





| Research Article

Resource Potential of the Mangrove Forest Ecosystem for Ecotourism Development in Pasar Rawa Village, Gebang District, Langkat Regency

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Abstract: Mangrove ecosystems provide essential ecological functions in coastal areas, including shoreline protection, biodiversity support, and opportunities for sustainable tourism development. Pasar Rawa Village in Gebang District, Langkat Regency, North Sumatra, has mangrove resources that can be developed as an ecotourism destination. However, the utilization of these resources requires an assessment of ecological suitability, environmental capacity, and community support to ensure sustainable management. This study aims to identify the potential resources of the mangrove ecosystem, evaluate ecological suitability for ecotourism development, analyze tourism carrying capacity, and examine community perceptions toward mangrove ecotourism in the study area. This research employed a descriptive method using qualitative and quantitative approaches. Data were collected through field observations, vegetation measurements, and interviews with local residents and visitors. Purposive sampling was used to determine observation stations based on variations in mangrove conditions such as vegetation density, substrate type, and accessibility. Data analysis included mangrove vegetation density analysis, ecological suitability index assessment, carrying capacity calculations, and descriptive analysis of community perceptions. The results show that the mangrove ecosystem in the study area consists of five dominant species: *Rhizophora* spp., *Avicennia* spp., *Bruguiera gymnorhiza*, *Sonneratia alba*, and *Apiculata* spp., with vegetation density ranging from 12 to 22 individuals per 100 m². Ecological suitability analysis indicates that two locations are highly suitable, three locations are conditionally suitable, and one location is unsuitable for ecotourism development. Community responses show positive support for mangrove ecotourism development, indicating strong potential for sustainable ecotourism in Pasar Rawa Village.

Keywords: Mangrove Ecosystem; Ecotourism; Ecological Suitability; Carrying Capacity; Coast.

1. INTRODUCTION

Mangrove ecosystems are among the most important coastal ecosystems worldwide because they provide a range of ecological, environmental, and socio-economic benefits. Globally, mangroves play a crucial role in protecting coastal areas from erosion, storms, and tidal waves, while also contributing to climate change mitigation by storing large amounts of carbon (Fudjaja et al., 2020). In addition, mangrove ecosystems support high biodiversity and serve as habitats for numerous marine organisms that depend on coastal environments for survival. Mangrove ecosystems also provide significant ecological functions that support the productivity of coastal waters (Kumar et al., 2021). They serve as feeding, nursery, and spawning grounds for various marine

organisms, including fish, crustaceans, and mollusks. Mangrove vegetation also helps improve water quality by trapping sediments and filtering pollutants, while producing organic matter that becomes an important nutrient source for coastal food chains (Gephart et al., 2021). These ecological functions make mangrove ecosystems essential components of coastal environmental sustainability.

In addition to ecological benefits, mangroves also provide economic benefits for coastal communities. Mangrove resources are often utilized for fisheries, aquaculture, and the collection of various forest products (Delgado-Lemus & Moreno-Calles, 2022). Furthermore, mangrove areas have the potential to be developed as nature-based tourism destinations. Tourism activities in mangrove areas can create new economic opportunities for local communities through services such as culinary businesses, tour guiding, fishing tourism, and other tourism-related activities (Yusoff et al., 2024; Riera-Spiegelhalder et al., 2023). Despite their importance, mangrove ecosystems in many coastal regions continue to face serious threats due to human activities. Land conversion, excessive resource exploitation, and coastal development often lead to the degradation of mangrove ecosystems. Poor management practices may result in the decline of mangrove quality and coverage. Therefore, sustainable management strategies, including mangrove rehabilitation and conservation-based utilization, are necessary to maintain the ecological integrity of mangrove forests (Ranjan et al., 2023).

One approach that integrates environmental conservation with economic development is ecotourism. Ecotourism is a form of tourism that emphasizes environmental conservation, community participation, and sustainable use of natural resources (Oliveira et al., 2022). Through ecotourism, natural ecosystems such as mangrove forests can be utilized as tourism attractions while maintaining ecological sustainability and improving the welfare of local communities (Deeks et al., 2024; Seddon et al., 2020). The development of mangrove ecotourism must consider several important aspects, including the potential of natural resources, ecological suitability, and environmental carrying capacity. The carrying capacity of a tourism area determines the maximum number of visitors that can be accommodated without causing environmental degradation. Therefore, analyzing ecological suitability and carrying capacity is essential in planning sustainable ecotourism activities within mangrove ecosystems (Kwong et al., 2022; Scheyvens & van der Watt, 2021).

In North Sumatra Province, efforts to conserve and rehabilitate mangrove ecosystems have been carried out by the government, non-governmental organizations, universities, and local communities. Mangrove planting programs implemented in several coastal areas have increased the extent of mangrove forests and opened opportunities for sustainable tourism development (Utomo & Pulungan, 2023). Pasar Rawa Village in Gebang District, Langkat Regency, is one of the coastal areas that has considerable mangrove resources. The mangrove ecosystem in this area covers approximately 178 hectares (Kalsum et al., 2024). Local communities utilize mangrove resources for various economic activities, including fishing, crab catching, shrimp harvesting, and small-scale culinary businesses. In addition, the presence of an active harbor and extensive mangrove forests creates opportunities to develop marine tourism activities, such as fishing tourism, floating culinary attractions, and mangrove ecotourism (Fitri et al., 2024).

Several previous studies have examined the use of mangrove ecosystems for ecotourism development, considering ecological suitability and environmental carrying capacity. A study conducted by Zulfikar & Lestari (2024) in the mangrove area of Kampung Bagan, Batam, showed that tourism suitability index analysis and carrying capacity calculations are essential to determine the appropriate number of visitors that can be accommodated without damaging the mangrove ecosystem. Another study Mandiangan et al. (2024) in Talengen Bay, North Sulawesi, revealed that mangrove ecosystems have strong potential for ecotourism development when ecological suitability and carrying capacity are properly assessed. The study indicated that the area could sustainably accommodate around 105 visitors per day.

However, studies that comprehensively analyze mangrove resource potential, ecological suitability, environmental carrying capacity, and community perceptions in Pasar Rawa Village are still limited. Therefore, further research is needed to evaluate the potential of the mangrove ecosystem as a basis for sustainable ecotourism development in the area. Based on these conditions, this study aims to identify the resource potential of the mangrove ecosystem in Pasar Rawa Village, evaluate its ecological suitability for ecotourism development, analyze the tourism carrying capacity of the mangrove area, and examine community perceptions regarding mangrove ecotourism development. The results of this study are expected to contribute to sustainable mangrove management while supporting economic opportunities for local communities.

2. RESEARCH METHODS

Research Location

Langkat Regency is one of the administrative regions in North Sumatra Province, Indonesia, covering approximately 6,263.29 km² (626,329 hectares). The regency consists of 23 districts, 240 villages, and 37 urban villages. This research was conducted in the mangrove forest area located in Pasar Rawa Village, Gebang District, Langkat Regency, North Sumatra Province. The study site was selected due to its considerable potential for mangrove-based ecotourism development.

Population and Sample

The study population comprises the entire mangrove ecosystem in Pasar Rawa Village, Gebang District, covering approximately 178 hectares. The sample size was determined by the number of observation plots required for the study. Sampling was conducted using purposive sampling, which involves intentionally selecting samples based on specific criteria. The criteria considered include variations in mangrove ecosystem conditions such as vegetation density, substrate type, and site accessibility. This approach ensures that the selected plots represent the diversity of environmental characteristics across the mangrove area. Observation plots were selected based on several physical factors that facilitate effective field measurements. In this process, maps were used as references to identify representative mangrove areas that were also readily accessible for sampling.

Data Collection Techniques

Data collection in this study was carried out using the following techniques:

- 1) Observations were conducted using observation sheets to collect primary data on mangrove species and associated biota present within the ecosystem. The collected data were recorded directly in observation sheets and used as measurement plots.
- 2) Measurement techniques were used to collect primary data on vegetation density in the mangrove ecosystem.
- 3) Interviews were conducted with local community members and visitors. Questions for local residents focused on their perceptions of mangrove ecotourism, community activities related to mangrove resource use, and respondent characteristics, including age, education level, and occupation. For visitors, questions addressed their perceptions of mangrove ecotourism facilities and environmental conditions, the tourism activities undertaken during visits, and respondent characteristics, including age, education level, and occupation.
- 4) Documentation was conducted to systematically record the mangrove ecosystem's ecotourism potential. This process aimed to identify and document resource potential, tourism carrying capacity, ecological suitability, and community perceptions regarding mangrove ecotourism development.

Data Analysis Techniques

This study employed descriptive, qualitative, and quantitative analysis. The collected data were analyzed systematically to allow interpretation and conclusion drawing.

- 1) Mangrove ecosystem resource potential

The collected data comprised species types, associated biota, and individual counts. Sampling measurements were processed to determine the density of each species and the total density.

- a. Density, calculated as the number of individuals per unit area using the following formula:

$$K = \frac{\text{Total number of individuals of species } i}{\text{Total area of observation plots}}$$

- b. Total Density represents the total number of mangrove individuals within a specific area:

$$KR_i = \frac{\text{Total number of individuals of species } i}{\text{Total area of observation plots}}$$

Table 1. Mangrove Density Categories

No	Criteria	Density
1	Good	>15–25
2	Moderately Good	>10–15
3	Moderately Poor	5–10
4	Poor	<5

(Source: Data Analysis Results, 2025)

2) Ecological suitability analysis

The ecological suitability for mangrove tourism was calculated using the following formula:

$$IKW = \frac{\sum Ni}{N_{max}} \times 100\%$$

Description:

IKW = Mangrove Tourism Suitability Index

Ni = Parameter value (Weight × Score)

Nmax = Maximum value of mangrove tourism suitability category (39)

Suitability categories are classified as follows:

- Highly Suitable: 83–100%
- Conditionally Suitable: 50–<83%
- Not Suitable: <50%

3) Mangrove carrying capacity analysis

The carrying capacity analysis was conducted using the Tourism Area Carrying Capacity (DDK) concept. Carrying capacity refers to the maximum number of visitors that can be accommodated within an area without causing environmental degradation or reducing visitor satisfaction. The formula used to calculate carrying capacity is:

$$DDK = \frac{K \times Lp}{Lt} \times \frac{Wt}{Wp}$$

Description:

DDK = Area Carrying Capacity (persons/day)

K = Ecological potential of visitors per unit area (constant = 1)

Lp = Length of area that can be utilized (m)

Lt = Unit area for specific category (constant = 50 m/person)

Wt = Total time available for tourism activities in one day (hours/day)

Wp = Average time spent by visitors for a specific activity (hours/day)

3. RESULTS AND DISCUSSION

a. Mangrove Ecosystem Resource Potential for Ecotourism Development in Pasar Rawa Village

The mangrove ecosystem in Pasar Rawa Village, Gebang District, Langkat Regency, possesses considerable natural resource potential to support the development of sustainable mangrove-based ecotourism. This potential can be identified through the diversity of mangrove species, vegetation density, and the presence of associated biota within the ecosystem. These ecological resources play an important role in maintaining coastal environmental balance while also providing opportunities for ecotourism activities that can improve the local economy.

1) Mangrove Species Composition

Field observations at six stations identified five main mangrove species across the study area. The composition and distribution of mangrove species are presented in Table 2.

Table 2. Mangrove Species Composition in the Study Area

No	Species	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
1	<i>Rhizophora</i> spp.	√	√	√	√	-	-
2	<i>Apiculata</i> spp.	-	√	√	√	-	√
3	<i>Avicennia</i> spp.	√	√	√	√	√	-
4	<i>Bruguiera gymnorhiza</i>	√	√	√	-	√	-
5	<i>Sonneratia alba</i>	-	-	-	-	√	√

(Source: Data Analysis Results, 2025)

Table 2 shows that *Rhizophora* spp. and *Avicennia* spp. are the dominant mangrove species in the study area, with a relatively wide distribution across several observation stations. These species are known for their high adaptability to coastal environmental conditions, particularly in muddy substrates rich in organic matter. Meanwhile, *Sonneratia alba* was found at only a limited number of stations, indicating a more restricted distribution than other species. The distribution pattern of mangrove vegetation forms a natural zonation from the coastal waters toward the inland areas. The seaward zone is generally dominated by *Avicennia* spp., which typically grows in muddy substrates with high organic content. This zonation pattern is influenced by environmental factors such as tidal inundation, salinity levels, wave action, substrate characteristics, and interactions between biotic and abiotic components. According to Nining Kustanti, mangrove zonation is strongly influenced by environmental gradients, including tidal dynamics, soil conditions, and hydrological processes within coastal ecosystems.

2) Mangrove Vegetation Density

In addition to species composition, the ecological condition of the mangrove ecosystem can also be evaluated through vegetation density. The results of field observations indicate that mangrove density varies among observation plots.

Table 3. Mangrove Density in Each Observation Plot

Plot	Total Density (ind/100 m ²)	Mangrove Species
1	22	<i>Rhizophora</i> spp., <i>Avicennia</i> spp., <i>Bruguiera gymnorhiza</i>
2	16	<i>Apiculata</i> spp., <i>Bruguiera gymnorhiza</i>
3	14	<i>Rhizophora</i> spp., <i>Bruguiera gymnorhiza</i>
4	14	<i>Rhizophora</i> spp., <i>Avicennia</i> spp.
5	16	<i>Avicennia</i> spp., <i>Bruguiera gymnorhiza</i> , <i>Sonneratia alba</i>
6	12	<i>Apiculata</i> spp., <i>Avicennia</i> spp., <i>Sonneratia alba</i>

(Source: Data Analysis Results, 2025)

Based on Table 3, the highest mangrove density was recorded in observation plot 1 with a value of 22 individuals per 100 m², while the lowest density was found in plot 6 with 12 individuals per 100 m². Overall, the density values indicate that the mangrove ecosystem in the study area remains in relatively good ecological condition and can support various ecological functions in coastal environments. Differences in vegetation density among observation plots are influenced by several environmental factors, including tidal flooding patterns, substrate type, salinity levels, and water depth. Each mangrove species has specific ecological requirements that determine its growth and distribution within the ecosystem.

In addition to vegetation resources, the mangrove ecosystem in Pasar Rawa Village also supports diverse fauna. The ecosystem provides habitat for various species, including mangrove crabs, fish, shrimp, birds, and other coastal wildlife. The presence of these species increases the area's ecological value and can serve as an additional attraction for ecotourism activities such as birdwatching, nature photography, and recreational fishing.

The findings of this study are consistent with previous research conducted [Manullang et al. \(2024\)](#) by others, which reported that mangrove ecosystems in the coastal areas of Langkat Regency have significant biodiversity and ecological functions that support their development as ecotourism destinations. Similar results were also reported by [Kodariawan et al. \(2025\)](#), who emphasized that community participation and the presence of well-preserved mangrove vegetation are essential factors in the successful development of mangrove-based ecotourism. The diversity of mangrove species, relatively high vegetation density, and the presence of associated fauna indicate that the mangrove ecosystem in Pasar Rawa Village has strong ecological potential for development as a sustainable ecotourism area. Proper management and community involvement will be essential to ensure environmental conservation while maximizing the socio-economic benefits for local communities.

b. Ecological Suitability and Carrying Capacity for Mangrove Ecotourism Development

Ecotourism development in mangrove ecosystems must consider ecological suitability and the area's carrying capacity to ensure that tourism activities do not undermine environmental sustainability. The assessment of ecological suitability is essential to determine whether a particular area can support tourism activities without causing ecological degradation. In this study, ecological suitability was assessed using several environmental parameters, including mangrove thickness, density, species diversity, tidal conditions, and the presence of associated biota.

1) Ecological Suitability for Mangrove Ecotourism

The ecological suitability analysis conducted at six observation locations in the mangrove ecosystem of Pasar Rawa Village shows varying levels of suitability for ecotourism development. The results of this analysis are presented in Table 4.

Table 4. Ecological Suitability for Mangrove Ecotourism Development

Observation Location	Total Score	Suitability Index (%)	Suitability Category
1	29	74.4	Conditionally Suitable (SB)
2	34	87.2	Highly Suitable (S1)
3	30	76.92	Conditionally Suitable (SB)
4	36	92.31	Highly Suitable (S1)
5	30	76.92	Conditionally Suitable (SB)
6	9	23.07	Not Suitable (TS)

(Source: Data Analysis Results, 2025)

Table 4 indicates that two locations (Stations 2 and 4) fall into the highly suitable (S1) category, meaning that the environmental conditions strongly support the development of mangrove ecotourism activities. Three locations (Stations 1, 3, and 5) are categorized as conditionally suitable (SB), indicating that the areas have potential for ecotourism development but require management improvements or ecological restoration before tourism activities can be fully implemented. Meanwhile, Station 6 is categorized as not suitable (TS) due to limiting environmental factors. The conditional suitability in several locations is mainly influenced by mangrove thickness and environmental characteristics that do not fully meet the optimal criteria for ecotourism development.

According to [Titisari et al. \(2022\)](#), mangrove ecosystems suitable for ecotourism development should ideally have sufficient mangrove thickness, good vegetation density, high biodiversity, and stable tidal conditions that allow tourism activities to be conducted safely and sustainably. In locations categorized as conditionally suitable, mangrove thickness was generally less than 500 meters, reducing the ecosystem's ecological value and attractiveness for tourism activities. Therefore, conservation and rehabilitation efforts are necessary to improve environmental quality and ensure that tourism development does not compromise ecosystem stability.

2) Carrying Capacity of the Mangrove Ecotourism Area

Another important aspect in ecotourism development is the carrying capacity of the tourism area. Carrying capacity refers to the maximum number of visitors that can be accommodated within a tourism area without causing environmental degradation or reducing visitor satisfaction. The carrying capacity analysis in this study considered both water-based and land-based ecotourism activities. The results of the carrying capacity analysis are presented in Table 5.

Table 5. Carrying Capacity of the Mangrove Ecotourism Area

No	Location	Proposed Track	Carrying Capacity (Persons/Day)
1	Water Area	1	44
2	Land Area	2–6 Tracks	208
Total			252

(Source: Data Analysis Results, 2025)

The results show that the water-based ecotourism track has a carrying capacity of 44 visitors per day, while the land-based ecotourism tracks can accommodate up to 208 visitors per day. In total, the mangrove ecotourism area in Pasar Rawa Village can support approximately 252 visitors per day without exceeding ecological limits. Water-based tourism activities generally involve exploring the mangrove ecosystem by boat along the river channels within the mangrove forest. These activities allow visitors to observe mangrove vegetation, wildlife, and the natural landscape of the coastal ecosystem. However, such activities must take tidal conditions into account, as some river sections become difficult to access during low tide. Therefore, appropriate infrastructure, such as small docks and safety equipment (e.g., life jackets), should be provided to ensure visitor safety.

Land-based ecotourism activities involve walking through the mangrove forest using boardwalks or tracking paths. These activities offer visitors opportunities to learn about mangrove species, observe wildlife, and understand the ecological importance of mangrove ecosystems. Visitors can also observe various species of fauna, such as birds, fish, crabs, shrimp, and other organisms that inhabit the mangrove environment. The concept of tourism carrying capacity was also emphasized by Yulianda, who stated that a tourism area's carrying capacity determines the maximum number of visitors it can accommodate without causing environmental damage. Proper management of visitor numbers is therefore essential to maintain ecological balance while ensuring sustainable tourism development.

Previous studies support the importance of ecological suitability and carrying capacity in the development of mangrove ecotourism. Research has [Opa et al. \(2021\)](#) found that ecological suitability analysis is essential for determining appropriate areas for mangrove ecotourism development, as it helps prevent environmental degradation caused by uncontrolled tourism activities. Similarly, a study conducted by [Skiniti et al. \(2024\)](#) showed that the carrying capacity approach can be used to regulate visitor numbers and ensure that tourism activities remain within sustainable ecological limits.

These findings reinforce the study's results, indicating that ecological suitability analysis and carrying capacity assessment are crucial components of planning sustainable mangrove ecotourism development. Proper environmental management and visitor control strategies are therefore necessary to maintain the ecological integrity of the mangrove ecosystem in Pasar Rawa Village. The results of the ecological suitability and carrying capacity analyses indicate that most parts of the mangrove ecosystem in Pasar Rawa Village have strong potential to support ecotourism development. Nevertheless, sustainable management strategies and environmental conservation efforts remain essential to ensure that tourism activities do not negatively affect the ecological integrity of the mangrove ecosystem.

c. Community Perception and Participation in Mangrove Ecotourism Development

Community perception and participation play a crucial role in the development of sustainable ecotourism. Local communities are directly connected to the mangrove ecosystem because their daily activities, livelihoods, and environmental interactions occur within the surrounding coastal area. Therefore, understanding community perceptions of mangrove ecosystems and ecotourism development is essential for effective and sustainable tourism management.

The results of the community survey in Pasar Rawa Village indicate that most respondents have a positive perception of the mangrove ecosystem's condition and benefits. The majority of respondents consider the current condition of mangroves to be relatively good and recognize their ecological functions, including coastal protection, habitat for marine organisms, and environmental balance. In addition, many community members understand that mangrove ecosystems can provide economic opportunities through tourism activities.

1) Community Perception of Mangrove Ecosystems

Community perceptions regarding the condition of mangrove ecosystems are presented in Table 6.

Table 6. Community Perception of Mangrove Ecosystem Conditions

No	Perception Category	Number of Respondents	Percentage (%)
1	Very Good	7	23.33
2	Good	17	56.67
3	Fair	5	16.67
4	Poor	1	3.33
Total		30	100

(Source: Data Analysis Results, 2025)

Based on Table 6, the majority of respondents (56.67%) perceive the mangrove ecosystem in Pasar Rawa Village to be in good condition, while 23.33% consider it very good. Only a small proportion of respondents perceive the mangrove ecosystem as being in poor condition. These results indicate that local communities are aware of the ecological importance of mangrove forests and recognize their role in maintaining coastal environmental stability.

2) Community Support for Ecotourism Development

Community support is also an important factor in the successful implementation of ecotourism development. The survey results show that most respondents support the development of mangrove ecotourism because it can create additional income opportunities and encourage environmental conservation.

Table 7. Community Support for Mangrove Ecotourism Development

No	Response	Number of Respondents	Percentage (%)
1	Support	22	73.33
2	Moderately Support	6	20.00
3	Do Not Support	2	6.67

(Source: Data Analysis Results, 2025)

Table 7 shows that 73.33% of respondents support the development of mangrove ecotourism in Pasar Rawa Village. Community members believe that tourism development can improve economic conditions by creating employment opportunities, supporting small businesses, and providing tourism-related services such as guiding, food stalls, and boat rentals. However, several respondents also expressed concerns about environmental threats, such as illegal logging, coastal pollution, and land conversion, that could damage the mangrove ecosystem. These challenges highlight the need for effective management strategies and stronger environmental protection measures.

Previous studies have also emphasized the importance of community involvement in ecotourism development. Research conducted by [Jadin & Rousseau \(2022\)](#) shows that community participation is a key factor in the sustainability of mangrove ecotourism, as local residents actively participate in conservation and tourism management. Similarly, a study [Maulidah et al. \(2023\)](#) found that positive community perceptions toward mangrove ecosystems can encourage conservation awareness and support sustainable tourism development. These findings reinforce the study's results, indicating that the successful development of mangrove ecotourism in Pasar Rawa Village requires strong collaboration among local communities, government institutions, and tourism stakeholders. Community participation in conservation activities, tourism

management, and environmental monitoring will be essential to ensure the long-term sustainability of the mangrove ecosystem.

4. CONCLUSION

Based on the research results, the mangrove ecosystem in Pasar Rawa Village, Gebang District, shows considerable potential for ecotourism development. Five main mangrove species were identified, namely *Rhizophora spp.*, *Apiculata spp.*, *Avicennia spp.*, *Bruguiera gymnorhiza*, and *Sonneratia alba*, with vegetation density ranging from 12–22 individuals per 100 m² and a total density of 94 individuals per 100 m². Ecological suitability analysis across six observation stations indicates varying levels of suitability, with two locations classified as highly suitable, three as conditionally suitable, and one as unsuitable for ecotourism development. The majority of local communities perceive the current condition of the mangroves as relatively good and recognize their ecological and economic importance. Community understanding of mangrove flora and fauna is also fairly adequate, and most respondents support the development of mangrove ecotourism because of its potential to improve local livelihoods. However, challenges such as illegal logging, environmental pollution, and land-use changes remain concerns. The mangrove ecosystem in Pasar Rawa Village has strong potential to support sustainable ecotourism development with proper management, conservation efforts, and community participation.

Based on the findings, several recommendations can be proposed to support the sustainable development of mangrove ecotourism in Pasar Rawa Village. Continuous conservation efforts, such as mangrove replanting, monitoring of illegal logging, and pollution control, are necessary to maintain ecosystem sustainability. Ecotourism development should actively involve local communities in tourism management, guiding services, and the production of mangrove-based products so that economic benefits can be directly received by residents. Improvements in tourism facilities and environmentally friendly infrastructure, including better trail markings and educational information boards, are also needed to enhance the visitor experience while protecting the ecosystem. In addition, environmental education and awareness programs should be strengthened through community outreach and educational tourism activities to promote collective responsibility for mangrove conservation. Finally, stronger monitoring and supervision systems involving community participation are essential to reduce environmental threats and ensure the long-term sustainability of the mangrove ecosystem and ecotourism activities.

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