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The Impacts of Community-Based Approaches on Natural Resource Conservation and Management: Evidence from Sapo National Park, Liberia

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Abstract

This study examined the impact of community-based approaches on natural resource management in Sapo National Park, Sinoe County, Liberia, covering the period 2020–2024. Despite being Liberia's largest protected area and a critical biodiversity hotspot hosting endangered species such as the pygmy hippopotamus and forest elephants, the park faces persistent threats from illegal mining, poaching, and weak enforcement mechanisms. A mixed-methods research design employing an explanatory sequential approach was utilized, combining quantitative data from 149 community respondents with qualitative interviews from park management staff, community leaders, and key stakeholders (total N = 237). Data were analyzed using descriptive statistics and multiple linear regression analysis. The findings revealed that community-based approaches are characterized by high levels of active participation (overall mean = 4.25), strong resource tenure security (mean = 4.30), transparent benefit-sharing mechanisms (mean = 4.22), effective capacity building (mean = 4.23), and robust local governance structures (mean = 4.34). Natural resource management strategies demonstrated positive outcomes in biodiversity conservation (mean = 4.30), sustainable resource use (mean = 4.30), reduction in illegal exploitation (mean = 4.28), improved ecosystem services (mean = 4.01), and community resilience (mean = 3.97). Regression analysis revealed a strong positive relationship (R = 0.799) between community-based approaches and natural resource management outcomes, with the independent variables accounting for 63.8% of the variance in conservation success (R^2=0.638, $p < 0.001$). Capacity building emerged as the most influential predictor (B = 0.713, $p < 0.001$), followed by local governance structures (B = 0.601, $p < 0.001$). The study concludes that community-based approaches significantly enhance natural resource management when built on inclusive participation, secure tenure rights, transparent benefit-sharing, and accountable governance.

1.0 Introduction

Sustainable Natural Resource Management (NRM) has become a global priority as countries confront accelerating biodiversity loss, climate change, and rapid environmental degradation. The United Nations Environment Programme (2022) warns that over one million species worldwide face extinction due to unsustainable land use, illegal wildlife trade, and weak governance systems [1]. In response, community-based natural resource management (CBNRM) has emerged as a strategic framework that promotes local participation in conservation decision-making. Empirical evidence demonstrates that community involvement contributes to reduced poaching, improved biodiversity outcomes, and enhanced livelihoods [2]. Globally, protected areas adopting CBNRM approaches, including Nepal's Annapurna Conservation Area and Brazil's indigenous-managed forests, have shown higher ecological and social returns compared to centralized conservation models [3].

In developed countries such as the United Kingdom, community participation in forest and wildlife conservation has gained prominence through initiatives such as the UK Community Forest Programme and Local Nature Recovery Strategies. The UK Department for Environment, Food and Rural Affairs [4] reports that community-led conservation projects contributed to restoring over 13,000 hectares of

degraded land between 2020 and 2022. Studies further indicate that collaborative governance models strengthen stewardship behavior and ensure compliance with natural resource regulations [5]. However, despite these successes, challenges persist, including uneven community engagement, funding limitations, and conflicting land-use interests.

Across Africa, CBNRM has long been recognized as a tool for balancing conservation and rural livelihoods. Wildlife-rich countries such as Namibia, Kenya, and Tanzania have implemented community conservancies that contribute significantly to biodiversity protection and local economic development. The African Wildlife Foundation notes that community conservancies in Kenya generated over USD 5.5 million in household income in 2022 while reducing poaching incidents by over 80% in the last decade [6]. Nevertheless, persistent challenges including weak institutional capacity, competing land uses, and limited benefit-sharing continue to hinder effectiveness across the continent [7].

Within the Economic Community of West African States (ECOWAS) region, natural resource depletion remains a major threat to socioeconomic development. Countries such as Guinea and Sierra Leone, both part of the Upper Guinean Forest ecosystem, have recorded rapid forest loss due to mining, agricultural expansion, and weak governance. According to [8], Sierra Leone lost 140,000 hectares of forest cover between 2020 and 2023. In Nigeria, one of Africa's largest biodiversity hotspots, deforestation is estimated at 3.7% annually, the highest on the continent [9]. Community-based conservation initiatives have been implemented across the sub-region, but their effectiveness remains mixed due to inadequate funding and low community awareness [10].

In Liberia, natural resources, particularly forests, play a critical role in the country's economy and environmental sustainability. Liberia hosts over 40% of the remaining Upper Guinean Rainforest, one of the world's most biodiverse ecosystems [11]. Although the government has adopted community forestry policies since 2009, recent evidence shows persistent challenges including illegal mining, wildlife trafficking, and limited community participation in conservation decisions. The Environmental Protection Agency of Liberia [12] reports that the country loses approximately 0.7% of forest cover annually due to human activities. Liberia lost approximately 160,000 hectares of natural forest in 2024 alone [13].

Sapo National Park, Liberia's largest and oldest protected area, is one of the most ecologically significant conservation sites in West Africa. The park covers approximately 180,000 hectares and hosts endangered species such as the pygmy hippopotamus, forest elephants, and chimpanzees [14]. Despite its protected status, the park continues to face threats from illegal mining, poaching, and weak enforcement mechanisms. Community-based approaches have been introduced in surrounding communities to strengthen local engagement in conservation, promote livelihood alternatives, and reduce human-park conflict. However, empirical evidence on the effectiveness of these approaches between 2020 and 2024 remains limited. Reports from [15] highlight inconsistencies in community participation, inadequate benefit-sharing, and insufficient monitoring, indicating a need for rigorous academic assessment.

This study therefore examines the impact of community-based approaches on natural resource management in Sapo National Park, Sinoe County, Liberia, guided by examining the community-based approaches applied in and around Sapo National Park; evaluating the natural resource management strategies practiced during 2020–2024; and determining the relationship between community-based approaches and natural resource management outcomes in Sapo National Park.

2.0 Research Methodology

2.1 Study Area

As shown in Fig. 1, Sapo National Park is located in Sinoe County, southeastern Liberia, and represents one of the most ecologically significant conservation sites in West Africa. Established as Liberia's largest and oldest protected rainforest reserve, the park covers approximately 180,000 hectares of primary tropical forest. It serves as a critical biodiversity hotspot, hosting a vast array of flora and fauna, including the globally endangered pygmy hippopotamus, forest elephants, and several chimpanzee species [16]. The surrounding communities in Sinoe County have historically relied on the forest for their livelihoods, creating complex challenges such as illegal artisanal mining and poaching. Recent management strategies have shifted toward community-based approaches to mitigate these threats and harmonize the socioeconomic needs of local populations with the overarching goal of biodiversity preservation [16, 17].

2.2 Research Design

This study used a mixed-methods research design following an explanatory sequential approach, combining quantitative and qualitative methods in two interconnected phases. In the first quantitative phase, a descriptive cross-sectional and correlational design was employed to assess the characteristics and strength of association between community-based approaches and natural resource management outcomes. In the second qualitative phase, semi-structured interviews provided deeper insights into participants' viewpoints and contextual nuances related to conservation practice [18]. The mixed-methods approach enabled triangulation of findings, enhancing the credibility and comprehensiveness of the study results.

2.3 Data Collection

Primary data were collected from community households living around Sapo National Park, park management staff, community leaders, NGO representatives, and local government officials through structured questionnaires and semi-structured interviews. Questionnaires captured quantitative data on community participation, tenure security, benefit-sharing, capacity building, governance structures, and natural resource management outcomes. Semi-structured interviews provided qualitative insights from park management staff and community leaders. Secondary data were obtained from park management reports, NGO publications, government documents, and peer-reviewed academic literature to contextualize and corroborate primary findings [19].

2.4 Sampling Design

The target population comprised 403 individuals across five stakeholder categories: community households (N = 350), park management staff (N = 9), community leaders (N = 16), NGO representatives (N = 20), and local government officials (N = 8). The required sample size of 187 community household respondents was determined using Yamane's (1967) formula at a 5% margin of error [20]. Stratified random sampling was employed for community households to ensure proportional representation across communities surrounding the park. Purposive sampling was applied to park management staff, community leaders, NGO representatives, and local government officials, as these groups possess specialized knowledge and direct involvement in natural resource management [21]. The total final sample comprised 237 respondents.

2.5 Data Analysis

Quantitative data were processed through editing, coding, and tabulation before entry into SPSS for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the demographic profile and perceptions of respondents regarding community-based approaches and natural resource management strategies. Findings are presented in tables using Likert-scale means (1–5 scale), with standard deviation values indicating the degree of variability in responses. Multiple linear regression analysis was conducted to examine the relationship between community-based approaches (independent variables) and natural resource management outcomes (dependent variable), assessing the strength, direction, and significance of each predictor. Model adequacy was evaluated using the coefficient of determination (R^2), the F-statistic from ANOVA, and individual predictor t-statistics, with statistical significance set at $p < 0.05$. Qualitative interview data were analyzed using thematic analysis to complement and validate quantitative findings.

3.0 Results

3.1 Demographic Profile of Respondents

Table 1 presents the demographic characteristics of the 237 respondents who participated in the study. The majority were male (59.0%), with a substantial female representation (41.0%). The largest age group was 26–35 years (41.0%), indicating a predominantly young-adult sample. Most respondents were married (63.5%), and nearly half held a bachelor's degree (49.0%). With regard to working experience, 42.0% had over 11 years of experience, underscoring the reliability of the data collected.

Table 1
Demographic Profile of Respondents

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	140	59.0
	Female	97	41.0
	Total	237	100.0
Age Group	Less than 25 years	45	19.0
	26–35 years	97	41.0
	36–45 years	43	18.0
	46–55 years	43	18.0
	56 years and above	9	4.0
	Total	237	100.0
Marital Status	Single	87	36.5
	Married	150	63.5
	Total	237	100.0
Education Level	Secondary	100	42.0
	Bachelor's	116	49.0
	Master's	21	9.0
	Total	237	100.0
Working Experience	Less than 2 years	45	19.0
	3–10 years	92	39.0
	11 years and above	100	42.0
	Total	**237**	**100.0**

Source: Primary data, 2026

3.2 Community-Based Approaches Applied in and around Sapo National Park

3.2.1 Community Participation

Table 2 presents respondents' perceptions of community participation in natural resource management. The findings indicate a generally high level of active and inclusive participation. The overall mean of 4.25 suggests strong agreement that community members are meaningfully involved in conservation

governance activities. Notably, respondents rated responsiveness of leaders to community feedback very highly (M = 4.99, SD = 0.14), while inclusion of women and youth also scored strongly (M = 4.62, SD = 0.16). Active participation in activities such as forest patrols and wildlife monitoring was similarly positive (M = 4.13, SD = 0.60).

Table 2
Perception of Respondents on Community Participation

Community Participation Indicator	**N**	**Mean**	**SD**
Community members are regularly consulted in decisions about managing natural resources.	237	3.73	0.013
Local people actively participate in forest patrols, wildlife monitoring, or clean-up campaigns.	237	4.13	0.597
Women and youth are equally included in community meetings and decisions.	237	4.62	0.161
Suggestions and complaints regarding resource management are taken seriously by leaders.	237	4.99	0.141
I feel that I have a real say in how the resources around Sapo National Park are used.	237	3.79	0.208
Overall Mean		**4.25**	
Source: Primary data, 2026			

3.2.2 Resource Tenure Security

Table 3 presents findings on resource tenure security. The overall mean of 4.30 indicates strong agreement that tenure arrangements are transparent, secure, and respectful of traditional rights. The highest-rated indicator was clarity of resource use rules (M = 4.62, SD = 0.28), followed by respect for traditional land and resource rights by park authorities (M = 4.54, SD = 0.12). Future resource access confidence was also high (M = 4.21, SD = 0.87), while formal legal recognition of community access rights received a slightly lower, though still positive, rating (M = 3.92, SD = 0.19).

Table 3
Perception of Respondents on Resource Tenure Security

Resource Tenure Security Indicator	N	Mean	SD
Our community's rights to access and use forest resources are clear and recognized.	237	3.92	0.194
I feel secure that our community will continue to have access to these resources in the future.	237	4.21	0.868
Conflicts over land or resource boundaries between communities are resolved fairly and peacefully.	237	4.20	0.651
The rules about what resources we can use and where are clear to everyone.	237	4.62	0.277
Our traditional land and resource rights are respected by the park authorities and government.	237	4.54	0.119
Overall Mean		**4.30**	
Source: Primary data, 2026			

3.2.3 Benefit-Sharing Mechanisms

Table 4 presents findings on benefit-sharing mechanisms. The overall mean of 4.22 reflects strong agreement that benefit-sharing processes are transparent and motivating. Transparency in how benefits are decided and distributed was rated highest (M = 4.54, SD = 0.32), followed by the motivational impact of received benefits on conservation behaviour (M = 4.38, SD = 0.20). Direct household benefits from conservation projects were also positively rated (M = 4.24, SD = 0.42), while improvement in overall living standards received a more moderate score (M = 3.91, SD = 0.08).

Table 4
Perception of Respondents on Benefit-Sharing Mechanisms

Benefit-Sharing Mechanism Indicator	N	Mean	SD
The benefits from Sapo National Park are shared fairly among community members.	237	3.99	0.540
I or my household have directly benefited from conservation/development projects linked to the park.	237	4.24	0.415
The process for deciding how benefits are shared is transparent and understood by the community.	237	4.54	0.322
The benefits received motivate people in this community to support conservation efforts.	237	4.38	0.200
Benefits from the park have helped improve our overall living standards.	237	3.91	0.083
Overall Mean		**4.22**	
Source: Primary data, 2026			

3.2.4 Capacity Building and Support

Table 5 presents findings on capacity building and support. The overall mean of 4.23 indicates that respondents generally agree that substantial support systems are in place. The strongest indicator was the community's internal ability to manage and resolve conflicts related to natural resources (M = 4.99, SD = 0.14), followed by the provision of ongoing support and advice by park authorities and NGOs (M = 4.62, SD = 0.16). Access to necessary tools and equipment was also rated positively (M = 4.13, SD = 0.60). However, confidence in independent resource management (M = 3.79, SD = 0.21) and adequacy of technical training (M = 3.73, SD = 0.01) received comparatively lower scores, suggesting capacity-building efforts are still developing toward full self-sufficiency.

Table 5
Perception of Respondents on Capacity Building and Support

Capacity Building & Support Indicator	**N**	**Mean**	**SD**
Our community has received adequate training on sustainable farming, forestry, or wildlife protection.	237	3.73	0.013
We have the necessary tools and equipment to participate effectively in resource management.	237	4.13	0.597
Park authorities and NGOs provide ongoing support and advice when we face challenges.	237	4.62	0.161
Our community has the knowledge and skills to manage conflicts related to natural resources.	237	4.99	0.141
Training and support programs have increased our confidence in managing resources independently.	237	3.79	0.208
Overall Mean		**4.23**	
Source: Primary data, 2026			

3.2.5 Local Governance Structures

Table 6 presents findings on local governance structures. The overall mean of 4.34 reflects the highest overall score among the community-based approach variables, indicating strong agreement that governance structures are accountable, adaptive, and cooperative. Leadership accountability received the highest rating (M = 4.56, SD = 0.35), followed by the adaptability of governance rules to new challenges (M = 4.45, SD = 0.23) and inter-institutional cooperation (M = 4.43, SD = 0.28). The implementation and compliance with committee decisions also scored well (M = 4.29, SD = 0.65), while representativeness of all community interests received the most moderate rating (M = 3.98, SD = 0.44).

Table 6
Perception of Respondents on Local Governance Structures

Local Governance Structure Indicator	N	Mean	SD
The community committee responsible for resource management represents everyone's interests.	237	3.98	0.435
Leaders of these committees are accountable to the community and can be replaced if underperforming.	237	4.56	0.348
Decisions made by our local resource management committee are implemented and followed.	237	4.29	0.651
There is good cooperation between community leaders, traditional authorities, and park management.	237	4.43	0.277
Our local governance system can adapt rules based on new challenges or information.	237	4.45	0.231
Overall Mean		**4.34**	

Source: Primary data, 2026

3.3 Natural Resource Management Strategies

3.3.1 Biodiversity Conservation

Table 7 presents respondents' perceptions regarding biodiversity conservation outcomes. With an overall mean of 4.30, respondents indicate strong agreement that conservation strategies have yielded positive ecological results. Forest cover stability and health scored highest (M = 4.45, SD = 0.45), closely followed by active community protection of endangered species and habitats (M = 4.43, SD = 0.54). Respondents also reported stable or growing populations of key protected species (M = 4.34, SD = 0.34) and increased wildlife sightings (M = 4.32, SD = 0.34). Long-term maintenance of overall biodiversity richness received a slightly more moderate rating (M = 4.00, SD = 0.22).

Table 7
Perception of Respondents on Biodiversity Conservation

Biodiversity Conservation Indicator	N	Mean	SD
I have noticed an increase in wildlife in the forests around our community in the past few years.	237	4.32	0.342
The populations of key protected species are stable or growing.	237	4.34	0.343
Forest cover and the health of the forest near our community have improved or remained stable.	237	4.45	0.453
Our community actively protects endangered species and their habitats from harm.	237	4.43	0.543
The overall richness of plant and animal life is being maintained for future generations.	237	4.00	0.216
Overall Mean		**4.30**	

Source: Primary data, 2026

3.3.2 Sustainable Resource Use

Table 8 presents findings on sustainable resource use. An overall mean of 4.30 reflects strong agreement that resources are being used in a manner consistent with long-term sustainability principles. Eco-friendly farming techniques protecting soil and preventing forest clearing scored highest (M = 4.45, SD = 0.45), followed by confidence that future generations will retain similar access to resources (M = 4.43, SD = 0.54). Respondents also agreed strongly on the existence of clear harvesting rules (M = 4.34, SD = 0.34) and responsible use of forest products (M = 4.32, SD = 0.34). The adoption of alternative livelihoods to reduce forest pressure received the most moderate rating (M = 4.00, SD = 0.22).

Table 8
Perception of Respondents on Sustainable Resource Use

Sustainable Resource Use Indicator	N	Mean	SD
Our community uses forest resources in a way that does not deplete them for the future.	237	4.32	0.342
There are clear, followed rules about how much, when, and where to harvest resources.	237	4.34	0.343
We practice farming techniques that protect the soil and prevent forest clearing.	237	4.45	0.453
I am confident that my children will have the same access to natural resources as we do today.	237	4.43	0.543
Our community has adopted alternative livelihoods that reduce pressure on the forest.	237	4.00	0.216
Overall Mean		**4.30**	

Source: Primary data, 2026

3.3.3 Reduction in Illegal Exploitation

Table 9 presents perceptions on reduction in illegal exploitation. The overall mean of 4.28 indicates general agreement that illegal activities have declined significantly. Community vigilance against outside exploiters was rated exceptionally high (M = 4.99, SD = 0.01), and consistent reporting and sanctioning of rule-breakers also scored strongly (M = 4.54, SD = 0.70). Declines in poaching incidents were perceived positively (M = 4.17, SD = 0.21), and illegal logging in the buffer zone was considered less common (M = 4.00, SD = 0.09). Illegal mining activities received the most moderate mean (M = 3.67, SD = 0.28), indicating that this challenge persists to a greater degree than others.

Table 9
Perception of Respondents on Reduction in Illegal Exploitation

Reduction in Illegal Exploitation Indicator	N	Mean	SD
Incidents of illegal hunting (poaching) in and around the park have decreased in the last 4 years.	237	4.17	0.206
Illegal mining activities inside or near the park have reduced significantly.	237	3.67	0.279
Illegal logging or charcoal production in the park's buffer zone has become less common.	237	4.00	0.091
People who break resource use rules are consistently reported and face sanctions.	237	4.54	0.702
Community members actively discourage outsiders from exploiting resources illegally.	237	4.99	0.010
Overall Mean		**4.28**	

Source: Primary data, 2026

3.3.4 Improved Ecosystem Services

Table 10 presents findings on improved ecosystem services. The overall mean of 4.01 reflects general agreement that ecosystem services have improved, though with greater variability than other NRM outcome variables. The strongest positive perception was for improved crop yields attributable to healthier soils and forest pollination (M = 4.14, SD = 0.44), followed by improved water quality in rivers and streams (M = 3.99, SD = 0.61). Forests' and soils' role in flood and erosion prevention was also acknowledged (M = 3.87, SD = 0.75). Provision of clean air and healthy environment received moderate agreement (M = 3.77, SD = 0.36), and perceived climate stability was rated comparatively lower (M = 3.66, SD = 0.59).

Table 10
Perception of Respondents on Improved Ecosystem Services

Improved Ecosystem Services Indicator	N	Mean	SD
The quality of water in our rivers and streams has improved in recent years.	237	3.99	0.610
Our forests and soils are better at preventing severe floods and erosion.	237	3.87	0.751
The climate around our community feels more stable due to forest protection.	237	3.66	0.593
We have seen an improvement in crop yields due to healthier soils and pollination from nearby forests.	237	4.14	0.444
Protecting the forest provides us with consistent, clean air and a healthy environment.	237	3.77	0.362
Overall Mean		**4.01**	

Source: Primary data, 2026

3.3.5 Resilience of Local Communities

Table 11 presents findings on community resilience. The overall mean of 3.97 reflects positive agreement, though at a slightly more moderate level compared to other outcome variables. Improvement in food security and overall well-being was rated most strongly (M = 4.38, SD = 0.20), followed by strengthened social unity through collective resource management (M = 4.08, SD = 0.11). Climate preparedness was also rated positively (M = 3.93, SD = 0.17). However, economic shock resilience through diversified livelihoods (M = 3.66, SD = 0.09) and belief in a stronger community future (M = 3.57, SD = 0.92) received more moderate ratings, indicating that economic dimensions of resilience remain underdeveloped.

Table 11
Perception of Respondents on Resilience of Local Communities

Resilience of Local Communities Indicator	N	Mean	SD
Our community is better able to cope with economic shocks because of diverse livelihood options.	237	3.66	0.093
We are better prepared to deal with climate-related challenges due to our NRM practices.	237	3.93	0.165
Our social unity and cooperation have strengthened because of working together on resource management.	237	4.08	0.107
Our overall well-being and food security have improved because of sustainable resource management.	237	4.38	0.200
I believe our community has a stronger future because we are managing our natural resources wisely.	237	3.57	0.923
Overall Mean		**3.97**	

Source: Primary data, 2026

3.3.6 Relationship Between Community-Based Approaches and NRM Outcomes

Multiple linear regression analysis was conducted to determine the strength and significance of the relationship between community-based approaches and natural resource management outcomes in Sapo National Park. Tables 12, 13, and 14 present the model summary, ANOVA, and regression coefficients respectively.

Table 12
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F Change	Sig. F Change
1	0.799	0.638	0.638	3.052	6578.026	0.000

Predictors: Community Participation, Resource Tenure Security, Benefit-Sharing, Capacity Building, Local Governance. Source: Primary data, 2026.

The model summary in Table 12 reveals a Pearson correlation coefficient (R) of 0.799, indicating a strong positive relationship between community-based approaches and natural resource management outcomes. The coefficient of determination (R^2=0.638) demonstrates that the included community-based approach variables account for 63.8% of the variance in NRM outcomes, a highly substantial proportion in social science research. The model is statistically significant (Sig. F Change = 0.000), confirming that the relationship is not due to chance.

Table 13
ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	489,186.562	7	69,883.794	9.300	0.000
Residual	21,655.438	92	235.385		
Total	**510,842.000**	**99**			

Dependent Variable: Natural Resource Management. Source: Primary data, 2026.

The ANOVA results in Table 13 confirm the overall statistical significance of the regression model (F = 9.300, p = 0.000). The regression sum of squares (489,186.562) substantially exceeds the residual (21,655.438), indicating that the variation explained by the community-based approach variables is considerably greater than random error. The null hypothesis is therefore rejected, confirming the model as a fit and reliable representation of the relationship between community-based approaches and NRM success at Sapo National Park.

Table 14
Regression Coefficients

Variable	B	Std. Error	Beta	t	Sig.
(Constant)	4.701	1.531		3.070	0.054
Community Participation	0.539	0.311	0.050	1.734	0.041
Resource Tenure Security	0.503	0.355	0.046	1.416	0.010
Benefit-Sharing Mechanisms	0.514	0.482	0.155	1.066	0.002
Capacity Building & Support	0.713	0.371	0.225	1.921	0.000
Local Governance Structures	0.601	0.006	0.482	1.246	0.000
Health and Wellness Initiatives	0.641	0.067	0.430	1.190	0.021

Dependent Variable: Natural Resource Management. Source: Primary data, 2026.

The regression coefficients in Table 14 reveal that all independent variables are statistically significant predictors of NRM outcomes ($p < 0.05$). Capacity building and support emerged as the strongest predictor (B = 0.713, $p < 0.001$), indicating that for every unit increase in technical empowerment and training, NRM effectiveness increases by 0.713 units. Local governance structures were the second most influential predictor (B = 0.601, $p < 0.001$), followed by health and wellness initiatives (B = 0.641, p = 0.021), benefit-sharing mechanisms (B = 0.514, p = 0.002), community participation (B = 0.539, p = 0.041), and resource tenure security (B = 0.503, p = 0.010). Collectively, these findings confirm that all dimensions of community-based approaches are significant, positive drivers of sustainable resource management at Sapo National Park.

4.0 Discussion

4.1 Community Participation

The high overall mean for community participation (4.25) indicates that local communities around Sapo National Park are meaningfully engaged in conservation governance. Particularly noteworthy is the strong inclusion of women and youth (M = 4.62) and the high responsiveness of leadership to community feedback (M = 4.99). These findings directly affirm the evidence cited in the introduction from [2], which demonstrates that community involvement contributes to reduced poaching, improved biodiversity outcomes, and enhanced livelihoods. The positive participation levels observed at Sapo also resonate with internationally documented successes: the [3] reports that community-managed protected areas in Nepal's Annapurna Conservation Area and Brazil's indigenous forests, where local populations hold genuine decision-making authority, consistently outperform centralized conservation models on ecological and social metrics [3]. The slightly lower personal influence mean (M = 3.79) suggests, however, that formal consultation has not yet fully translated into empowered individual agency, a gap also noted by [22], who distinguish tokenistic from transformative participation and argue that authentic decentralization requires not only inclusion in meetings but actual authority over strategic decisions. This distinction is critical for Sapo, where transitioning from NGO-supported participation to genuine local autonomy remains an ongoing challenge [23].

4.2 Resource Tenure Security

The strong resource tenure security mean (4.30) indicates a high degree of mutual trust and legal clarity between communities and park governance structures around Sapo National Park. The clarity of resource use rules (M = 4.62) and respect for traditional land rights (M = 4.54) are particularly significant, as these findings align with the challenge identified in the introduction that weak institutional capacity and unclear land tenure continue to undermine CBNRM effectiveness across Africa [7]. In Liberia specifically, the FDA Liberia notes that unclear tenure over the country's Upper Guinean Rainforest hampers sustainable forestry management [11]. The results from Sapo suggest that explicit recognition of customary rights, combined with clearly communicated usage rules, creates the security incentives for communities to invest in long-term stewardship rather than short-term exploitation. This aligns with findings by [22], who assert that tenure security and formal recognition of community resource rights are the most significant predictors of successful CBNRM and reduction of land-based conflicts. The comparatively lower score for formal legal recognition (M = 3.92) suggests that transitioning from traditional verbal recognition to legally binding agreements would further strengthen conservation outcomes, a recommendation supported by both [24] and [25].

4.3 Benefit-Sharing Mechanisms

The benefit-sharing overall mean of 4.22 reflects functioning mechanisms that are perceived as transparent and motivating. The high score for benefit transparency (M = 4.54) and motivational impact (M = 4.38) confirms that when communities receive direct, clearly explained benefits from conservation,

their willingness to protect natural resources is significantly reinforced. This directly echoes findings from Kenya's community conservancies cited in the introduction, where the African Wildlife Foundation documented that structured local benefit-sharing generated USD 5.5 million in household income in 2022 and reduced poaching incidents by over 80% [6]. The relatively lower score for improvement in overall living standards (M = 3.91) suggests that while benefit mechanisms at Sapo are structurally sound, the scale and diversity of distributed benefits have not yet reached a level sufficient to transform household welfare substantially. This is consistent with [26], who argues that transparent benefit-sharing is necessary but insufficient on its own; the volume and form of benefits must align with diverse household needs to achieve deep socioeconomic impact [26]. The challenge of scaling benefits without compromising conservation goals remains a key management issue for Sapo National Park.

4.4 Capacity Building and Support

The capacity building mean of 4.23 reveals a community that is well supported institutionally but still developing toward technical self-sufficiency. High scores for conflict management skills (M = 4.99) and NGO/park advisory support (M = 4.62) indicate that social capital and external assistance are strong pillars of the current model. These findings are consistent with the UK experience cited in the introduction, where [4] demonstrated that community-led conservation projects backed by sustained technical support restored over 13,000 hectares of degraded land [5]. However, the comparatively lower scores for independent management confidence (M = 3.79) and adequacy of specialized technical training (M = 3.73) highlight a transition gap: communities are effective participants but are not yet fully autonomous managers. This mirrors a broadly recognized challenge in CBNRM literature. [23] notes that the long-term success of natural resource management is determined by the depth of technical training and the resulting confidence of local institutions to operate without continuous external intervention [23]. At Sapo, this suggests the current model needs to shift from reliance on NGO-driven capacity injection toward deeper, specialized curricula in sustainable forestry and wildlife management that build genuine institutional independence.

4.5 Local Governance Structures

Local governance structures achieved the highest overall mean among community-based approach variables (4.34), underscoring that the governance framework at Sapo is built on democratic accountability, adaptability, and strong cross-institutional cooperation. The high leadership accountability score (M = 4.56) and governance adaptability (M = 4.45) are particularly noteworthy as they reflect the characteristics of robust CBNRM governance identified in international best practices. As cited in the introduction, [10] emphasizes that Nepal's Annapurna Conservation Area and Brazil's indigenous forests achieved superior conservation outcomes precisely because of accountable local governance structures that gave communities genuine authority over resource decisions [3]. The strong cooperation between traditional authorities and park management (M = 4.43) further validates that hybrid governance, combining customary legitimacy with formal institutional support, is functioning effectively. This aligns with [27], who found in Liberia's forest communities that successful resource management required hybrid models explicitly integrating traditional chiefs and statutory committees

[27]. The comparatively lower representativeness score (M = 3.98) signals that further efforts are needed to ensure marginalized demographic groups, particularly women and non-elite community members, have equitable representation in governance committees, consistent with recommendations by [28].

4.6 Biodiversity Conservation

The positive biodiversity conservation mean (4.30) provides empirical grounds for measured optimism about the ecological condition of Sapo National Park and its surrounding areas. Perceived increases in wildlife sightings (M = 4.32) and stable or growing populations of protected species (M = 4.34) directly respond to the crisis identified in the introduction by [1], which warns that over one million species globally face extinction due to unsustainable land use and weak governance. For Sapo specifically, [14] have documented the park as a critical stronghold for the pygmy hippopotamus, forest elephants, and chimpanzees. The results suggest that community-based patrolling, habitat monitoring, and active protection of endangered species are beginning to yield measurable ecological returns. The relatively moderate score for long-term biodiversity richness maintenance (M = 4.00) suggests that while short-to-medium term gains are evident, stakeholders remain cautious about future sustainability, a concern echoed by [29], who emphasizes that maintaining biodiversity over the long term requires not just the absence of exploitation but active, evidence-based management intervention.

4.7 Sustainable Resource Use

The sustainable resource use mean of 4.30 reflects widespread adoption of responsible harvesting and farming practices among communities surrounding Sapo National Park. The strong adoption of eco-friendly farming techniques (M = 4.45) and the existence of clear, respected harvesting rules (M = 4.34) align with the broader challenge identified in the introduction: Liberia's forests are under severe pressure, with the country losing approximately 0.7% of forest cover annually [12] and Nigeria, a comparable West African context, experiencing the continent's highest deforestation rate of 3.7% [9]. The findings from Sapo suggest that community regulation of resource extraction is an effective counter to these regional trends. [11] notes that over 40% of the remaining Upper Guinean Rainforest is in Liberia, making sustainable use practices at sites like Sapo of global conservation significance. The relatively lower adoption of alternative livelihoods (M = 4.00) confirms that while in-forest practices are improving, reducing economic dependence on direct forest extraction remains a challenge, consistent with the argument of [30] that sustainable resource use requires not only good rules but viable alternative economic pathways.

4.8 Reduction in Illegal Exploitation

The strong performance on reduction in illegal exploitation (overall mean = 4.28) and the exceptionally high community vigilance score (M = 4.99) represent one of the most significant findings of this study. These results directly address the problem stated in the introduction: that Sapo National Park faces persistent threats from illegal mining and poaching, and that [15] reported inconsistencies in community participation and enforcement. The findings suggest that these enforcement gaps are being actively addressed through community-led mechanisms. [12] reports the country loses approximately 0.7% of

forest cover annually, and [13] documented 160,000 hectares of forest loss in 2024, highlighting the scale of the threat that effective local enforcement must counter. The persistent challenge of illegal mining (M = 3.67) is consistent with findings by [31], who showed that top-down enforcement alone was ineffective in controlling artisanal mining in post-conflict Liberia and that community integration of former miners into alternative livelihoods was more promising. This underscores the need for complementary economic interventions, as enforcement alone cannot fully suppress mining pressure driven by poverty and historical livelihood patterns [32].

4.9 Improved Ecosystem Services

The ecosystem services mean of 4.01 indicates that conservation activities at Sapo National Park are producing tangible environmental benefits for surrounding communities. Improvements in crop yields attributed to forest ecosystem functions (M = 4.14) and water quality enhancement (M = 3.99) illustrate the material welfare connection between forest health and community livelihoods. This finding affirms the foundational rationale for CBNRM cited in the introduction: [2] states that community involvement enhances livelihoods through improved ecosystem provisioning, a relationship clearly reflected in respondents' agricultural productivity perceptions. The more moderate scores for climate stability (M = 3.66) suggest that while local ecosystem services are improving, communities remain exposed to broader climatic pressures that lie beyond the scope of local conservation management. [33] emphasizes that protecting natural ecosystems enhances essential services including clean water, soil fertility, climate regulation, and agricultural productivity, confirming that the community-perceived improvements reported here are consistent with the ecological mechanisms underpinning ecosystem services delivery.

4.10 Resilience of Local Communities

Community resilience received the lowest overall mean among NRM outcome variables (3.97), though still reflecting positive agreement. The strong food security and well-being mean (M = 4.38) and social unity score (M = 4.08) indicate that CBNRM at Sapo has successfully reinforced the social safety nets and nutritional foundations of community resilience. However, the more moderate scores for economic shock absorption (M = 3.66) and optimism about the future (M = 3.57) highlight a persistent vulnerability. This finding resonates with the structural challenges facing the broader ECOWAS region, where [8] notes that natural resource depletion and limited economic diversification leave communities highly exposed to environmental and market shocks. [34] argues that while community-based conservation effectively builds social capital and food security, long-term resilience of protected area communities requires integration of innovative economic buffers and climate-smart agricultural transitions. The evidence from Sapo suggests that while conservation strategies have strengthened immediate welfare outcomes, a deliberate transition toward economically diversified livelihoods is essential for comprehensive resilience, particularly in the face of potential external funding fluctuations from supporting NGOs [22].

4.11 Community-Based Approaches and NRM Outcomes: Regression Findings

The regression analysis results provide the strongest quantitative evidence for the study's central argument. The high R value of 0.799 and R^2 of 0.638 confirm that community-based approaches are powerful and reliable predictors of NRM success at Sapo National Park, accounting for 63.8% of the variance in conservation outcomes. This substantial predictive power directly substantiates the evidence presented in the introduction: [2] demonstrated that community involvement produces improved conservation outcomes, and [3] documented that CBNRM models at Nepal and Brazil's protected areas yield higher ecological and social returns. The findings from Sapo now provide a quantified, context-specific contribution to this global body of evidence.

The emergence of capacity building as the strongest individual predictor ($B = 0.713$, $p < 0.001$) has significant policy implications. It indicates that technical empowerment is the most effective lever for improving NRM effectiveness, surpassing even participation and tenure security in its individual effect. This aligns with the UK experience cited in the introduction, where [5] demonstrated that sustained technical support enabled community-led conservation to restore over 13,000 hectares of degraded land. The strong influence of local governance structures ($B = 0.601$, $p < 0.001$) further confirms that institutional accountability and adaptive leadership are non-negotiable foundations of effective conservation management, consistent with [3] findings from globally recognized CBNRM models. The significance of all five community-based approach variables ($p < 0.05$) confirms that CBNRM effectiveness at Sapo is truly multi-dimensional, requiring simultaneous strengthening of participation, tenure, benefits, capacity, and governance rather than isolated interventions [35].

5.0 Conclusion and Recommendations

5.1 Conclusion

This study demonstrated that community-based approaches have a transformative and statistically significant impact on natural resource management at Sapo National Park, Sinoe County, Liberia. The integration of inclusive participation, secure resource tenure, transparent benefit-sharing, robust capacity building, and accountable local governance has fostered a foundation of trust and social cohesion that directly contributes to perceived biodiversity recovery, reduced illegal exploitation, and improved ecosystem services between 2020 and 2024.

While the findings are largely positive, the study identified important areas for strengthening the model. The persistence of illegal mining pressures despite strong community vigilance confirms that enforcement alone cannot address the deep structural drivers of resource exploitation. Furthermore, transitioning from traditional tenure recognition to legally formalized agreements and from participation in meetings to genuine decision-making authority are necessary steps toward a fully empowered, self-sustaining CBNRM model. Ultimately, the findings confirm that empowering local stakeholders through structured governance and sustained technical empowerment represents the most effective pathway for reconciling human development needs with the long-term conservation of Liberia's biodiversity heritage.

5.2 Recommendations

The following recommendations were made:

1. There is need to strengthen formal recognition of community resource rights to bridge the gap between traditional acknowledgement and legal protection. Sapo National Park authorities and the Liberia Forestry Development Authority should prioritize the documentation and legal formalization of community tenure agreements through legally binding community protocols that clearly define access boundaries and usage rights, thereby reducing ambiguity and preventing future land conflicts.

2. Enhance technical training for independent resource management with capacity-building efforts are currently more focused on immediate problem-solving than long-term technical self-sufficiency. It is recommended that comprehensive, long-term technical training curricula be developed in partnership with universities, NGOs, and park authorities to progressively transition communities from externally supported participants to self-sufficient NRM managers, particularly in sustainable forestry, agroforestry, and wildlife monitoring.

3. Improve inclusiveness of local governance structures with certain demographic groups, particularly women, youth, and marginalized households, feel their interests are not fully captured in community management committees. A comprehensive review of committee composition and selection procedures, including quota systems and inclusive election mechanisms, should be conducted to ensure all demographic groups are equitably represented in conservation decision-making.

4. Develop alternative livelihood programs to address illegal mining in the park management. NGOs, and government agencies should invest in structured alternative income programs, such as sustainable cocoa farming cooperatives, eco-tourism initiatives, and NTFP value chains, that provide economically viable options for communities currently engaging in or at risk of engaging in illegal resource extraction.

Declarations

Ethics approval and consent to participate

This study was conducted as part of a Master of Science in Environmental and Development Studies thesis at the University of Lay Adventists of Kigali (UNILAK), Rwanda. The research proposal underwent academic review and approval through the University's supervisory and thesis defense processes. Permission to conduct the study and collect data was granted by the management of Sapo National Park, Liberia.

Consent for publication

Not applicable. This study did not include individual personal data, pictures or identifying

Competing interests

The authors declare that they have no competing interests.

Funding Declaration

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Author Contribution

PF and CM conceptualized the study, conducted data collection, and drafted the manuscript. IJ and NJ performed data analysis, contributed to data interpretation, and critically reviewed the manuscript. All authors reviewed the final manuscript.

Availability of data and materials

The datasets used and or analyzed during the current study are available from the corresponding author on reasonable request.

information of participants.

Participation in the study was voluntary. All participants were informed of the purpose of the research, assured of confidentiality and anonymity, and informed consent was obtained from all respondents before their participation.

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Figures

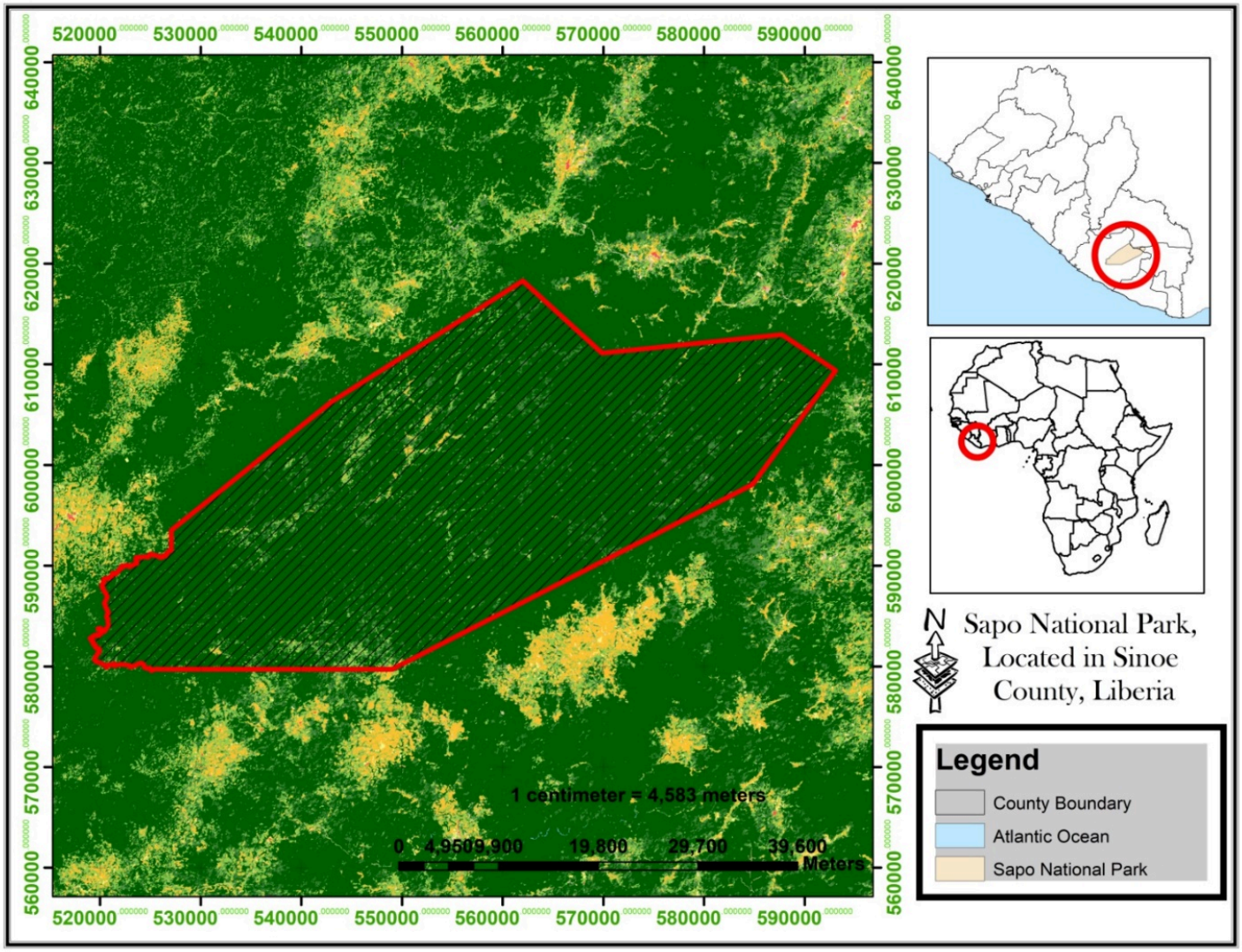


Figure 1

Map of Sapo National Park, Sinoe County, Liberia. Source: Authors, 2026

Supplementary Files

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- PrinceSupplementaryFile1.pdf