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COASTAL RESOURCE ASSESSMENT: SUITABILITY AND CARRYING CAPACITY INDICES OF PANGANDARAN EAST COAST, WEST JAVA

Penilaian Sumber Daya Pesisir: Indeks Kesesuaian dan Daya Dukung Pesisir Timur Pangandaran, Jawa Barat

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ABSTRACT

This study aims to evaluate the tourism suitability index and carrying capacity of the Pangandaran East Coast area, West Java, as a tourist destination based on beach recreation and marine activities. This research was conducted in April 2025. The research method involved primary data collection through field surveys of environmental parameters such as beach conditions, water quality, and supporting facilities, as well as secondary data from relevant agencies. The analysis was conducted using a quantitative descriptive approach with the tourism suitability index formula and the carrying capacity of the area. The results showed that Pangandaran East Beach has a tourism suitability index for beach tourism, camping and swimming activities in a row of 97.3%; 91.7%; 85.9% which is classified in the "very suitable" category. The carrying capacity of the area for beach recreation activities was calculated at 253 people/day, then for swimming activities at 189 people/day and camping at 710 people/day which reflects the maximum capacity of visitors that can be received without disturbing the beach ecosystem or reducing the quality of the tourist experience. This approach provides important recommendations for tourism managers to optimize the management of visitor numbers and improve supporting facilities to maintain the sustainability of the area. With calm beach characteristics and good accessibility, Pangandaran East Beach has great potential as a leading destination in West Java for marine recreation. This research is expected to be a reference for the development of sustainable tourism policies in coastal areas.

Keywords: Beach Tourism, Carrying Capacity, Sustainable Tourism, Tourism Suitability Index

ABSTRAK

Penelitian ini bertujuan untuk menganalisis indeks kesesuaian wisata dan daya dukung kawasan Pantai Timur Pangandaran, Jawa Barat, sebagai destinasi wisata berbasis rekreasi pantai dan aktivitas kelautan. Penelitian dilaksanakan pada April 2025 dengan menggunakan metode survei lapangan untuk memperoleh data primer berupa parameter lingkungan, meliputi kondisi fisik pantai, kualitas perairan, serta fasilitas pendukung wisata. Selain itu, data sekunder diperoleh dari instansi terkait. Analisis data dilakukan secara deskriptif kuantitatif menggunakan perhitungan indeks kesesuaian wisata dan daya dukung kawasan. Hasil penelitian menunjukkan bahwa nilai indeks kesesuaian wisata untuk aktivitas rekreasi pantai, berkemah, dan berenang masing-masing sebesar 97,3%; 91,7%; dan 85,9%, yang termasuk dalam kategori sangat sesuai. Sementara itu, nilai daya dukung kawasan untuk kegiatan rekreasi pantai sebesar 253 orang per hari, berenang sebesar 189 orang per hari, dan berkemah sebesar 710 orang per hari. Hasil tersebut menunjukkan bahwa Pantai Timur Pangandaran memiliki kapasitas optimal untuk menerima kunjungan wisatawan tanpa menimbulkan gangguan terhadap ekosistem pesisir maupun penurunan kualitas pengalaman wisata. Pendekatan ini memberikan rekomendasi penting bagi para pengelola pariwisata untuk mengoptimalkan pengelolaan jumlah pengunjung dan meningkatkan fasilitas pendukung guna menjaga keberlanjutan kawasan tersebut. Dengan karakteristik pantai yang tenang dan aksesibilitas yang baik, Pantai Pangandaran Timur memiliki potensi besar sebagai destinasi unggulan di Jawa Barat untuk rekreasi laut. Penelitian ini diharapkan dapat menjadi acuan bagi pengembangan kebijakan pariwisata berkelanjutan di kawasan pesisir.

Kata Kunci: Daya Dukung Kawasan, Indeks Kesesuaian Wisata, Pariwisata Berkelanjutan, Wisata Pantai

INTRODUCTION

Pangandaran Regency has abundant marine tourism potential, one of which is Pangandaran Beach, one of the most popular beach and marine activity destinations in West Java. The stunning beauty of the beach, with its beautiful black and white sand, makes it an attractive choice for a visit (Hasibuan et al., 2021; Prihadi et al., 2024; Annida & Baihaqi, 2025). Pangandaran Beach has two sides, namely the West Beach and the East Beach, each with its own distinct characteristics. Pangandaran's East Beach is known as a center for water sports tourism activities, offering tourists the opportunity to witness the tradition of Pangandaran fishermen as they drag their nets from the sea to land, offer fishing activities, and witness the panoramic sunrise (Fajri et al., 2019; Annida et al., 2024; Annida et al., 2026). The number of tourists visiting Pangandaran Beach from May 28 to April 4 during the 2025 Eid al-Fitr holiday reached 243,899, with an average daily visitor count of 30,000 (detik.com, 2025). Of course, rapid tourism development must be balanced with management that implements sustainable tourism principles to avoid threatening environmental sustainability, the well-being of local communities, and the safety and comfort of tourists.

The concept of sustainability assumes a limited life or activity, meaning it does not involve activities or levels of activity that would have a permanent negative impact on other activities and natural systems (Panigoro et al., 2023; Pieranski et al., 2023). Analysis of tourism suitability and tourism carrying capacity is a crucial aspect in the planning and management of tourism on East Pangandaran Beach. In tourism management, managers must understand the criteria for coastal tourism to take corrective actions to improve the quality and comfort of tourism. This can be done through characteristic assessments to determine the level of suitability (Cahyani et al., 2023; Nurjayanti et al., 2023; Diniz et al., 2024). Tourism carrying capacity is needed to limit the number of tourist visits to match the capacity of an area and avoid overtourism. Carrying capacity is the number of tourists that can be accommodated in an

area while minimizing damage, aiming to preserve the environment and ecosystem sustainably (Isnani et al., 2024; Du et al., 2024; Skiniti et al., 2024). Verification of the determination of tourist numbers must be conducted periodically because the concept of carrying capacity of a tourism area is dynamic (Yudhistira & Komarudin, 2021).

Previous research on Pangandaran tourism has largely focused on tourism development strategies, visitor perceptions, and risk assessment. However, research specifically integrating the tourism suitability index and carrying capacity analysis for various coastal tourism activities on Pangandaran's East Coast is still limited. Therefore, this study aims to evaluate the tourism suitability index and carrying capacity of Pangandaran's East Coast through a comprehensive assessment of beach recreation, swimming, and camping activities. This study aims to provide important recommendations for tourism managers in designing sustainable management strategies, optimizing tourism management, and serving as a reference for developing sustainable coastal tourism policies.

RESEARCH METHODS

Research Time and Location

This research was conducted in April 2025, located on the East Coast of Pangandaran, in Pananjung Village, Pangandaran District, Pangandaran Regency, West Java Province. A map of the research location can be seen in Figure 1.

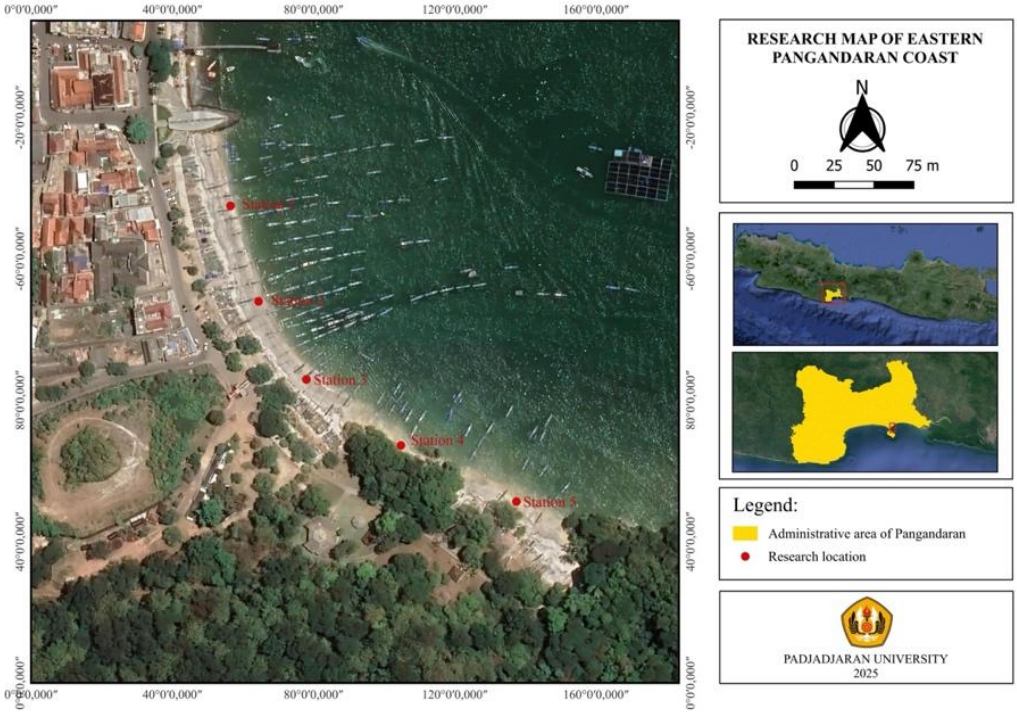

Figure 1. Research Map

Tools and Materials

The tools and materials used in this research included direct data collection by determining location coordinates using a Global Positioning System (GPS), a flowmeter to measure current velocity, a depth gauge to measure water depth, a Secchi disc to measure water clarity, and a roll meter to measure beach width and distance to freshwater sources. Wave height and slope angle were measured using a depth gauge and a theodolite.

Research Procedure

The data collection method used was direct observation at the research location to determine the physical condition of the beach. The necessary parameters were measured at a total of five stations spaced approximately 473 m apart, systematically divided along the East Pangandaran coastline.

Data Analysis

This analysis uses a quantitative descriptive approach using the tourism suitability index and regional carrying capacity formulas. According to Yulianda (2019), the formula used to determine the tourism suitability index is as follows:

$$\text{Tourism Suitability Index} = \sum \left(\frac{\text{Ni}}{\text{Nmax}}\right) \times 100\%$$

Where:
IKW = tourism suitability index (%)
Ni = value of the i-th parameter (weight x score)
Nmax = maximum value of a tourism category

The tourism suitability index percentage is categorized as follows:
Highly suitable = 83% ≤ IKW ≤100%
Suitable = 50% ≤ IKW <83%
Not suitable = 17% ≤ IKW <50%
Very unsuitable = IKW <17%

The analysis of coastal tourism suitability considers several parameters, namely, beach type, beach width, bottom material, water depth, water clarity, current velocity, beach slope, coastal land cover, dangerous biota, and freshwater availability. The suitability of beach tourism in the recreation category considers ten parameters with four assessment classifications (Yulianda, 2019). The tourism suitability parameters can be seen in Table 1 below:

Table 1. Beach Tourism Suitability Assessment Matrix

No.	Parameter	Weight	Suitability Class (score)			
			3	2	1	0
1	Beach Type	0.200	White sand	White sand, coral	Black sand, coral	Muddy, rocky, steep
2	Beach Width (m)	0.200	>15	10-15	3-<10	<3
3	Bottom Material	0.170	Sand	Sandy reef	Muddy sand	Mud, muddy sand
4	Water Depth (m)	0.125	0-3	>3-6	>6-10	>10
5	Water Transparency (%)	0.125	>80	>50-80	20-50	<20
6	Current Velocity (cm/s)	0.080	0-17	>17-34	>34-51	>51
7	Beach Slope (°)	0.080	<10	10-25	>25-45	>45
8	Beach Land Cover	0.010	Coconut, open land	Shrub, thicket, low, savanna	Tall thickets	Mangrove forests, settlements, harbors

No.	Parameter	Weight	Suitability Class (score)			
			3	2	1	0
9	Dangerous Biota	0.005	Nothing	Sea urchins	Sea urchins, stingrays	Sea urchins, stingrays, lionfish, sharks
10	Freshwater Availability/Distance to Freshwater Source (km)	0.005	<0.5	>0.5-1	>1-2	>2

Meanwhile, the suitability analysis for camping tourism activities consists of five assessment parameters with four assessment categories. The suitability analysis for camping tourism activities is presented in Table 2 (Yulianda, 2019).

Table 2. Tourism Suitability Assessment Matrix for Camping Tourism Activities

No.	Parameter	Weight	Distribution Class Values			
			3	2	1	0
1	Substrate type	0.375	Grass or sand	Grassy land	Muddy or rocky	Unstable rock or soil
2	Beach width (m)	0.225	x >10	$7 < x \leq 10$	$5 < x \leq 7$	≤ 5
3	Coastal vegetation	0.150	Coconut, pine and acacia trees	A forest with few trees and bushes	Tall bushes	Tall bushes and swamps or areas without vegetation
4	Beach slope angle (°)	0.150	x <5	$5 < x \leq 15$	$15 < x \leq 30$	> 30
5	Object view	0.100	Beaches, forests, mountains, rivers	Beach and 2 of 3 views	1 of 4 views	There is no beautiful view

The tourism suitability assessment for swimming tourism activities uses nine parameters with four assessment classifications. The tourism suitability assessment matrix for swimming tourism activities can be seen in Table 3 (Yulianda, 2019).

Table 3. Tourism Suitability Assessment Matrix for Swimming Tourism Activities

No.	Parameter	Weight	Distribution Class Values			
			3	2	1	0
1	Water depth (m)	0.143	0-3	>3-6	>6-10	>10
2	Substrate material	0.143	Sand	Sandy coral	Muddy sand	Mud or sandy mud
3	Current velocity (cm/s)	0.143	0-0.17	0.17-0.34	0.34-0.51	>0.51
4	Wave height (m)	0.143	0-0.5	0.5-1	1-1.5	>1.5

No.	Parameter	Weight	Distribution Class Values			
			3	2	1	0
5	Beach type	0.086	White sand	White sand mixed with coral chips	The black sand beach is a bit steep	Muddy, rocky, steep
6	Beach width (m)	0.086	>15	10-15	3-<10	<3
7	Water clarity (%)	0.086	>80	>50-80	20-50	<20
8	Presence of harmful biota	0.086	There is no dangerous biota	jellyfish	Sea urchins, jellyfish	Sea snakes, sea urchins, jellyfish
9	Distance to freshwater source (km)	0.086	<0.5	>0.5-1	>1-2	>2

Area Carrying Capacity (DDK) is the maximum number of visitors that can physically be accommodated in a designated area at a given time without causing disruption to nature and humans (Yulianda, 2019). To calculate the DDK, the following formula is used:

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

Where:
DDK = Carrying capacity of the tourism area (people/day)
K = Ecological potential of visitors per unit area
Lp = Area or length of usable area
Lt = Unit area for a specific category
Wt = Time allocated by the area for tourism activities in one day
Wp = Time spent by visitors for each specific activity

DDK can be calculated for each category of tourism activity. The ecological potential (K) for beach tourism and swimming activities is 1 person per 25 m of beach length, while the ecological potential for camping activities is 4 people per area of 20 x 20 m or 400 m². The average time spent by tourists (Wp) on beach tourism activities includes 3 hours for beach recreation, 4 hours for swimming, and 24 hours for camping. Meanwhile, the time provided by the area for tourism activities in one day (Wt) in the category of beach recreation and swimming tourism activities is eight operational hours per day and 24 full hours for camping tourism activities (Yulianda, 2019).

RESULT

The research results regarding the tourism suitability index for East Pangandaran Beach for beach recreation, swimming, and camping are presented in Tables 4, 5, and 6, respectively:

Table 4. Tourism Suitability Index for the Beach Recreation Category

No.	Parameter	Category	Score
1	Beach Type	White Beach	60%
2	Beach Width (m)	30	60%
3	Bottom Material	Sand	51%
4	Water Depth (m)	2.4	38%
5	Water Transparency (%)	88	38%
6	Current Velocity (cm/s)	25	16%

No.	Parameter	Category	Score
7	Beach Slope (°)	0-3	24%
8	Beach Land Cover	Coconut trees, open area	3%
9	Dangerous Biota	No harmful biota	2%
10	Freshwater Availability/Distance to Freshwater Source (km)	<0.5	2%
	IKW Value		97.3%

Table 5. Tourism Suitability Index for the Camping Category

No.	Parameter	Category	Score
1	Substrate type	Sand	113%
2	Beach width (m)	30	68%
3	Coastal vegetation	A forest with few trees and bushes	30%
4	Beach slope angle (°)	0-3	45%
5	Object view	Beach, forest, mountains	20%
	IKW Value		91.7%

Table 6. Tourism Suitability Index for the Swimming Category

No.	Parameter	Category	Score
1	Water depth (m)	2.4	43%
2	Substrate material	Sand	43%
3	Current velocity (cm/s)	25	29%
4	Wave height (m)	1.3	14%
5	Beach type	White sand	26%
6	Beach width (m)	30	26%
7	Water clarity (%)	88	26%
8	Presence of harmful biota	There is no dangerous biota	26%
9	Distance to freshwater source (km)	<0.5	26%
	IKW Value		85.9%

Based on Tables 4, 5, and 6, the suitability of the East Pangandaran Beach area for beach recreation, camping, and swimming is 97.3%, 91.7%, and 85.9%, respectively. The tourism suitability index indicates that the suitability levels for beach recreation, camping, and swimming are very good.

The assessment of the carrying capacity of the Pangandaran East Coast tourism area for beach recreation, camping, and swimming activities is presented in Table 7 below:

Table 7. Carrying Capacity of Pangandaran East Coast Tourism Area

No.	Type of Activity	K	Coastal Length (m)	Suitable Area (m^2)	Wt	Wp	Capacity (tourists/day)
1	Beach Recreation	1 people	2,368	71,040	8	3	253
2	Camping	4 people	2,368	71,040	24	24	710
3	Swimming	1 people	2,368	71,040	8	4	189

Based on Table 7 above, the carrying capacity of Pangandaran East Coast tourism for beach activities is 253 people per day, camping 710 people per day, and swimming 189 people per day.

DISCUSSION

Pangandaran Beach is geographically located on the east side of the coast, bordered by a bay known as the Nature Reserve, which connects the west side of the coast, namely West Pangandaran Beach. The physical condition of the east coast offers white sand and clear water, although the East Coast is not as wide as the West Pangandaran Beach. For recreational activities, the east coast has an area of approximately 30 meters, where the potential of this area is very suitable for beach recreation activities. In line with the statement of Sari et al. (2023) who stated that beaches with wide expanses offer comfort and freedom for tourists to engage in various tourism activities without being disturbed by other tourists. Pangandaran East Beach also has a sandy base and a beach depth of approximately 2.4 meters with a water clarity of 88%. This depth and clarity of the water allow tourists to enjoy beach tourism activities safely and comfortably. Water clarity parameters play a very important role in the comfort of tourists who engage in water tourism activities, one of which is swimming (Mugini et al., 2022). A current speed of 25 cm/s indicates that the coastal current conditions are not too high, this is certainly safe for beach tourism activities and swimming.

The research results also indicate that the east coast has wave heights of approximately 1.3 m. However, this condition does not apply to all points along Pangandaran's East Coast; other areas outside the study area have high currents and wave speeds, making swimming unsuitable. This location is a center for water sports tourism. The East Coast is primarily used for water sports due to its high wave conditions (Dikara et al., 2022). The beach slope at the study area ranges from 0 to 30°, indicating a relatively gentle slope and safety for tourism activities. Furthermore, the beach is free of dangerous biota that could pose a threat to tourists; the absence of dangerous biota certainly adds to the beach's suitability for tourism. Freshwater sources are also relatively close to the beach, less than 0.5 km away. The availability of adequate water sources and the proximity of the beach are certainly very suitable for beach tourism activities. Beach cover consists of coconut trees and open areas with views of the beautiful beach, forest, and mountains for tourists to enjoy. Good land cover management can impact regional sustainability and, of course, increase tourist appeal (Mugini et al., 2022).

The tourism suitability index for East Pangandaran Beach for beach recreation activities reached 97.3%, categorized as highly suitable, 91.7% for camping, and 85.9% for swimming. These three highly suitable tourism activities clearly demonstrate significant potential for tourism development on East Pangandaran Beach. This potential must be properly utilized and managed through the principles of sustainable tourism, which responsibly utilizes resources.

After determining the tourism suitability value, the carrying capacity of an area for tourism activities is equally important. This carrying capacity aims to limit the number of tourists in a tourist area so that it does not exceed the area's capacity. This carrying capacity aims to preserve nature and maintain tourist comfort (Yulianda, 2019). The carrying capacity of the Pangandaran East Coast tourist area for beach tourism is 253 people per day, camping 710 people per day, and swimming 189 people per day. This value represents the maximum tourist limit for each beach tourism activity.

Periodic assessment of the carrying capacity of a dynamic area is necessary for the management of the Pangandaran East Coast tourist area. Analysis of the tourism suitability index and carrying capacity of the area can provide important recommendations for tourism managers in designing sustainable management strategies, optimizing tourism management, and serving as a reference for developing sustainable tourism policies. With management based on carrying capacity, where the number of tourists does not exceed the carrying capacity while maintaining environmental conservation, the area's utilization can be more optimal (Syafira et al., 2023).

CONCLUSION

The tourism suitability index on Pangandaran East Beach for beach recreation activities has a value of 97.3%; camping category is 91.7%; and swimming recreational activities have a value of 85.9%. The suitability level of each of these tourism activities is categorized as very suitable. Natural condition factors that influence the tourism suitability index value such as ocean currents, water depth, sand type, water clarity, and others cannot be changed, but the government can strive to utilize the area by applying the principles of sustainable and responsible tourism in the use of natural resources. The carrying capacity of the Pangandaran East Beach area for beach recreation activities is calculated at 253 people/day, for camping at 710 people/day, and swimming at 189 people/day, which reflects the maximum capacity of visitors that can be accepted without disrupting the coastal ecosystem or reducing the quality of the tourism experience.

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