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Utilization of GIS in the development of marine tourism in the provincial strategic tourism area (KSSP) of Carita

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ABSTRACT

The development of marine tourism is crucial as it holds great potential to boost the economy, particularly in coastal areas and small islands. This is related to the potential for new income sources, economic growth, environmental awareness, cultural heritage preservation, and the promotion of infrastructure development. The purpose of this study is to design a strategy for the development of marine tourism in the Carita Strategic Tourism Area (KSPP) using GIS, in order to produce a well-structured and directed marine tourism development plan. This research uses a mixed-method approach, combining quantitative and qualitative methods, where data were collected through literature reviews, surveys, observations, and in-depth interviews with tourism stakeholders in the Carita KSPP. The research findings show that Matahari Beach has moderate attractiveness with a classification value of 660 and moderate accessibility with a classification value of 300. Karang Sari Beach has moderate attractiveness with a classification value of 540 and moderate accessibility with a classification value of 300. Meanwhile, Pasir Putih Carita Beach has high attractiveness with a classification value of 930 and high accessibility with a classification value of 300.

ABSTRAK

Pengembangan pariwisata bahari sangat penting untuk dilakukan karena memiliki potensi yang besar untuk meningkatkan perekonomian, khususnya di daerah pesisir dan pulau-pulau kecil. Hal ini berkaitan dengan potensi adanya sumber pendapatan baru, ekonomi, kesadaran lingkungan, menjaga warisan budaya, serta mendorong pembangunan infrastruktur. Tujuan dari penelitian ini adalah untuk merancang strategi pengembangan pariwisata bahari di KSPP Carita dengan menggunakan G.I.S sehingga dapat menghasilkan rencana pengembangan pariwisata bahari yang terstruktur dan terarah. Penelitian ini menggunakan metode campuran dengan pendekatan kuantitatif dan kualitatif dimana data diperoleh dengan cara studi literatur, survey, observasi dan wawancara mendalam dengan para *stakeholder* pariwisata di KSPP Cirata. Hasil penelitian menghasilkan bahwa Pantai Matahari memiliki daya tarik sedang dengan nilai klasifikasi 660 dan aksesibilitas sedang dengan nilai klasifikasi 300. Pantai Karang Sari memiliki daya tarik sedang dengan nilai klasifikasi 540 dan aksesibilitas sedang dengan nilai klasifikasi 300. Sedangkan Pantai Pasir Putih Carita memiliki daya tarik tinggi dengan nilai klasifikasi 930 dan aksesibilitas tinggi dengan nilai klasifikasi 300.

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1. Introduction

The province of Banten is a land area located at the western tip of Java Island, surrounded by the Java Sea, the Sunda Strait, and the Indian Ocean. The marine area of Banten province spans 11,500 km² with a coastline length of 499.62 km. This makes Banten rich in natural resources and tourism potential. The tourism sector is one of the key sectors with great potential to increase national and regional income. Globally, the tourism sector plays a crucial role in the world economy [1]. Therefore, efforts to develop tourism in Indonesia are essential [2]. Suboptimal tourism development remains a challenge that hampers the advancement of the tourism industry, both in Banten Province and Pandeglang Regency. To encourage the growth of the tourism industry in Banten Province, the local government issued Banten Provincial Regulation No. 6 of 2019 concerning the Master Plan for Tourism Development in Banten Province for 2018–2025. This regulation identifies strategic areas for tourism development, including strategic tourism areas [3].

One of the tourism sectors the Banten government is focusing on is marine tourism. Marine tourism development is a strategy to boost the economy and expand tourism areas [4]. This is outlined in the Banten Provincial Regulation No. 6 of 2019 concerning the Master Plan for Tourism Development in Banten Province for 2018–2025. A key point in this regulation is the establishment of Strategic Tourism Areas of Banten Province (KSPP), one of which is the KSPP Carita. It is expected to contribute to the Gross Regional Domestic Product (GRDP) by 3.19% by 2025. This initiative is part of the government's program to increase tourist numbers by prioritizing tourism development in 10 locations, one of which is in Banten Province [2]. Additionally, the aim of developing the KSPP is to attract both domestic and foreign investors to enhance the regional economy. Data from the Statistics Agency indicates that economic growth in 2022 has increased [5]. This is supported by the fact that marine tourism has proven to drive economic growth through its contribution to national income in various countries [6]. Some analyses needed by investors include economic and capital market analysis, industry analysis, and company analysis [7].

In recent years, the KSPP Carita has experienced a significant increase in tourist visits and rapid infrastructure development. However, if not properly managed, this development could lead to complex future problems. Issues in the KSPP Carita include conflicts over land use, unsynchronized regulations between central and regional levels, low appreciation and protection of local culture, increasing environmental pollution from land and sea, and uneven development of facilities at several tourist sites [8]. Additionally, social issues such as overcrowding, environmental degradation, traffic congestion, declining quality of life, and cultural damage are becoming serious concerns among environmental and tourism observers. These issues are defined as "over-tourism," meaning that tourism development exceeds the maximum threshold [9]. Congestion, in particular, can lead to the loss of environmental and/or social value in urban areas. In tourist destinations, congestion can be seen as a spatial externality of the tourism industry, reducing visitor satisfaction and increasing negative perceptions among residents toward tourism. Consequently, urban congestion threatens destination competitiveness and socio-economic sustainability [10].

The application of spatial analytics in smart tourism cities opens new opportunities for research to monitor and characterize these phenomena. Integrating geolocation data of people flows (residents and tourists) into Geographic Information Systems (GIS) enables the detection of spatial patterns and supports the calculation of spatial indicators for urban congestion. This information can be used to design smart tourism tools to regulate the number of visitors to certain areas or streets according to their capacity. GIS can be utilized to understand spatial variations in certain elements of the coastline [11]. Additionally, with the support of geographic information-based systems, it is expected to be easier to obtain information about the development and natural potential of a region [12]. Physical capacity, on the other hand, is calculated through field inventorying of urban land use, supported by GIS tools that accurately measure available pedestrian areas. GIS successfully integrates structure, adaptability, and accuracy into decision-making processes, handling large volumes of spatial data, visualizing results, and analyzing extensive areas [13]. From a geographical perspective, the relationship between anthropogenic tourism systems and the potential of natural contours can be synthesized through an approach that measures, weighs, and characterizes the impact of specific economic activities on natural systems [14].

In relation to the challenges faced by KSPP Carita, an effective solution to optimize tourism development is by using Geographic Information Systems (GIS) with a spatial analysis approach from environmental, social, economic, and cultural perspectives. This will produce a comprehensive suitability map for marine tourism resources, aiding in the development of marine tourism. GIS is an information technology used to collect, manage, and analyze geographic data. Its utilization can assist tourism management in addressing challenges and managing potential risks such as natural disasters, congestion, and environmental degradation [15]. By leveraging GIS, tourism management can obtain more complete and accurate information about tourism areas, including data on tourism potential, infrastructure, accessibility, and the environment [16]. GIS can assist tourism management in several ways. First, Mapping and Visualizing Tourism Areas: GIS facilitates the identification of tourism potential and the necessary infrastructure to develop marine tourism in the region [17]. Second, Identifying Disaster-Prone Areas: GIS can identify areas around tourism sites susceptible to natural disasters, enabling management to prepare strategies and evacuation plans [18]. Third, Optimizing Tourist Travel Routes: GIS helps reduce congestion and minimizes negative environmental impacts by optimizing visitor travel routes [19]. Fourth, Coastal Area Mapping: GIS can support environmental assessments and spatio-temporal monitoring of coastal regions [20].

Previous studies on marine tourism development related to GIS or other approaches have provided initial insights into the potential, challenges, and opportunities for developing marine tourism. For example, the assessment of beach potential using the Integrated Beach Value Index method [3] and the evaluation of tourism carrying capacity in marine tourism areas as part of sustainable tourism development [2]. Meanwhile, GIS offers a more comprehensive perspective on factors affecting ecotourism success, aiding decision-makers in sustainable ecotourism development [21]. GIS also supports formulating effective strategies to enhance marketing for cultural and natural heritage sites as tourism products and increases knowledge about the maintenance expectations of heritage sites. Moreover, it examines how cities can transform from being mere stopover destinations to full-fledged accommodation hubs for tourists [22]. GIS can also map pedestrian tourist mobility and evaluate regional density based on traversable space, aiding tourism management decisions and promoting sustainability at tourist destinations [10]. The use of GIS in tourism development improves efficiency by mapping tourism potential based on specific areas, thereby increasing tourism appeal and generating greater economic benefits for local communities [23]. GIS can also facilitate the creation of diverse data on local runoff potential, allowing users to access information quickly [24]. Additionally, GIS can provide information on variables such as slope gradients, elevation, distance from the coastline, and land use [25].

From various studies, no research has yet explored the utilization of GIS with a spatial analysis approach to develop marine tourism areas from environmental, social, economic, and cultural perspectives, particularly in analyzing attractiveness and accessibility. Therefore, the aim of this study is to analyze the attractiveness and development of marine tourism in the Strategic Tourism Area of Banten Province (KSPP) Carita through spatial analytics using Geographic Information System (GIS) methods. This research is expected to serve as a bridge to provide comprehensive information about the marine tourism potential in KSPP Carita, the challenges and issues faced in developing marine tourism in the area, and how GIS can assist tourism management in optimizing marine tourism development in KSPP Carita. Additionally, this study is also expected to contribute to addressing the challenges of sustainable tourism development in Indonesia.

2. Methodology

This study employs a mixed-method approach, combining quantitative and qualitative methods. The quantitative approach is used to explore the marine tourism potential in KSPP Carita based on primary and secondary data obtained from surveys, visits to relevant agencies, and field observations. The data is then processed using ArcGIS 10.3.1 software to perform spatial suitability analysis, which is subsequently used to produce maps that spatially represent sectors related to marine tourism development in KSPP Carita [14]. The qualitative approach utilizes a comparative case study method in the context of sustainable tourism development in KSPP Carita. The research focuses on three beaches within KSPP Carita: Matahari Beach, Karangsari Beach, and Pasir Putih Carita Beach.

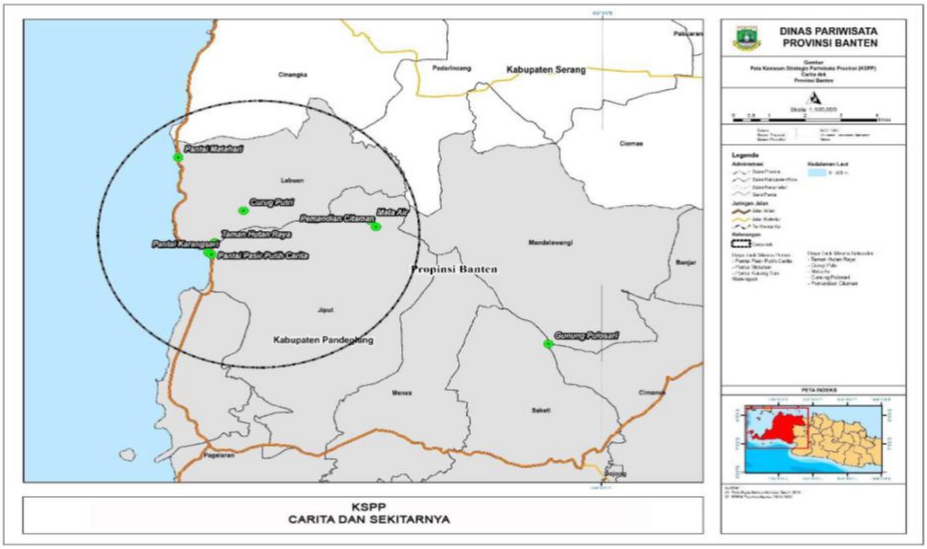

Figure 1. Research location map.

The determination of the sample size for each beach location is based on William G. Cochran's formula:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2} \quad (1)$$

where:
n = required sample size
Z = Z-score corresponds to the confidence level; for a 95% confidence level, the Z value is 1.96.
p = Estimated population proportion, set at 50%
E = *margin of error*, set at 5%

2.1. Assessment Analysis of ADO-ODITWA

The tourism assessment analysis using the Geographic Information System (GIS) method in KSPP Carita is measured based on two criteria: attractiveness and accessibility. The use of data analysis with a modified ADO-ODTWA method aims to evaluate the condition of the area and determine the priority scale for development and alternative planning of tourist destinations [26]. Each aspect of ADO-ODTWA is assigned different weights, adjusted to the significance of the objects and tourist attractions being analyzed [27]. The two assessment criteria, both for attractiveness and accessibility, consist of main elements and sub-elements, as presented in the following table.

Table 1. Attractiveness Assessment Criteria for KSPP Carita

No	Element	Sub-element	Achievement Score of Sub-element					
			5	4	3	2	1	0
1	Landscape variation based on land cover	Sandy beach areas (e.g., fine or coarse sand) Coastal vegetation (e.g., mangrove forests, beach forests) Rocky beaches or cliffs Sand dunes or other geomorphological formations Coral reefs or marine ecosystems near the shore	180	150	120	75	60	6
2	Variation of attractions based on the distribution of tourist sites	Natural rock formations (e.g., coral rock stacks or sea arches) Tide pools and tidal zones Wildlife observation points (e.g., birdwatching areas, marine life) Cultural or historical sites near the beach (e.g., ancient ruins, lighthouses) Man-made tourist attractions (e.g., piers, sidewalks, beachfront resorts)	180	150	120	75	60	6

No	Element	Sub-element	Achievement Score of Sub-element					
			5	4	3	2	1	0
3	Uniqueness of resources based on land cover and distribution of attractions	Rare marine ecosystems (e.g., coral reefs, seagrass meadows) Unique tidal rock formations or features Habitat for endemic or endangered species (e.g., sea turtle nesting areas) Clear water or distinctive colors (e.g., turquoise lagoons, black sand beaches) Coastal caves or hidden beaches	180	150	120	75	60	6
4	Sensitivity of resources based on value, viewed from land cover and distribution of attractions	Fragile ecosystems (e.g., mangrove forests, coral reefs) Protected or endangered species zones (e.g., nesting sites) Areas or sand dunes prone to erosion Zones with high biodiversity (e.g., marine reserves) Coastal areas vulnerable to the impacts of climate change (e.g., sea level rise)	180	150	120	75	60	6
5	Variation of tourism activities based on land cover and distribution of attractions	Swimming, snorkeling, and diving in clear water Surfing or windsurfing in coastal areas Beach sports (volleyball, picnics) Ecotourism (birdwatching, guided nature walks) Fishing (traditional and recreational)	180	150	120	75	60	6
6	Variation in elevation	Flat beach areas at sea level Sand dunes slightly higher than sea level Low coastal cliffs near the water Higher observation points for beautiful beach views Hilltops or high headlands with sea and coastline views	180	150	120	75	60	6
7	Variation in slope (%)	Flat sandy beach slopes (0-2%) Steeper sand dune slopes (3-5%) Cliffs with steep inclines (15-30%) Gentle slope to the water (2-5%) Varying slopes along rocky coastlines depending on the terrain	180	150	120	75	60	6

Table 2. Accessibility Assessment Criteria of KSPP Carita

Element	Sub-element	Achievement Score of Sub-element			
		Ring 1	Ring 2	Ring 3	Ring 4
Estimated distance from the beach to the sub-district capital center	0-5 km (Ring 1) 5-10 km (Ring 2) 10-15 km (Ring 3) 15-20 km (Ring 4)	400	300	200	100

2.2. Criteria Assessment Classification

The calculation of tourism resource criteria, both in terms of attractiveness and accessibility, is divided into three classifications: low, medium, and high. Each tourism resource criterion is calculated based on the results of the classification assessment of the condition and attractiveness of tourist objects. The intervals determined in the classification are calculated using the formula:

$$I_i = \frac{Nt_i - Nr_i}{3} \quad (2)$$

where:
I_i = Classification interval for i-th criterion
Nt_i = The highest ideal value for i-th criterion
Nr_i = The lowest ideal value for i-th criterion

The final classification of tourism attractiveness assessment is categorized into low, medium, and high within specific intervals. This assessment aims to identify the potential of natural and cultural tourism resources that should be given high priority for development [28].

3. Result and Discussion

The criteria for assessing natural tourism resources serve as an instrument to determine the feasibility of a specific resource for development as a natural tourist attraction. These criteria function as the basis for planning the development of tourism resources by establishing the elements, weights, and calculations for each sub-element. Using equation (1), the determined sample is:

$$n = \frac{(1,96^2) \times 0,5 \times (1-0,5)}{0,05^2} \approx 385 \text{ tourism}$$

A sample of 385 tourists was used to evaluate the attractiveness criteria for the following elements: variation in landscape based on land cover, variation in objects based on the distribution of tourist attractions, uniqueness of resources based on land cover and object distribution, sensitivity of resources based on value (assessed from land cover and object distribution), and variation in elevation. Meanwhile, the element of slope variation was assessed through observation.

3.1. Assessment Analysis of ADO-ODITWA

3.1.1. Analysis of Criteria Assessment Classification

The assessment process for tourism resource criteria based on attractiveness criteria involves a spatial analysis process, which includes the derivation of criteria maps and classification. Relevant elements and sub-element factors, as presented in Table 1, are created and stored as GIS layers. The attractiveness criteria are divided into several elements. The first element is the number of different types of resources derived from land cover and the distribution of tourist attractions, with the focus of analysis based on resource variability in each research location unit (Matahari Beach, Karangsari Beach, and Pasir Putih Carita Beach). The land cover factor was classified and reclassified using the 2014 land cover map. Tourist attractions were classified using the 2014 object distribution map, generated from field verification of 2013 data from the Department of Tourism and Culture of Pandeglang Regency. Other elements include resource uniqueness, resource value, and activity variation, with scores determined based on the number of different resources, focusing on the variability of resource uniqueness, value, and activity variation in a research location unit. The vulnerability of resource sub-elements was obtained from topographic and elevation maps integrated with the locations of natural uniqueness, focusing the analysis on the variability of topography and elevation in a research location unit.

Table 3. The score of KSPP Carita Attractiveness Criteria

No	Element	Tourist Location		
		Matahari Beach	**Karangsari Beach**	**Pasir Putih Beach**
1	Landscape variation based on land cover	90	90	150
2	Object variation based on the distribution of tourist attractions	90	60	120
3	Resource uniqueness based on land cover and object distribution	60	60	90
4	Resource sensitivity based on value, as seen from land cover and object distribution	120	90	150
5	Tourism activity variation based on land cover and object distribution	150	60	180
6	Elevation variation	60	60	90
7	Slope variation (%)	90	120	150
	Total	**660**	**540**	**930**

Table 3 presents the attractiveness criteria values of tourism resources for each element at three different tourist locations in the Carita Strategic Tourism Area (KSPP), with attractiveness scores of 660 for Matahari Beach, 540 for Karangsari Beach, and 930 for Pasir Putih Beach.

3.1.2. Analysis Assessment of Attractiveness Criteria

The accessibility criteria consist of the element of travel distance to the district development center, classified based on Euclidean analysis in relation to the nearest sub-district capital. In the GIS database, attribute factors are represented as map layers containing attribute values for each pixel in the raster data. During this process, data from all selected factors are stored, presented, and managed individually. The classification map is used as a reference basis for the element factors in assessing resources at each tourist location.

Table 4. The score of KSPP Carita Accessibility Criteria

Tourist Location	Sub-element	Score
Matahari Beach	Ring 2	300
Karangsari Beach	Ring 2	300
Pasir Putih Beach	Ring 2	300

Table 4 illustrates the distances of the three tourist destinations in KSPP Carita such as Matahari beach, Karangsari Beach, and Pasir Putih Beach which are all located within ring 2, or approximately 5–10 kilometers from the respective sub-district capitals.

3.2. Classification of Criteria for Assessment of Tourism Resources KSPP Carita

The classification of each criterion, both for attractiveness and accessibility, is used to categorize them into three groups: low, medium, and high. The interval for the classification is determined using equation (2), resulting in the following intervals.

a. Attraction Criteria Classification

$$Nt_{DT} = 7 \times 180 = 1260 \; ; \; Nr_{DT} = 7 \times 6 = 42$$

$$I_{DT} = \frac{1260 - 42}{3} = 406$$

b. Accessibility Criteria Classification

$$Nt_{AS} = 1 \times 400 = 400 \; ; \; Nr_{AS} = 1 \times 100 = 100$$

$$I_{AS} = \frac{400 - 100}{3} = 100$$

So that the assessment classification intervals of the attractiveness and accessibility criteria are presented in the following table.

Table 5. Classification Interval of KSPP Carita's Attractiveness and Accessibility Criteria Assessment

Criteria	Classification Interval		
	Low	Moderate	High
Attractive	42 – 448	449 – 854	855 – 1260
Accessibility	100 – 200	201 – 300	301 – 400

Based on table 5, each tourist location for each criterion from Table 3 and Table 4 can be classified as follows.

Table 6. Klasifikasi Lokasi Wisata pada Kriteria Daya Tarik dan Aksesbilitas KSPP Carita

No	Tourist Location	Daya Tarik		Aksesibilitas	
		Skor	Klasifikasi	Skor	Klasifikasi
1	Matahari Beach	660	Moderate	300	Moderate
2	Karangsari Beach	540	Moderate	300	Moderate
3	Pasir Putih Beach	930	High	300	Moderate

Table 6 illustrates that the weights for each tourism resource criterion element are derived from the analysis of the criteria-derived maps and element classification. The weight values are based on ADO-ODTWA, as presented in Tables 3 and 4. The results of the assessment and weighting are then used as a basis for classifying tourism resources at each tourist location according to the predetermined categories: high, medium, and low. The classification and weighting results are represented as derived maps of the classified elements, based on the resource assessment criteria of attractiveness and accessibility.

3.3. Analisis Geographic Information System (GIS)

The analysis of the derived classification maps for tourism resource assessment generates weighted scores for each element at each tourist location within the administrative area of Pandeglang Regency. The weighted scores are stored as GIS layers, which serve as the foundation for conducting a dissolution analysis. This analysis aims to consolidate and classify data obtained from the resource assessments, derived from the classification maps for attractiveness (Figure 2) and accessibility (Figure 3). The combined analysis is then used to further evaluate the derived resource assessment maps based on attractiveness and accessibility (Figure 4). The purpose of this analysis is to identify each village unit that possesses suitable resources, in terms of both attractiveness and accessibility, for the development of nature-based tourism. The combined analysis results in a tourism resource assessment map for nature-based tourism in the Carita KSPP area, based on attractiveness and accessibility. This derived resource assessment map reveals seven typologies of regions: (1) areas with high attractiveness and low accessibility, (2) areas with high attractiveness and medium accessibility, (3) areas with high attractiveness and low accessibility, (4) areas with high attractiveness and high accessibility, (5) areas with medium attractiveness and medium accessibility, (6) areas with medium attractiveness and low accessibility, and (7) areas with low attractiveness and high accessibility.

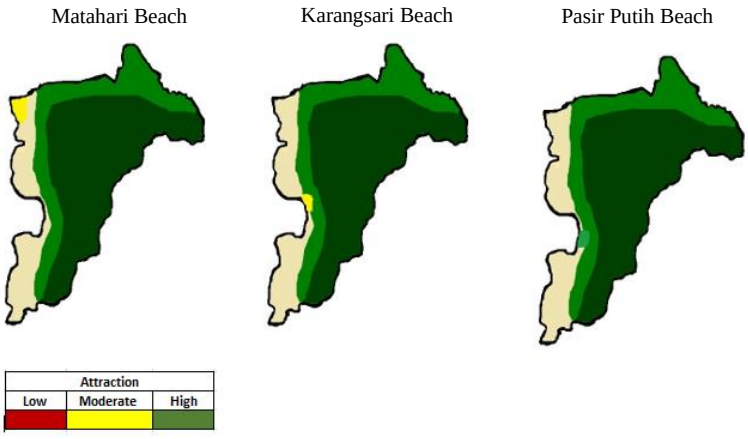

Figure 2. KSPP Carita Resource Assessment Based on Attractiveness.

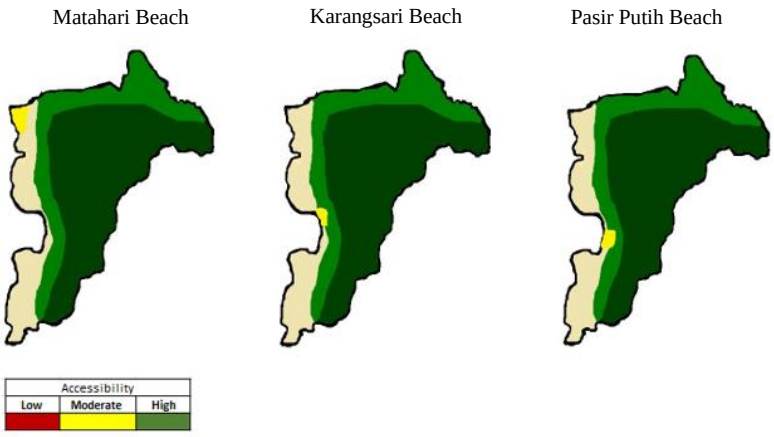

Figure 3. KSPP Story Resource Assessment Based on Accessibility.

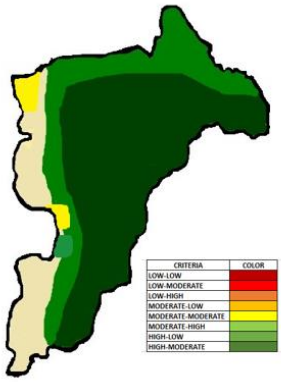

Figure 4. Combined Analysis of Resource Assessment Derived Maps Based on Attractiveness and Accessibility.

Based on Figure 4, the combined map of resource assessment derived from attractiveness and accessibility indicates that Pantai Matahari falls under the typology of a region with medium attractiveness and medium accessibility. Similarly, Pantai Karangsari is also categorized as a region with medium attractiveness and medium accessibility. In contrast to the previous two beaches, Pantai Pasir Putih is classified as a region with high attractiveness and medium accessibility.

4. Conclusion

Based on the results of spatial analysis and the assessment of tourism resources, the recommended site for nature-based tourism planning in the Banten Provincial Tourism Strategic Area (KSPP) Carita is Pantai Pasir Putih, which demonstrates high resource attractiveness and moderate accessibility. Comprehensive planning is a crucial prerequisite for tourism development. Without a clear development direction agreed upon by all stakeholders involved, tourism initiatives may lose focus and become susceptible to unintended negative impacts. Identifying suitable areas for tourism serves as a means to achieve sustainable tourism development rather than being the ultimate goal of the planning process. Meanwhile, the other two locations, Pantai Matahari and Pantai Karangsari, require improved development planning across environmental, social, economic, and cultural aspects to enhance their potential to attract more visitors.

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