities. These tools provided real-time, actionable data on forest health, survival rates, and spatial coverage, enabling the mapping team to validate reported progress and identify restoration gaps.
- 2) Field Observations: On-the-ground assessments were conducted to observe and verify planting activities, survival rates, and the impact of environmental stressors, such as browsing by crabs and extreme weather. These observations were documented to ensure accuracy in mapping data.
- 3) Stakeholder Consultations: Structured interviews and focus group discussions were conducted with six (6) key stakeholders. These sessions explored stakeholder contributions, challenges encountered, and recommendations for enhancing restoration practices.
- 4) Community Involvement: Community participation was a key focus of the mapping exercise. The mapping team assessed the extent to which local communities were engaged in restoration activities, documenting their roles in propagule collection, planting, and monitoring. The team also captured demographic data on community participation, analyzing involvement by gender to highlight inclusivity in the restoration process.

The benefits accrued by the community were also documented. These included economic empowerment through the sale of seedlings, engagement in complementary livelihood

projects such as beekeeping and ecotourism, and improved ecological services that directly benefited local households. This data provided insights into how restoration efforts aligned with community development objectives.

2.4. Monitoring and Evaluation

The effectiveness of restoration efforts was evaluated through several indicators:

- 1) Survival Rates: The percentage of surviving planted species, including *Ceriops tagal*, *Rhizophora mucronata*, and *Avicennia marina*, was monitored to assess the success of restoration interventions.
- 2) Stakeholder Engagement: The roles and contributions of stakeholders were assessed, highlighting successes and identifying areas for improvement in collaboration frameworks.

2.5. Challenges and Conflict Analysis

Challenges faced during restoration activities were systematically documented. These included:

- 1) Environmental Stressors: Issues such as browsing by crabs, extreme weather conditions, and soil salinity were recorded for their impact on propagule and seedling survival.
- 2) Logistical Constraints: Access to remote sites posed difficulties for monitoring and maintenance efforts.
- 3) Socio-Economic Conflicts: Conflicts over land use and resource allocation were explored to understand their impact on restoration progress.

2.6. Data Analysis

Quantitative data, such as survival rates, areas restored, and demographic participation figures, were statistically analyzed to identify trends and measure progress. Qualitative data from stakeholder consultations and field observations were thematically analyzed to capture insights into challenges, successes, and recommendations for improvement. The analysis aimed to provide a holistic understanding of restoration dynamics in Kilifi County.

3. Findings and Implications

3.1. Mapping of Restoration Areas in Kilifi County

Maps showing restored mangrove landscapes in selected areas of Kilifi County are shown in [Figure 2](#).

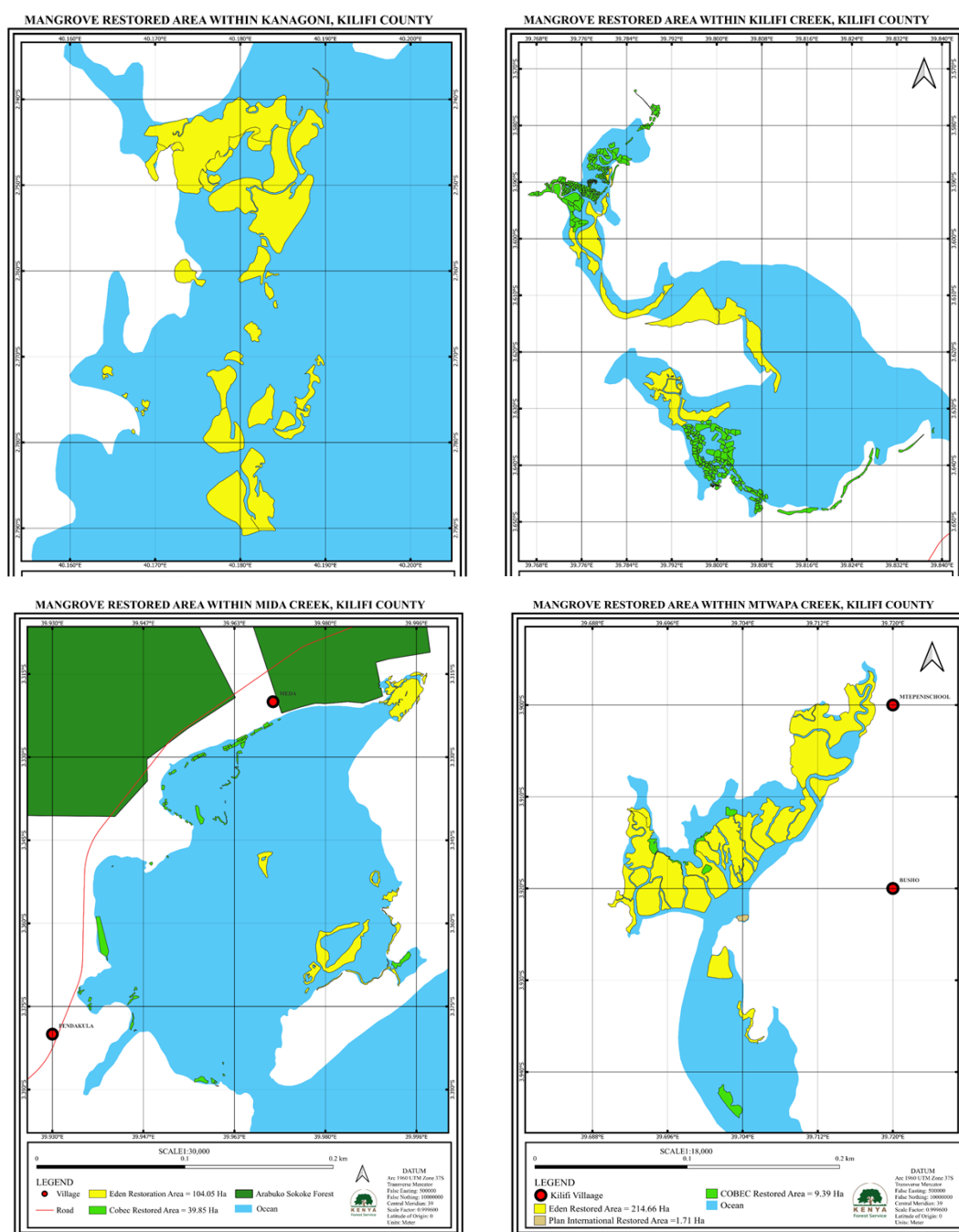


Figure 2. Maps showing restored mangrove landscapes in selected areas of Kilifi County.

The current project was undertaken to restore mangrove in Kenya and followed protocols in mangrove forests reported in other parts of the world [20]. The current map showed that between 2019 and 2024, a significant area of mangroves in Kilifi was restored, with a total of 640 hectares being targeted for rehabilitation and protection. This project, aims to restore and conserve over 2,550 hectares of mangroves (Mangrove Restoration Plan (2024-2028)). Similar restoration efforts have been reported in Colombia [21], Vietnam [22].

3.2. Restoration Status of Mangrove Ecosystem Restoration

Status of mangrove ecosystem restoration in Kilifi County is shown in Table 1. The key restoration materials used are either propagules or seedlings as established in other countries. Propagules are often used in mangrove ecosystems forest restoration efforts, especially in mangrove ecosystems and capable of growing into mature plants in appropriate conditions [23]. They play a significant role in establishing new mangrove forests, particularly in areas where seedling availability

is limited or where faster natural regeneration is desired. Meanwhile seedlings, mature young plants grown in controlled conditions, are frequently used for reforestation and restoration in both terrestrial and marine ecosystems [24]. They are often chosen when the goal is to ensure higher survival rates or when propagules are not readily available or suitable for planting.

The restoration methods employed were: enrichment planting, direct planting, hydrological Services Restoration (HSR) tree planting for active restoration. Enrichment planting involves planting additional propagules to increase the density or diversity of existing mangrove forests [25]. These restoration method have also been used in other restorations area such as has been used in countries across Southeast Asia and beyond, particularly in Indonesia, the Philippines, Thailand, Vietnam, and Myanmar [26]. It is aimed at enriching areas that are already under partial restoration, ensuring faster and more successful establishment of the ecosystem. Direct planting method involves direct planting of either propagules or seedlings in areas that have been degraded or where mangrove forests are absent. This method aims at re-establishing mangrove ecosystems by planting directly into the soil or aquatic substrates. It has been extensively employed by organizations and has been a primary restoration technique in Southeast Asia, including countries like Indonesia, the Philippines, and Thailand [27]. This method also includes planting for hydrological services restoration, which has used both propagules and seedlings. Hydrological Services Restoration combined the use of propagules and seedlings specifically for hydrological services restoration, emphasizing the role of mangroves in controlling erosion, improving water quality, and mitigating coastal flooding [28]. This method is more widely practiced in several countries, particularly in regions with significant mangrove ecosystems like the Western Indian Ocean (WIO) and Southeast Asia [29].

3.3. Forest Station and No of Seedling/Propagules Planted

Seedlings/propagules planted and survival of mangroves in three forest stations are shown in Table 2. The collected data shows the number of seedlings or propagules planted across different forest stations. This information highlights the variation in planting efforts, with some stations demonstrating substantial planting activity, while others report less frequent or smaller-scale planting efforts. Overall total estimates of

seedlings/propagules planted across all stations: 16,000,000. Jilore has the highest number of seedlings/propagules planted across the dataset, with multiple records indicating large planting efforts, including figures like 10,000,000. The total number of seedlings planted here appears to be the most significant among all stations. Gede also shows considerable planting activity, although on a smaller scale compared to Jilore with notable records include 2,000,000 seedlings/propagules planted. However, Gede has some small-scale planting activities like the placement of a few thousand seedlings, which contrasts with Jilore's large volumes. Sokoke, while showing a mixed range of planting efforts, also contributes notable numbers, including 2,117,950 and 837,491 seedlings. The survival rate at Jilore forest station has a high average survival rate of approximately 71.72%, indicating a relatively successful rate of plant survival. There are a significant number of entries with high survival rates (81-100%), but there are also moderate survival rates in the 41-60% and 61-80% ranges, along with a few lower rates at 21-40% and 0-20%. Gede forest station shows a strong average survival rate of approximately 72.22%. The majority of the survival rates are within the higher ranges (61-100%), with a strong presence of plants surviving in the 81-100% category. However, there are still some entries in the 41-60% range. Sokoke forest station has a moderate average survival rate of approximately 55.88%, which suggests that while a considerable number of plants survive (41-80%), there is room for improvement. The station has some entries with very low survival rates (0-20% and 21-40%), which could indicate challenges in those areas.

3.4. Assessment of Marine Forest Restoration with Stakeholder Integration

Status of marine forest restoration with stakeholder integration are shown in Table 1. Restoration initiatives in Kilifi County reflect a dynamic interplay between marine and terrestrial ecosystems, driven by a coalition of diverse stakeholders as in other restoration efforts [26, 27]. These efforts ensure that restoration not only supports ecological integrity but also aligns with the livelihoods, cultures, and aspirations of local communities. Their main roles was restoration prioritizes resilient species such as *Ceriops tagal* and *Rhizophora mucronata* in vulnerable coastal regions like Ngomeni, Mtwapa Creek, and Marereni. These initiatives combat shoreline erosion, enhance carbon sequestration, and safeguard critical fisheries.

Table 1. Status of mangrove ecosystem restoration in Kilifi County.

Organizations	Status Area restored	Restoration methods	Restoration materials	Number of Seedlings or propagules planted	Source of seedlings	Remark
NGO 1	20 ha.	Proposed to be	Propagules	-		Not yet to started

Organizations	Status Area restored	Restoration methods	Restoration materials	Number of Seedlings or propagules planted	Source of seedlings	Remark
		planting	and seedlings			
NGO 2	2100 ha.	Reforestation (Planting)	Propagules	10,000 seedlings and propagules	Nurseries and specialized seed banks	Ongoing successful partnership with KFS and CFAs
CBO 1	150 ha.	Reforestation (Planting), Hydrological Services Restoration, Assisted Natural Mangrove Regeneration (ANMR)	Propagules and seedlings	3,000 to 8,000 seedlings per site	Local community nurseries, government-run nurseries, and seed banks	Allocated 785 ha. but restored 150 Ha
NGO 3	612 ha.	Reforestation (Planting), Hydrological Services Restoration, Assisted Natural Mangrove Regeneration (ANMR)	Propagules and seedlings	4,000 seedlings	Private-sector nurseries and community-based nurseries	Focus on improving protection and enforcement
NGO 4	7 ha.	Reforestation (Planting)	Propagules and seedlings	2,500 seedlings	Local nurseries managed	Allocated 100 Ha but managed to restore 7 ha.
NGO 5	15 ha.	Reforestation (Planting), Assisted Natural Mangrove Regeneration (ANMR)	Seedlings	2,000 seedlings	Government-run nurseries and community nurseries	Allocated 172 ha. but restored 15 ha. Need support
NGO 6	80 ha.	Mangrove Reforestation (Planting), Hydrological Services Restoration, Assisted Natural Mangrove Regeneration (ANMR)	Seedlings	1,500 seedlings		Allocated 100 ha. managed to restore 80ha.
NGO 7	45 ha.	Mangrove planting), Assisted Natural Mangrove Regeneration (ANMR)	Propagules and seedlings	3,000 to 5,000	Government-run nurseries and accredited private nurseries	Not yet started

The seedlings/propagules planted and survival of mangroves in three forest stations are shown in [Table 2](#).

Table 2. Seedlings/propagules planted and survival of mangroves in three forest stations.

Station	Seedlings/propagules planted	Survival
Jilore	10,000,000	71.72%
Gede	2,000,000	72.22
Sokoike	4,000,000	55.88%

Mangrove restoration efforts with stakeholder integration are shown in [Table 3](#). The table shows that several stakeholders were involved in the mangrove restoration efforts. Mangrove restoration efforts in the Western Indian Ocean (WIO) region often involve a wide range of stakeholders, including local communities, government agencies, non-governmental organizations (NGOs), private sectors, and funding agencies [28-30].

Table 3. Status of marine forest restoration with stakeholder integration.

Environment	Stakeholders Involved:	Roles
Marine Environment	NGO 1, CBO 1, CBO 4, CBO 7	These organizations spearhead large-scale mangrove planting projects, integrating local fishing communities for propagule collection, nursery management, and survival monitoring.
	Kenya Forest Service (KFS)	Plays a central role in technical oversight, policy integration, and harmonization with national frameworks such as the National Mangrove Management Plan (2017–2027).
	Local Communities:	Partner with NGOs and government agencies to execute restoration activities, contributing traditional ecological knowledge and fostering long-term stewardship.
Terrestrial ecosystem	Plan International:	Utilizes innovative tools like Survey123 for mapping and monitoring while engaging communities in participatory restoration.
	NGO 2, NGO 7, KFS:	Coordinate reforestation of degraded areas, with a focus on integrating ecological and cultural values.
	Local Communities and Kaya Elders:	Vital for restoration in culturally significant sites such as Kaya forests, ensuring that interventions respect sacred traditions and ecological balance.
	Kilifi County Government:	Provides logistical support, funding, and alignment with county-level conservation strategies.

3.5. Species Utilization and Survival During Restoration Efforts

Mangroves species planting density and survival in Kilifi County are shown in Table 4. *Ceriops tagal* is the most commonly planted and widely used in restoration efforts, often in combination with species like *Rhizophora mucronata* and *Bruguiera gymnorhiza*. *Ceriops tagal* is typically restored alongside *Avicennia marina* and *Rhizophora mucronata*, but it exhibits slightly lower survival rates due to its sensitivity to environmental stressors. Factors such as salinity, temperature fluctuations, and unstable water levels can negatively affect its growth [31]. Restoration partners like NGO 3 often select sites with suitable soil and water conditions for planting *Ceriops tagal*. Despite its lower resilience, this species is important for maintaining ecosystem biodiversity and stability when restored in optimal environments. *Rhizophora mucronata* is another staple in mangrove restoration, frequently planted alongside *Ceriops tagal* or *Bruguiera gymnorhiza*. *Rhizophora mucronata*, known for its iconic stilt roots, plays a vital role in stabilizing coastal soils and mitigating erosion [32, 33]. It is a priority species for restoration partners, valued for its shoreline protection capabilities and habitat provision for marine life. Though its survival rates tend to be slightly lower than those of *Avicennia marina*, *Rhizophora mucronata* remains a reliable option for coastal restoration. Environmental factors such as tidal flow, site accessibility, and competition with other vegetation influence its growth, emphasizing the importance of targeted site selection and management [31].

Avicennia marina is moderately utilized: While not as prevalent as *Ceriops tagal* and *Rhizophora mucronata*, *Avicennia marina* remains an important species in restoration efforts. *Avicennia marina* is one of the most commonly restored mangrove species due to its exceptional adaptability to a range of environmental conditions, including fluctuating salinity and waterlogged soils [34]. Restoration partners have consistently achieved high survival rates for this species, which thrives in dynamic coastal environments. *Bruguiera gymnorhiza* is frequently used but is planted less frequently than *Ceriops tagal* and *Rhizophora mucronata*, often as part of mixed-species restoration. Though less commonly restored, *Bruguiera gymnorhiza* is vital for stabilizing coastal zones and enhancing biodiversity [35]. This species thrives under specific environmental conditions, including good water quality, nutrient levels, and suitable site locations. Partners have successfully restored *Bruguiera gymnorhiza* at sites such as Takaungu and Kizingitini, where moderate survival rates are achieved under favorable conditions. *Sonneratia alba* is well-suited for areas with higher tidal ranges and saline soils, making it an essential species for projects in dynamic coastal zones. Restoration efforts by partners have demonstrated the species' resilience in challenging conditions. While survival rates are influenced by factors like nutrient availability and tidal action, *Sonneratia alba* plays a critical role in enhancing coastal wildlife habitats and providing valuable ecosystem services. Mixed Species is used for diverse restoration efforts: Many restoration projects involve mixed-species plantings, which often include *Ceriops tagal*, *Rhizophora mucronata*, *Avicennia marina*, and *Bruguiera gymnorhiza*. *Terminalia brownii*, *Allophylus ferrugineus*,

and *Agauria salicifolia* are less commonly used: These species are planted in smaller quantities, typically ranging from 1,000 to 5,000 seedlings/propagules. Their use tends to be more specialized, suited to specific ecological needs or restoration areas.

Table 4. Mangroves species planting density and survival in Kilifi County.

Species	Planting volume (seedlings/propagules)	Survival
<i>Ceriops tagal</i>	1.7 million	60%–75%
<i>Rhizophora mucronata</i>	1000 to 100,000	70%–80%
<i>Avicennia marina</i>	1,000 to 13,000	75%–85%
<i>Bruguiera gymnorhiza</i>	1000 to 100,000	60%–70%
<i>Sonneratia alba</i>		65%–80%
<i>Terminalia brownii</i> , <i>Allophylus ferrugineus</i> , and <i>Agauria salicifolia</i>		-

It was noted that the most common species: *Ceriops tagal* and *Rhizophora mucronata*, often in combination, dominate the planting efforts, making up the majority of seedlings/propagules. Moreover, moderately used species: *Avicennia marina* and *Bruguiera gymnorhiza* are less frequently planted but still crucial for ecosystem restoration. The least common species: *Terminalia brownii*, *Allophylus ferrugineus*, and *Agauria salicifolia* are used in smaller quantities, typically for niche restoration purposes or specific ecological roles.

3.6. Challenges Faced During Restoration

The challenges encountered in restoration of mangroves are shown in Table 5. Restoration efforts in these critical habitats encounter a range of challenges influenced by local conditions, socioeconomic dynamics, and environmental pressures. These challenges are mainly environmental, anthropogenic activities such as grazing, encroachment, illegal logging, and logistic challenges. These challenges have been reported in other mangrove restorations programmes in other countries [36–38]. Similar challenges related to climate variability, community engagement, and long-term sustainability of restoration projects have also been reported in large-scale mangrove rehabilitation programs across developing coastal regions [39].

Table 5. Challenges encountered in restoration of mangroves.

Environment	Challenges
Marine Environment	Coastal erosion, salinity stress, competition with aquaculture, and land-use conflicts. NGOs fund innovative solutions like erosion barriers and nature-based approaches. KFS ensures regulatory compliance, while communities monitor restoration sites.
Terrestrial ecosystem	Encroachment, illegal logging, seasonal fires, and reliance on rainfall. NGO 5 uses digital tools for monitoring, while local groups engage in reforestation and fire management. KFS enforces conservation laws and provides technical guidance.
Jilore Forest Station	Site Species Matching: Issues with selecting appropriate species for specific sites, leading to potential mismatches in ecological suitability. Grazing: Livestock grazing has been noted as a significant threat to young seedlings and overall restoration success. Climate Change Impacts: Variability in weather patterns and rising sea levels affecting the growth and survival of planted species. Monitoring and Evaluation Gaps: Insufficient tracking of restoration progress and survival rates, leading to a lack of data for adaptive management. Limited Technical Expertise: Challenges in implementing best practices due to a lack of skilled personnel.
Sokoke Forest Station	Illegal Logging or Harvesting: Ongoing illegal activities threaten the integrity of restored areas and the survival of planted species. Community Engagement Challenges: Difficulty in effectively involving local communities in restoration efforts, which can lead to a lack of ownership and support. Seedlings Scarcity: Limited availability of quality seedlings hampers the scale of restoration efforts. Climate Change Impacts: Similar to Jilore, climate change poses risks to the success of restoration projects, affecting species survival and growth. Monitoring and Evaluation Gaps: Inadequate systems for tracking the success of restoration efforts, leading to challenges in assessing outcomes.

Environment	Challenges
Gede Forest station	Grazing: Livestock grazing continues to be a significant challenge, impacting the survival of young plants.
	Climate Change Impacts: The effects of climate change are evident, with altered weather patterns affecting restoration success.
	Limited Technical Expertise: A lack of skilled personnel to implement effective restoration practices.
	Illegal Logging or Harvesting: Ongoing illegal activities threaten the restored areas and the overall ecosystem.
	Monitoring and Evaluation Gaps: Insufficient tracking of restoration efforts, leading to challenges in assessing the effectiveness of interventions.

4. Conclusions

The restoration efforts in Kilifi County represent a significant step forward in ecological recovery and sustainable development, demonstrating the transformative power of collaboration among stakeholders, local communities, and conservation organizations. With over 16 million propagules and seedlings planted, these initiatives have not only revitalized vital mangrove and terrestrial ecosystems but also generated economic opportunities and strengthened community resilience. However, challenges identified during the study, ranging from environmental stressors to logistical constraints highlighting the need for a proactive and adaptive approach to restoration.

Looking ahead, it is essential for stakeholders to apply the lessons learned and implement the strategic recommendations outlined in this report. By enhancing coordination, securing the necessary resources, and actively engaging local communities, the restoration efforts can be expanded and sustained, ensuring long-term ecological and socioeconomic benefits. The journey to restore Kilifi's forests goes beyond tree planting; it involves fostering a shared vision for a healthier environment and more empowered communities. As these initiatives continue to evolve, they have the potential to serve as a replicable model for other regions, proving that with commitment and collaboration, the initiatives can restore vital ecosystems and secure a sustainable future for generations to come. Through these collective efforts, stakeholders can further enhance the effectiveness of restoration activities in Kilifi County, ensuring that both ecological and socioeconomic goals are met in a sustainable and inclusive manner.

5. Recommendations

There is needed to develop clear and streamlined collaboration frameworks that define stakeholder roles and responsibilities. This will enhance coordination, improve communication, and facilitate timely project implementation. Foster partnerships with local communities to ensure their active involve-

ment in sourcing planting materials and participating in restoration activities. This will promote ownership and incentivize community engagement.

Enhancing Monitoring and Evaluation through investing in robust monitoring and evaluation systems to track restoration progress, survival rates, and the effectiveness of different restoration methods. Utilize technology, such as mobile GIS applications and remote sensing, to gather real-time data. Conduct regular assessments to identify challenges and successes, allowing for adaptive management strategies that can be implemented in response to changing conditions.

There is need to secure funding and resources by actively seek additional funding sources to bridge existing gaps and scale up restoration initiatives. This could include partnerships with private sector organizations, government grants, and international funding opportunities. Allocate resources for critical infrastructure, such as Forest Ranger outposts, to safeguard restored areas from illegal activities and enhance monitoring and enforcement efforts.

Provide training and resources to Community Forest Associations (CFAs) and local groups to enhance their capacity for stewardship and engagement in restoration efforts. This will empower communities to take an active role in managing and protecting restored areas. Promote income-generating activities tied to restoration efforts, such as ecotourism, beekeeping, and sustainable harvesting practices, to provide economic incentives for community involvement.

There is need to address Illegal Activities. This can be achieved by collaborating with law enforcement agencies to strengthen the enforcement of regulations against illegal logging and unsanctioned harvesting. This will help protect restored areas and ensure the sustainability of restoration efforts. Increase community awareness and involvement in monitoring illegal activities, empowering local residents to act as stewards of their environment. Collaborate with local law enforcement and community leaders to develop proactive measures against illegal logging and unsanctioned harvesting. This could include community patrols, awareness campaigns, and stricter enforcement of regulations.

Abbreviations

ANMR	Assisted Natural Mangrove Regeneration
CBO	Community based Organizations
CFA	Community Forest Associations
GPS	Global Positioning System
KFS	Kenya Forest Service
NGO	Non Governmental Organization

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Benjamin Mutuku Kinyili: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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