Water physical factor analysis using aqua-modis image data to determine the tour ship route in Karimunjawa

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Submission date: 28-Jan-2022 08:25AM (UTC+0700)
Submission ID: 1749651390
File name: C34_-_Water_physical_factor_analysis_using_aqua-modis.pdf (363.6K)
Word count: 3046
Character count: 16137

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Abstract Tourism development is closely related to the sustainable development that has been declared by the Government. The development of the tourism sector is in line with national development goals. The tourism development must be based on sustainability criteria, which means that development which was environmentally supported in the long-term as well as economically feasible, ethically fair, and socially fair to society. The condition of sea transportation (accessibility) of the Karimunjawa Islands people toward mainland (Java Island) was very limited, that was an average of 10 trips / week in and out of the Karimunjawa port, until the end of 2012. The Inter-island transportation was using fishing boats. This become an obstacle for economic activity, fulfilled the needs of coastal communities and the limited number of tourist visits. The purpose of this research was to identify the average range of water parameters for the route of the tour ship using aqua-modis and to analyze the average range of the waters suitability for determining the port of tour ship. The results of the study used aqua-modis image data, the range of average water temperature in Karimunjawa was ranged from 27 - 320C, the average depth measurement was ranged from 2 - 3 meters at high and low tide, while the average current was ranged from 0.8 - 1.0 m / s. The results of this study proved that the physical parameters of Karimunjawa water were very suitable for tour routes with the category of long vessel capacity with 12 m dimensions, 10 m width, 2.1 m and with an engine size of 5 GT.

1. Introduction

Karimunjawa is the first National Park (KNP) in Indonesia, as a marine conservation area designated by the Director-General of Forest Protection and Nature Conservation (PHKA) Number 123 / Kpts-II / 1986, on April 9, 1986. According to the government of Indonesia decree PP No. 68 of 1998 states that KNP management through a zoning system. The zoning system is revised every 5 years, and the last zoning revision is by decree [1].

Karimunjawa Island is the administrative area of Karimunjawa District government, has ± 93% sea area (sea area is 104.592 hectare, land area is 7.033 hectare), situated at 45 miles from Java Island, at a geographic position between 50040'39"- 50055'00" SL and 110005'57"- 110031'15" EL [2]. Until now, there are 4 villages found in Karimunjawa sub-district, namely; Karimunjawa Village, Kemujan Village, Parang Village, and Nyamuk Village [3]. Karimunjaya consist of 27 islands with 5 islands with a permanent population (Karimunjawa, Kemujan, Nyamuk, Bengkoang, Parang) and 2 island (Menyawakan and Sambangan) with non-permanent population. According to statistical data 2018, Karimunjawa Village has a population of 9,514 people [4].

The development of the marine transportation sector in Karimunjawa Island is directed at the realization of a reliable, effective, efficient marine transportation system, enable to drive the development dynamic,

support the human's good/service mobility. The area of marine tourism destination requires community-based marine tour transportation as a manifestation of community participation in activities [5].

The condition of sea transportation (accessibility) for the people of Karimunjawa Islands to the mainland (Java Island) is very limited. Until 2014, The Jepara-Karimunjawa crossing is served by three ships, namely KMP Siginjai, KMC Kartini, and KMC Express Bahari 2C [6]. Transportation between islands is using fishing boats. This becomes an obstacle for the economic activities, fulfills the needs of coastal communities, and limits the number of tourists visiting the area.

Previous research "Analysis of Community-based Marine Tourism Transportation in the Development of Marine Tourism in Karimunjawa Islands, Central Java", raised the issue: limited information, maritime tourism transportation coverage index based on time distance and side conditions for fishermen to increase fishermen's income, as well as the starting point for increasing marine tourism transportation activities using the fishing vessel [7]. The objective of this study is to map the average range of water parameters of tour ship routes for determining tour ship ports.

2. Research Method

2.1 Place and time of research

This research was conducted during September - October 2020 in Karimunjawa, Jepara Regency, Central Java. The map of the research location can be seen in Figure 1.

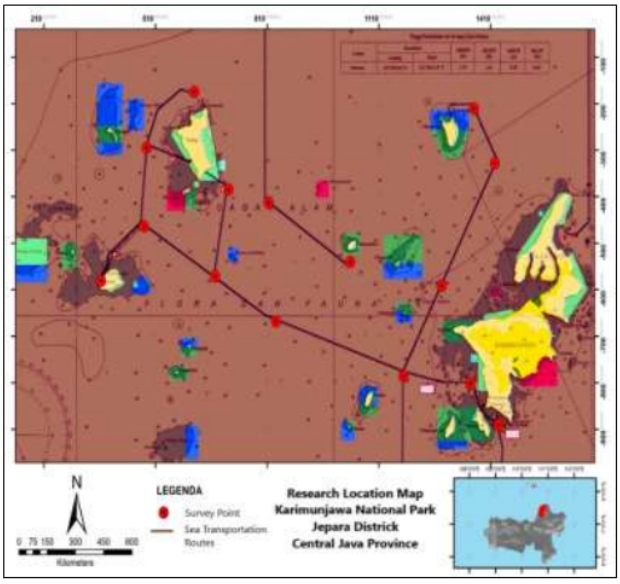

Figure 1. Map of the research location

2.2 Research materials and tools

Material and tools usded in this research and its uses can be seen in Table 1.

Table 1. Materials and tools used in this research

No	Tools/Materials	Uses	Measurement
1	GPS (*Global Positioning System)* Tipe 76CSx	Used to retrieve the coordinates of the ship's route.	*In situ*
2	*Gridded Bathymetric Data Set* (GEBCO), 2020. Dept was 20 - 200 m	Water depth measurement and modeling (https://www.gebco.net/data_and_products/gridded_bathymetry_data)	*In situ*
3	Current Meter	Current speed measurement for modeling	*In situ* and Oceanography Laboratory, UNDIP
4	*Er. Mapper* 7.0	Processing and modeling of satellite image data, especially allgorithm modeling	Oceanography Laboratory UNDIP
5	*Mike* 21	Average current speed modeling	Oceanography Laboratory UNDIP
6	ArcGis 10.3	Mapping data processing	Oceanography Laboratory UNDIP
7	SPSS (*Statistical Package for the Social Sciences*) 22	Perform statistical data processing	Library UNDIP
8	*MS Excel* 2010	Raw import data from survey results	Library UNDIP
9	*Log Book*	Carry out survey data recording in the field	*In situ*
10	*MS Word* 2010	Performing the analysis of data analysis results	Library UNDIP
11	Tour Ship	Transport track survey	Community and tourists
12	Satellite Image Data Sentinel 2B	Analysis and discussion of temperature data and chlorophyll-a	Oceanography Laboratory UNDIP
13	Indonesia's earth shape data (RBI) 2019	Analysis and discussion of spatial patterns	Oceanography Laboratory UNDIP
14	Sea water temperature data	Analysis and discussion of field temperature data for modeling	Oceanography Laboratory UNDIP
15	Sea Water Brightness Data	Analysis and discussion of current data rates and modeling	Oceanography Laboratory UNDIP
16	Tidal data	Analysis and discussion of tidal data	Oceanography Laboratory UNDIP

2.3. Data collection

This research used the field observation method in which the researcher measured the field data directly at the research location. This study used two methods, namely the remote avoidance method and ground check. The data was collected during the research include sea surface temperature, depth, and current speed. The method used in this research was the exploratory method, which was a type of research that seeks to find ideas or new relationships. This descriptive research aimed to create a systematic, factual, and accurate picture or painting of facts, phenomena (symptoms) in actual field conditions.

2.4. Data analysis

The data analysis used in this study was by tourism area suitability matrix for coastal tour development with a remote sensing technology approach. The land suitability matrix could be seen in Table 2.

Table 2. Tourism area suitability matrix

No	Parameter	Weight	Category S1	Score	Category S2	Score	Category S3	Score
1	Sea water depth (m)	5	0-3	3	>3-6	2	>6-10	1
2	Beach type	5	White sand	3	White sand, little coral	2	Black sand, rugged. Little steep	1
3	Beach width (m)	5	>15	3	<10-15	2	3-<10	1
4	Basic substrate	5	Sand	3	Coral rugged	2	Sand/muddy	1
5	Surface current (m/s)	5	0-0.17	3	0.17-0.34	2	0.34-0.51	1
6	Beach slope (^{0})	3	<10	3	10-25	2	>25-45	1
7	Sea water brightness (%)	1	>10	3	>5-10	2	3-5	1
8	Coastal land cover	1	Coconut, open area	3	Shrubs, bush, savanna	2	Tall grove	1
9	Dangerous biota	3	None	3	Sea urchin	2	Sea urchin, stringray	1
10	Freshwater availability (distance/km)	3	<0.5	3	>0.5-1	2	>1-2	1

3. Results and Discussion

3.1. Sea surface temperature parameters

Measurement of seawater surface temperature was conducted directly in the field (in situ) during the research in September 2020. The results of temperature measurements of the research location range from 27.0 ^{0}C to 32.4 ^{0}C as shown in Figure 2. The temperature was also one of the physical parameters of the waters that were very important in Marine tourism development.

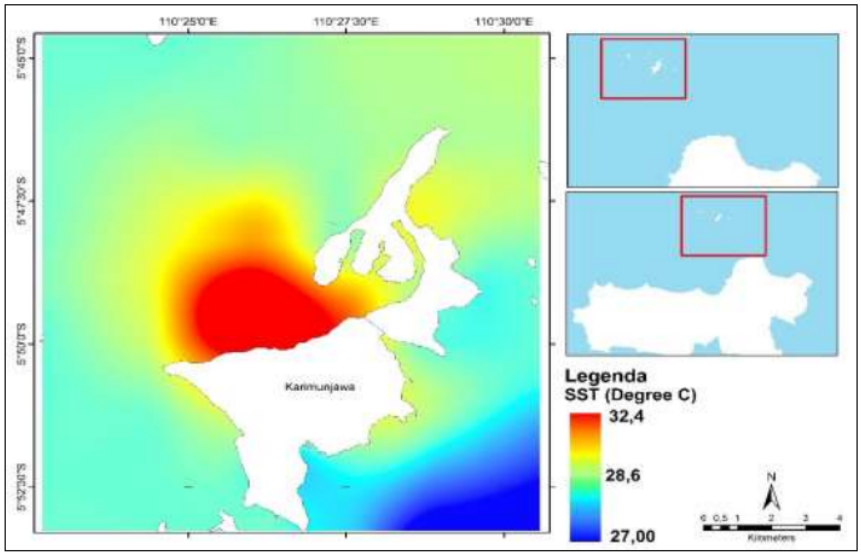

Figure 2. Seawater surface temperature of waters in Karimunjawa

From Figure 2, it was found that the seawater surface temperature distribution of Karimunjawa waters had the optimum water surface temperature range. The temperature range was very good for coral growth and other tropical marine biotas. This was supported by [9, 10, 11] it was found that the seawater surface temperature distribution of Karimunjawa waters had the optimum water surface temperature range. The temperature range was very good for coral growth and other tropical marine biotas. This was supportd fluctuations, in coastal areas that had a relatively shallow depth due to contact with the exposed substrate [12].

One of the tour vessel route areas for tourism vessel was the coral reef area. The water temperature is one of the supporting factors for determining the tour ship route area in Karimunjawa. By looking at the water temperature range which was between 27.00 ^{0}C - 34.40 ^{0}C, it could be concluded that this temperature range is very suitable for the ship tour route because of the temperature range which supports the existence of coral reef as one of the Karimunjawa marine tourism destinations .

3.2. Depth parameters

The results of the depth of Karimunjawa waters measurement ranging from 2m – 3m (Figure 3) which is suitable for the tour vessel route. The highest depth value was found in the reef area, while the lowest was on the coastal area. The difference in water depth at the sampling location is due to the seabed relief. The

topography of the coastal areas of Karimunjawa waters from inland to sea was generally sloping, then followed by a sharp cutting edge to the seabed. According to [10], ~~(7)~~ the seabed relief affects the depth of water.

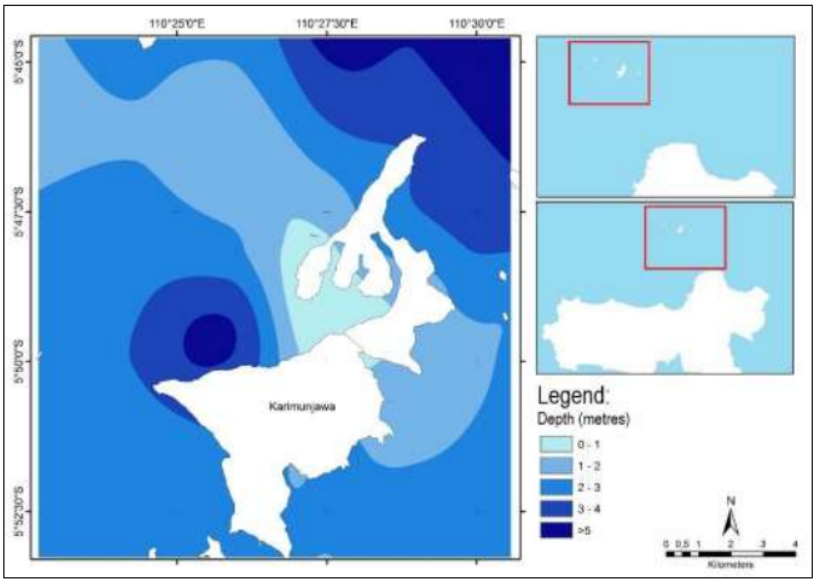

Figure 3. Depth of waters in Karimunjawa

The water depth shown in Figure 3 indicates that the depth range is suitable for the tour vessel to sail with the tour vessel that has length of 12 m, dimensions of 10 m, draft of 1 m, width of 2.1 m, and an engine capacity of 5 GT. The water depth is one of the most important water parameters to be taken into account in determining an area that would be used as a tourism area, especially for tour vessel routes because it greatly affected the safety aspect when visiting tourism destinations. Physically, shallow waters were good enough to be used as a recreational object, especially for bathing and swimming. The results of water depth measurements in Karimunjawa showed that the depth range of coastal waters is between 1 m -3 m. The depth range of Karimunjawa waters, therefore, is considered appropriate for coastal tourism development activities. This was supported by statements by [13, 14, 15] which declares that the depth value limit for the suitability of coastal ecotourism is between 3 to 6 meters based on tourism area suitability matrix.

3.3. Current speed

The results of the current speed measurement in Karimunjawa waters ranged from 0.0 m / s to 0.5 m / s. The distribution of the current speed average result could be seen at Figure 4.

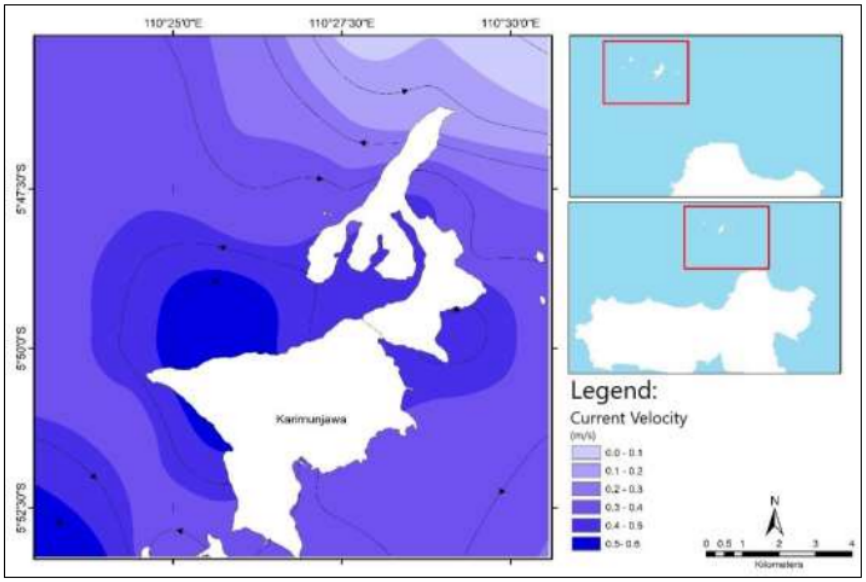

Figure 4. Average current velocity in Karimunjawa

There are some common current types *i.e*. tidal current, longshore current, current caused by wind, and caused by the difference in seawater density [16]. The current measurement is the current that influenced by the waves. Current velocity data collection is carried out at predetermined coordinate points using GPS. The results of the current speed measurement in Karimunjawa range from 0.1–0.9 m / s. This condition was included in the S1 category (very suitable) in the suitability index for beach recreation tourism [17, 18, 19]. The current speed was closely related to the comfort current condition for the tourists who come to this tourism site. Under high current velocity, no tourist activities (surface snorkeling, swimming) take place since it is unsafe for tourists. On the contrary, the light current speed will give comfort conditions for tourists to do snorkeling or swimming in tourism destinations.

4. Conclusion

Based on the results of the study, the average water temperature in Karimunjawa was ranging from 27 - 32.4^{0}C, the depth ranges was between 2 - 3 meters at high tide and low tide, and the current speed average was ranges from 0.0 m/s - 0.5 m/s, it can be concluded that the physical parameters of Karimunjawa waters are very suitable for tour ship route based on tourism area suitability matrix.

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