Analysis of Beach Tourism Suitability Index in Relation to Marine Ecosystems in Ambon City

Lilian Sarah Hiariey[1*], Renoldy Lamberthy Papilaya[2], Johanis Hiariey[3], James Abrahamsz[4]

[1]Faculty of Marine Science Study Programme, Pattimura University, Ambon, Maluku, Indonesia
[2]Department of Doctoral Marine Science Study Programme, Postgraduate, Faculty of Marine Science
Study Programme, Pattimura University, Ambon, Maluku, Indonesia
[3]Department of Fisheries and Marine Science, Faculty of Fisheries and Marine Science, Pattimura
University, Ambon, Maluku, Indonesia
[4]Department of Fisheries and Marine Science, Faculty of Fisheries and Marine Science, Pattimura
University, Ambon, Maluku, Indonesia

*Corresponding Author: lilyfauzia35@gmail.com

ARTICLE INFO

ABSTRACT

This study assessed the suitability of beach tourism destinations in the southern part of Ambon District, focusing on recreational potential and marine ecosystems. Oceanographic and ecological parameters were evaluated through analysis of secondary data and in situ surveys, using a spatial tourism suitability analysis approach. The aim was to identify the potential for beach tourism and to determine whether these destinations are suitable for the leisure market. According to the study, the South Leitimur District has significant potential for growth in the beach tourism sector. Three out of four locations—Namsua Beach, Namseri Beach, and Lawena Beach—were rated as "very suitable" based on the Index of Tourism Completeness (IKW). In contrast, Senu Beach received an "average" rating. The report concludes that natural resources and marine ecosystems can support sustainable tourism development, enhance the local economy, and generate regional revenue. It emphasizes the need for thoughtful planning and development of beach tourism that considers the importance of marine environmental preservation. The findings can inform policy development and decision-making for sustainable tourism in Ambon and other coastal areas. Maintaining the ecological and aesthetic value of marine ecosystems is essential, and promoting environmentally friendly tourism can both support the local economy and help preserve the area's biodiversity and natural beauty.

INTRODUCTION

Ambon City, with most of its villages located along the coast, is the capital of the province of Maluku. Ambon has great potential for biodiversity and unique marine ecosystems and services, making it an ideal location for tourism development **(Hidayat, 2016)**. The tourist potential of Ambon City includes beautiful natural sights of pristine white beaches, rich diversity of marine life in its vibrant marine ecosystems and the

breathtaking beauty of the underwater world as well as great cultural significance **(Rumerung & Siaila, 2023)**. Tourism remains one of the main drivers of the Indonesian economy and a key component of the country's economic development strategy. The town of Ambon can promote environmentally friendly tourism strategies that benefit the local population and the environment by exploiting its unique marine ecosystems and natural attractions.

According to the **Ambon City Tourism Office (2021)**, the beaches of Ambon offer outstanding characteristics and potential to attract visitors who want to swim, dive and enjoy other recreational activities in the thriving marine eco-system of the city. Unemployment rates are expected to decline significantly due to the growth potential of beach tourism **(Mony *et al.,* 2023)**. There are many natural beach attractions and diverse marine ecosystems, which offer a unique opportunity to develop sustainable tourism that preserves environmental and cultural resources while boosting local incomes. Understanding and nurturing the potential of Ambon beach tourism is crucial to optimizing financial returns and ensuring long-term sustainable growth in the region.

Marine tourism, which includes the study and enjoyment of the marine environment, is an important part of the Indonesian tourism sector. The number of visitors from maritime tourism has increased significantly in the past four years and many tourists are engaged in activities such as enjoying the atmosphere and scenery of beaches or simply enjoying the recreational opportunities in these ecosystems. In 2022, the number of foreign visitors reached 5.47 million **(KEMENPAREKRAF RI, 2022)**, while local tourists numbered 5.53 million. Given these statistics, the government must optimize governance and policy strategies to develop the potential of the tourism sector further, ensuring the conservation of marine ecosystems.

The development of coastal areas as tourist attractions is crucial for the local government of Maluku Province, given that this region comprises numerous islands rich in natural resources and diverse marine ecosystems. According to Maluku Province Regional Regulation **(Singgalen & Simange, 2018)**, No. 1/2018, which outlines the Zoning Plan for Coastal Areas and Small Islands from 2018 to 2038, Island Cluster VII—including Ambon Island and the Lease Islands—encompasses two administrative areas: Ambon City (specifically the South Leitimur sub-District and Nusaniwe) and Central Maluku Regency (covering the Salahutu and Leihitu sub-Districts). The government has designated these areas as tourism zones, leveraging their unique marine ecosystems and natural attractions.

Ambon City, the capital of Maluku Province, boasts significant potential for high biodiversity and marine services within its rich marine ecosystems, which can support regional development and enhance community welfare, particularly in the tourism sector **(Herdiansyah *et al.,* 2021)**. Situated in Ambon Bay, which the Banda Sea directly influences, the city has opportunities to leverage its marine resources and ecosystems as captivating tourist attractions. According to **BPS (2021)**, nature tourism in the South Leitimur sub-district accounts for nine attractions, compared to 5 in cultural tourism and 5

in historical tourism, with a focus on the natural beauty and biodiversity of its marine ecosystems.

Beach tourism holds significant development potential as a key attraction in Ambon City, leveraging its rich coastal resources, diverse marine ecosystems, fisheries, and marine services **(Tourism Office of Ambon City, 2023)**. The South Leitimur sub-district is characterised by excellent beaches suitable for swimming, diving, fishing and family picnics, and by the richness and beauty of its marine ecosystems. The potential for sustainable tourism development in this region, which has 28 natural tourist destinations, including 10 beach resorts, is vast.

The number of tourists has increased over the past three years (18,372 in 2021, 71,992 in 2022 and 83,803 in 2023), showing the potential of the tourism sector to generate regional indigenous income. However, to fully realize this potential, an integrated development concept should be adopted that considers the impact of tourism on the local environment and marine ecosystems **(Astutik *et al.,* 2025)**.

According to the Ambon City Tourism Office, the coastal areas of the Southern Leitimur district, linked to beach tourism and the marine eco-system, have a potential for biodiversity which is still under-exploited and under-managed **(Mehdila *et al.,* 2023)**. The tourism sector needs to optimize and preserve the biodiversity and beauty of marine ecosystems by addressing problems in tourism management such as poor facilities and insufficient promotion.

There are a number of findings from recent studies on the archipelago's suitability index for leisure beach tourism. Based on research, the marine ecosystems of Southeast Maluku Regency's Ngursarna and Ohoililir Beaches are thought to be ideal for beach recreation. **Towoliu *et al.* (2020)** identified three beach destinations—Hutumuri, Hukurila, and Kilang villages in Ambon City, Maluku Province—that also exhibit a very suitable index value based on ten parameters for beach tourism suitability within the context of marine ecosystems conservation.

Considering the beach tourism potential in South Leitimur, Ambon City boasts beaches facing the Banda Sea, with unique marine ecosystems and semi-enclosed beaches characterized by fine gravel mixed with sand and mud. A thorough study of beach tourism potential is essential to evaluate the possibilities for integrated tourism within sustainable development, balancing economic benefits with marine ecosystems conservation.

This study examined the potential of beach tourism in South Leitimur, Ambon City, by assessing factors such as beach shape, substrate color, and granular characteristics of the beach substrate, while analyzing the suitability of beach tourism in the context of marine ecosystems and sustainable tourism practices. The goal was to determine a tourist area according to its designation as a beach tourist area in the recreational category, optimizing the potential in coastal tourism areas as sustainable tourism destinations.

MATERIALS AND METHODS

1. Data

This research was conducted from November to December 2023, focusing on beach tourism in the South Leitimur District of Ambon City. The study included four specific beach locations: (I) Namsua Beach in Negeri Naku, (II) Namseri Beach in Negeri Kilang, (III) Seu Beach in Hukurila, and (IV) Lawena Beach in Hutumuri (Fig. 1). Data were gathered from these four locations through purposive sampling, ensuring they effectively represent the beach tourism landscape in the South Leitimur sub-district. This area encompasses ten beach tourism sites featuring attractions highly sought after by visitors.

Fig. 1. Research location

This research employed survey methods as its primary approach. Additionally, it incorporated quantitative research, which yielded findings derived through statistical procedures or other forms of measurement. The study utilized both primary and secondary data. Primary data were gathered directly at the research site through *in situ* observation. These data pertain to the suitability of beaches for recreational tourism and encompasses various factors such as beach type (shape and substrate colour), granule characteristics of substrate cover, seawater pH, water clarity, current speed, wave height, beach slope, and beach width. The observations focused on the physical parameters relevant to the suitability of beach tourism for recreational purposes. Table (1) outlines the tools and materials used in this study.

Table 1. Tools and materials

No.	Tools and Materials	Usability
1	Current meter	Measuring current speed
2	GPS (global positioning system)	Determine the coordinates of the research location
3	Sicchi Disk	Measuring water brightness
4	Rollmeter	Measuring the width of the beach
5	Scale Stick	Measuring beach slope and water depth
6	Slank Waterpass	Measuring the slope of the beach

7	Sediment Core	Sampling of beach sediment/substrate
8	Stopwatch	Calculating time
9	Camera	Documentation of research activities
10	Stationery	Recording research data and information

(Source: Prepared by the author (2025)

Researchers collected data to evaluate the potential of beach tourism within the marine ecosystems of South Leitimur District, Ambon City, through observation and interviews. They observed the current state of beach tourism, focusing on the unique characteristics of the marine ecosystems and coastal environment. Interviews were conducted with various stakeholders, including beach tourism owners, managers, and the surrounding community, to gather insights into the internal and external potential of beach tourism.

Data collection involved observing factors such as beach type, brightness, current speed, beach slope, and beach width, while considering the impact of these factors on the marine ecosystems. Secondary data, including literature studies and bathymetric maps from **Pushidrosal TNI-AL (2012)**, were utilized to determine the depth of coastal waters and understand the dynamics of the marine ecosystems.

The analysis of suitability for the recreational category of beach tourism followed, with modifications and additions made to the suitability parameters based on the conditions of the research location and the characteristics of the marine ecosystems. The criteria for assessing the suitability of recreational beach tourism include the following factors:

- Beach type includes beach shape and substrate color, conducted by direct visual observation **(Chasanah *et al.,* 2017)**.
- Beach substrate characteristics were analyzed using the granual method for naming substrate dominance (substrate grain size), mainly gravel and sand grain size characteristics based on the Wentworth scale **(Janowski *et al.,* 2018)**.
- Beach type includes beach shape and substrate color, conducted by direct visual observation **(Kontu *et al.,* 2024)**.
- Beach substrate characteristics were analyzed using the granual method for naming substrate dominance (substrate grain size), mainly gravel and sand grain size characteristics based on the Wentworth scale.
- Coastal Waters Brightness is the intensity of sunlight entering the water.
- Current Velocity was analyzed descriptively using AEM213-D Data Processing Ver.1.21 and MS Excel software.
- The beach slope was analyzed using the equation according to **Sujantoko *et al.* (2023)**, which is expressed in angles, namely $\beta = [\![\tan]\!]\,^{\wedge}(-1)\,(A/D)$. Moreover, the results of the analysis were interpreted in the slope classification **(Kalay *et al.,* 2018)**.

- The width and depth of coastal waters were measured directly in the field, except for the seas. The bathymetry maps were analysed based on literature studies. The width and depth values of coastal waters were analyzed using MS. Excel software.
- Beach Land Cover was conducted through visual observation of the area around the beach, according.
- Freshwater availability was assessed through ground checks and community consultations at the research site and surrounding areas. Potentially dangerous biota were also identified during field observations

Data analysis method

This research aimed to determine beach tourism's internal and external potential by describing symptoms and events using a descriptive method. This research uses a qualitative descriptive study in a factual, systematic and accurate manner.

In this study, we focused our analysis of beach tourism suitability exclusively on the beach recreation category, adapting the assessment parameters to the local context of regional island tourism. The parameters considered included beach type (shape and substrate color), beach width, granule characteristics of the beach substrate, water depth, water clarity, current speed, wave height, beach slope, coastal land cover, presence of harmful biota, and freshwater availability. The matrix used to assess beach tourism suitability was modified based on the standard suitability matrix, as shown in Table (2).

Table 2. Beach recreation category tourism suitability index matrix

No	Parameters	Weight	S1	Score	S2	Score	S3	Score	N	Score
1	Beach type (shape and colour of sand)	0.200	White sand	3	White sand, coral fragments	2	Slightly rugged black sand	1	Muddy, rocky, steep	0
2	Beach Width	0.200	>15	3	10-<15	2	3-<10	1	<3	0
3	Beach Substrate	0.170	Sand	3	Sandy coral	2	Silty sand	1	Mud, sandy silt	0
4	Depth (m)	0.125	0-3	3	>3-6	2	>6-10	1	>10	0
5	Water brightness (%)	0.125	>80	3	>50-80	2	20-50	1	<20	0
6	Coastal current velocity (m/s)	0.080	0-17	3	17-34	2	34-51	1	>51	0
7	Beach slope	0.080	<10	3	10-25	2	>25-45	1	>45	0
8	Coastal land cover	0.010	Coconut, open land	3	Bush, scrub, savannah	2	Tall scrub	1	Mangroves, settlements, harbours	0

| 9 | Harmful Biota | 0.005 | None | 3 | Sea urchin | 2 | Sea urchin, stingray | 1 | Sea urchin, stingray, lepu, shark | 0 |
| 10 | Freshwater Availability (km) | 0.005 | <0.5 | 3 | >0.5 - 1 | 2 | >1 - 2 | 1 | >2 | 0 |

Source: Prepared by the author (2025)

The tourism suitability index (IKW) was analysed based on the equation of **Yulianda (2019)**:

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

Where, IKW is the tourism suitability index, N is the number of fit parameters. Bi is the weight of the 1st parameter; Si is the score of the 1st parameter. Furthermore, the IKW value is divided into 4 (four) suitability classes, including:

1. Strongly matches the IKW value ≥ of 2.5
2. Corresponds to a value of 2,0 ≤ IKW < 2.5
3. Not Suitable 1 ≤ IKW < 2.0,
4. Highly Incompatible with IKW value < 1.

RESULTS AND DISCUSSION

1. Description of research location

The South Leitimur sub-district has potential as a new tourist area, boasting unique characteristics that differentiate it from other regions in Ambon City. The attractiveness of the beach stems from the physical characteristics of the sea, the beach, and the surrounding marine ecosystems, as well as the culture of the people in this area.
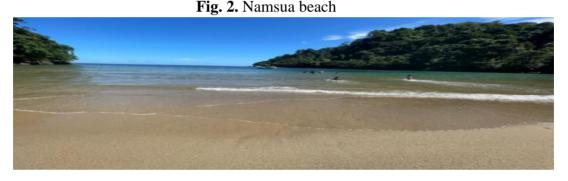
With an area of 50.50km², the sub-district consists of eight villages: Hutumuri, Rutong, Leahari, Naku, Kilang, Hukurila, Ema, and Hatalae. Leahari village is the capital of the sub-district. There are 11 beach attractions out of 28 natural attractions in the South Leitimur Sub-district **(Tourism Office of Ambon City, 2021)**, showcasing the rich biodiversity and beauty of the marine ecosystems.

The distribution of population settlements is more dominant in the mountains, while the coastal areas, with their diverse marine ecosystems, offer scenic cliffs, hills, and coves that create an exclusive atmosphere for visitors **(Tela *et al.*, 2024)**. The unique combination of natural beauty and cultural heritage makes the South Leitimur sub-district an attractive destination for tourists, with opportunities for sustainable tourism development that benefits both the local community and the marine ecosystems.

2. *Beach tourism potential*

2.1.   *Namsua beach*

- Internal potential: Namsua Beach Tourism has a beautiful beach charm on the outskirts of the Banda Sea with clear water, fine white sand and a little fine gravel. This beach forms a bay that juts in, flanked by large rock formations on both sides, as illustrated in Fig. (2). Visitors to Namsua Beach can enjoy its beautiful scenery and white sand, sunbathe, swim, and dive. The beach remains peaceful due to its distance from the village crowd.
- External potential: The beach is just 30 minutes from the city center, whether by car or motorcycle. Each year, the "antar sontong" tradition draws visitors to Namsua Beach, one of its main attractions. Currently, the beach remains undeveloped, mainly preserving its natural beauty. Nearby, visitors can also explore "Anihang," a stunning 15-meter-high waterfall situated 0.40km away from the beach, providing clean water. Fortunately, the mobile network in this area operates effectively, enabling tourists to communicate quickly and be able to access the Internet.

Fig. 2. Namsua beach

2.2.   *Nanseri beach*

- Internal potential: Nanseri Beach has exposed white sand and natural rocks. Here, tourists can enjoy the beauty of the beach, swimming, and diving. The view of the Banda Sea makes this location a huge tourist attraction. Nanseri Beach is like Namsua Beach, which is still natural, as seen in Fig. (3). Facilities are not yet available at this beach. Clean water sources are obtained in a residential area 2km from this beach.
- External potential: Nanseri Beach is 30 minutes from the city center by two or four wheels. It is 10 minutes walking down the hill to get to the location. There is a cellular network that can function properly and make it easier for tourists to communicate and access the Internet.

Fig. 3. Nanseri beach

2.3. Seu beach

Internal potential: This beach is a greyish-white pebble beach along the coast and is a unique attraction for visitors. This location is a tourist spot for swimming, fishing, and diving. The condition of this beach is still natural, and visitors enjoy the beach as a relaxing spot where they can take in the natural beauty surrounding them, as seen in Fig. (4).

External potential: Accessibility to this location via the Ambon land route to Negeri Hukurila is approximately 30 minutes using two or four vehicles. Seu Beach is still natural, and no facilities are available. Seu Beach is adjacent to Tihulessy Beach, hence tourists use Tihulessy Beach facilities such as toilets and bathrooms. An operating mobile network is sufficient to facilitate tourist internet access and communication.

Fig. 4. Seu beach

2.4. Lawena beach

- Internal potential: This beach is famous for its sandy and coral beach, with many starfish and tiny shells. Lawena Beach has shady trees that make the atmosphere more relaxed. Tourists can enjoy the panoramic view of the Banda Sea with blue sea water.
- External potential: The distance from the city center is roughly 40 minutes by two or four-wheeled vehicles. The road is well-paved, ensuring excellent and smooth access to the location. While amenities are limited, Lawena Beach offers toilets, relaxation areas, and bathrooms, all within a natural setting. A cellular network is also available, allowing tourists to communicate quickly and easily through the Internet.

Fig. 5. Lawena beach

3. Index of tourism suitability (IKW) analysis beach type

The beach types examined in this study are classified based on the shape and color of the predominant substrate, whether sand or gravel. The natural and anthropogenic coastal landscapes influence the shape of each beach to the adjacent sea, categorized as open beaches, semi-open beaches, and closed beaches. According to the research findings, the beaches at Location I (Namsua Beach), Location II (Namseri Beach), and Location III (Seu Beach) exhibit a slightly concave shape (Fig. 1).

The three tourism research sites are flanked by headlands on either side, creating a more sheltered or semi-enclosed beach formation. In contrast, Lawena Beach in Negeri Hutumuri features an elongated shape and is open to the Banda Sea (Table 1). The dominant substrate colour in Locations I, II, and IV is white sand, while Location III primarily comprises greyish-white gravel (Table 3). This analysis indicates that the beaches at the research sites are classified within the Suitable and Very Suitable categories based on their type.

Table 3. Beach type at each study site

Location	Type of coast		Scores	Suitability category
	Beach Shape	Sand/gravel colour		
I	Semi-enclosed	White sand	3	Very suitable
II	Semi-enclosed	White sand	3	Very suitable
III	Semi-enclosed	Greyish white gravel	2	As per
IV	Open	White sand	3	Very suitable

Source: Primary data (2025)

4. Beach substrate characteristics

The characteristics of the beach substrate in this study show that the dominant substrate obtained varies from gravel to fine sand. Based on the results of granualmetry analysis (grain size) of sediments at location I (Namasua Beach) in Negeri Naku, the dominant substrate is fine sand and slightly fine gravel, location II (Namseri Beach) in Negeri Kilang has a dominant substrate of fine sand and slightly gravel **(Elly *et al.,* 2021)**. At location III (Seu Beach) in Negeri **(Elisecarmel *et al.*, 2025)**, Hukurila has a dominant substrate of sandy gravel. At the same time, location IV (Lawena Beach) in Negeri Hutumuri has a dominant substrate of slightly gravelly sand, as shown in Table (3). The suitability category of beach tourism based on the dominant characteristics of the beach substrate obtained is the Suitable and Very Suitable category.

Table 4. Dominant characteristics of the Beach substrate

Location	Dominant substrate	Scores	Suitability category
I	Fine sand and slightly fine gravel	3	Very suitable
II	Fine sand and slightly gravelly	3	Very suitable
III	Fine sandy gravel	2	As per
IV	Slightly gravelly sand	3	Very suitable

Source: Primary data (2025)

4.1. *Water brightness*

Light attenuation in the water column, as determined by the water's brightness, reveals measurement results ranging from 8 to 16 meters. This indicates that the water conditions at the four tourist sites are clear. The water brightness parameters measured at each location showed values between 91 and 95%, as detailed in Table (5). This suggests that the brightness of the waters is highly conducive to recreational tourism.

Table 5. Water brightness at the study site

Location	Brightness		Scores	Suitability category
	(m)	(%)		
I	8	91	3	Very suitable
II	8	91	3	Very suitable
III	16	95	3	Very suitable
IV	11	93	3	Very suitable

Source: Primary data (2025)

4.2. *Beach current velocity*

The measurement of surface current velocity at four tourist sites in the South Leitimur District ranged from 0.18 to 0.20 m/s. The highest current speed was recorded at location III (Seu Beach), at approximately 0.20 m/s, while the lowest was observed at location IV (Lawena Beach), around 0.14 m/s. Locations I (Namsua Beach) and II (Namseri Beach)

exhibited a current speed of approximately 0.18 m/s, as detailed in Table (6). The overall surface current velocity is relatively slow, influenced by seasonal factors. These beaches are sheltered from the westerly winds that prevail during the western season.

Table 6. Current velocity at the study site

Location	Kec. Current (m/s)	Scores	Suitability category
I	0.18	2	As per
II	0.18	2	As per
III	0.20	2	As per
IV	0.14	3	Very suitable

Source: Primary data (2025)

4.3.   Beach slope

The results of the beach slope analysis at the location I (Namsua Beach) ranged from 17-19.5%, or from the sloping to steep category. At location II (Namaseri Beach) ranges from 18-21.7%, from sloping to steep, then at location III (Seu Beach), the slope ranges from 19.6-21.3%, which is a very sloping to steep category, while at location IV (Lawena Beach) ranges from 18.4-20.1% with a very sloping to steep category **(Sahureka *et al.,* 2016)**. This tourist destination strongly encourages beach tourism activities, as shown by the results of the beach slope analysis, which placed Namsua and Namseri beaches in the appropriate category and Seu beach and Lawena beach in the very appropriate category.

Table 7. Beach slope at the study site

Location	Coastal slope (%)	Scores	Suitability category
I	17 - 19.5	2	As per
II	18 - 21.7	2	As per
III	19.6 - 21.3	3	Very suitable
IV	18.4 - 20.1	3	Very suitable

Source: Primary data (2025)

4.4.   Beach width

The width of the beach was measured to see how much space tourists can use for tourist sites. From the last remaining ground vegetation to the lowest point of the low tide, the thickness of the shrubbery was measured **(Dimara & Renyoet, 2020)**.

Location I (Namsua Beach) has a beach width of 15m and a depth of 2m in addition to Location II (Namaseri Beach) having a beach width of 16m and a depth of 2m in addition to Location III (Seu Beach) and Location IV (Lawena Beach) have a beach width of 5 and 11m, respectively.

Table 8. Beach width results

Location	Coastal width (metres)	Scores	Suitability category
I	15	2	As per
II	16	3	Very suitable
III	5	1	Not suitable
IV	11	2	As per

Source: Primary data (2025)

5. Depth of coastal waters

The depth of the beach is ± 2m, as shown in Table (9). The results of measuring the depth of the beach at the four tourist sites show that it is included in the Very Suitable category for beach tourism. As for the width of the beach for 2 (two) locations including the appropriate category, namely location I (Namsua Beach) and location IV (Lawena Beach), then which is included in the Very Suitable category at location II (Nanseri Beach), and those at location III (Seu Beach) are included in the unsuitable category because the width of the beach is 5m **(Hiariey *et al.,* 2021)**.

Table 9. Beach depth results

Location	Shore depth (metres)	Scores	Suitability Category
I	3	3	Very suitable
II	2	3	Very suitable
III	2	3	Very suitable
IV	2	3	Very suitable

Source: Primary data (2025)

5.1. *Beach land cover*

Based on observations, the beach land cover can be seen in Table (10). The tourist sites are far from residential areas, so these 4 locations can be categorized as suitable for beach tourism.

Table 10. Results of beach land cover observations

Location	Land cover	Scores	Suitability Category
I	Open Land	3	Very suitable
II	Open Land	3	Very suitable
III	Open Land	3	Very suitable
IV	Open Land	3	Very suitable

Source: Primary data (2025)

5.2. *Harmful biota*

Based on the observation results, no harmful biota was found, and included in the suitability category is very suitable with a score of 3, as seen in Table (11).

Table. 11. Observation results of harmful biota

Location	Harmful biota	Scores	Suitability Category
I	None	3	Very suitable
II	None	3	Very suitable
III	None	3	Very suitable
IV	None	3	Very suitable

Source: Primary data (2025)

6. Fresh water availability

Based on the measurements and observations, fresh water was available at the location I (Namsua Beach) at 0.40m from the beach. In other places, fresh water was not available. This is because the area remains natural, lacking the facilities and infrastructure to support tourism activities.

Table 12. Results of freshwater availability measurement

Location	Freshwater availability (km)	Scores	Suitability category
I	0.40	3	Very suitable
II	2	2	Not suitable
III	3	0	Very Unsuitable
IV	0.1	3	Not suitable

Source: Primary data (2025)

Table 13. Recreation category beach tourism suitability index matrix (Modified from Yulianda)

No.	Parameters	Weight	Lok I	Score	Lok II	Score	Lok III	Score	Lok IV	Score
1	Beach type (Shape and Colour of sand)	0.200	Semi-closed, white sand	3	Semi-closed, white sand	3	Semi-closed, greyish-white gravel	2	Semi-closed, white sand	3
2	Beach Width (m)	0.200	15	2	16	3	5	1	11	2
3	Beach Substrate	0.170	Fine sand and slightly fine gravel	3	Fine sand and slightly gravelly	2	Fine gravel and sandy	2	Slightly gravelly sand	3
4	Depth (m)	0.125	3	3	2	3	2	3	2	3
5	Water	0.125	91%	3	91%	3	95%	3	93%	3

	brightness (%)									
6	Coastal current velocity (m/s)	0.080	0.18	2	0.18	2	0.20	2	0.14	3
7	Coastal slope (%)	0.080	17 - 19,5	2	18 - 21.7	2	19.6 - 21.3	3	18.4- 20.1	3
8	Coastal land cover	0.010	Open land	3	Open land	3	Open land	3	Open land	3
9	Harmful Biota	0.005	None	3	None	3	None	3	None	3
10	Freshwater Availability (km)	0.005	0.40	3	2	2	3	0	0.1	3
	Total Score			2.64		2.67		2.13		2.8
	Suitability Category			SS		SS		S		

Source: Prepared by the author (2025)

The results of the suitability analysis at the research site indicate that: (I) Namsua Beach (2.64), (II) Namseri Beach (2.67), and (IV) Lawena Beach (2.8) fall into the "Very Suitable" category for beach tourism development within the context of marine ecosystems conservation.

In contrast, (III) Seu Beach (2.13) falls into the "Suitable" category. The suitability of these beaches relies on the natural panorama of white sand beaches and the brightness of clear waters, characteristic of small island marine ecosystems **(Widodo *et al.*, 2023)**.

The IKW analysis reveals varying beach types, from gravel to fine white sand, reflecting the diversity of marine ecosystems in the area. Location III (Seu Beach) features fine greyish-white pebbles and sand, highlighting the unique characteristics of each beach within the marine ecosystems. The study measured beach width to determine the area suitable for beach tourism activities within the marine ecosystems **(Renjaan & Susanty, 2020)**. The average beach width at the tourist locations ranged from 5-16 meters, influencing the suitability of the beach for various activities.

With a width of 16 metres, Site II (Nanseri Beach) is classified as very suitable for beach tourism, offering ample space for swimming and sunbathing, while highlighting the beauty of the surrounding marine ecosystems. It is made more attractive by the beautiful view of the Barents Sea.

Given their respective widths of 15 and 11 metres, Namsua Beach and Lawena Beach locations are also suitable for beach tourism, allowing swimming and sunbathing, while protecting marine ecosystems.

In contrast, Location III (Seu Beach) has a smaller beach width of 5 meters, categorizing it as "Unsuitable" **(Marwan & Anwar, 2020)**. However, visitors can appreciate the natural beauty of the beach, the attractive slopes and the magnificent scenery, which accentuates the unique charm of this marine ecosystem. The substrate of the beach in the marine ecosystem of the site is mainly fine sand and slightly gravel, while the

substrate of the beach at Seu is fine gravel and sandy. According to current literature, sand bottom material is most suitable for shallow water recreational tourism activities shallow water shallow water shallow water sailing.

Beach tourism activities are perfect when sand substrates dominate a beach, compared to rocky beaches or those dominated by dead coral faults, which can interfere with visitor comfort **(Hardjowigeno & Widiatmaka, 2007)**. The average water depth at the research location is between 2-3 meters, categorizing it as "Very Suitable" for beach recreational activities such as swimming and sunbathing within the marine ecosystems.

Water depth is a determining factor in beach recreation, focusing on visitor safety and security **(Preez & Plessis, 2024)**. Studies recommend water depths of 0-3 meters or 0-5 meters for swimming and recreational activities. Safe swimming areas with shallow waters are essential for tourists, particularly in marine ecosystems where currents, waves, and sediment transport can impact water conditions.

The water brightness parameter at each research location within the marine ecosystems obtained values between 91% and 95%, indicating excellent visibility ranging from 8-16 meters. This allows for clear visualization of the coastal waters' bottom, making the brightness levels very suitable for recreational tourism activities.

According to **Tampo *et al.* (2023)**, factors such as suspended solids, turbidity, weather conditions, and measurement time significantly influence water brightness in marine ecosystems. The surface current speed at depths of less than 2 meters ranged from 0.14 to 0.18 meters per second, indicating slow currents.

Location IV (Lawena Beach) falls into the "Very Suitable" category, while other locations, such as Namalatu Beach with a current speed of 0.21 m/s, have moderate current speeds **(Fan *et al.*, 2022)**. Current speed is crucial for tourist safety during activities like swimming and bathing in marine ecosystems, as strong currents can pose significant risks **(Saraswati *et al.*, 2023)**.

The slope of the beach significantly affects safety during beach tourism activities within marine ecosystems. According to **Arias *et al.* (2024)**, a flat to gentle slope is very suitable for beach tourism, and the slope at the research location ranges between 16.5% and 19%, falling within the suitable category.

A beach slope of 3-30% is considered suitable for tourism activities, providing a safe and comfortable environment for visitors **(Kinanti & Wagistina, 2025)**. The gentle slope at the research location is ideal for activities like swimming, playing in the sand, and enjoying the waves, enhancing the overall experience in the marine ecosystems.

The beach land cover at the research location is open land dominated by coconut trees, which is suitable for recreation. The absence of dangerous biota, such as sea urchins and stingrays, further enhances the safety and appeal of the location for tourism activities within the marine ecosystems **(Setiawan & Suryasih, 2016)**.

Freshwater availability is also crucial, with locations I (Namsua Beach) and IV (Lawena Beach) having suitable distances of 0.40 and 0.1km, respectively **(Putra *et al.***

2023). In contrast, locations II (Nanseri Beach) and III (Seu Beach) are more natural, with limited facilities and freshwater sources located 2-3km away, highlighting the need for further development to support tourism in these marine ecosystems.

CONCLUSION

Safety during beach tourism activities is strongly influenced by the slope of the beach in a dynamic and diverse marine ecosystem. The slope of the research site, which is between 16 and 19 per cent, is within the appropriate range for sustainable tourism development in marine ecosystems.

The flat, gentle slope is said to be a major attraction for tourism thanks to the rampant vandalism of the beaches. The ideal slope for tourism is between 3 and 30 percent, offering guests a safe and comfortable environment in which to observe the marine environment.

To add to the overall experience of a vibrant marine ecosystem, the gentle slope of the research site is ideal for swimming, sand-playing and watching the waves. The beach area of the study area is open and coconut trees dominate, which makes it ideal for recreational purposes and for preserving the nearby marine ecosystems.

This location is safer and more attractive for tourism activities in marine ecosystems, as it is devoid of harmful organisms such as stingrays and sea turtles. Availability of fresh water is also crucial to promote tourism in the marine environment; sites I (Namsua Beach) and IV (Lawena Beach) are located respectively at 0-40 km and 0-1 km. Sites II (Nanseri Beach) and III (Seu Beach) are more undeveloped, with freshwater sources and few amenities within a distance of two or three kilometres. This highlights the need for further development to support sustainable tourism in these unique marine ecosystems.

ETHICAL CONSIDERATIONS

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

Arias, A.; Almar, R.; Regard, V.; Bergsma, E.W.J.; Castelle, B. and Garlan, T. (2024). Assessment of Beach Slope and Sediment Grain Size Anywhere in the World: Review of Existing Formulae, Integration of Tidal Influence, and Perspectives from Satellite Observations. J. Mar. Sci. Eng., 13(1): 1-15.

Astutik, E.P.; Anggraeni, L.; Juanda, B. and Rindayati, W. (2025). Analysis of sustainable tourism policy development strategies to support the creative economy in Banten Province. BIO. Web. Confer., 175: 06013.

Chasanah, I.; Purnomo, P.W. and Haeruddin, H. (2017). Analysis of the Suitability of Jodo Beach Tourism, Sidorejo Village, Gringsing District, Batang Regency. J. Natu. Resou. Environ. Manag., 7(3): 235–243.

Dimara, L. and Renyoet, A. (2020). Analysis of Suitability and Carrying Capacity of Urfu Bay Marine Tourism Area, Biak Numfor Regency. ACROP. Papua. J. Mar. Fisher. Sci., 3(2): 43–49.

Elisecarmel, S.M.; Astina, I.K. and Sihasale, D.A. (2025). Tourism Suitability Index Assessment and Development Strategy in Werahung Beach, Ambon City, Maluku. Indones. J. Tour. Leisu., 06(1): 95–111.

Elly, A.J.; Retraubun, A.S.W.; Sahetapy, D. and Papilaya, R. (2021). Mapping of spatial features model in developing marine ecotourism in Waerole and Nusa Telu, Maluku Province, Indonesia. J. Indones. Fish. Policy., 13(1): 17–30.

Fan, S.; Zhang, B.; Perrie, W.; Mouche, A.; Liu, G.; Li, H.; Wang, C. and He, Y. (2022). Observed ocean surface winds and mixed layer currents under tropical cyclones: Asymmetric characteristics. J. Geophys. Res. Oceans., 127(2): 1-13.

Hardjowigeno, S. and Widiatmaka, W. (2007). Evaluasi Kesesuaian Lahan dan Perencanaan Tataguna Lahan. Gadjah Mada University Press eBooks.

Herdiansyah, H.; Saiya, H.G.; Afkarina, K.I.I. and Indra, T.L. (2021). Coastal Community Perspective, Waste Density, and Spatial Area toward Sustainable Waste Management (Case Study: Ambon Bay, Indonesia). Sustainability., 13(19): 10947.

Hiariey, L.S.; Papilaya, R.L.; Hiariey, J. and Abrahamsz, J. (2024). Study of Beach Tourism Potential in Ambon City. Int. J. Arts. Soc. Sci., 7(2): 52-57.

Hidayat, M. (2011). Tourism Object Planning and Development Strategy (Case Study of Pangandaran Beach, Ciamis Regency, West Java). Tour. Hosp. Essent. J., 1(1): 33–43.

Janowski, Ł.; Tęgowski, J. and Nowak, J. (2018). Seafloor mapping based on multibeam echosounder bathymetry and backscatter data using Object-Based Image Analysis: a case study from the Rewal site, the Southern Baltic. Oceanol. Hydrobiol. Stud.,

47(3): 248–259.

Kalay, D.E.; Villian, F.; Lopulissa, and Yunita, A.N. (2018). Analysis of coastal slope gradient and distribution of coastal sediments in Waai Village, Salahutu District, Maluku Province. J. Triton., 14(1): 10–18.

Kemenparekraf, RI. (2022). Statistics of Domestic and Foreign Tourist. Jakarta

Kinanti, A.A. and Wagistina, S. (2025). Identification of tourism using the tourism suitability index (IKW) on Watukarung Beach, Pacitan Regency, East Java. Geogr. J. Educ. Res. Dev. Stud., 13(1): 50.

Kontu, T.; Oroh, D. and Lintong, O. (2024). Navigating tourism potential and environmental limits: A Suitability analysis of PAL beach (Indonesia) as an emerging coastal recreational destination. Turiz., 28(3): 189–205.

Marwan, N.F. and Anwar, D.R. (2020). Landscape design for coastal ecotourism of Jati Beach, North Sipora Island, Mentawai West Sumatera. IOP. Conf. Ser. Earth. Environ. Sci., 501(1): 012049.

Mehdila, N.M.C.; Sihasale, N.D.A.; Manakane, N.S.E. and Rakuasa, N.H. (2023). Spatial distribution of marine tourism objects in Leitimur Selatan District, Ambon City. Engl. Tour. Stud., 1(1): 6–12.

Mony, F.; Azuz, F.; Zakaria, S.; Marasabessy, A. and Kaisupy, T. (2023). The impact of community-based tourism development on the socio-economic dimensions of local communities in the coastal area of Ambon Island. Technium. Soc. Sci. J., 47(1): 269–278.

Preez, M.D. and Plessis, E.D. (2024). Who is Visiting South African Beaches and Why?. Afric. J. Hosp. Tour. Leisu., 13(1): 1-9.

Pushidrosal TNI-AL. (2012). Peta pulau Seram Bagian Barat, proyeksi mercrator. No. 398a. Pusat HidroOseanografi.

Putra, S.P.; Imran, Z. and Sulistiono, S. (2023). Suitability of Nesting Habitat and Tourism and Visitation Carrying Capacity in The Batu Kumbang Beach Turtle Conservation Area, Muko-Muko Regency, Bengkulu Province. Indonesia. J. Agricu. Sci., 28(2): 192–200.

Renjaan, M.J. and Susanty, I.I.D.A.R. (2020). Carrying capacity and tourism suitability of Ngurbloat Beach, Southeast Maluku Regency. IOP. Conf. Ser. Earth. Environ. Sci., 517(1): 012011.

Rumerung, D. and Siaila, S. (2023). Analysis of Nusaniwe Peninsula ecotourism Management : Sustainable ecotourism Management Strategies in Ambon City, Indonesia. Khaz. Sos., 5(2): 287–317.

Sahureka, M.; Lelloltery, H. and Hitipeuw, J.C.H. (2016). Implementation of Community-Based Ecotourism Development in the Mount Sirimau Protected Forest, Ambon City. Small. Isla. For. J., 1(2): 128.

Saraswati, S.A.; Manu, F.D. and Kangkan, A.L. (2023). Potential and carrying capacity of tourism area in Onanbalu Beach, Bokonusan Village, Semau Island, Kupang

District. Adv. Trop. Biod. Environ. Sci., 7(2): 70–79.

Setiawan, L. and Suryasih, I.A. (2016). Characteristics and Perceptions of Tourists on the Attraction of Kata Beach Tourism in Pariaman City, West Sumatra. J. Tour. Destinat., 4(1): 1.

Singgalen, Y.A. and Simange, SM. (2018). Livelihood and rural tourism development in coastal area North Maluku Province Indonesia. IOP. Conf. Ser. Earth. Environ. Sci., 156: 012010.

Sujantoko, N.; Mustain, M.; Wahyudi, N. and Ikhwani H. (2023). Hydrodynamic Model due to Reclamation in Lamong Bay. IOP. Conf. Ser. Earth. Environ. Sci., 1198(1): 012004.

Tampo, L.; Kaboré, I.; Mande, S.L.A.S. and Bawa, L.M. (2023). Water Quality and Aquatic Ecosystem Assessment Using Water quality Indices in West Africa: Challenge and Perspectives. IntechOpen eBooks.

Tela, I.N.; Ghani, M.Z.A.; Aryanti, D.; Zaitul. and Ilona, D. (2024). Community support toward Village-Based tourism development in Indonesia. J. Desi. Buil. Environ., 2004: 100–114.

Tourism Office of Ambon City. (2021). RIPDA Ambon City, 2021-2026**.**

Tourism Office of Ambon City. (2023). RIPDA Ambon City**,**

Towoliu, B.I.; Runtuwene. T.; Permana, D.E.; Lumettu. A.; Alelo, M. and Sangari. F. (2020). Coastal Carrying Capacity for Mangrove Ecotourism Development, Case Study in Budo Village, North Minahasa Regency. Adv. Soc. Sci. Educ. Hum. Res., 298(1): 132–135.

Widodo, M.P.S.; Idris, I.; Aprilya, N.; Fakhrurrozi, F.; Yusri, S.; Paryono, P.; Lestariningsih, W.A. and Damayanti, A.A. (2023). Analysis of the suitability and carrying capacity of marine and coastal tourism on Tunda Island, Banten Province. BIO. Web. Conf., 70: 06008.

Yulianda, F. (2019). Ekowisata perairan: suatu konsep kesesuaian dan daya dukung wisata bahari dan wisata air tawar. Bogor, Indonesia: IPB Press