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SUSTAINABLE MANAGEMENT PRACTICES AND THE PERFORMANCE OF THE BLUE ECONOMY IN KENYA; A CASE OF THE MANGROVE FOREST

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ABSTRACT

Purpose of the study: The study examined the influence of sustainable management practices on the performance of the blue economy in Kenya, focusing on the case of the mangrove forest.

Problem statement: Although various conservation and management initiatives have been implemented, a lack of well-defined relationships and evidence-based sustainable management practices remains, hindering the full potential of mangrove ecosystems to support the performance of the blue economy. In light of these challenges, there was a need to study and evaluate current mangrove management approaches in pursuit of bridging the gaps towards supporting the blue economy, which will improve the living standards of coastal communities and enhance climate resilience.

Methodology: A descriptive research design was employed to gather qualitative and quantitative data.The target population included community forest association members, beach management unit members, the Directorate of Blue Economy and Fisheries, and the Kenya Forest Service. A stratified random sampling technique was used to ensure representation from different stakeholder groups

Results of the study: The results revealed high awareness of sustainable practices but only moderate perceptions of their effectiveness, highlighting gaps in enforcement, monitoring, and coordination. Correlation analysis showed strong and significant positive relationships between conservation practices and the performance of the blue economy. Regression analysis revealed that conservation practices have a significant and positive influence on the performance of the blue economy, accounting for a very high percentage of the variation.

Conclusion and policy: The study concludes that conservation efforts are critical drivers of positive outcomes in the blue economy.

Recommendations: The study recommends that conservation initiatives should be enhanced through stronger community involvement, provision of technical resources, and standardized waste management strategies to improve ecosystem resilience and support the blue economy. Governance structures should be strengthened with participatory management plans, improved inter-agency coordination, and adaptive resource management strategies that promote sustainable livelihoods and long-term environmental health.

Keywords: *Biodiversity, Blue economy, Carbon Sequestration, Conservation practices, Ecosystem Services, Blue Carbon, Mangroves, Waste management, Kenya*

INTRODUCTION

Mangrove forests can be broadly classified into two regions: the Indo-West Pacific (IWP), also referred to as the Old World mangroves, which consists of Eastern Africa, Australia, southern Japan, and the West Pacific Islands, and the Atlantic-East Pacific (AEP), also known as the New World mangroves, which includes the mangroves of the Americas and West Africa. Mangroves are thought to cover 15 million hectares globally (Friess et al., 2019). The blue economy refers to the sustainable use of the ocean and other aquatic resources to provide jobs, more income, and better livelihoods while maintaining the health of ocean ecosystems. Fisheries, tourism, renewable energy, and marine protection are all included. To promote social justice, environmental sustainability, and economic growth, it has been embraced to optimize

the prudent use of ocean resources, guaranteeing long-term advantages for coastal ecosystems and communities (Yousef, 2024).

Despite the creation of protected areas, restoration efforts, and other conservation measures, mangrove forest cover has decreased in Mombasa with 49.1% overall decimation. This has been caused by anthropogenic pressure, preventing both natural and artificial regeneration when combined with unfavorable environmental circumstances. The planning and management of mangrove forests can be improved with an awareness of phenological features, leading to greater mangrove area cover and benefits for restoration. Phenological features in mangrove forests refer to the seasonal patterns and life cycle events of mangrove species, such as flowering, fruiting, and leaf production. These phenological events are influenced by environmental factors, including temperature, salinity, tidal regimes, and rainfall. Understanding phenology is essential for assessing mangrove forest health, ecosystem dynamics, and their responses to environmental changes.

Mangroves are coastal ecosystems found along the shores of the world's oceans and sea mudflats. They are characterized by salt-tolerant trees, shrubs, and various associated flora and fauna. The world has over one hundred mangrove species, nine of which are found in Kenya (GOK 2017). Eight of these species are naturally thriving in Mombasa Kenya and include *Rhyzophora mucronata, Ceriops tagal, Avicennia marina, Soneratia alba, Bruguiera gymnorhyza, Heriteria litoralis, Xylocarpus molusensis, and Xylocarpus granatum*. The mangroves' habitats cover approximately 4,233.15ha, representing approximately 12.75% of the total land area in Mombasa (GOK 2021). Their distribution is spread in the three creeks; Portreitz, Tudor, and Mtwapa. Mangroves are often referred to as the "rainforests of the sea" due to their rich biodiversity and their role in maintaining coastal ecosystems (Lippuner, 2021). They serve as nurseries and breeding grounds for numerous fish and marine species, supporting the livelihoods of local fishermen and contributing to the overall health of marine life. Additionally, mangroves help mitigate the effects of climate change by sequestering carbon dioxide ten times more than terrestrial trees and acting as buffers against coastal erosion and storm surges (Arfan et al., 2024).

The economic significance of mangroves include timber, firewood, and traditional medicines (though there is a current moratorium in the County) (Arfan et al., 2024). The fishing industry also relies on this forest as it is a breeding ground for fish. It has been a spot for natural beauty, and the biodiversity in such areas has promoted ecotourism initiatives, attracting domestic and international tourists. Despite their ecological, social, and economic importance, Mombasa

County's mangroves face numerous challenges and threats that include unsustainable harvesting practices, land-use changes, pollution, and climate change. These contribute to the degradation and loss of mangrove ecosystems, leading to a decline in ecosystem services (Arfan et al., 2024). Most of the benefits derived from this ecosystem are indicators of the blue economy. This makes it inseparable from the blue economy.

STATEMENT OF THE PROBLEM

Kenya's gross domestic product (GDP) at current prices in 2023 was estimated at Ksh 10.40 trillion, with the highest combined sectoral contribution coming from agriculture, forestry, and fisheries, as per the Central Bank of Kenya Report 2024 (Annual GDP _ CBK, n.d.). There are about 27,000 people who are engaged in fishing and related activities, including over 13,400 small-scale fishers who depend on the marine fisheries for their livelihood and income (Richard, 2021). The blue economy has been promoted, though not fully harnessed, to address the widespread poverty and livelihood needs of coastal communities and bring about development in the rural coastal areas.

Mangrove forests are critical ecosystems that provide essential ecological, social, and economic services, contributing significantly to the blue economy in Kenya (Richard, 2021). They serve as breeding grounds for fisheries, protect coastal communities from extreme wave action, are a source of livelihoods, and play a crucial role in carbon sequestration. Mangrove forests in Kenya, particularly in Mombasa County, face severe threats, including pollution, deforestation, and inadequate management due to the fast-growing nature of the city. The degradation of these forests compromises their ecological, social, and economical integrity, hence limiting their contribution to the blue economy performance (Friess et al., 2019).

Although various conservation and management initiatives have been implemented, a lack of well-defined relationships and evidence-based sustainable management practices remains, limiting their contribution to other sub-sectors. Challenges such as limited community involvement and slow restoration efforts hinder their sustainability and maximized contribution to the blue economy. The absence of thorough studies that interrogate the relationship between sustainable management of mangrove forests and blue economy performance in Kenya has created a knowledge gap, limiting the development of practical solutions.

In order to close the gaps between conservation methods and the blue economy's success, it was necessary to investigate the mangrove management techniques now in use. SDG 13, which addresses reducing the effects of climate change through the land use, forestry, and agriculture

sectors, was taken into consideration in the study. Additionally, it promoted plans that integrate SDG 12, responsible consumption and production through sustainable forest management, SDG 14 and 15, protecting mangroves as ecosystems for biodiversity, and sustaining life on land and below sea (Chisika & Yeom, 2023).

This research, therefore, sought to investigate the extent to which sustainable mangrove forest management practices influence the performance of the blue economy in Kenya through identifying and evaluating existing practices, challenges, and opportunities. The study aimed to provide actionable insights to enhance the sustainable utilization of mangrove resources so as to improve the blue economy performance. Addressing this gap is essential for achieving Kenya's commitments to environmental conservation, livelihood creation, climate resilience, and the advancement of blue economy strategies aligned with the Sustainable Development Goals (SDGs).

RESEARCH OBJECTIVE

To determine the influence of conservation practices on the performance of the blue economy in Kenya: a case of the mangrove forest.

RESEARCH HYPOTHESIS

H_{o1}: There is no statistically significant influence of mangrove forest conservation practices on the performance of the blue economy.

THEORITICAL FRAMEWORK

The Sustainable Development Theory, which provides a thorough framework for analyzing the connection between sustainable resource management and economic development, served as the foundation for this study. The World Commission on Environment and Development's 1987 study "Our Common Future," which defines sustainable development as development that satisfies current demands without jeopardizing the capacity of future generations to satiate their own, serves as the basis for this notion. Two interconnected elements are outlined in the definition: the necessity of prioritizing development that meets the fundamental needs of the world's poor and the necessity of setting limitations on the environment's capacity to support both present and future demands (World Commission on Environment and Development, 1987).

In the context of this study, the Sustainable Development Approach provided a critical framework for understanding how mangrove forest conservation practices influence the

performance of the blue economy in Kenya. The blue economy, which emphasizes sustainable use of the ocean and other aquatic resources for economic growth, aligns closely with the goals of sustainable development (Natarajan et al., 2022). This framework emphasizes the interdependence between ecological health and economic sustainability. In the context of this study, it suggests that to achieve long-term blue economic growth, mangroves must be conserved and managed in a way that not only meets current income needs but also safeguards ecological integrity for future generations.

The Sustainable Development Approach justifies integrating ecological and socio-economic development. Conservation of mangroves through reforestation and habitat protection helps maintain biodiversity and ecosystem functions that are crucial for sustaining fisheries productivity and ecotourism, which are both pillars of the blue economy.

Conclusively, the Sustainable Development Approach served not only as the theoretical foundation for this study but also as a guiding principle in analysing the practical linkages between environmental stewardship and economic development. By embedding sustainable management practices in mangrove ecosystems, Kenya can unlock the full potential of its blue economy sustainably. This theoretical lens provided clarity and coherence to the research by explaining how environmentally responsible actions today ensure economic prosperity and ecological viability for future generations (World Commission on Environment and Development, 1987).

EMPIRICAL REVIEW

Previous studies show that conservation practices enhance mangrove regeneration, biodiversity, and fisheries' productivity (Walters et al., 2018). The Lamu Blue Carbon Project, which was initiated in 2023, focuses on restoring and protecting 4,000 hectares of mangrove forests in Lamu County, Kenya. By involving local communities in conservation efforts, the project aims to generate over 50,000 tonnes of carbon dioxide equivalents annually, which can be converted into carbon credits and sold on global markets. This is an important milestone in ensuring that there is massive mangrove growing and also that the community benefits economically through carbon credits. It has a ripple effect as other benefits are derived from the forests, both ecological and economic. That means conservation practices have some direct link to the performance of the blue economy when viewed through this lens.

In Gazi Bay, Kwale County, community-led mangrove restoration has been linked to improved fisheries productivity and carbon credit programs (Kairo et al., 2019). However, there are some

challenges, including conflicts over resource access and a lack of sustainable financial support for community-led initiatives (Owuor et al., 2019). The study measured how restoration has restored the ecological dignity of the mangrove ecosystems in support of the blue economy through fisheries productivity, ecotourism growth, and environmental resilience, among other benefits. It also delved into how the community involvement in conservation initiatives has led to the creation of alternative livelihoods through beekeeping, crab fattening, among others.

According to the World Bank (2017), a thriving blue economy depends on the ripple growth of inclusive economic, social, and resource conservation. The indicators encompass economic growth from marine and aquatic resources, including livelihood improvement schemes through the creation of income-generating avenues, job creation, environmental sustainability, biodiversity protection, and social equity.

Sustainable livelihoods are crucial for reducing pressure on mangroves while enhancing economic resilience. Alternative livelihoods, such as beekeeping (asali mkoko) and ecotourism, have reduced dependence on mangrove wood harvesting in Tanzania and some parts of the Kenyan Coast. Women-led community enterprises in Kenya's mangrove areas have enhanced household incomes and improved conservation outcomes. However, limited market access and funding constraints remain barriers to scaling up livelihood programs (WWF, 2020). An example is the case is the Jomvu Women in Fisheries and Aquaculture project in Mombasa. Projects like the Kenya Marine and Fisheries Socio-Economic Development (KEMFSED) have endeavored to promote the development of revenue-generating, environmentally sound, and socially viable programs.

Mangroves are critical breeding and nursery grounds for fish and other crustaceans, directly influencing coastal fisheries. In West Africa, countries with well-managed mangroves report up to 50% higher fish yields than those with degraded mangrove ecosystems. Studies in Kenya's Lamu and Mombasa counties indicate a strong correlation between mangrove health and artisanal fishery productivity (Huxham et al., 2015). Overfishing and habitat destruction remain major threats, requiring stronger governance interventions (FAO, 2022). In areas where there has been massive destruction of mangrove forests for mega infrastructural developments, fishery production has gone down.

Eco-tourism leverages mangrove ecosystems for sustainable income while promoting conservation awareness. The Mida Creek Boardwalk Project in Kilifi County, Kenya, has successfully integrated tourism with conservation, generating revenue for local communities.

A similar one in Miritini Mkupe within Mombasa County has become a game changer as it traps both national and international tourism as it rests in a strategic place, near the SGR Terminus and Moi International Airport. In the Philippines, community-led mangrove ecotourism increased local income by 40%, supporting conservation initiatives (Camacho et al., 2019). However, challenges such as seasonality and lack of infrastructure hinder long-term sustainability (Spalding & Parrett, 2019).

CONCEPTUAL FRAMEWORK

The study was guided by a conceptual framework that illustrates the hypothesized relationship between conservation practices and the performance of the blue economy.

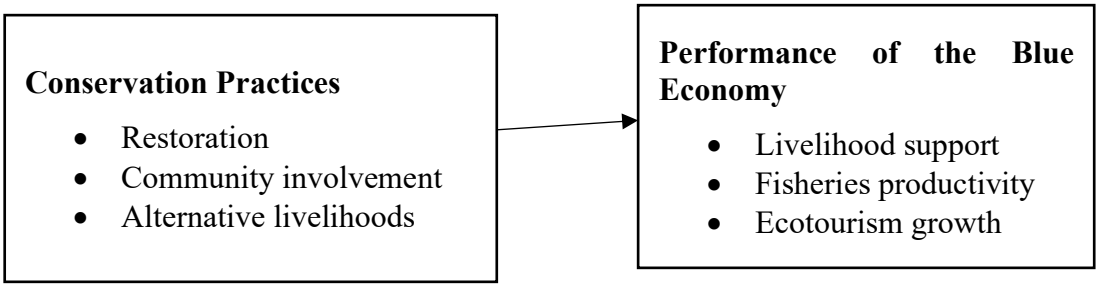

Figure 1: Conceptual framework

RESEARCH METHODOLOGY

This study employed a mixed-methods research design, combining both qualitative and quantitative approaches. Primary data included the administration of a 5-point Likert-scale semi-structured in-person questionnaire done by trained research assistants to evaluate the resource utilization practices, perceptions, and socioeconomic factors (Walliman, 2021). The target population included members of Community Forest Association (CFA) and Beach Management Units (BMUs), as well as key government agency officials, i.e., Kenya Forest Service and the Directorate of Blue Economy and Fisheries. They were selected due to their direct roles in mangrove conservation and management, policy implementation, and resource-based livelihood activities.

To ensure that the different stakeholder groups were fairly represented, the study employed stratified random sampling. This technique enabled the division of the population into homogeneous strata based on institutional affiliation and community role in resource utilization and management. Within each stratum, respondents were selected using simple random sampling, thereby enhancing the representativeness and the reliability of the data (Saunders et al., 2019).

The total target population was 1700, comprising 1200 members of beach management units (BMUs) and 500 community forest association (CFA) members as verified from their respective registers. The sample size was then determined using Cochran's formula (Cochran, 1977). While the calculated minimum sample population was 85, the study opted to engage a larger group of 115 respondents to increase the robustness and reliability of the findings (Creswell & Creswell, 2018). This included 10 respondents from key government institutions, the Kenya Forest Service, and the Directorate of Blue Economy and Fisheries (5 questionnaires each), and 105 community-level respondents, BMUs, and CFA.

The distribution of community respondents followed the population ratio of 3:1 (BMU: CFA), resulting in a sample of 79 BMU members and 27 CFA members. This method is known as proportionate stratified sampling and is commonly used to ensure that each subgroup is properly and fairly represented in the sample. This approach considers population diversity and enhances the accuracy of statistical estimates across different categories (Kumar, 2019). Quantitative data was analyzed using the Standard Statistical Package for Social Sciences (SPSS). This included descriptive statistics, correlation analysis, and regression analysis, used to identify patterns and relationships among variables (Pasikowski, 2024).

RESULTS AND DISCUSSIONS

The results are presented in descriptive and inferential statistical formats, including frequencies, percentiles, mean scores, standard deviations, and regression analysis(Walliman, 2021). The study issued 115 questionnaires, of which 100 were filled out and returned, giving a response rate of 87%, which was adequate for data analysis. Chilibasi (2019) notes that for a descriptive study, a questionnaire response rate of 50 % is sufficient for data analysis and findings reporting; a response rate of 60 % is good, while a response rate of 70% and above is treated as excellent. Thus, this study had an excellent response rate (Walliman, 2021).

Descriptive Analysis

Descriptive analysis included measures such as the mean to show the average responses and the standard deviation to indicate the variability of responses across items. This approach provided a clear summary of central tendencies and the spread of data, making it easier to interpret stakeholder perceptions regarding conservation practices and the performance of the blue economy.

Table 1: Conservation Practices

Conservation Practices	N	Mean	Std. Deviation
Are you aware of any conservation practices for mangrove forest	100	3.95	.219
Efficiency of the current conservation practices in preserving mangroves	100	3.49	1.030
Conservation measures are in place for mangrove protection	100	3.09	1.471
To what extent do conservation practices influence the performance of the blue economy	100	3.36	.990
Valid N (listwise)	100		

The descriptive results indicated that respondents had a high level of awareness of conservation practices (Mean = 3.95, SD = 0.219), suggesting strong knowledge of existing initiatives. Nonetheless, the efficiency of these practices was rated moderately (Mean = 3.49, SD = 1.030), pointing to possible shortcomings in implementation and monitoring. Conservation measures in place scored lower (Mean = 3.09, SD = 1.471), reflecting uneven or insufficient approaches across different areas. Respondents also acknowledged that conservation practices influence blue economy performance (Mean = 3.36, SD = 0.990), highlighting their importance in supporting ecosystem services. Overall, the findings show that conservation practices such as mangrove restoration and community engagement are central in enhancing ecological sustainability and economic benefits. Still, moderate ratings for effectiveness reveal challenges in enforcement, coordination, and resourcing, which could limit long-term gains.

Table 2: Performance of the Blue Economy

Performance of the Blue Economy	N	Mean	Std. Deviation
How is the performance of the blue economy in your view	100	2.46	1.158
What suggestions would you make to improve the performance of the blue economy in relation to mangroves	100	2.56	1.183
Which mangrove-related blue economy sector has benefited the most from sustainable management practices	100	2.34	1.289
What barriers do you think limit the contribution of mangrove forests to the blue economy	100	2.33	1.256
Valid N (listwise)	100		

The results from the respondents showed that the perceived performance of the blue economy was moderate (Mean = 2.46, SD = 1.158). Suggestions for improving performance recorded a slightly higher mean (2.56, SD = 1.183), reflecting optimism that better management could

yield stronger outcomes. Respondents identified sectors such as fisheries, coastal protection, biodiversity conservation, and ecotourism as key beneficiaries of sustainable mangrove management, though the mean rating was modest (2.34, SD = 1.289). Barriers limiting contributions of mangrove forests to the blue economy were also noted (Mean = 2.33, SD = 1.256), with varying perceptions likely tied to differences in roles and levels of engagement. The moderate standard deviations across items suggest a fair level of agreement among respondents. Overall, the findings highlight that while mangrove-related activities are recognized as important for strengthening the blue economy, there remain clear opportunities for addressing barriers and enhancing their contribution through more effective management practices.

Correlation Analysis for the study variables

Correlation analysis was conducted to examine the strength and direction of the association among the study variables. Pearson correlation was used to examine if there was a correlation or a degree of association for the variables in the study. The correlation ranges between +1 and -1 where the sign of the correlation coefficient indicates the direction of the association (Chatama, 2013). The results are presented in Table 3

Table 3: Correlation Analysis Results

Variables	Conservation Practices	Waste Management Practices	Sustainable Governance Practices	Sustainable Resource Management	Performance of the Blue Economy
Conservation Practices	1.000				
Waste Management Practices	.855**	1.000			
Sustainable Governance Practices	.939**	.868**	1.000		
Sustainable Resource Management	.765**	.886**	.841**	1.000	
Performance of the Blue Economy	.939**	.913**	.931**	.828**	1.000

Conservation practices demonstrated the strongest relationship with blue economy performance ($r = 0.939$, $p < 0.001$). Waste management practices also showed a very strong positive correlation ($r = 0.913$, $p < 0.001$. Sustainable governance practices similarly exhibited a very strong correlation ($r = 0.931$, $p < 0.001$). Sustainable resource management practices, while slightly lower in strength, still showed a strong and significant positive correlation ($r = 0.828$, $p < 0.001$). Additionally, the intercorrelations among the independent variables were notably high, such as between conservation practices and governance ($r = 0.939$), waste management and resource management ($r = 0.886$), and governance and resource management ($r = 0.841$). Correlation analysis confirms that conservation, waste management, governance, and resource management practices are all integral to the success of Kenya's blue economy.

Regression Analysis

Regression analysis was conducted to determine the effect of conservation practices on the performance of the blue economy. The results included the model summary, ANOVA, and regression coefficients, which collectively demonstrate the explanatory power and significance of the study variables.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.980a	.960	.952	.254

The regression analysis confirmed that conservation practices significantly explain 96% ($R^2 = 0.960$) of the variation in the performance of the blue economy. The high R value (.980) demonstrates a very strong positive correlation between conservation practices and blue economy performance. The adjusted R^2 (.952) indicates that the model remains robust even after accounting for predictor adjustments, underscoring the reliability of the results.

Table 5: ANOVAa

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	127.496	16	7.968	123.756	.000b
Residual	5.344	83	.064		
Total	132.840	99			

The ANOVA results ($F = 123.756$, $p < 0.001$) show that the regression model is statistically significant, confirming that conservation practices have a substantial influence on blue economy performance. The regression sum of squares (127.496) being far greater than the

residual sum of squares (5.344) demonstrates that the model explains most of the variation in the dependent variable. This strong model fit underscores the need for sustainable management practices in supporting the growth and resilience of the blue economy in Mombasa County.

Table 6: Multiple Regression Coefficients

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	-1.746	.311		-5.621	.000
Conservation Practices	.616	.124	.427	4.971	.000

The regression coefficients provide clear evidence for hypothesis testing. For Ho_1, which stated that there is no statistically significant influence of conservation practices on the performance of the blue economy, the findings revealed a coefficient ($B = 0.616$), $t = 4.971$, and $p < 0.001$. These results confirm a statistically significant and positive effect of conservation practices on blue economy performance. Consequently, Ho_1 was rejected, affirming that conservation practices are vital in strengthening the outcomes and sustainability of the blue economy.

CONCLUSION

The study concludes that sustainable management practices are fundamental to the success and long-term viability of the blue economy. Based on the findings, high levels of stakeholder awareness demonstrate that knowledge for sustainability is present, yet moderate perceptions of practice effectiveness reveal that more effort is needed to translate awareness into consistent and impactful action. This represents the gap the study sought to address, underscoring the need for deliberate strategies that move from understanding to tangible results. The analysis further established that conservation practices significantly influence the performance of the blue economy. Institutional frameworks, participatory decision-making, and adaptive management strategies emerged as essential elements in ensuring that conservation efforts are well-structured, inclusive, and responsive to evolving environmental and socio-economic challenges. Strengthening these aspects will be central to advancing sustainability in marine and coastal ecosystems.

The strong explanatory power of the regression model ($R^2 = 0.960$) confirms that targeted improvements in sustainable management practices can yield substantial benefits. These include gains in economic productivity through resource efficiency, improvements in social well-being by securing livelihoods, and enhanced environmental health through ecosystem protection. Without such integrated interventions, the potential of the blue economy could

remain underutilized or become unsustainable in the long term. In summary, the study concludes that sustainable mangrove and marine resource management is not only an environmental obligation but also a strategic economic and social priority for Kenya. By reinforcing conservation practices and embedding them into national policy frameworks, Kenya can directly accelerate progress toward Sustainable Development Goals, particularly SDG 1 (No Poverty), SDG 13 (Climate Action), and SDG 14 (Life Below Water).

RECOMMENDATIONS

The study recommends that conservation initiatives should be strengthened by enhancing community participation, providing adequate technical resources for restoration, and conducting continuous education campaigns to raise awareness of the ecological and economic importance of mangroves. Waste management strategies should be standardized and integrated across mangrove areas, with stronger pollution control mechanisms and community training on waste reduction and recycling prioritized to reduce environmental pressure. Public-private partnerships should be encouraged to establish recycling plants that transform waste into valuable products, thereby reducing environmental degradation while creating sustainable livelihoods that support the blue economy.

Furthermore, sustainable governance should be reinforced through the development of participatory management plans, signing of enforceable agreements, and capacity building for local governance structures to ensure accountability and inclusiveness in conservation efforts. Inter-agency coordination between county and national governments should be improved to avoid overlap and strengthen enforcement of environmental laws. Adaptive resource management strategies should be implemented to enhance flexibility in responding to environmental and socio-economic challenges, while sustainable livelihood options such as ecotourism and fisheries should be promoted to secure both ecosystem health and community well-being.

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