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Evaluating the Tourism Suitability Index and Carrying Capacity of Pangandaran Beach, West Java, Indonesia

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Abstract: Pangandaran Beach, a marine tourism destination located in Pangandaran, West Java, is stipulated as a priority tourism area and has three eminent locations, i.e., East Coast, West Coast, and White Sand Coast, all of which are famed for their natural appeals, bringing about a sharp increase in the number of visitors after the pandemic. This research explores the tourism suitability index and carrying capacity of Pangandaran Beach as a recreation tourism area. Data analysis method using the tourism suitability matrix for beach recreation and carrying capacity for tourism activities including beach recreation, swimming and sunbathing. The tourism suitability index demonstrated that the West Coast belonged to the Very Suitable category, and the East Coast and White Sand Coast belonged to the Suitable one. Furthermore, each tourism area' carrying capacity related to recreation activities at the beach, swimming, and sunbathing was 1,536 visitors per day. Policies applicable at Pangandaran Beach are also expected to cover the regulations concerning visitors' visits and tourism activities. Thus, it is necessary to manage a sustainable marine tourism development strategy and the development of various tourism activities by considering the carrying capacity so as not to damage the ecosystem.

Keywords: *Pangadaran Beach, Suitability Index, Carrying Capacity, Marine Tourism*

1. Introduction and Background

Pangandaran, West Java, Indonesia, nurtures a leading sector in tourism and is designated as a National Tourism Strategic Area (Hasibuan et al. 2019; Rizal, Apriliani, and Permana, 2021; Taofiqurohman, Zallesa, and Faizal, 2023). The swift expansion of tourism along the Pangandaran coastlines indicates a broader variety of water-based recreational activities. The number of both domestic and international visitors to these coastal areas has risen, particularly after the COVID-19 pandemic, as well as the Special Economic Zone was designated for development as one of Indonesia's international tourist destinations in March 2019. Regardless of the COVID-19 pandemic, the number of tourists visiting in 2020 and 2021 reached 2,930,506 and 3,604,128, respectively, and even at the end of 2022, it increased sharply to 3,851,962 (INEWS 2022; BPS Jawa Barat 2023). The district's five most visited beaches by tourists are Pangandaran Beach, Batukaras Beach, Madasari Beach, Batuhiu Beach, and Karapyak Beach, which have different characteristics and numbers of visits (Putri, Khadijah, and Novianti 2020). Among those five beaches, Pangandaran Beach is the most visited as it is visited by almost three million visitors (Hasibuan et al. 2019; Taofiqurohman, Zallesa, and Faizal 2023; ruber.id 2023).

Tourists also find that the East Coast, West Coast, and White Sand Coast, three areas in Pangandaran Beach, are attractive, but the ever-increasing number of tourists brings on concerns that it may harm the physical and ecological conditions of the marine tourism areas and cause unsustainable tourism. The Tourism Suitability Index (TSI) serves as a tool for evaluating an area's capability to support specific tourism activities by examining its environmental conditions and resource availability, taking various parameters into account (Renjaan and Raka Susanty, 2020; Yulianda, 2019; Lelloltery et al. 2018; Shokri and Mohammadi, 2021). In addition to assessing the suitability of a particular tourism site, another approach to evaluating a tourism area is by determining its carrying capacity. According to the United Nations World Tourism Organization (UNWTO), carrying capacity is defined as the maximum number of visitors that a tourist destination can accommodate simultaneously without causing adverse effects on the physical, economic, sociocultural, and environmental conditions surrounding the tourism area, which can ultimately affect customer satisfaction (UNWTO 2018).

Carrying capacity is strongly connected with the many tourists visiting to enjoy the attractions. The high number of tourists and carrying capacity above the threshold will affect the quality of tourist convenience, tourist satisfaction (Egi and Darsiharjo, 2014; Nian et al. 2023), and environmental degradation (Stefanica et al. 2021).

According to Suana et al. (2020) and Tan et al. (2020), A tourist area needs to be able to manage a large number of tourists, generating an environmental carrying capacity that allows tourists to enjoy the beauty of nature to the fullest and reduces environmental damage. It can also increase their awareness of the importance of protecting nature and increasing the development of natural tourism. Tourism support is oriented to the maximum number of people who visit tourist attractions without causing physical, economic, and socio-cultural damage to the environment and loss of quality, which is detrimental to tourist satisfaction (Rahmafitria et al. 2021; Renjaan and Raka Susanty 2020). Moreover, by applying the carrying capacity of nature-based tourism using zoning, it can provide recommendations for the maximum number of tourists that can be accommodated in the destination so that it can be sustainable (Rahmafitria and Nurazizah, 2022).

In this study, it is vital to investigate the extent to which Pangandaran Beach, a popular destination, can be protected for the sake of the environment without forgoing tourist convenience. The purpose of this study is to assess Pangandaran Beach's appropriateness for beach leisure tourism and its carrying capacity for activities like beach recreation, swimming and sunbathing. In addition, it is critical to develop sustainable marine tourism by considering the beach's tourism suitability and carrying capacity, which are probed here to sustain the tourism area.

2. Research Methodology

Research Location and Time

This study focused on tourist areas in the coastal areas of Pangandaran Beach: East Coast, West Coast, and White Sand Coast. The criteria used in selecting potential research locations include location accessibility, tourism activities that are already running at the location, and popular tourism destinations. This research was conducted in Pangandaran, West Java, Indonesia from July to early August 2023

Data Collection Technique

Primary and secondary data were used. The primary data was gathered through on-site and off-site observations (via Google Earth), surveys, and interviews with respondents such as visitors and local government officials. Secondary data was collected from relevant studies and literature concerning the data about Pangandaran Beach. The first was collected through direct field observation and interviews with 150 informants regarding their perceptions of the tourism location, and the secondary data was collected through a literature study and data gathered by relevant institutions, e.g., the Tourism Office in Pangandaran and the Geospatial Information Agency (BIG).

Data Analysis

Marine Tourism Areas' Tourism Suitability Index

The TSI analysis was conducted to determine if an area was suitable or unsuitable for tourism by observing available parameters and comparing them with those in a suitable area (Yulianda, 2019). Determining the coastal tourism areas' tourism suitability index (TSI) was done using the following formula (Yulianda, 2019):

$$TSI = \sum_{i=1}^{n} (Bi\ xSi)$$

n = the number of suitability parameters
Bi = the weight of the parameter i-th
Si = the score of the parameter i^{th}

Description:
Very Suitable : TSI ≥ 2.5
Suitable : 2.0 ≤ TSI < 2.5
Unsuitable : 1 ≤ TSI < 2.0
Very Unsuitable: < 1

The outcomes of multiplying the scores and weights assigned to each parameter were utilized to assess the suitability of an area for tourism activities. The overall suitability score for each parameter reflects the final result of the tourism suitability index. Based on the obtained TSI value, four categories can be identified from the tourism suitability assessment (Very Suitable, Suitable, Unsuitable, Very Unsuitable)

Marine Tourism Areas' Carrying Capacity

Researching the carrying capacity was crucial for developing marine tourism using sustainable marine resource potentials (Sun et al. 2022). Tourism Carrying Capacity (TCC) refers to an ecotourism destination's capacity to accommodate the number of visitors without jeopardizing the ecosystem(Adrianto et al. 2021; Yulianda 2019). Carrying capacity was calculated based on the maximum number of visitors a tourist area could physically accommodate at a certain time without damaging nature and human beings.

We identified the coasts' carrying capacity using the following formula (Yulianda 2019):

$$CC = Kx\frac{Lp}{Lt}x\frac{Wt}{Wp}$$

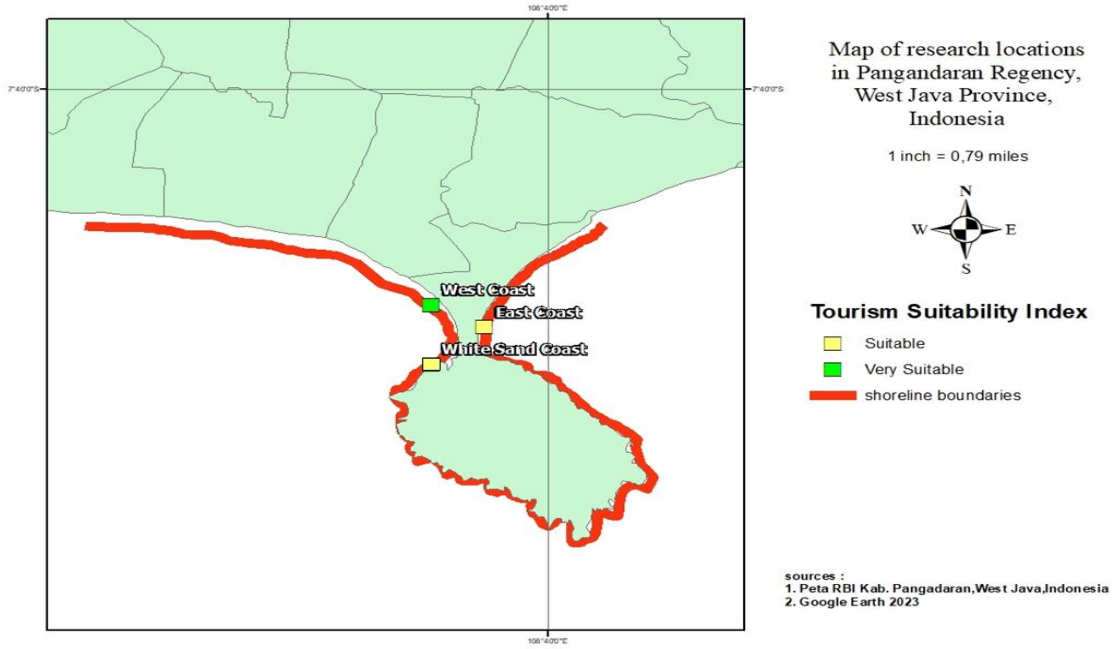
Where:

DDK = Carrying capacity of each tourism area (people/day)
K = Ecological potency of visitors per area unit
Lp = Width or length of each area that could be used
Lt = Area unit for a particular category
Wt = Time provided by each area to do a tourism activity in a day
Wp = Time spent by visitors on a specific activity

3. Results

Pangandaran had a 91 km line area and beaches in the southern part of Java Island, Indonesia. One of the beaches, Pangandaran Beach, was famous for its breathtaking natural beauty and a range of recreational and tourism activities that its visitors could enjoy.

Figure 1: Research Location and the Tourism Suitability Index of Pangandaran Beach



Tourism Suitability Index

Measuring the tourism suitability index relied on suitability parameters of a beach as a tourism area, and the parameters encompassed beach type, beach width, beach base material, water depth, water brightness, current

speed, beach slope, beach land cover, dangerous biota, and freshwater availability. We exhibit the tourism suitability index of Pangandaran Beach in Table 1.

Table 1: Beach's Tourism Land Suitability Matrix

Parameter	Score	Category				West Coast	East Coast	White Sand Coast
Beach type	0.2	Beach sand	White sand mixed with coral fragments	Black sand, slightly steep	Muddy, rocky, steep	0.6	0.4	0.4
Beach width (m)	0.2	> 15	> 10-15	3- < -10	< 3	0.6	0.4	0.2
Water-based material	0.17	Sand	Sandy coral	Muddy sand	Muddy, sandy mud	0.51	0.34	0.34
Water depth (m)	0.125	0-3	> 3-6	> 6-10	> 10	0.375	0.25	0.375
Water brightness (%)	0.125	> 80	> 50-80	20-50	< 20	0.25	0.375	0.375
Current speed (cm/second)	0.08	0-17	17-34	34-51	> 51	0.24	0.24	0.24
Beach slope (°)	0.08	< 10	> 10-25	> 25-45	> 45	0.24	0.16	0.24
Land cover	0.01	Coconut trees, open land	Low scrubs, savanna	High scrubs	Mangroves, settlements, harbor	0.03	0.03	0.02
Dangerous biota	0.005	None	Sea urchins	Sea urchins, stingrays	Sea urchins, stingrays, lionfish, sharks	0.015	0.015	0.015
Freshwater availability/ distance to the freshwater source (km)	0.005	< 0.5	> 0.5-1	> 1-2	> 2	0.015	0.015	0.005
Tourism Suitability Index (TSI)						**2.875**	**2.225**	**2.21**

Source: field observations and data processing, 2023-2024

Table 1 indicates that among the three studied locations in Pangandaran Beach, the West Coast was very suitable based on the parameters of a beach for recreational tourism, while the East Coast and White Sand Coast were suitable. Based on observation in the field, the West Coast of Pangandaran Beach has become tourists' favorite due to a sandy beach with a width of more than 15 meters, which offers leisure marine tourism activities like sunbathing, swimming, relaxing, sitting, playing and taking photos. The more the width beach the more spacious the area for various tourism activities (Renjaan and Raka Susanty 2020). The water depth of the West Coast near the shoreline area is within 0-3 meters, which is very suitable for swimming (Manu, Kangkan, and Saraswati 2023). However, the bright water in the White Sand Coast is clearer than the others. Both the West Coast and White Sand Coast areas, the beach slopes that tend to be gently sloping in comparison with the East Coast. The coastal land cover on both the West Coast and the East Coast is open land with coconut trees while the White Sand Coast is mangrove trees although very few. Observing the dangerous biota in marine tourism needs to be carried out due to tourists' inconvenience and disturbance. During the field, Pangandaran beach as a research location doesn't contain dangerous biota. The availability of fresh water, both on the East Coast and on the West Coast, is very close, in contrast to the White Sand Coast, which is a conservation area that is a little bit far away from the sources of fresh water.

Figure 2: Tourism Suitability Index of Pangandaran Beach (West Coast, East Coast and White Sand Coast)

"VERY SUITABLE" WEST COAST PANGANDARAN BEACH.

"SUITABLE" EAST COAST PANGANDARAN BEACH.

"SUITABLE" WHITE SAND COAST PANGANDARAN BEACH.

Beach Tourism Areas' Carrying Capacity

The carrying capacity of a beach tourism area points out the area's capacity to accommodate visitors performing a certain activity. This study scrutinized Pangandaran Beach's carrying capacity by taking into account recreational activities at the beach, swimming and sunbathing on the East Coast, West Coast, and White Sand Coast. We present the results in Table 2.

Table 2: Pangandaran Beach's Tourism Carrying Capacity

No.	Tourism Activities at Pangandaran Beach	Carrying Capacity
1	Beach recreation	1,536 people/day
2	Swimming	1,536 people/day
3	Sunbathing	1,536 people/day

The Tourism Carrying Capacity (TCC) calculated for the three study locations shows varying results depending on the scale of tourism activities and the size of each site. For Pangandaran Beach, the maximum number of visitors it can accommodate in a single operational day, specifically for water-based ecotourism (beach recreation, swimming, sunbathing), is approximately 4.608 visitors per day. This number was determined after factoring in seasonal and weather conditions that could limit visitor activities. The calculation assumes that the tourism sites are operational for 8 hours per day. Table 2 shows that the beach's carrying capacity for each tourism activity of beach recreation, swimming, and sunbathing was 1,536 people/day at a total beach length of 19,200 m. The suitability of any attractions that could be improved at Pangandaran Beach. Tourists could perform the three tourism activities in a day but not necessarily at the same time. Efforts were made to regulate tourism activities, help visitors undertake tourism activities well, and maintain the area's carrying capacity. Besides, they prevented over-tourism and preserved the area's sustainability (Butler, 2020; Mihalic, 2020; Zekan et al., 2022). The management of tourist visits by the carrying capacity of coastal areas is crucial for achieving sustainable tourism. The carrying capacity of a beach includes the environmental limits on the number of visitors it can accommodate without damaging the ecosystem. By limiting the number of visitors to match the area's capacity, managing tourism activities to avoid disrupting the natural balance, and implementing environmentally friendly policies such as waste management and resource conservation, coastal destinations can be preserved. This effective management approach not only maintains the quality of the tourism experience but also ensures the ecological functions of the coastal areas are sustained for future generations. Moreover, based on the literature states that limiting the number of visitors was carried out to realize a sustainable use of marine tourism (Adrianto et al. 2021; Samal and Dash 2023; Nofiansyah, Akbar and Sulastri 2021; Sun et al. 2022).

4. Conclusion

To conclude, based on the results, Pangandaran Beach, as a tourism area, was very suitable for tourism recreation, particularly its West Coast, and suitable, specifically, its East Coast and White Sand Coast. The area's carrying capacity for beach recreation, swimming, and sunbathing activities was 1,536 people/day. Our study of tourism suitability and carrying capacity is expected to be the groundwork for making policies concerning Pangandaran Beach's sustainability. The limitation of this research is the short time, so further research is needed regarding the number of tourists that can be accommodated based on variations in marine tourism activities on Pangandaran beach so that it regulates the pattern of tourist visits based on tourism activities based on the carrying capacity of tourism activities.

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