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## Suitability Study for Tourism Sites in the Southern Coast of West Java

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### ABSTRACT

Diversity of tourist attraction of the regencies/cities in West Java provides an alternative for travellers. One of the potential activity that can be utilized is coastal tourism. The main objective of this research was to provide a suitable site for tourism sites which can be used as a guide for government, private and planners to decide for the development of coastal tourism. Furthermore, visitors can use this application to get information about the beach resources—primary data in tabular data form and secondary data in vector format and satellite imagery format. ArcGIS was used for spatial analysis of thematic. Simple Additive Weighting method was used in this research to rank the factors and to calculate the weight in each factor. This method was commonly used for resolving spatial decision-making problems. The decision-maker directly assigns a weight of relative importance to each factor. There were 32 beach sites visited in the survey with 20 sites of suitable category and 12 sites belonging to a very suitable category. Pangandaran Regency has the most beach site at ten beaches (32.5%), consisting of 7 sites of suitable category and three sites of very suitable category. They are followed by Sukabumi which has nine sites, consisting of 7 sites of suitable category and two sites of very suitable category. The least number of sites were found in Cianjur regency, which only has three sites, consisting of 1 suitable site and two very suitable sites. According to the result, it can be seen that tourism was more developed in Pangandaran and Sukabumi regency. Besides the infrastructure support, natural conditions also influence the development of coastal tourism in the area.

**Keywords:** Coastal Tourism, Mapping, India Ocean, West Java, Indonesia

## **1. INTRODUCTION**

The geographical location of West Java has the potential area for the development of tourism. Diversity of tourist attraction of the regencies/cities in West Java provides an alternative for travellers. One of the potential activity that can be utilized is coastal tourism. The potential of coastal and marine areas in terms of physical are sea areas of around 6,315.22 km<sup>2</sup>, 99,093 km coastline and 13,466 islands.

These potential resources can be used for tourism activities, which have many beautiful beaches. Coastal tourism activities in Indonesia are divided into beach tourism and sports tourism, which generally utilize coastal resources [1]. The majority of coastal tourism includes recreation, panorama, swimming, rafting, sailing, fishing and mangrove tourism [2]. This activity has a direct impact on the local community and local government to increase benefit [3]. Climate change issues also affect the tourism sector [4]. It affects the natural state of the coast [5] and changes the choice of tourists in choosing tourist destinations [6].

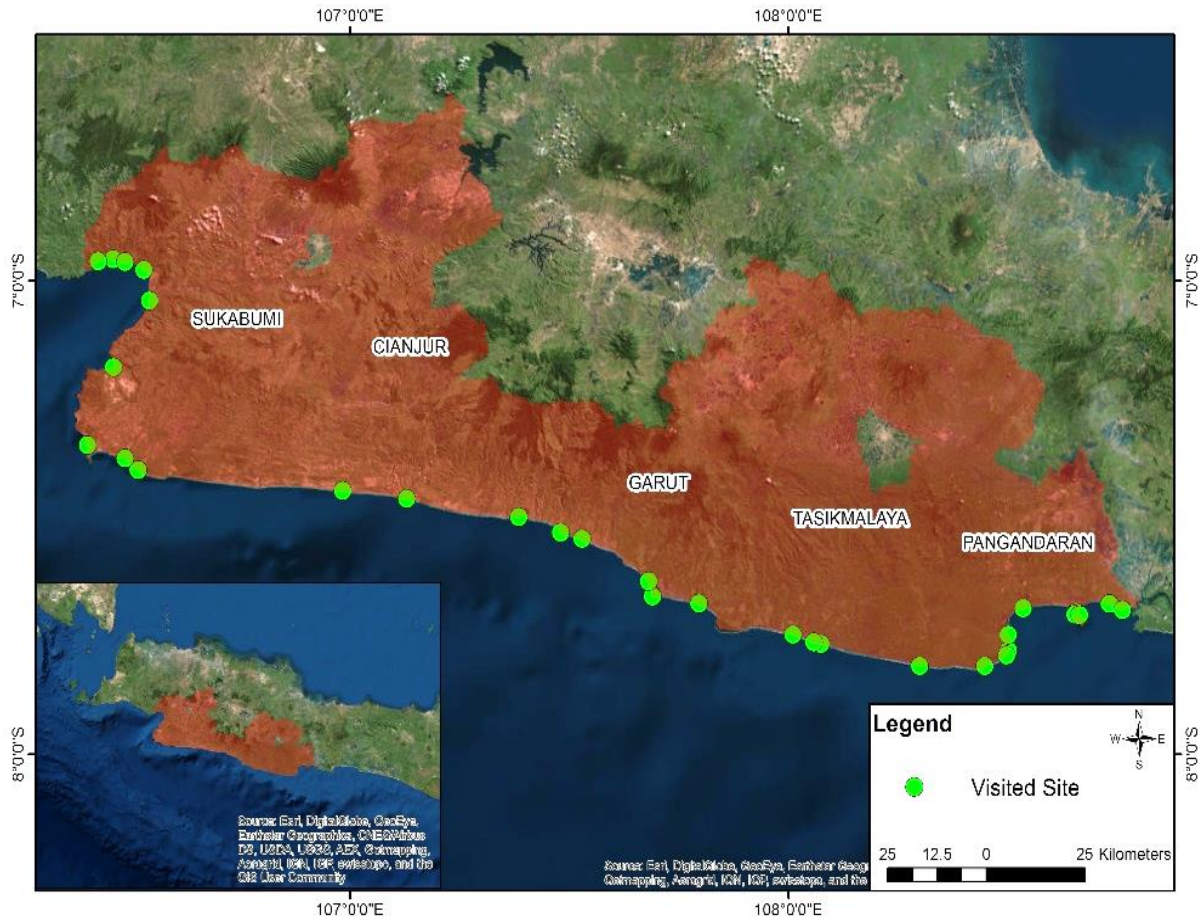
Many of these tourists might do not know what kind of activities that could match with the beach condition that they are visiting, or where are locations for the best places to fulfill their interest. Due to different topographic, every beach has something to offer to everyone that comes [7]. A Geographic Information System (GIS) is very much useful in this tourism [8, 9]. GIS can be a useful tool to solve the specific question that concerns tourism development including location, condition of the area, trends and changes, routing to and through the site, and patterns associated with resource utilization [10]. A Spatial Decision Support System (SDSS) is defined as an interactive, computer-based system designed to support a user or a group of users in achieving a more effective decision by solving a semi-structured spatial problem [11].

One of the methods to analyze the suitability site in this research is Simple Additive Weighting (SAW). This method is based on the weighted average using the arithmetic mean. The advantage of the SAW method is that there is a proportional linear transformation of the raw data. It means that the relative order of magnitude of the normalized score remains equal [12]. This research is focused on using GIS to assess the suitability of the coastal area for tourism activity.

## **2. MATERIAL AND METHODS**

### **2. 1. Study Sites**

This research was conducted in January 2018. Southern of West Java was selected as a study area, especially in Pangandaran Regency, Tasikmalaya Regency, Garut Regency, Cianjur Regency and Sukabumi Regency. Based on the results of the field survey, there were 32 sites visited in the study area (**Figure 1**).



**Figure 1.** Study Sites in Southern Coast West Java. Green Dot Located Beached in this area divided into five regencies in South Coastal of West Java

## 2. 2. Data and Tools

Data required in this research were primary data from the field observation and secondary data collected from government. Primary data are in tabular form while secondary data in the vector and satellite image form (**Table 1**). The tabular data are inputted to the database and then merged with the vector data. The output was in the form of a digital map for multi-criteria analysis method. In this research, almost all of the data were obtained through the field survey.

**Table 1.** Data used in application.

No	Data	Format	Source
1	Administrative	Vector	RBI BIG
2	Bathymetry	Vector	LPI BIG
3	Beach Type	Tabular	Field survey

4	Beach Width	Tabular	Field survey
5	Substrate	Tabular	Field survey
6	Current Speed	Satellite Imagery	Hycom
7	Beach Slope	Tabular	Field survey
8	Water Transparency	Satellite Imagery	USGS
9	Beach Cover	Tabular	Field survey
10	Danger Species	Tabular	Field survey

Note: RBI = Indonesian Earth Map  
 BIG = Geospatial Information Agency  
 LPI = Indonesian Coastal Environment  
 USGS = United State Geological Survey  
 HYCOM = Hydropower Competence Center

**2.3 Analysis Data**

Multi-Criteria Evaluation (MCE) technique was applied to suitability analysis and to build suitability sites. The MCE process was divided by three-step, namely classifying based on criteria, assigning factor priority, weight and class weight, determining spatial analysis. According to [13] research, multi-criteria evaluation for ecotourism was done based on three criteria; biophysical (landscape/naturalness, wildlife and topography), accessibility and settlement size. This study uses the criteria from [13-15] with some sub-factor modifications, namely biophysical, managerial and socio-economic. The modifications in biophysical characteristic of such turbidity, in managerial factor were modified by adding cleanliness factor and also in socio-economic factor modified by adding distance from road and road type factor.

**Table 2.** Criteria for Swimming and Recreation.

Factor	Sub-Factor	N	S3	S2	S1
		Not Suitable	Conditionally Suitable	Suitable	Very Suitable
		(score: 0)	(score: 1)	(score 2)	(score: 3)
Bio-physical	Depth (m)	>10	>6-10	>3-6	0-3
	Beach type	mud, rock, steep	Black sand, coral, a bit steep	White sand, a bit coral	White sand
	Width (m)	<3	3-10	10-15	>15
	Substrate material	Mud	Sand mud	Sandy coral	Sand

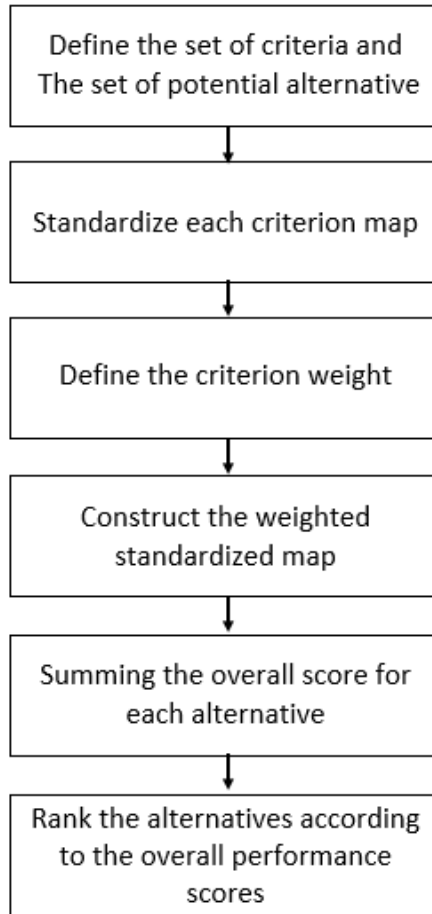
	Current speed (m/s)	>0.51	0.34-0.51	0.17-0.34	0-0.17
	Beach slope (deg)	>45	>25-45	10-25	<10
	Turbidity (mg/l)	>800	600-800	400-600	<400
	Beach cover	Mangrove, settlement	High bush	Thicket, bush, savanna	Coconut, bare land
	Danger biota	Sea urchins, stingray, shark	Sea urchins, stingray	Sea urchins	none
	Fresh Water (km)	>2	>1-2	>0.5-1	<0.5
<b>Socio-economic</b>	Distance from roads (km)	>7	5-7	1-5	<1
	Road type	Ground	Rocky Ground	Concrete, Gravel, Asphalt	Asphalt
	Population	>10000	1001-10000	100-1000	0-100
<b>Managerial</b>	Beach Infrastructure	Campsites and Shelters	Restaurant, Campsites, and Shelters	Lodge, Restaurant, Campsites, and Shelters	Hotel, Lodge, Restaurant, Campsites, and Shelters
	Cleanliness	Very much rubbish	Much rubbish	Little rubbish	No rubbish

Environmental factors of a tourism region are essential to determine the type and direction of development of tourism in the region [1, 16]. On the other hand, the population has been identified as significant pressure on biodiversity, water resources and marine environments. Managerial is the factor that shows what the conditions of management are in a tourist area [17]. This factor gives an enormous influence on the development of a tourist area. The fundamental factors can be used to analyze the chance of developing an area to be used as a tourist area under the potential and condition of the existing circumstances (**Table 2**).

Simple Additive Weighting (SAW) method was used in this research to rank the factors and to calculate the weight in each factor [18]. This method was commonly used for resolving spatial decision-making problems. The decision-maker directly assigns a weight of relative importance to each factor. The alternative with the highest overall score was chosen [11], delivered in **Table 3**. Simple Additive Weighting (SAW) was calculated using the following formula:

$$A_i = \sum W_j * X_{ij}$$

where  $X_{ij}$  is the score of the  $i$ th alternative concerning the  $j$ th attribute and  $W_j$  is the normalized weight. The weight represents the relative importance of the attribute. The most preferred alternatives are selected by identifying the maximum value of  $A_i$ ,  $i = 1, \dots, m$ . According to this author, the GIS-based Simple Additive Weighting method involves the following steps in **Figure 2**.



**Figure 2.** Schematic diagram of the SAW process

**Table 3.** Classification of weight values [11].

<b>Weight</b>	<b>Classification</b>
1	Equal Importance
2	Equal to Moderately Importance
3	Moderate Importance
4	Moderate to Strong Importance

5	Strong Importance
6	Vital to Very Strong Importance
7	Very Strong Importance
8	Very to Extremely Strong Importance
9	Extremely Strong Importance

Simple Additive Method has two strong assumptions; there are linearity and additivity attributes. The linearity assumption means that the desirability of an additional unit of an attribute is constant for any level of that attribute. The additivity means that there is no interaction effect between attributes. Advanced tourism activities should be adjusted to the potential of a resource allocation. Every tourist activities have appropriate resources and environmental attractions that will be developed. The formula used to calculate the suitability of coastal and marine tourism [15, 19-21] is as follows:

$$IKW = \sum_{i=1}^n \left( \frac{N_i}{N_{max}} \right) \times 100 \%$$

in which:

- IKW* = Suitability Tourism Index
- N<sub>i</sub>* = Value Parameter -*i*
- N<sub>max</sub>* = Maximum value from all category of tourism.

Determination of suitability was obtained by multiplying scores and weights from each parameter. Suitability can be seen from the percentage of the area. Suitability index was obtained by summing the values of all parameters. The percentage was divided into four categories; very suitable, suitable, conditionally suitable and not suitable.

$$\text{Total} = (\text{Score} \times \text{Weight})$$

- S1= 83 – 100 % Very Suitable
- S2= 50 - < 83% Suitable
- S3= 17 - < 50% Conditionally Suitable
- N = below 17% Not Suitable.

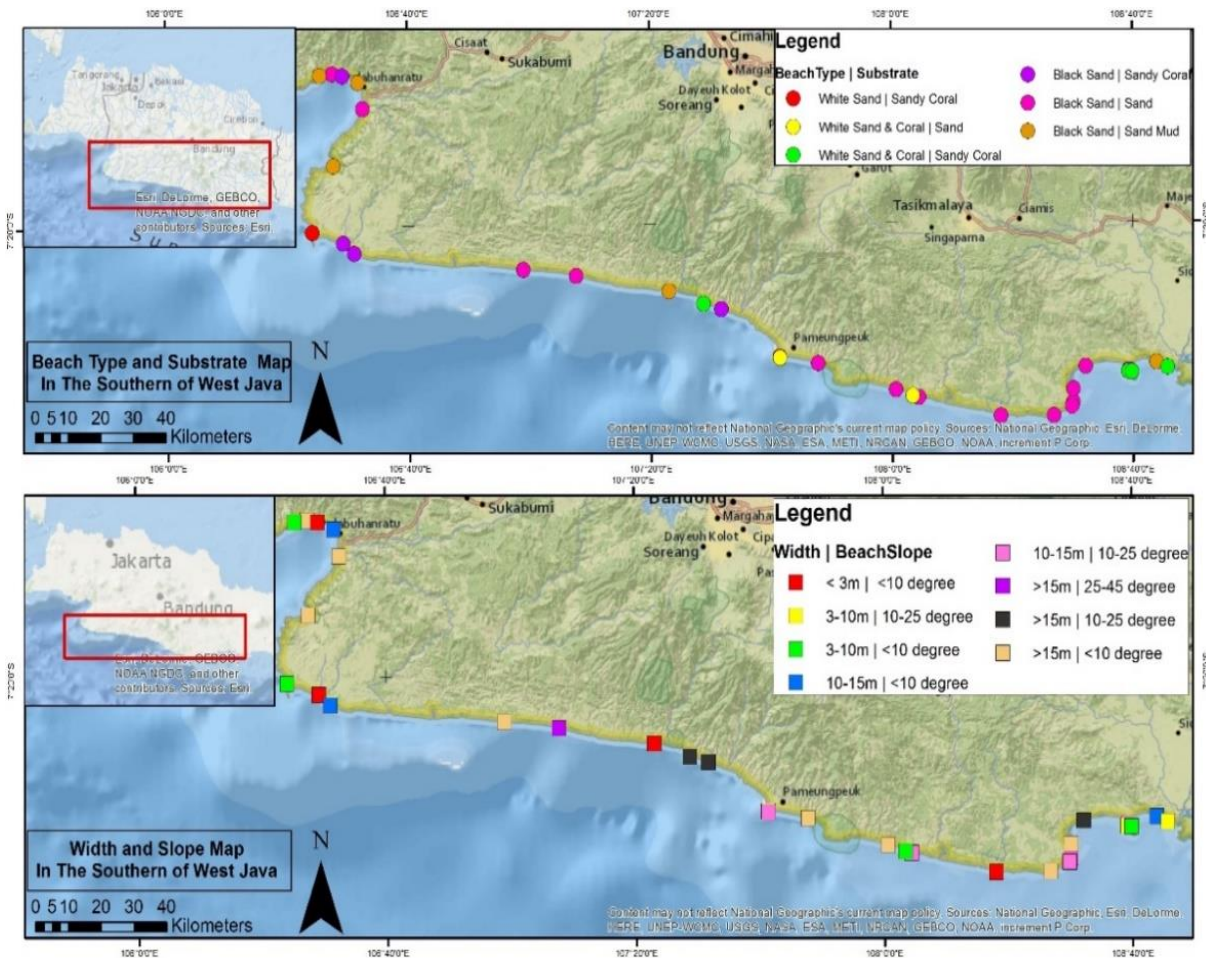
### 3. RESULTS AND DISCUSSIONS

#### 3. 1. Biophysics Factors

Based on the biophysical factor, a map of types of beach and substrates along the southern coast of western Java can be seen visually in **Figure 3**. Along the coast of Pangandaran Regency to Sukabumi regency, there were different types of substrate which will determine the type of



beach. Beach width and coastal slope map were gained by direct measurements in the field. Based on the observations, beach width was divided into four categories: < 3 m, 3-10 m, 10-15 m, and >15 m, while the slope of the beach was divided into three categories: below 10°, 10-25°, and 25-45°. Average width around the West Java has more than 15 meters with a variant of slopes [22].



**Figure 3.** Beach Type, Substrate, Width, and Beach Slope Map. There were six types of beach based on the substrate, namely white sand and sandy coral, white sand with coral and sand, white sand with coral and sandy coral, black sand and sandy coral, black sand and sand, black sand, and mud

Current and turbidity maps were obtained through the satellite imagery. The result for the map of current was generated with a current range between 0 to 0.66 m/s. The current direction that comes from the ocean (offshores) towards the mainland showed a decrease in flow velocity. Meanwhile, turbidity map was obtained using satellite image interpretation with the value varying from 0 – 852 mg/l. On the coastline, the turbidity was found at 150-500 mg/l with an average of 287.5 – 450 mg/l. Turbidity towards offshore decline gradually with a depth around the coastal area, with a depth of 0-25 m. Areas that have shallow depths have a substrate



reef jutting into the sea so that they have a shallow tidal area [23]. Whilst in the sandy beach areas which on the average have sufficient depth, they are ranging from 10-25 meters.

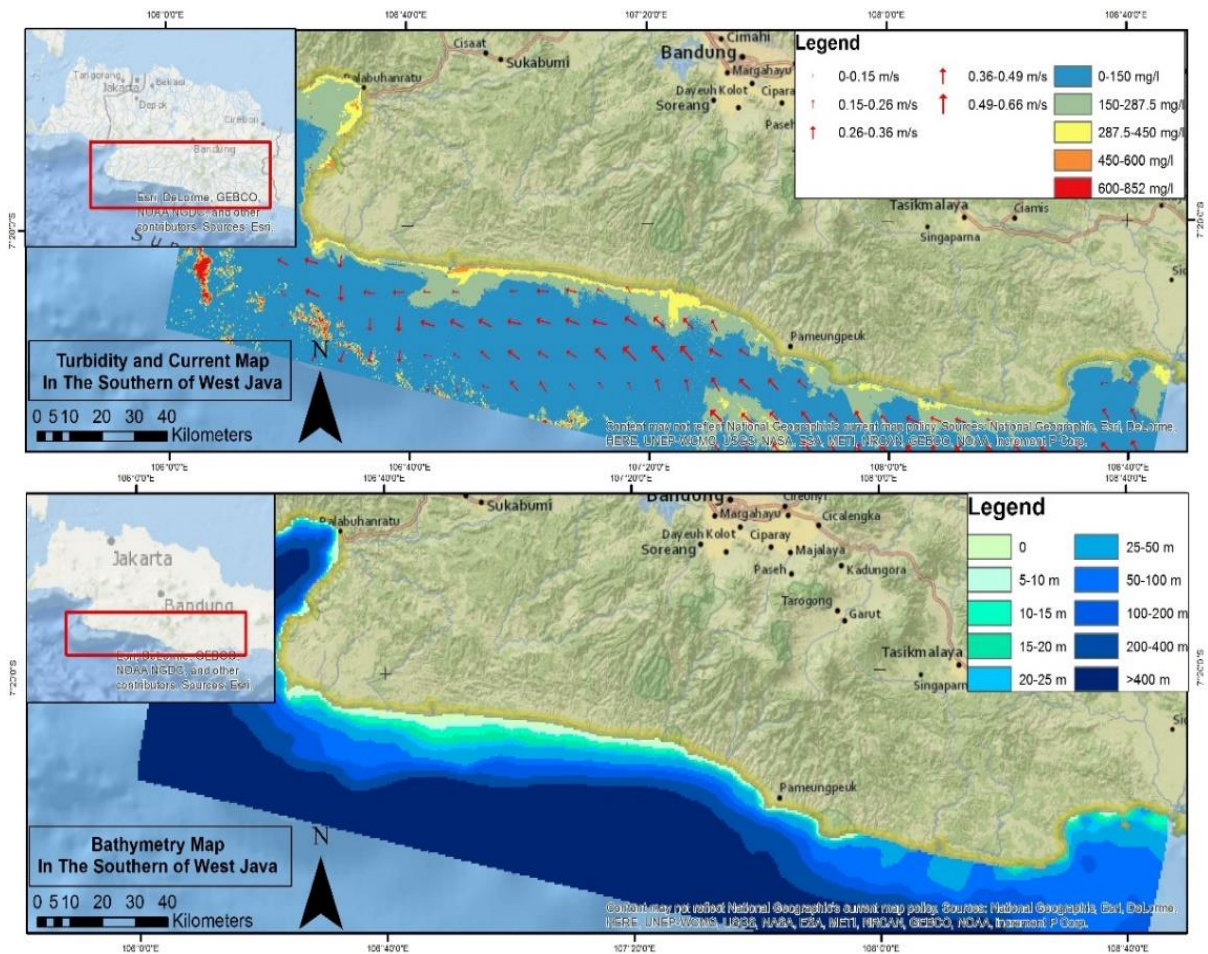


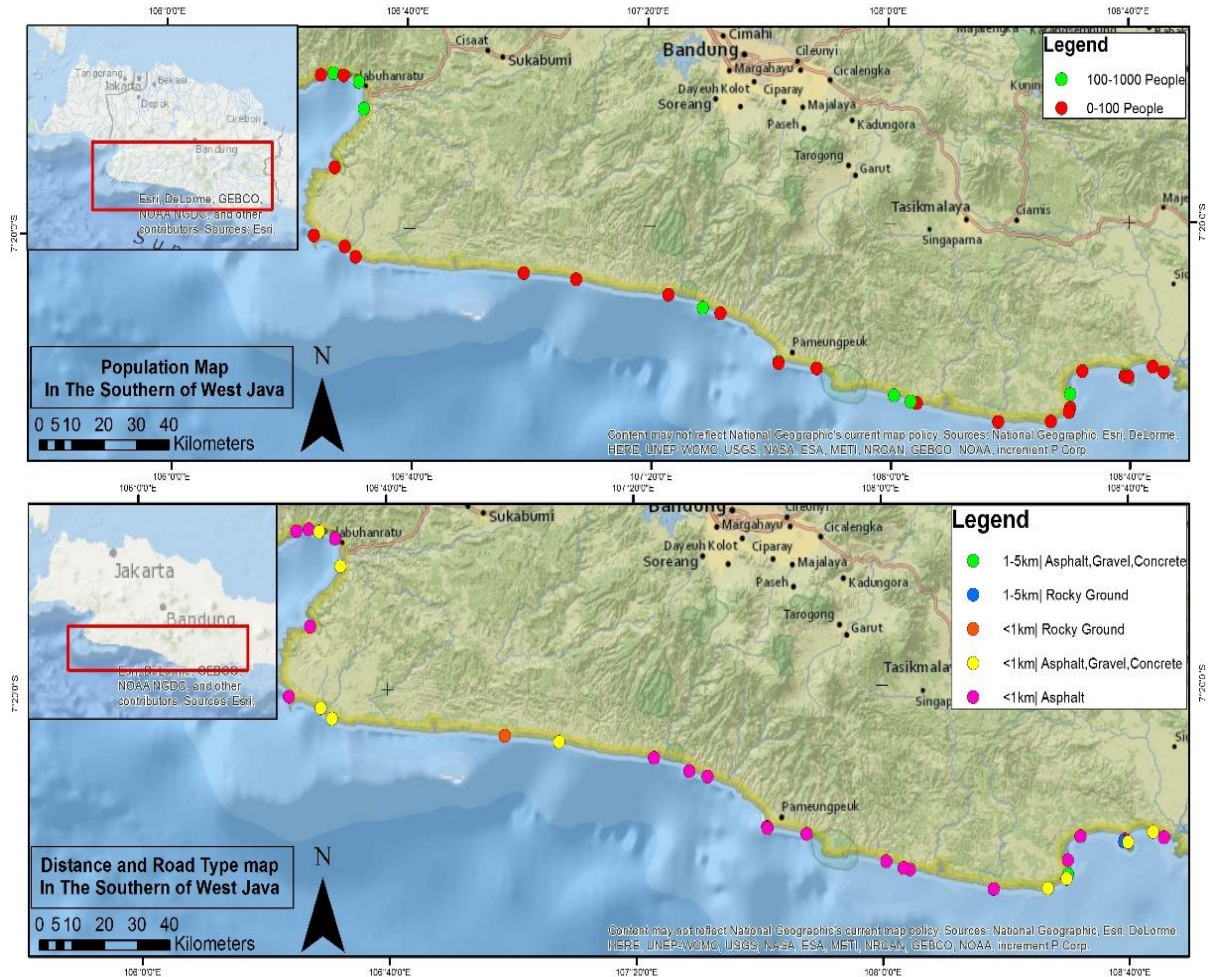
Figure 4. Total Suspended Sediment, Current, and Bathymetry Map

Land cover map and distribution harmful biota maps were generated from the field survey (Figure 4). Land cover in the coastal area consists of coconut, bare land, thicket, bush and savanna. Coconut and bare land cover are dominating around the coast. The only harmful biota discovered was the sea urchin. Mostly all the beaches do not contain a dangerous biota besides Karapyak Beach. The distance of freshwater in almost beach site has less than 0.5 km. The existence of vegetation in addition to protecting beaches and coastlines also has a connection with the aesthetics of the beauty of the coast which is related to tourism factors [24].

### 3.2 Socio-Economic and Managerial Factors

Distance from the beach, road conditions as well as population density around the beach also relates to the suitability of beach tourism (Figure 5). Road condition in the coast area varied from asphalt, concrete, gravel, even still in rocky ground. However, the majority of the beaches visited was already in asphalt condition. Only some of the beach had concrete and

gravel conditions. Based on these results, the average area that had a density of 0-100 people was a beach that has not been managed very well. Meanwhile, the coastal site which had a population density of 100-1000 people, was a beach that frequently was visited by the public and its management had been well maintained.



**Figure 5.** Socio-Economic Map. Population densities were 0-100 people and 100-1000 people while Distance map was categorized as two types: less than 1 km and a distance of 1-5 km

Managerial factors consist of cleanliness and public facilities that exist in the area (**Figure 6**). Distribution of facility location map was composed of campsites, shelters, restaurant, lodge and hotel. Most complete public facilities were found on the crowded beach. Cleanliness factor was divided into three categories; little rubbish, much rubbish, and a pile of very much rubbish. Most of the frequently visited beaches have much rubbish and very much rubbish. Tourism activities contribute to trash on the beach [25]. Provision of facilities and education about the environment is vital in changing behaviour patterns.



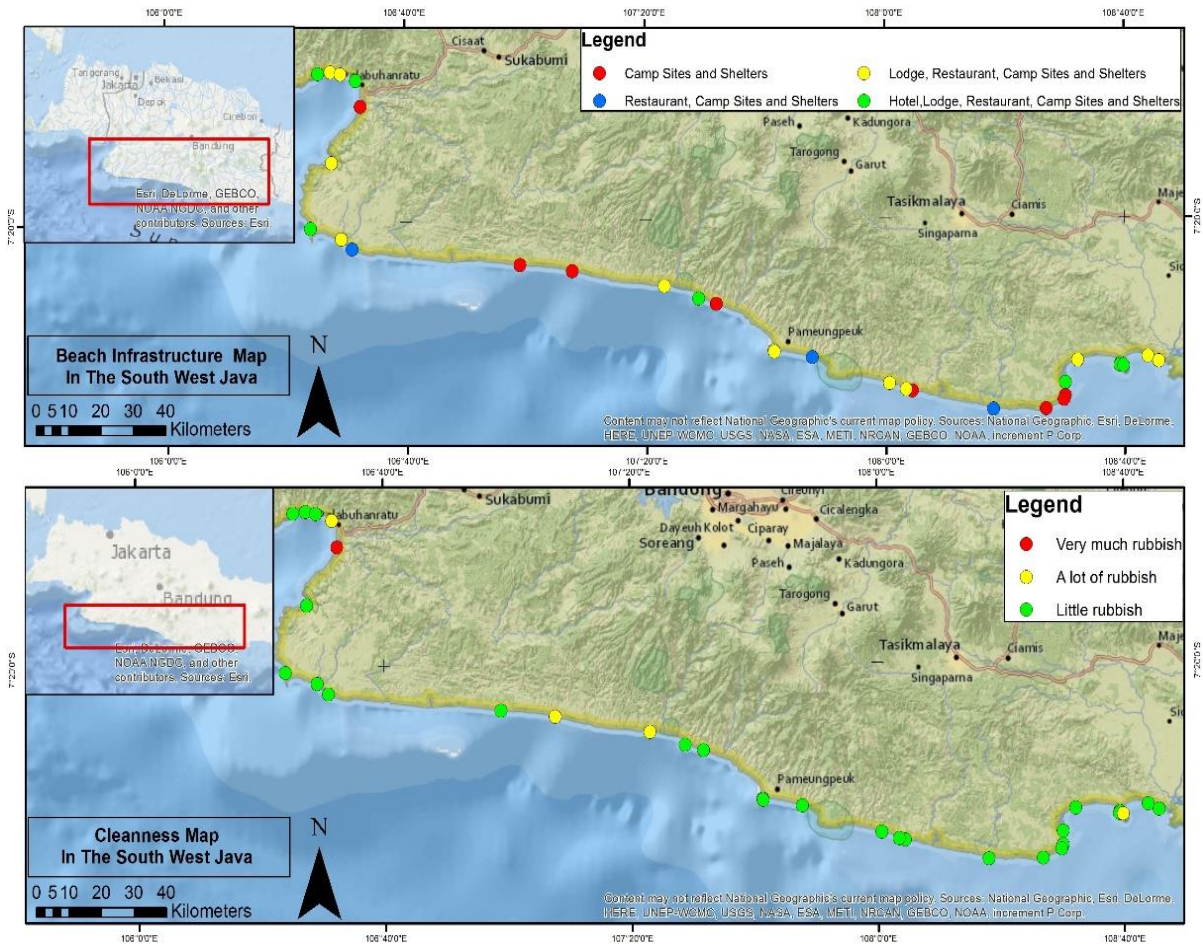


Figure 6. Managerial Factor Map including Facility Location and Cleanliness Factor

### 3. 3. Weight Calculation and Suitability Score

The suitability area for coastal tourism determines using Simple Additive Weighting (SAW) method, also known as a weighted linear combination. Determination of the weighting was based on the results of the correspondence. Eight respondents participated in this judgment, including government area, consultant, businessman, and academics.

In determining the suitability of the area, there were three main factors, containing 15 subfactors. The calculations of the final value were done by normalizing weight and score [18]. It is essential because both two values have different scales. The score was calculated by dividing the unit scores by the maximum value of the scores in each category. On the other hand, normalization of weight was acquired by dividing the value of weighting by the total number of weight value. This value was inserted into each parameter on the map to achieve the final value of coastal tourism suitability.

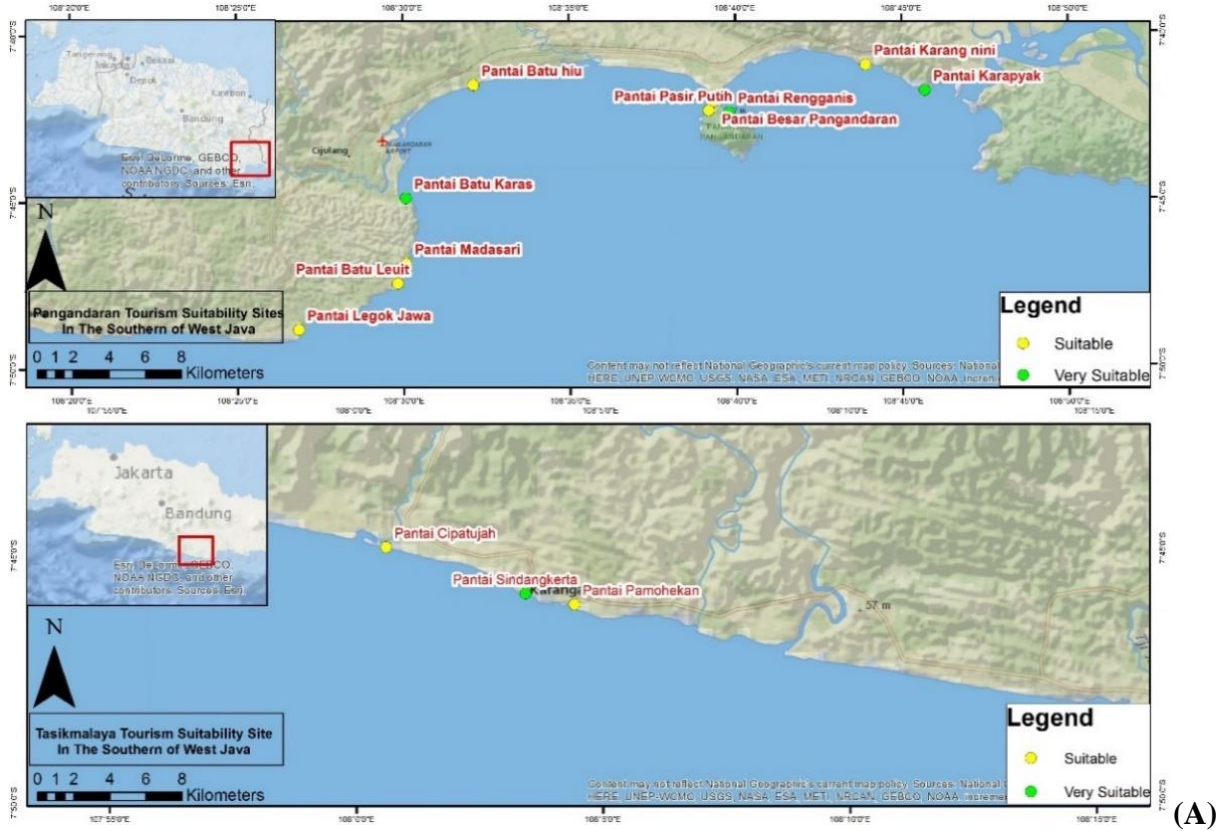
Table 4 described the result of a SAW process for each normalized subfactor. Based on the Table, the most considerable weight in biophysical factor was owned by depth and beach type factor, while the lowest value is beach slope and danger biota factor. For the other aspect, the correspondent chooses distance from road as the highest weight for the socio-economic

factor. At the same time, cleanliness had the highest weight on the managerial factor. This result was consistent with the result of a survey conducted by UNEP to the German tourist where cleanliness was the top marks with a percentage of 64.5% (United Nations Environment Programme 2009). According to this result, biophysical and managerial is the most influential factor in this weighting result.

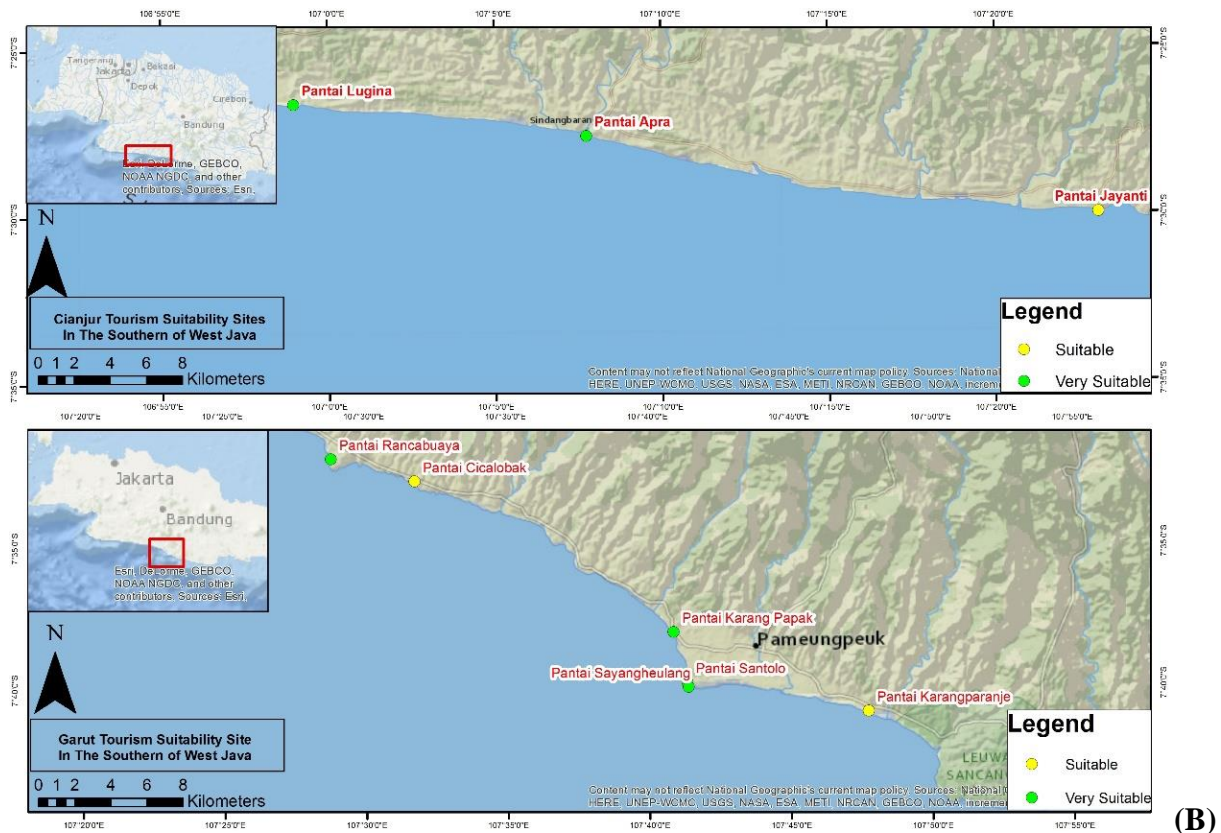
**Table 4.** Assigned weight for this study.

Sub-Factor	Weight	Normalize	Score				Normalize			
			0	1	2	3	0	0.33	0.66	1
Depth	6	0.087	0	1	2	3	0	0.33	0.66	1
Beach Type	6	0.087	0	1	2	3	0	0.33	0.66	1
Width	5	0.072	0	1	2	3	0	0.33	0.66	1
Substrate Material	5	0.072	0	1	2	3	0	0.33	0.66	1
Current Speed	4	0.057	0	1	2	3	0	0.33	0.66	1
Beach Slope	3	0.043	0	1	2	3	0	0.33	0.66	1
Turbidity	5	0.072	0	1	2	3	0	0.33	0.66	1
Beach Cover	4	0.057	0	1	2	3	0	0.33	0.66	1
Danger Biota	3	0.043	0	1	2	3	0	0.33	0.66	1
Fresh Water	4	0.057	0	1	2	3	0	0.33	0.66	1
Distance from Roads	5	0.072	0	1	2	3	0	0.33	0.66	1
Road Type	4	0.057	0	1	2	3	0	0.33	0.66	1
Population	4	0.057	0	1	2	3	0	0.33	0.66	1
Beach Infrastructure	5	0.072	0	1	2	3	0	0.33	0.66	1
Cleanliness	6	0.086	0	1	2	3	0	0.33	0.66	1

The result of weighting was generated for the final result of the suitability map, based on all parameters displayed on the map. The map of suitability for coastal tourism sites is shown in **Figure 7**.



(A)



(B)



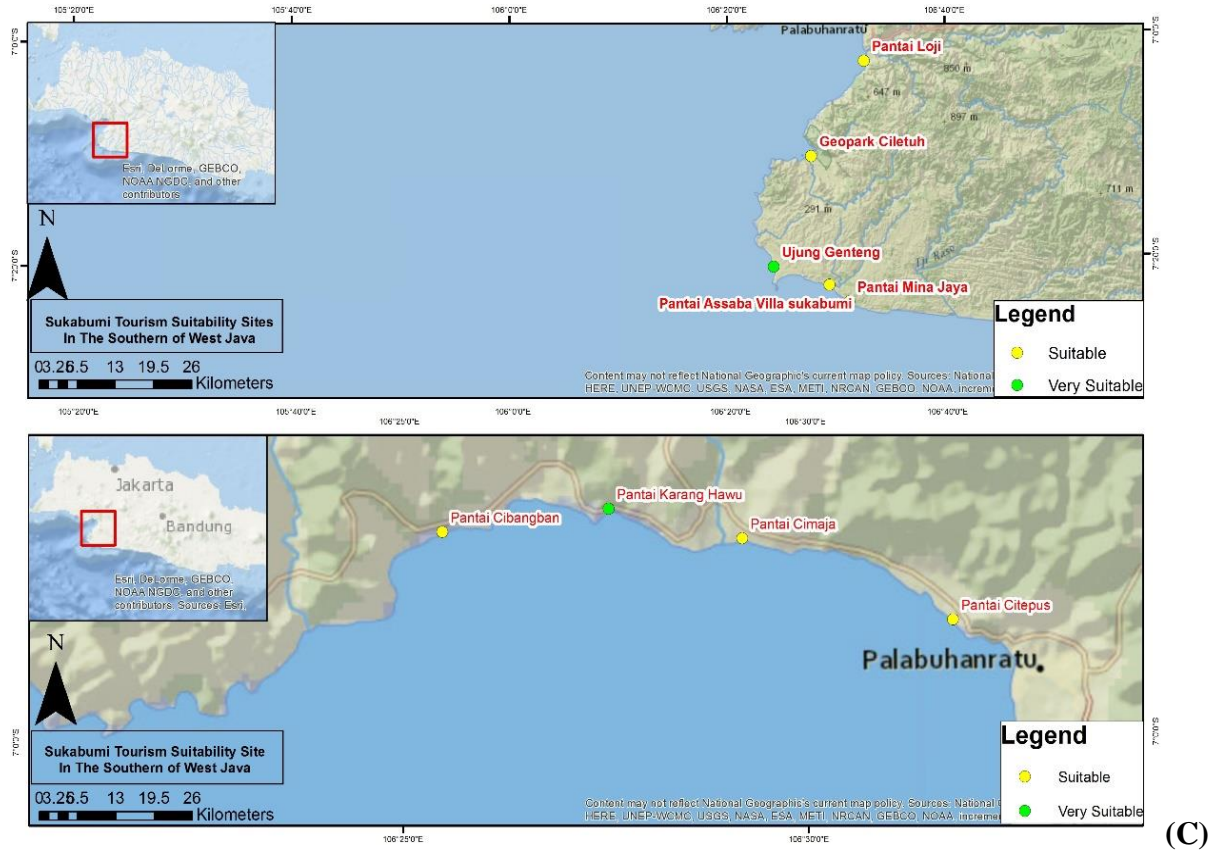


Figure 7(A,B,C). Tourism suitability site in Southern Beach of West Java

Table 5 shows the suitability of 32 beach sites in the southern regions of West Java. Twenty sites belong to a suitable category, and twelve sites belong to a very suitable category. Pangandaran regency had the most beach site at ten beaches (32.5%), consisting of seven sites of suitable category and three sites of very suitable category. Sukabumi Regency which has nine sites, is consisting of seven sites of suitable category and two sites of very suitable category. The least number of sites were found in Cianjur Regency, which only has three sites, consisting of one suitable site and two very suitable sites. According to the result, it can be seen that tourism was more developed in Pangandaran and Sukabumi regency. Besides the infrastructure support, natural conditions also influence the development of coastal tourism in the area.

Table 5. Suitability site based on all factors.

No	Regency	Suitable Category	Very Suitable Category
1	Sukabumi	7	2
2	Tasik	3	1



3	Pangandaran	7	3
4	Garut	2	4
5	Cianjur	1	2

#### 4. CONCLUSIONS

Coastal tourism suitability site in The Southern Coast of West Java was developed by examining three main factors such as: bio-physic, socio-economic and managerial. The system produced a suitability percentage and recommendation. This research shows not only the usefulness of GIS but also reveals how to combine the decision support system with a simple additive weighting method. The final result enables to help decision-makers to solve the problem in selecting coastal tourism site. This application can be used to searching for a suitable location criteria desired by the visitor or tourist.

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