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Study of The Suitability of Tourism in the Lubuk Kertang Mangrove Forest Area, Langkat District, North Sumatra

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Abstract

Mangrove forests serve as a natural barrier against storm surges, tsunamis and coastal erosion. Their complex root systems dissipate wave energy, protecting coastal areas from the effects of severe weather. This article serves to evaluate the tourism potential of the Lubuk Kertang mangrove area, highlight its ecological and community significance, identify challenges, and propose sustainable management strategies to enhance ecotourism opportunities. Mangrove observation using the transectional square methodology was used to assess mangrove density. It involves establishing transect squares consisting of 20 units, each measuring 10 x 10 meters, starting from the coastal area and extending inland. The study found that the mangrove area consisted mainly of Avicennia marina, with a density of 1860 individuals per hectare (18.6 individuals per 100 m²). The tourism suitability index results for the Lubuk Kertang mangrove forest area were very high at 87.5%, categorizing it as "very suitable" for ecotourism development. This indicates a strong potential to attract tourists and promote sustainable tourism practices in the region.

Keywords: *Agritourism, Langkat, Mangrove Ecosystem, North Sumatra*

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INTRODUCTION

Mangrove forests are vital coastal ecosystems that provide many ecological, economic, and protective benefits. They act as natural barriers against storm surges, tsunamis, and coastal erosion, effectively dissipating wave energy through their complex root systems (Cuenca-Ocay, 2024; Weaver & Stehno, 2024). In addition, mangrove forests serve as a significant carbon sink, trapping carbon-rich particles and contributing to climate change mitigation (Cuenca-Ocay, 2024). Their rich biodiversity supports a variety of species, including protected fish, crabs, and mammals, which depend on mangroves for habitat and breeding grounds (Hamzah et al., 2023). In addition, these ecosystems improve water quality by filtering pollutants and stabilizing sediments (Weaver & Stehno, 2024). The degradation of mangrove areas, mainly due to anthropogenic activities such as aquaculture and urban development, poses a significant threat to their ecological functions and the communities that depend on them (Hamzah et al., 2023). Despite their importance, the continued loss of mangroves raises concerns about biodiversity and coastal resilience, highlighting the need for sustainable management practices to protect these critical ecosystems.

Mangrove areas, particularly in Kertang, have significant potential for nature tourism, fuelled by rich biodiversity and community engagement. Studies show that mangrove forests can serve as ecotourism sites, offering unique flora and fauna experiences while promoting environmental conservation. For example, the Bakau Mas ecotourism area in Lubuk Kertang has been evaluated for its recreational and socioeconomic value, revealing an economic potential of IDR 55,002,604.00/year (USD 3,929) (Murni et al., 2023). Furthermore, community involvement in mangrove planting increases the prospects for ecotourism, as seen in Sorong City, where local participation fosters environmental awareness and supports small businesses (Ambarita et al., 2005). In addition, the diversity of species found in mangrove ecosystems in the lubuk kertang area , such as 14 tree species and a variety of birds and mammals, contribute to their attractiveness as tourism destinations (Kissinger et al., 2020). Overall, the integration of ecological and socio-cultural aspects is crucial to developing sustainable tourism in the Kertang mangrove area.

However, challenges such as limited access and infrastructure must be addressed to fully realize the tourism potential of the region, ensuring that both environmental and community needs are met. The Lubung Kertang mangrove area presents significant potential for nature tourism, particularly due to its rich biodiversity and community involvement in ecotourism. Studies show that Lubuk Kertang's mangrove ecosystem can accommodate 36 visitors daily, underscoring the ecological importance and community perception of mangrove conservation (Prihadi et al., 2024). Bakau Mas Ecotourism Area exemplifies effective landscape planning, generating an estimated IDR 55 million per year (Bunga, 2024). A SWOT analysis highlighted strengths such as high biodiversity and opportunities for sustainable tourism development (Sari et al., 2023). Conversely, while the prospects for mangrove tourism are promising, inadequate government support and infrastructure development may hinder growth, requiring strategic planning and investment in the region (Prasadi et al., 2023). This study aims to provide a detailed evaluation of the ecotourism potential of Lubuk Kertang mangrove area, focusing on ecological significance, community involvement, challenges, and sustainable management strategies.

METHOD

Time and Place

This study was conducted between July until October 2023 in Lubuk Kertang Village, Langkat Regency, North Sumatra (Figure 1). A large amount of data was collected in this investigation, including mangrove thickness, mangrove density, biotic diversity, and seawater fluctuations. Mangrove forest identification was conducted regarding the Handbook of Introduction to Mangroves in Indonesia (Noor et al., 2006). Mangrove density assessment was conducted using the transect square method; a transect square was formed consisting of 20 units with dimensions of 10 x 10 meters (Figure 2), with the transect position starting from the coastal area and extending towards the inland area (Hasan et al., 2024). Mangrove thickness measurements were made by calculating the distance from the shoreline to the Terres.

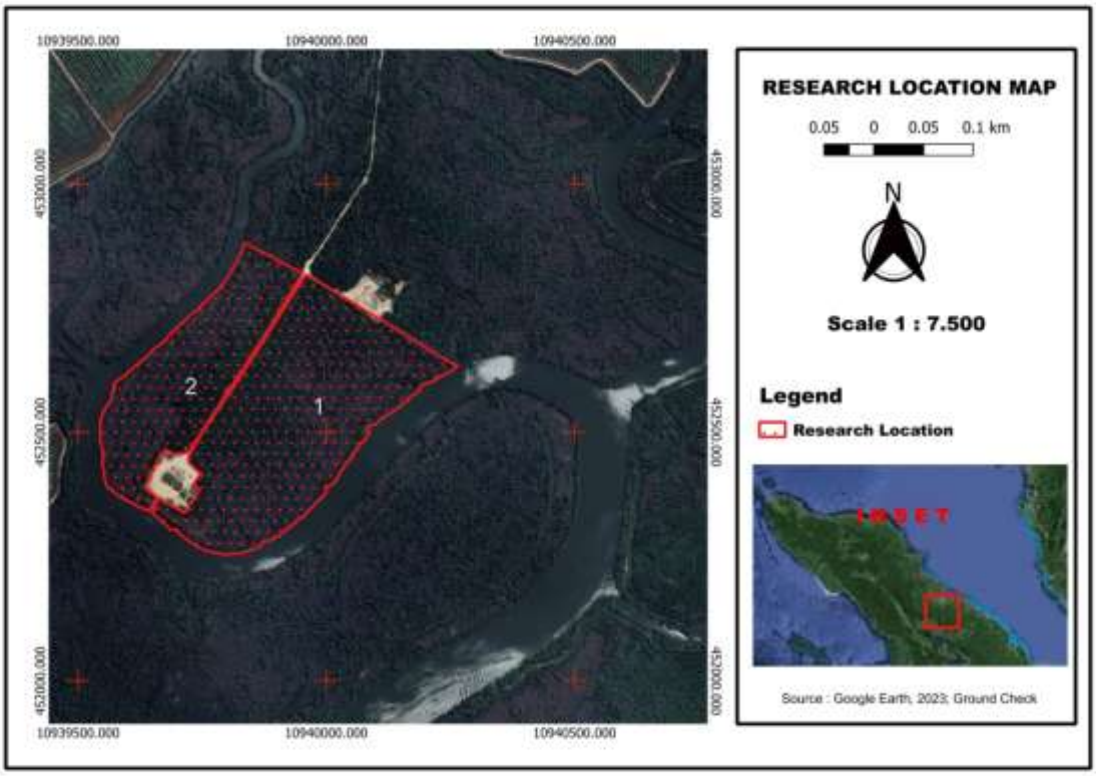

Figure 1. Map of Research Location

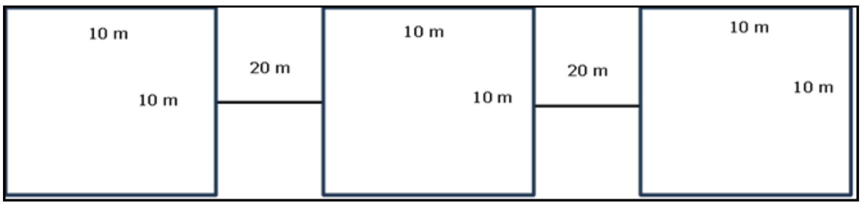

Figure 2. illustration of the quadrat transect method

Data Analysis

Assessment of the level of suitability of mangrove areas is done by using a matrix of the suitability of the area for the mangrove tourism beach category. The assessment is based on the weighting and the value indicated by the magnitude of the score, which is then done by combining several variables of the difference in value between classes to determine the classification of the suitability of mangrove areas in Lubuk Kertang Village, Langkat Regency. The table 1 is refers to Yulianda (2007).

Tabel 1. Mangrove tourism suitability matrix

Parameter	Bobot	Category	Skor
		>500	4
Mangrove		>200-500	3
thickness (m)	0.380	50-200	2
		<50	1
		>15-20	4
Mangrove density		>10-15; >20	3
(100m^2)	0.250	10-15	2
		<5	1
		>5	4
Mangrove species		3-5	3
	0.150	2-1	2
		0	1
		0-1	4
Tidal (m)		>1-2	3
	0.120	>2-5	2
		>5	1
Biota objects	0.100	Fish, shrimp, crabs, mollusks, reptiles, birds and typical/endemic/rare animals	4
		Fish, shrimp, crabs, mollusks	3
		Fish, mollusks	2
		One of the aquatic biota	1

This section describes the sample of participants in the study. The author can also explain how the sample was involved and ethical statements about the recruitment of participants. For the field of scientific research, the author can write research materials and how a complete description of the material is obtained. General tools and materials do not need to be written down. macrozobenthes sampling technique using hand sorting method and identification using compendium of seashclls book Abbott & Dance (2000). Fish observations were made by observing fish - fish caught by traditional fishermen operating around the lubuk kertang mangrove forest. identification using the Marbel fish of Indonesia book White et al., (2013).

Mangrove Density

Mangrove density was calculated using the formula by English et al., (1997):

$$Di = \frac{Ni}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where :
Di= density of the i-th species;

Ni= total number of individuals of the i-th speciestrial area where mangroves remain;
A= total sampling area

The ecotourism suitability index was calculated using the formula (Yulianda, 2007):

$$IKW = \sum \left[\frac{N_i}{N_{Max}}\right] x\ 100\ \% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ldots\ldots \quad (2)$$

Where :
IKW = Tourism Suitability Index
N_i = The value of the i-th parameter (Weight x Score)
N_{max} = Maximum score (4)

The value of the tourism suitability index obtained is then adjusted to the following (Yulianda, 2007) categories :
S1 = Very Suitable, with IKW > 75-100%
S2 = Suitable, with IKW> 50-75%
S3 = Conditionally Suitable, with a value of > 25-50%
N = Not Suitable, with a score > 25

RESULT AND DISCUSSION

Mangrove Thickness

The results of mangrove thickness measurements in the Lubuk Kertang village area show that the thickness of mangroves is around 201.3 meters. Mangrove thickness measurements in Indonesia reveal significant variability across different regions and conditions. For example, in the Eti area, Piru Bay, the average mud thickness was recorded as 43 cm in the front, 31 cm in the middle, and 29 cm in the back (Badu et al., 2022). In contrast, a study in North Buton showed a mangrove thickness of 65.61 m, which plays an important role in wave energy attenuation (Yanti et al., 2022).

Mangrove Species Density

Based on observations, the study site only contained *Avicenia marina* with a density of 1860 ind/Ha (18.6 ind/100 m^2). A study in Moramo Bay showed an excellent increase in density class from 627.74 hectares in 2014 to 727.50 hectares in 2020, emphasizing the need for community involvement in conservation efforts (Gandri et al., 2023). In the Segara Anakan Lagoon, sedimentation levels significantly affected mangrove density and distribution, with more than 85% of the area being muddy, affecting ecological dynamics (Cahyo et al., 2024).

Tides

Tidal data was obtained from the Hydro-Oceanographic Center (PUSHIDROSAL) of the Indonesian Navy. The highest tide occurred in September 2024 with a height of 2.05 meters and the lowest tide was 0.35 meters. Meanwhile, the average tidal height during the study was 1.66 m.

Table 2. Average tidal range in Lubuk Kertang Village, North Sumatra, during the study

Month	Hight Tides (HT)	Low Tides (LT)	HT-LT
July	2.00	0.37	1.63
Augustus	2.03	0.38	1.65
September	2.05	0.35	1.70
October	2.03	0.39	1.64
Average			1.66

Tidal events in different regions of the Earth's surface exhibit significant non-uniformity, mainly influenced by variations in the gravitational forces exerted by the Moon and Sun, as well as the unique geological and hydrological characteristics of each area. Research shows that gravitational pull produces tidal stresses that vary with depth and location, affecting seismic activity differently across regions (Varga & Grafarend, 2017). Mangrove ecosystems exhibit complex responses to changes in tidal patterns, significantly affecting their resilience to coastal challenges such as sea level rise. Variations in tidal range and sediment supply are particularly important; for example, mangroves in macro-tidal conditions benefit from increased sediment accretion, which reduces vulnerability and favors terrestrial habitat formation, while those in micro-tidal areas face a greater risk of displacement due to limited sediment capture (Xie et al., 2022). Access to mangrove ecosystems for tourists is particularly challenging during high tide, despite favorable conditions for activities such as photography, due to flooding of pathways and limited visibility of the mangrove structures themselves (Hickey & Radford, 2022).

Table 3. Biota objects in the mangrove area of Lubuk Kertang Village, North Sumatra

Group	Species	Common Name
Bivalva	*Geloina erosa*	Mud Shells
	Geloina expansa	Mud Shells
	Glauconome virens	Razor Clam
Gastropoda	*Telescopium telescopium*	Mangrove snails
Pisces	*Mugil sp*	Flathead grey mullet
	Lates calcaliver	Barramundi
	Megalops cyprinoides	Indo-Pacific Tarpon
	Eleutheronema tetradactylum	Fourfinger threadfin
	Chanos chanos	Milkfish
	Plotosus canius	Gray eel-catfish
Crustacean	*Penaeus monodon*	Tiger Prawn
	Penaeus merguensis	White Prawn
	Metapenaeus ensis	Brown Shrimp
Arthropoda	*Scylla serrata*	Mud Crab
	Scylla tranquebarica	Mud Crab
Mamalia	*Macaca fascicularis*	Crab-Eating Monkey

Object Biota

The various biota observed at the mangrove site in Lubuk Kertang Village, North Sumatra consisted of *Bivalves*, *Gastropods, Pisces, Crustaceans, Arthropods, Mammals*. Mangrove ecosystems are characterized by unique flora and fauna, which significantly increases their attractiveness for tourism. Perancak mangrove in Bali, for example, hosts 25 species of mangrove flora, including dominant species such as *Rhizophora mucronata* and *Avicennia marina*, contributing to a high diversity index indicating a stable ecosystem (Ginantra et al., 2024). In addition, the unique adaptations of mangrove organisms, such as specialized root systems and salt-dispensing mechanisms, allow them to thrive in harsh coastal environments, making them an attractive subject for ecotourism (Ramesh et al., 2024). Travelers are attracted to the natural beauty and biodiversity of these areas, which include a variety of aquatic and terrestrial species, as well as the cultural aspects of local communities (Abubakar et al., 2024). In addition, mangrove forests provide important environmental services, such as coastal protection and carbon sequestration, which increase their ecological value and attract environmentally conscious visitors (Hasibuan et al., 2023). Overall, the combination of rich biodiversity, unique ecological adaptations, and environmental significance makes mangrove ecosystems highly attractive for tourism.

Tourism Suitability Index

Based on the results of the ecotourism suitability analysis, it is known that the tourism suitability index value is 87.5 % with a very suitable category (Table 4). Comparison of mangrove ecotourism suitability analysis across different studies revealed significant variability in suitability index and ecological conditions. In Budo Village, the tourism suitability index was found to be 54.6 %, categorizing it as conditionally suitable, with a carrying capacity of 116 visitors per day (Tambunan et al., 2023). In contrast, Reroroja Village achieved a higher average suitability score of 71. 5%, indicating suitable potential for ecotourism development (Calumba et al., 2023). In contrast, the mangrove forest in Kuala Alam was deemed unsuitable with a TSI score below 2, while Pematang Duku showed promise with a score of 2.38, indicating that it meets the ecotourism criteria (Sodikin et al., 2023). In addition, Pekalongan Mangrove Park recorded a suitability index of 68%, supporting its development as an ecotourism site. Notably, the Budo mangrove area was ultimately classified as unsuitable, requiring restoration efforts to improve its ecotourism viability (Oroh et al., 2024). This synthesis underscores the diverse ecological contexts and management needs of different mangrove areas.

CONCLUSION

This study concludes that although the Lubuk Kertang mangrove forest area has significant ecotourism potential, strategic planning and management are required to ensure that both environmental and community needs are met. The findings provide a basis for future initiatives aimed at promoting sustainable tourism while preserving the vital mangrove ecosystem.

Table 4. Suitability Matrix of Mangrove Tourism

No	Parameters	Weight	Category	Score	Lubuk Kertang Results	B x S	Ni/Nmax
1	Mangrove Thickness (m)	0.38	> 500	4	201.3	1.14	0.285
			>200-500	3			
			50-200	2			
			<50	1			
2	Mangrove Density (100/m^2)	0.25	>15-20	4	18.6	1	0.25
			>10-15; >20	3			
			10 s/d 15	2			
			<5	1			
3	Mangrove Type	0.15	>5	4	9	0.6	0.15
			3 s/d 5	3			
			2 s/d 1	2			
			0	1			
4	Tidal	0.12	0 sd 1	4	1,66	0.36	0.09
			>1-2	3			
			>2-5	2			
			>5	1			
5	Object Biota	0.1	Fish, shrimp, crabs, mollusks, reptiles, birds and typical/endemic/ rare animals	4	Fish, shrimp, crabs, mollusks, mammals	0.4	0.1
			Fish, shrimp, crab, mollusks	3			
			Fish, mollusks	2			
			One of the aquatic biota	1			
			∑			3.5	0.875
			Tourism Suitability Index (%)				87.5
			Category			Very suitable	

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