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ANALYSIS OF TOURISM SUITABILITY AS THE BASIS FOR COASTAL ENVIRONMENT MANAGEMENT AT BLEBAK BEACH, JEPARA REGENCY

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ABSTRACT

The increasing utilization of coastal tourism requires an integrated assessment of area suitability that combines biophysical characteristics and water quality. This study aims to evaluate the suitability of Blebak Beach for tourism using the Tourism Suitability Index (TSI) and to determine water quality status through the STORET method as a basis for sustainable management. The study was conducted at 2 stations during April–July 2025. The TSI was calculated based on coastal and water biophysical parameters, including beach width and slope, depth, current velocity, water clarity, freshwater availability, and the presence of hazardous biota. Water quality was analyzed using physical, chemical, and microbiological parameters, and results were compared with coastal water quality standards. Results showed an IKW score of 2.210 (suitable) at Station 1 and 2.690 (highly suitable) at Station 2, indicating the area's spatial and functional suitability for recreational activities. Conversely, water quality was classified as moderately polluted, with a score of -22 at both stations, due to nitrate and phosphate concentrations exceeding quality standards, which are attributed to aquaculture pond runoff, particularly uneaten feed and metabolic waste. Integration of both approaches is necessary to ensure sustainable coastal tourism management through nutrient input control and periodic water quality monitoring. Zoning of aquaculture ponds and tourism zones is implemented to reduce direct interaction between pollution sources and recreational areas.

Keywords: Tourism Suitability Index; Water Quality; Blebak Beach; Sustainable Management

INTRODUCTION

Tourism plays a strategic role in supporting regional development, particularly in areas supported by natural resource potential. Coastal areas are among the primary spaces targeted for tourism destination development due to their landscape appeal, ecosystem characteristics, and unique socio-economic dynamics of local communities. However, coastal tourism development without proper planning can lead to environmental degradation, land-use conflicts, and a weakening of the local community's role in area management (Maysarah *et al.,* 2026).

These conditions indicate that coastal tourism development must take into account environmental capacity and regional characteristics. Physical water conditions, coastal dynamics, and coastal ecosystems serve as crucial foundations for assessing the suitability of safe, comfortable, and sustainable tourism activities (Firdaus *et al.,* 2025). The growing interest in marine tourism is driving the development of coastal ecotourism that emphasizes a balance between environmental conservation and economic utilization. This approach prioritizes environmental carrying capacity and water quality as the primary foundations for sustainable coastal tourism management (Phelan *et al.,* 2020).

Jepara Regency has potential for sustainable coastal tourism, as evidenced by Blebak Beach. This area is increasingly utilized as a tourist destination, with a focus on educational and conservation activities, featuring biophysical characteristics such as white sand, relatively calm waters, and water clarity that support recreational activities (Wardhani *et al.,* 2024). These ecological attractions have driven increased utilization of the area, reflected in the rise in the number of tourist visits from 10,796 people per year in 2021 to 252,864 people per year in 2024 (Central Java Statistical Yearbook). This situation underscores that the use of coastal areas is influenced not only by visual and ecological appeal but also by the suitability of the coast's biophysical characteristics and water conditions, which support the comfort and safety of tourism activities.

Tourism development at Blebak Beach faces challenges related to the beach's biophysical characteristics. The relatively limited beach width in some sections restricts space for tourism activities, particularly during high tide, potentially reducing comfort and leading to overlapping activities (Tiawati *et al.,* 2025). Tourism activities tend to concentrate in shallow-water zones, leading to overcrowding in specific beach segments despite the area generally having sufficient space. This condition affects tourist comfort and increases utilization pressure, making it a consideration in assessing tourism suitability based on biophysical characteristics (Saputra *et al.,* 2024). Additionally, the potential for coastal erosion has not yet been fully evaluated in relation to the suitability of water-based recreational activities. The relatively calm, clear water conditions are the main attraction of the area; however, increased tourism activity, the presence of aquaculture ponds, and suboptimal domestic wastewater management have the potential to affect water clarity and quality, which are directly related to tourist comfort (Firzanah *et al.,* 2025). The presence of seagrass beds in coastal areas also faces pressure from tourism activities in the same zone, posing a risk of disrupting ecological functions if their use is not adapted to the local environment.

Coastal tourism suitability assessment aims to evaluate the feasibility of a coastal area as a tourism utilization space based on the area's biophysical characteristics (Nita *et al.,*

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2025). The Tourism Suitability Index evaluates coastal areas as biophysical systems with specific utilization tolerance limits, based on a combination of physical coastal characteristics and water conditions that determine comfort, safety, and environmental stability. This approach emphasizes that tourism suitability is not determined solely by natural attractions but also by the environment's capacity to support tourism activities without compromising its ecological functions. Water quality conditions serve as a critical supporting factor within this framework, as changes in water quality directly impact the tourism experience while reflecting the environment's response to the intensity of use (Yulianda, 2019). Research by Wardhani *et al.* (2024) examines the potential for coastal tourism development based on the area's biophysical characteristics and stakeholder perceptions. This approach provides an overview of the potential for tourism destination development, but the analysis remains focused on spatial feasibility and perceptions of area development. Tourism suitability assessments that are solely oriented toward biophysical characteristics and management perceptions have not yet fully captured the aquatic environmental conditions that directly support coastal tourism activities.

The biophysical conditions of the beach and increasing tourism pressure necessitate a more comprehensive assessment of Blebak Beach's environmental suitability. This study integrates the Tourism Suitability Index analysis with an evaluation of water quality status using the STORET (Storage and Retrieval) method. This integration allows for an assessment not only of the suitability of the coastal area for recreational activities but also of the water quality conditions as an indicator of ecological pressure on the tourism area. Therefore, this study aims to: (1) determine the level of coastal tourism suitability at Blebak Beach using the Tourism Suitability Index (TSI); (2) determine the water quality status of Blebak Beach based on the STORET method; and (3) evaluate the environmental suitability of Blebak Beach as a coastal tourism area based on the integration of the Tourism Suitability Index and water quality status as a basis for coastal environmental management.

RESEARCH METHOD

The research method used was a descriptive, quantitative approach through field observation. Water quality data and physical beach parameters were measured directly, then processed into scores and index calculations to produce the Tourism Suitability Index (TSI) value and a description of water quality conditions.

Research Location and Time

The research was conducted in the Blebak Beach area, located in Sekuro Village, Mlonggo Subdistrict, Jepara Regency. Geographically, Blebak Beach is situated at coordinates 6°30′8.76″ South Latitude and 110°40′7.86″ East Longitude. The research location is shown in Figure 1. Observations were conducted from April to July 2025, with samples collected once per month. Measurements of tourism suitability and water quality were conducted at two observation stations located approximately 30 meters from the shoreline. Station selection was performed using purposive sampling, taking into account the representativeness of coastal land-use characteristics and the intensity of activities in the Blebak Beach area.

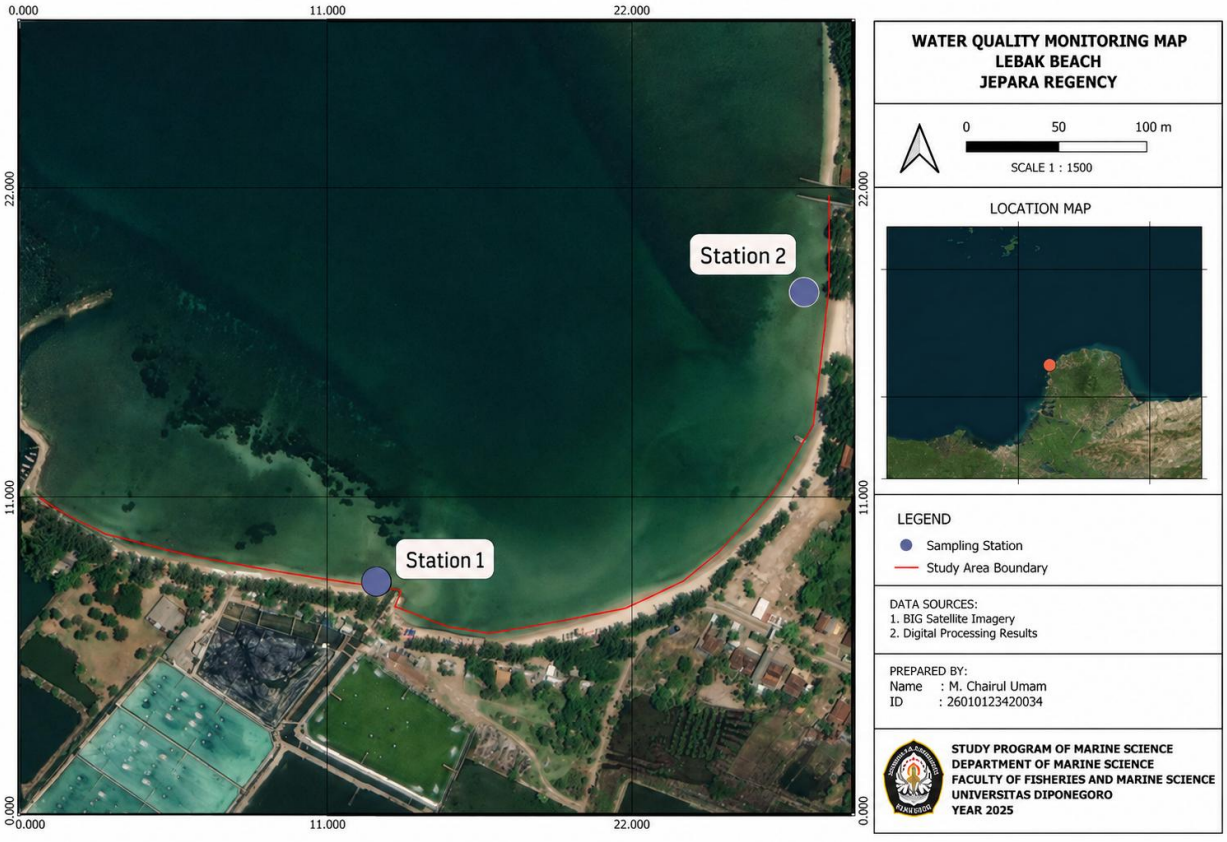

Figure1 . Study Location, Blebak Beach, Jepara Regency

Station 1, located in the southern part of the area, is dominated by vendor activities and tourist stalls, with aquaculture ponds on the land behind the beach. These conditions can influence water quality dynamics through runoff from land-based activities and shoreline tourism. Station 2, situated in the northern part of the area, is a zone with the highest intensity of tourism activities, including swimming, water play, and tourist boat rides (Wardhani *et al*., 2024). The selection of these two stations is intended to represent the two main characteristics of Blebak Beach's land use: the "zone in the southern part, characterized by land-based activities and tourism services, and the northern zone, where water-based recreational activities are more dominant. The Blebak Beach shoreline is relatively homogeneous morphologically and spans approximately 600–700 meters; considering these two stations, they are deemed capable of representing the variations in biophysical conditions and land-use pressures within the study area.

Field data collection was conducted in the afternoon, between 3:00 PM and 4:00 PM, to ensure consistent measurement conditions across sampling periods. Based on tidal data for the Java Sea in the Jepara region, the Blebak Beach area exhibits a semi-diurnal tidal pattern, meaning there are two high tides and two low tides in a single day. During the observation period from April to July, water conditions at the time of sampling generally occurred during the rising tide phase through to mid-high tide, which took place between midday and the afternoon. These conditions were consistently selected for each data collection to minimize the influence of tidal variations on the measured parameters, particularly tourism suitability parameters such as beach width and water depth, as well as water quality parameters sensitive to changes in water mass. Consistency in measurement timing and relatively similar tidal conditions were maintained to minimize environmental variability, ensuring that the data accurately reflect the water conditions at Blebak Beach during the study period.

Data Collection and Analysis

Data were collected through field observations, water quality measurements, and a literature review. The assessment of Blebak Beach's environmental suitability in this study was conducted using two distinct analytical approaches: the Tourism Suitability Index (TSI) and water quality evaluation using the STORET method. The Tourism Suitability Index assesses the suitability of coastal areas based on biophysical characteristics that influence the comfort and safety of tourism activities, including water depth, beach type, beach width, substrate material, water clarity, and current velocity. Meanwhile, the STORET method is used to assess the water quality status or environmental health of the water body by comparing water quality parameters to applicable quality standards. Several water parameters, such as water clarity, are measured simultaneously at each observation station and used in both analyses for different purposes: as indicators of visual comfort in tourism suitability assessments and of water quality conditions in environmental quality status evaluations.

Tourism Suitability Index

Primary data collection was conducted in situ for 10 variables, including beach type, beach width, water depth, current velocity, beach slope, substrate, water clarity, land cover, the presence of hazardous biota, and freshwater availability (Yulianda, 2019). Data collection was conducted through visual observation and direct measurements using tools such as a roll meter, a Secchi disk, a measuring rod, and a GPS. The selection of observation stations considered differences in beach characteristics and variations in tourism activity intensity. Secondary data were used to support spatial interpretation and area feasibility analysis.

Physical parameter measurements were conducted using methods adapted to field conditions. Beach width was measured using a roll meter from the high-tide line to the boundary of the sandy substrate up to the physical boundary (wall/barrier). The beach slope was calculated from elevation differences between points using satellite imagery. Water depth was measured using a roll meter, while current velocity was calculated using the float method (current ball) based on the elapsed time over 60 seconds. Water clarity was measured using a Secchi disk. Beach type parameters, bottom materials, land cover, and the presence of hazardous biota were determined through visual observation. Freshwater availability was determined by the distance from the shoreline to clean water sources near public facilities, supported by information from managers (Agry et *al.,* 2025).

The assessment based on observations was then adjusted using a 10 variables suitability matrix, with each variable evaluated and weighted. Weights are assigned based on the level of dominance or influence of each limiting factor on coastal tourism activities, thereby reflecting the overall suitability of the area for development as a recreational destination (Krebru *et al.,* 2025). The assessment categories consist of ten parameters, listed in Table 1.

Table 1. Tourism Suitability Index (TSI) Assessment Parameters (Yulianda, 2019)

Variable	Weight	Score			
		0	1	2	3
Beach type	0.200	Muddy, rocky, steep	Black sand, slightly steep	White sand mixed with coral fragments	White sand
Beach width (m)	0.200	< 3	3 – <10	10–15	> 15
Water base material	0.170	Silt, sandy silt	Silty sand	Sandy coral	Sand
Water depth (m)	0.125	> 10	> 6–10	> 3–6	0 – 3
Water clarity (%)	0.095	< 20	20–50	> 50–80	> 80
Flow velocity (cm/s)	0.080	> 51	34–51*	17–34*	0 – 17*
Beach slope (°)	0.080	> 45	> 25–45	10 – 25	< 10
Coastal land closure	0.010	Mangrove forests, settlements, ports	Tall shrubland	Shrubs, low scrub, savanna	Coconut palms, open land

Variable	Weight	Score			
		0	1	2	3
Hazardous flora	0.005	Porcupines, stingrays, lepu, sharks	Porcupines, stingrays	Porcupine	None
Freshwater availability (distance to freshwater source)	0.005	> 2 km	> 1–2 km	> 0.5 – 1 km	< 0.5 km

*Intervals at the same numbers. If there is an exact value at the boundary, such as 17 cm/s, that value is assumed to fall within the 0–17 cm/s class, which has a score of 3.

The scores for these categories were then analyzed using the formula provided by as follows:

$$TSI = \sum_{i=1}^{n}(Bi \times Si) \ldots\ldots(1)$$

Notes: n = number of suitability parameters; Bi = weight of the i-th parameter; Si = score of the i-th parameter;

When calculating with this formula, a value is produced that determines the beach tourism suitability category. The categories include: Highly Suitable if the value is ⩾ 2.5; Suitable if the value is between 2.0 and less than 2.5; Not Suitable if the value is between 1 and less than 2.0; and Highly Not Suitable if the value is below 1 (Yulianda, 2019).

Water Quality Measurement

Surface water sampling is in accordance with SNI 6989.57:2008, Methods for Sampling Surface Water for Biophysical-Chemical Testing. Sampling was conducted at two observation stations in the Blebak Beach tourist area, with two repetitions. Samples were collected at a depth of 20–50 cm below the water surface (Hidayati *et al.,* 2025). The water quality parameters analyzed included physical (turbidity, temperature, odor), chemical (pH, DO, salinity, nitrate, phosphate), and biological (total coliforms). Turbidity was measured with a Secchi disk, and temperature was measured with a thermometer integrated into the DO and pH meters. DO was measured with a DO meter, pH with a pH meter, and salinity with a refractometer. Odor parameters are determined through sensory observation. Analysis of nitrate, phosphate, and total coliform is conducted ex situ in the laboratory, with the nitrate method referencing IKO 4 Spectrophotometry, phosphate referencing IKO 6 Spectrophotometry, and total coliform referencing SNI/ISO 9308-1:2010 and ISO 8199:2018. All measurement results were then compared with Class II water quality standards outlined in Appendix VIII of Government Regulation No. 22 of 2021, specifically for water intended for use in water recreation facilities and infrastructure (Afifah *et al.,* 2025).

The STORET method was applied by compiling water quality data periodically to form a time series; subsequently, the measurement results for each parameter were compared with the quality standards corresponding to the water use class. Parameters that meet the quality standards are assigned a score of 0, while those that exceed the standards are assigned negative scores according to STORET's provisions in Table 2. All negative scores are then summed to obtain a total score, after which the water quality status is determined using the STORET scoring system's classification based on the total score.

Assessment in the STORET method is a scoring system developed by the US Environmental Protection Agency (US-EPA) that classifies water quality into several classes based on the scores obtained (Agry et *al.,* 2025). The classification is shown in Table 3.

Table 2. Determination of the Scoring System to Determine Water Quality Status

Number of Samples	Value	Physical		
		Physical	Chemical	Biology
<10	Maximum	-1	-2	-3
	Minimum	-1	-2	-3
	Average	-3	-6	-9
≥10	Maximum	-2	-4	-6
	Minimum	-2	-4	-6
	Average	-6	-12	-18

Table 3. Water Quality Classification

Storet Score	Class	Status
0	A	Excellent (Meets quality standards)
-1 ≤ x ≤ -10	B	Good (Slightly contaminated)
-11 ≤ x ≤ -30	C	Moderate (Moderately polluted)
≤ -31	D	Poor (Heavily Polluted)

Source: Minister of Environment Decree No. 115 of 2003

RESULTS AND DISCUSSION

Blebak Beach is classified as a shallow beach with water depths ranging from 1 to 2.5 meters. Sea temperatures during the day can reach around 30°C, consistent with the characteristics of warm tropical waters that support the sustainability of coastal ecosystems such as coral reefs, seagrass beds, and other marine life. The measured ocean current speed is 0.15 m/s, flowing in a southerly direction (185°S), indicating a relatively weak current that is safe for fishing boats and coastal tourism activities. Wave heights range from 0.3 to 1 meters, originating from the northeast due to the influence of the Java Sea current pattern (BMKG and Daily Tidal Data, 2025).

Tide data indicate that there are two high tides and two low tides per day (semi-diurnal tide pattern). Measurements taken from April to July show that the average maximum tidal range is 0.7–1.1 meters and the average minimum tidal range is 0.3–0.5 meters. High tides occur around midnight to early morning (12:00 AM–2:00 AM) and again in the late evening (10:00 PM), with sea levels approaching 1.8 meters. The lowest low tide is recorded between 06:00 and 08:00, with water levels nearly reaching 0 meters, while the mid-tide occurs around

12:00 and 13:00 with a height of approximately 0.9 meters (BMKG and Daily Tide Data, 2025).

Tourism Suitability Index

The tourism suitability analysis in this study is presented in Table 4. The calculation of the tourism suitability index at Blebak Beach shows slight differences between the two observation stations. Station 1, located on the southern side, received a total score of 2.210, categorized as Suitable for beach tourism activities. Consistent management practices evidence this; although the area is dominated by food stalls directly bordering the shoreline, it still provides space for tourism activities. Station 2 received a score of 2.690 and was categorized as "Highly Suitable" for beach tourism activities because it possesses more supportive area characteristics, such as a gently sloping beach topography, sufficient width, and relatively small currents, making it safe and comfortable for swimming and water recreation.

Table 4. Blebak Beach Tourism Suitability Index, April–July 2025

Parameter	Weight	Station 1			Station 2		
		Note	Score	Result	Notes	Score	Results
Beach type	0.2	White sand with some mud and seagrass	2	0.400	White sand	3	0.600
Beach width (m)	0.2	6.89	1	0.200	13.88	2	0.400
Water-based material	0.17	Sand	3	0.510	Sand	3	0.510
Water depth (m)	0.125	1.2	3	0.375	0.9	3	0.375
Water clarity (%)*	0.095	81%	3	0.285	97%	3	0.285
Flow velocity (cm/s)	0.08	33.4	2	0.160	15.3	3	0.240
Beach slope (°)	0.08	2.6–10°	3	0.240	6.1–8.4°	3	0.240
Coastal land cover	0.01	Open land, casuarina. Fish ponds	1	0.010	Open land, Casuarina, Residential/resort	1	0.010
Hazardous biota	0.005	None	3	0.015	None	3	0.015
Freshwater availability (distance to freshwater source)	0.005	0.15	3	0.015	0.1	3	0.015
Ni max (Weight × Highest score)	3	Total		2.210	Total		2,690

* Water clarity was measured using a Secchi disk and expressed in meters; the percentage value in the TSI analysis was calculated based on the ratio of water clarity to water depth at the time of observation.

Calculations of the tourism suitability index at Blebak Beach indicate slight differences between the two stations. Station 1, located on the southern side, received a total score of 2,210 and is categorized as Suitable for beach tourism activities. Consistent management practices evidence this; although the area is dominated by food stalls directly bordering the shoreline, it still provides space for tourism activities. Station 2 received a score of 2.690 and was categorized as “Highly Suitable” for beach tourism activities due to more supportive area characteristics, including a gently sloping beach topography, sufficient width, and relatively small currents, which make it safe and comfortable for swimming and water recreation.

Blebak Beach is a white-sand beach with a predominantly sandy substrate. At Station 1, the white sand is influenced by the presence of limited amounts of mud associated with aquaculture activities in the surrounding area, as well as a seagrass bed spanning 0.451 ha dominated by *Thalassia hemprichii* (Maulana *et al.,* 2025). The presence of mud in this section can affect the texture of the beach substrate and the comfort of tourist activities. However, the white sand character still dominates. Station 2 features a sandy-substrate beach and serves as a hub for tourist activities, supported by shallower waters and relatively calm waves. The dominance of white sand in this area enhances aesthetic appeal. It improves visitor comfort, as the beach surface does not readily absorb excessive heat, thereby better supporting beach recreational activities (Firdaus *et al.,* 2025).

The average beach width ranges from 5 to 20 meters, influenced by tides and by the physical boundaries established by management. Station 1 has a relatively narrow beach width of 6.89 m, limiting the effective space for tourist activities, particularly since part of the beach area must serve as a visitor pathway and a safe zone from tidal effects. These conditions mean that an increase in the number of tourists simultaneously can raise spatial density and reduce the comfort of tourism activities. Station 2 has a beach width of 13.8 m, which can be considered sufficient to support beach recreational activities while maintaining a more controlled level of spatial density. Although Blebak Beach has a total coastline length of approximately 660 m, tourism space utilization is uneven, with tourism activities concentrated in the wider beach segments.

In contrast, narrow segments serve as transition areas. Based on the beach width at Station 1, the minimum space requirement for beach tourism realistically accommodates only about 100–130 people simultaneously (estimated spatial density); however, this does not account for the area’s overall carrying capacity, which also encompasses the scope of tourism activities. The conditions at Blebak Beach confirm that beach width influences tourists’ mobility during activities. Wider beaches tend to provide higher comfort levels, whereas narrow beaches can restrict activities and reduce visitor comfort (Marara & Muhsoni, 2024).

The parameters of water depth, clarity, and current speed generally fall within the suitable category for beach tourism activities. Station 2 has shallower water than Station 1

due to differences in coastal topography, making it more conducive to water recreational activities, such as swimming and playing in the shallow zone. Water depth is a critical factor in determining suitability for tourism, as it directly affects visitor safety, particularly regarding current dynamics, waves, and sediment movement (Hiariey *et al.,* 2024). Water clarity at Station 2 is also relatively high, with visibility reaching 100%, indicating clear water conditions that enhance visual comfort for tourists. Variations in water clarity are influenced by weather conditions, suspended sediment concentrations, measurement timing, and aquaculture activities around Station 1, which may increase turbidity. The current speed at Station 2 is recorded as lower compared to Station 1, which is related to water depth and coastal topography. Calmer current conditions contribute to improved visitor safety and open opportunities for the development of water-based tourism attractions (Hiariey *et al.,* 2024).

The slope of the beach supports beach tourism activities. The characteristics of the beach slope directly influence the safety and comfort of visitors engaging in tourism activities in the coastal zone. Blebak Beach is classified as a gently sloping beach with a slope of less than 10°, making it suitable for safe recreational beach tourism activities for visitors (Silalahi *et al.*, 2025).

Land use around Blebak Beach is characterized by a coastal landscape dominated by aquaculture ponds, settlements, and lowland agriculture. On the northern side of the beach, adjacent to Station 2, a small river flows into the sea and could carry runoff from agricultural activities, settlements, and tourism. The southern side of the beach, adjacent to Station 1, is dominated by aquaculture areas. These land-use patterns increase pressure on the coastal ecosystem, particularly by increasing the potential for pollutants to enter coastal waters. The presence of land cover in the form of coastal vegetation is also a key element in supporting the suitability of the beach for recreational tourism, as it helps maintain environmental stability while enhancing the area's visual quality through the presence of green spaces, the shade provided by vegetation, and a more natural coastal landscape (Cahyani *et al.,* 2023).

No dangerous wildlife that could disrupt tourists' comfort and safety, such as sea urchins and stingrays, was found at the study site. This indicates that the Blebak Beach area falls into the category suitable for beach tourism activities, due to the minimal ecological risks that could limit visitors' recreational activities. The absence of dangerous marine life provides a sense of safety and enhances tourists' comfort in engaging in various beach tourism activities (Hiariey *et al.,* 2024). The availability of freshwater at Station 2 is also relatively closer compared to Station 1, given its role as a hub for tourism activities requiring shower and rinse facilities. The distance to freshwater sources falls within the recommended range for beach recreational activities, approximately 0.5 km, to support tourist comfort (Yulianda, 2019).

The Tourism Suitability Index assessment indicates that Blebak Beach is generally classified as suitable for tourism use. Differences in suitability levels are influenced by the physical conditions of the beach, particularly beach width, calmer currents, and higher water clarity at Station 2. Suitability evaluation was conducted using a weighted assessment matrix that reflects the relative influence of each parameter on the safety, comfort, and sustainability of the tourism area (Firdaus *et al.,* 2025). The assessment results were then used to guide zoning-based spatial management, with swimming and water-play activities directed toward Station 2. At the same time, Station 1 was prioritized for land-based recreation and environmental education to minimize activity conflicts and maintain the stability of the coastal ecosystem. Identified limiting factors include uneven water depths, which affect tourist safety, as well as limited supporting facilities and limited accessibility to the site (Elisecarmel *et al.,* 2025).

Water Quality Measurement

The assessment of water quality at Blebak Beach consists of 2 stations analyzed using the STORET method. The scoring in the STORET method is based on the Ministry of Environment Decision No. 115 of 2003. The rating system is differentiated based on the number of water quality parameters analyzed. This study uses the <10 category because the number of water quality parameters tested is less than ten. The results of water quality measurements at Station 1 of Blebak Beach are presented in Table 5, and those at Station 2 in Table 6.

Table 5. Seawater Quality Status at Blebak Beach Station 1 Based on the STORET Method (April–July 2025)

No	Parameter	Unit	Quality Standard*	Measurement Results			Score
				Maximum	Minimum	Average	
Physics							
1.	Brightness	m	>6	1.057	0.885	0.981	0
2.	Temperature**	°C	natural	33.7	25.95	30.175	0
3.	Odor	-	Odorless	Odorless	Odorless	Odorless	0
Biology							
1.	Total Coliform	count/100ml	1000	244	9	72.85	0
Chemistry							
1.	pH	-	7–8.5	8.67	8.235	8.523	-2
2.	DO	mg/L	>5	8.75	5.6	7.175	0
3.	Salinity**	0/00	natural	34	25	29.125	0
4.	Nitrate	mg/L	0.06	<2.88	1.6	2.007	-10
5.	Phosphate	mg/L	0.015	<2.12	0.69	1.290	-10
			Total				-22

Quality standards refer to the Marine Tourism Quality Standards in Appendix VII of Government Regulation No. 22 of 2021
**Temperature is allowed to vary by up to 2°C and salinity is allowed to vary by up to 5% (30–35 ppt)

Table 6. Seawater Quality Status at Blebak Beach Station 2 Based on the STORET Method (April–July 2025)

No	Variable	Unit	Quality Standard*	Measurement Results			Score
				Maximum	Minimum	Average	
Physics							
1.	Brightness	m	>6	Total to the bottom (0.9)	0.85	0.88	0
2.	Temperature**	°C	natural	32.95	24.5	29.51	0
3.	Odor	-	Odorless	Odorless	Odorless	Odorless	0
Biology							
1.	Total Coliform	count/100ml	1000	108	1	54.95	0
Chemistry							
1.	pH	-	7–8.5	8.69	8.5	8.59	-2
2.	DO	mg/L	>5	7.75	5.9	6.625	0
3.	Salinity**	0/00	natural	34	23	28.25	0
4.	Nitrate	mg/L	0.06	<2.88	1.3	2.05	-10
5.	Phosphate	mg/L	0.015	<2.12	0.865	1.447	-10
			Total				-22

*Quality standards refer to the Marine Tourism Quality Standards in Appendix VII of Government Regulation No. 22 of 2021
**Temperature is allowed to vary by up to 2°C and salinity by up to 5% (30–35 ppt)

Analysis results for Stations 1 and 2 indicate that both fall into the moderately polluted category (Category C). This condition suggests that water quality at Blebak Beach has deteriorated, as chemical parameters have exceeded the established quality standards. The decline in water quality may be attributed to various factors, including increased tourism activity, proximity to aquaculture areas, and suboptimal management of tourism, particularly of water resources.

Water quality measurement results show that physical and biological parameters remain below quality standards, while chemical parameters have declined, particularly nitrate and phosphate. Nitrate concentrations reached 2.00 mg/L, exceeding the Ministry of Environment and Forestry ( ) standard for marine water quality for tourism of 0.6 mg/L, while phosphate levels ranged from 1.2–1.4 mg/L, far above the threshold of 0.015 mg/L. The -10 score for the nitrate and phosphate parameters is the cumulative assessment using the STORET method, based on the Ministry of Environment Regulation No. 115 of 2003, for a sample count <10. This value is derived from the sum of the maximum (-2), minimum (-2), and average (-6) scores, all of which exceed the quality standards, resulting in a total score of -10 for each parameter. For the pH parameter, the score of -2 is assigned when the maximum value exceeds the quality standard threshold.

Nitrate concentrations of 2.00 mg/L and phosphate concentrations of 1.2–1.4 mg/L indicate nutrient-rich conditions that have the potential to trigger eutrophication in coastal ecosystems. Increased inputs of nitrogen and phosphorus into marine waters are known to stimulate excessive phytoplankton growth, thereby increasing the risk of Harmful Algal Blooms (HABs) in coastal waters with high nutrient levels (Lan *et al.,* 2024). Coastal waters receiving nutrient runoff from land-based activities, such as residential areas, agriculture, and tourism, are more likely to experience eutrophication, which can alter the balance of marine ecosystems (Wang, 2024). High phosphorus concentrations in the water also play a significant role in triggering algal blooms, which can cause water discoloration, reduced water clarity, and a rapid increase in phytoplankton biomass (Han & Wang, 2025). Reduced water transparency due to increased algal biomass can affect the aesthetic quality of the coastal environment and the comfort of water-based recreational activities in coastal tourist areas.

This indicates that the coastal waters of Blebak Beach have been subjected to pollution pressure from organic waste. The increase in inorganic nutrients reflects nutrient inputs from land-based and coastal activities, particularly from aquaculture operations around the tourist area, agricultural fertilizer runoff, and domestic wastewater discharge. Aquaculture activities are known to result in the accumulation of nitrates and phosphates from uneaten feed and excretions of farmed organisms. At the same time, agricultural runoff introduces easily soluble fertilizer compounds into coastal waters (Hidayati *et al.,* 2025). Additionally, sediments serve as a source of phosphate through the diffusion and decomposition of bound phosphorus compounds, thereby raising dissolved phosphate levels in the water column (Ghozali *et al.,* 2024). This triggers eutrophication, and excessive nutrient loads can accelerate water quality decline and disrupt the stability of coastal ecosystems (Surya *et al.,* 2024).

This condition is reinforced by findings that total coliform levels remain below quality standards, indicating that the primary source of contamination is dominated by non-fecal nutrient inputs rather than direct fecal waste. This also suggests a relatively low risk of microbial contamination for water-based recreational activities. This imbalance indicates the potential for coastal water eutrophication, which can reduce water clarity, affect tourist comfort, and increase ecological pressure on coastal ecosystems (Yolanda, 2024).

Coastal tourism suitability is shaped by the interaction between the biophysical characteristics of land and water quality; thus, a decline in water quality can reduce tourism suitability even if the physical parameters of the beach remain within the suitable range. The water quality of Blebak Beach is categorized as moderately polluted (Category C), indicating that the waters can still be used for beach tourism activities with pollution sources controlled and restricted. The decline in water quality, marked by increased levels of organic matter and dissolved nutrients, has the potential to affect tourist comfort and reduce the tourism suitability score for water quality parameters. Physically, the waters of Blebak Beach can maintain optimal ecological values. However, nutrient pressure from land-based and coastal activities, particularly those related to aquaculture ponds and domestic wastewater, is indicated to increase the risk of environmental degradation, ecological disturbances, and impacts on seagrass habitat (Agry et *al.,* 2025).

The Tourism Suitability Index (TSI) value for Blebak Beach, which falls within the "suitable" to "very suitable" categories, does not directly reflect optimal water quality conditions. This discrepancy stems from differences in the assessment focus between the TAI and the water quality evaluation. TAI assessment is based on biophysical characteristics relevant to tourism activities, including beach slope and width, water depth, current velocity, and visual clarity, which reflect the suitability of the coastal area's spatial and functional aspects for supporting recreational activities (Ambarwati *et al.,* 2021). Conversely, water quality assessment using the STORET index is based on physical, chemical, and microbiological parameters that reflect the water body's quality relative to established standards. This approach is specific to water quality and sensitive to changes in chemical parameters, particularly increases in nutrient concentrations resulting from aquaculture activities and land runoff. While these increased nutrient concentrations have not yet significantly affected the physical parameters used in the TSI assessment, they have been sufficient to downgrade the water quality status to moderately polluted. This situation indicates that high tourism suitability values reflect the feasibility of using coastal areas under current conditions. At the same time, water quality status serves as an early indicator of environmental pressures that could reduce tourism suitability (Tallar & Sunaris, 2019).

Water quality management at Blebak Beach requires continuous monitoring of land-based pollution sources, particularly those from aquaculture activities, domestic wastewater, and sediment inflow from river basins. An ecosystem-based approach is implemented through waste control, coastal vegetation rehabilitation, and aquaculture zoning to maintain stable water quality. Mitigation efforts are also aimed at maintaining the area's suitability for tourism by preserving the biophysical conditions of the beach and waters that support tourism activities. Regular water quality monitoring involving coastal communities is implemented as a basis for sustainable management (Ambarwati *et al.*, 2021).

CONCLUSION

This study indicates that Blebak Beach has a tourism suitability level categorized as "suitable" at Station 1 and "highly suitable" at Station 2, based on the Tourism Suitability Index (TSI). However, the results of the water quality assessment using the STORET method showed a score of -22 at Stations 1 and 2, indicating that the waters of Blebak Beach are in a state of moderate pollution, primarily influenced by high concentrations of nitrate and phosphate nutrients that exceed quality standards. The discrepancy between the TAI value and the water quality status reflects the differing assessment focuses of these two approaches. The integration of TAI results and water quality assessments confirms that Blebak Beach remains suitable for use as a coastal tourism area under current conditions; however, it is already in the early stages of environmental pressures that could reduce the sustainability of tourism use.

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