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Analysis of the Suitability of Beach Tourism and the Carrying Capacity of Slili Beach, Gunungkidul, Yogyakarta

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***Abstract*— Slili Beach in Gunungkidul Regency is one of the rapidly developing coastal tourist destinations that requires an evaluation of area suitability and environmental carrying capacity to ensure sustainable management. This study aims to analyze the level of suitability for beach tourism and the area's carrying capacity based on biophysical parameters and tourist activities. The survey method used to collect data involved field observations at three sampling stations and the distribution of questionnaires to 100 respondents considered representative of the population. The data obtained were then analyzed using the Tourism Suitability Index (IKW) and Area Carrying Capacity. The results show that the level of suitability for recreational tourism at the three stations ranged from 84–94%, while suitability for swimming ranged from 86–93%, all of which fall into the "highly suitable" (S1) category. The area's carrying capacity for beach recreation is 274 people per day, while for swimming activities it is 145 people per day, with a total capacity of 419 people per day. Based on these results, Slili Beach has the potential to be a safe, comfortable, and viable beach tourism destination, provided that the area's carrying capacity is taken into account.**

Keywords*— *Carrying Capacity; Slili Beach; Suitability Index; Tourism component;

I. INTRODUCTION

Slili Beach in Gunungkidul Regency has become a rapidly growing tourist destination thanks to its easy access, tranquil atmosphere, and beautiful coastline.Although its area is relatively small, the increasing number of tourists has led to ecological pressures in the form of vegetation damage, a decline in aesthetic quality, and the potential for pollution. The waters off Slili Beach also feature coral reefs with low coverage of approximately 19.5%, yet they continue to serve as a vital habitat for marine organisms [1]. The well-preserved environmental conditions are largely due to the absence of large-scale fishing activities and the active involvement of the local community in protecting the coastal area. This situation indicates that tourism development at Slili Beach requires management grounded in environmental conditions to ensure that pressures arising from tourism activities do not exceed the area's natural carrying capacity.

Tourism suitability assessment serves as a crucial tool for evaluating the potential and viability of Slili Beach as a sustainable tourism destination. This assessment involves evaluating physical and environmental parameters, such as water quality, the condition of the coastal ecosystem, accessibility, and supporting facilities [2]. A suitability analysis provides a comprehensive overview of the beach's conditions, thereby helping policymakers identify areas suitable for development while minimizing the risk of environmental degradation—including erosion, pollution, habitat loss, and increased pressure on specific species. Additionally, tourism suitability serves as a monitoring tool for changes in beach quality resulting from tourist activities or natural dynamics, making it highly relevant for ensuring that tourism development at Slili Beach remains aligned with sustainability principles [3].

The concept of carrying capacity is used to ensure that the number of visitors does not exceed the area's ability to maintain environmental quality and the tourism experience [4]. Carrying capacity encompasses three dimensions—environmental, economic, and social—which respectively assess ecosystem resilience, the sustainability of economic benefits for the community, and the local community's ability to accommodate tourism activities without disrupting social and cultural stability.

The community's dependence on the tourism sector has become increasingly evident as the number of tourists visiting Slili Beach rises each year. This situation calls for more targeted management, as excessive tourism pressure can affect the quality of the coastal environment as well as the socioeconomic balance of the local community. Uncontrolled tourism activities have the potential to accelerate ecosystem degradation, degrade water quality, and disrupt the sustainability of local community enterprises.

This study aims to analyze beach tourism and the carrying capacity of the Slili Beach area in Gunungkidul Regency, Yogyakarta.

II. RESEARCH METHODS

A. Research Location

The study was conducted from August to September 2025 at Slili Beach, Yogyakarta (Figure 1). Sampling stations were divided into three areas, taking into account the principles of representativeness and the characteristics of the area. Point 1 represents conditions in the western section (near rocks or shoreline vegetation); Point 2 captures conditions in the center of activity (generally the busiest area); and Point 3 represents the eastern section (potential for activities or natural features). The method used in this study was a survey. A survey is a scientific approach to collecting data from a number of respondents considered representative of a population. Data

collection for the survey was conducted by asking respondents questions in the field to obtain information relevant to the research objectives [5].

B. Research Procedures

Measurements of tourism suitability parameters were conducted using several techniques, including depth measurements with a graduated rod at a distance of 20 m from the shoreline. Beach width was measured using a roll meter from the vegetation line to the highest high-tide line, and beach type and substrate were determined through visual observation and sand sampling. Current velocity was measured using a current meter 20 m from the shoreline, while beach slope was calculated by comparing the height differences between tide lines using trigonometric formulas. Water clarity was measured using a Secchi disk; freshwater availability was determined by identifying the nearest source; and the presence of hazardous biota was observed directly or through interviews with local residents. Data collection for carrying capacity assessment was conducted by distributing questionnaires to tourists to gather information on visitation patterns, types of activities, and length of stay, thereby providing a comprehensive overview of tourism conditions at Slili Beach.

III. DATA ANALYSIS

A. Variable Testing

. Variable testing includes validity and reliability tests. A validity test is a method used to measure the extent to which a research instrument (such as a questionnaire) is capable of measuring what it is intended to measure according to the research objectives. If the correlation coefficient of an item with the total score exceeds the r-table value at the specified significance level, then that item is deemed valid [6]. A reliability test is a process for measuring the consistency of a research instrument, such as a questionnaire, in generating data. If the reliability value is low, then the inconsistent items need to be revised [7].

B. Coastal Suitability Index (IKW)

The Tourism Suitability Index (IKW) is used to assess the suitability of a coastal area as a tourist destination based on biophysical parameters, such as beach width, the presence of hazardous biota, substrate, slope, depth, current velocity, water clarity, and other supporting aspects [8]. Each parameter is scored on a scale of 0–3 according to [9] criteria, which range from poor to very good conditions. The TSI value is calculated using the formula:

$$IKW^{a)} = \Sigma\ (Ni^{b}) /Nmax^{c}) \times 100\%$$

Notes:

a) Tourism Suitability Index

b) Value of the i-th parameter (weight × score)

c) Maximum value for a tourism area

The final results are then classified into four categories: highly suitable (IKW ≥ 2.5), suitable (2.0≤ IKW ≤ 2.5), unsuitable (1.0 ≤ IKW < 2.0), and highly unsuitable (IKW < 1). This index serves as the basis for determining the level of feasibility and potential for sustainable coastal tourism development.

C. Carrying Capacity of The Area

The calculation of area carrying capacity is used to determine the maximum number of tourists a beach can accommodate without causing environmental damage or a decline in the quality of the visitor experience. The calculation is performed using Yulianda's (2019) formula:

$$CCA = K^{a)} \times (Lp^{b}) / Lt^{C}) \times (Wt^{d}) / Wp^{e})$$

Notes:

a) Ecological visitor potential per unit area

b) Area available for use

c) Area unit for a specific category

d) Daily operating hours of the area

e) Time spent by visitors on specific activities

IV. RESULTS AND DISCUSSION

A. Results and Discussion Tourism Suitability Index (TSI)

Parameters measured in the beach Tourism Suitability Index include water depth ranging from 0.88 to 1.12 m, beach width ranging from 16 to 19 m, beach type at stations 1 through 3 consisting of white sand with some coral, seabed substrate at all three stations consisting of sandy coral, current velocity at all three stations ranging from 0.026–0.041 m/s, beach slope ranging from 7.96 to 9.09, freshwater availability ranging from 0.029 to 0.04, water clarity ranging from 74 to 85, no presence of hazardous biota at all three stations, and land cover at all three stations consisting of gazebos. The SWI results for the three stations are shown in Table 1 and Table 2.

Table 1. Calculation of the Recreational Tourism Suitability Index at Slili Beach During Low Tide at 11:00 a.m. GMT +7

Parameter	Weigh t	Station 1		Ni	Station 2		Ni	Station 3		Ni	Nmax
		Result	S		Result	S		Results	S		
Depth	5	0.88	3	15	1.12	3	15	0.9	3	15	15
Width	5	16	3	15	19	3	15	18	3	15	15
Beach Types	5	White sand, coral	2	10	Sand, some coral	2	10	Sand with some steep coral	1	5	15
Substrate	3	Coral	2	6	Sandy coral	2	6	Sandy reef	2	6	9
Speed	3	0.026	3	9	0.041	3	9	0.033	3	9	9
Slope	3	9.09	3	9	7.96	3	9	9.09	3	9	9
Freshwater	1	0.04	3	3	0.029	3	3	0.032	3	3	3
Brightness	1	85	3	3	74	2	2	81	3	3	3
Hazardous organisms	1	None	3	3	None	3	3	None	3	3	3
Closing	1	Gazebo	3	3	Gazebo	3	3	Gazebo	3	3	3
				76			**75**			**71**	

Table 2. Calculation of the Swimming Suitability Index at Slili Beach During Low Tide at 11:00 a.m. WIB

Parameter	Weigh t	Station 1		Ni	Station 2		Ni	Station 3		Ni	Nmax
		Result	S		Results	S		Results	S		
Depth	5	0.88	3	15	1.12	3	15	0.9	3	15	15
Width	3	16	3	9	19	3	9	18	3	9	9
Substrate	5	Coral	2	10	Sandy coral	2	10	Sandy reef	2	10	15
Speed	5	0.026	3	15	0.041	2	10	0.033	2	10	15
Brightness	3	85	3	9	74	3	9	81	3	9	9
Hazardous organisms	3	None	3	9	None	3	9	None	3	9	9
TOTAL				**67**			**62**			**62**	**72**

An assessment of the suitability of the Slili Beach tourism area based on the Tourism Suitability Index (TSI) indicates that all observation stations have biophysical conditions that support beach recreational activities. Water depth ranges from 0.88 to 1.12 meters and is classified as highly suitable, with variations influenced by the seabed topography. The beach width, which ranges from 16 to 19 meters, is also classified as highly suitable because it provides sufficient space for tourists.

The beach type at Slili Beach is dominated by white sand with a few coral reefs, making it suitable for recreational activities. The seabed substrate, consisting of sandy coral, received a "suitable" score because it still provides comfort for water-based tourism activities. Current speeds fall within the slow current range (0.026–0.041 m/s), making the water conditions safe for visitors.

The beach slope, ranging from 7° to 9°, falls into the "highly suitable" category and supports a comfortable tourism experience. Freshwater sources located less than 50 meters from the shoreline indicate good accessibility. Water clarity levels reached 74–85%, with most stations showing clear water conditions. Additionally, no hazardous marine life was found at any of the stations, so the area is considered safe for marine tourism.

Land cover, dominated by open areas with trees, creates a cool and comfortable coastal environment for tourists. Overall, the IKW score of 2.8 at stations 1 and 2 and 2.67 at station 3 places Slili Beach in the S1 category (highly suitable). This reflects relatively uniform environmental conditions that are ideal for beach recreation and swimming.

B. Results and Discussion Swimming Suitability Index

Water depths at the three stations range from 0.88 to 1.12 meters and are considered very safe for swimming. These depths are ideal because they are neither too shallow nor too deep, thus facilitating tourist movement. The variation in depth among the stations also indicates stable and consistent water conditions for water-based tourism activities [10].

The beach width ranges from 16 to 19 meters and is considered adequate for visitor comfort. Station 2 has the widest beach, allowing it to accommodate more tourists without causing overcrowding. This ample space enables both onshore and water-based activities to take place comfortably [11].

The seabed substrate is dominated by sandy coral at Stations 2 and 3, while Station 1 has a coral substrate. The sandy substrate provides a higher level of comfort for tourists by reducing the risk of injury, making these two stations more suitable for swimming. Nevertheless, the presence of coral remains a visual attraction for visitors [12]

Current speeds ranged from 0.026 to 0.041 m/s and were all classified as safe. These stable currents pose no potential danger to tourists. Additionally, the high water clarity—74–

85%—reflects good water quality and supports comfortable swimming activities [13].

The absence of hazardous marine life at all monitoring stations further reinforces that this area is safe for water-based tourism. Overall, the combination of safe water depths, adequate beach width, comfortable seabed substrate, stable currents, high water clarity, and the absence of hazardous marine life makes Slili Beach highly suitable for swimming [14].

C. Result and Discussion Area Carrying Capacity

The carrying capacity obtained in this study for beach recreation activities was 274, while that for swimming was 145. The total achieve a carrying capacity for beach recreation and swimming of 419. The results of the Area Carrying Capacity for beach recreation and swimming activities are shown in Table 3

Table 3. Calculation of Area Carrying Capacity at Slili Beach During Low Tide at 11:00 a.m. GMT + 7

Activity Type	K	Lp (m^2)	Lt (m^2)	Wt (hours)	Wp (hours)	CCA
Beach recreation	1	547	4	6	3	274
Swimming	1	435	6	4	2	145

Area carrying capacity refers to the maximum number of tourists an area can accommodate without disrupting environmental balance or human activities. At Slili Beach, the main tourist activities are beach recreation and swimming; therefore, the sustainability of these activities requires that the area's conditions remain well-preserved [15].

Survey results indicate that beach recreation is the most dominant activity at 74%, while swimming accounts for only 9% and a combination of both makes up 17%. The average visit duration for recreation is 6 hours, reflecting a generally leisurely visit pattern. Differences in activity preferences are also evident across age groups, with older tourists preferring non-water activities.

Carrying capacity calculations indicate that Slili Beach can accommodate 274 people per day for recreation and 145 people per day for swimming, with a total capacity of 419 people per day. These figures remain within safe limits, influenced by the available area—547 m² for recreation and 435 m² for swimming. The relatively narrow width of the beach limits the area's capacity, necessitating effective spatial management to ensure visitor comfort and environmental sustainability [16].

V. CONCLUSION

Based on the research results, it can be concluded that Slili Beach has a very good suitability level (S1) for beach tourism and swimming activities. The biophysical conditions of the beach are classified as safe, comfortable, and supportive of tourism activities, with 10 parameters falling into the "very suitable" category. In addition, the carrying capacity of the beach area is still considered safe, with a total capacity of 419 people per day, consisting of 274 beach recreation visitors and 145 swimmers.

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