Temporal analysis of total suspended solids (TSS) at Ujung Pangkah Beach, Gresik, from 2016 - 2020 using aqua MODIS image data

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ABSTRACT

Total suspended solids (TSS) is a parameter widely used to detect pollution on the coast, especially in areas that have a sloping coastal structure where currents and waves parallel to the coast will accumulate these solids to form sedimentation gradually. This study aims to map the distribution of TSS on the coast of Ujung Pangkah Gresik where at the end of this coast there is a flow from the Bengawan Solo river. The method in this study implements remote sensing technology to collect Aqua MODIS satellite image data of from 2016 to 2020. Based on calculation results, the wavelength band 1 (660 nanometers) of the Aqua MODIS image is the best wavelength by looking at the R correlation value generated of 0.573, so it can be concluded that the Aqua MODIS satellite imagery with a resolution of 250 - 500 meters can still be used to create a mathematical model for mapping the TSS distribution on the coast. In terms of forecasting for 5 years, the reflectance value generated from the image does not give significant results, because this satellite image is very influenced by the weather, so it is very difficult to get a cloud-free image in the same month every year to extract the reflectance value.

1. Introduction

Total suspended solids (TSS) is the turbidity occurs in water bodies which is widely used to study environmental pollution or changes of the ecosystem in a coastal area where ocean currents and waves, especially waves parallel to the coastline, will carry these solid grains to settle on the coastline which over a period of time will cause continuous sedimentation.

The occurrence of the sedimentation process on the coast for a certain time is interesting to study because the accumulation throughout the year will change the morphology of the beach, this will happen quickly on the type of sloping beach where there are not many rocks that will slow down the sediment deposition process.

Ujung Pangkah Gresik is an area where there is an estuary of a large river, namely the Bengawan Solo river. This area is a type of sloping coastline with its characteristic, namely sandy beaches and not many cliffs attached to it, so that the scouring or sedimentation process occurs a lot in this area, besides that the Ujung Pangkah area is a pond area with little mangrove forest which acts as a shield. for seawater currents. In this area, there has been no research on the mapping of total suspended solids (TSS) mainly in the west coast area, while during the last 10 years the growth of mud is quite large due to the estuary of the Bengawan Solo River. Thus, conducting research in this area becomes interesting to produce the latest information about it.

To map the occurrence of the sedimentation process requires recording data throughout the year that can describe the changes that occur in the existing coastline. There have been many studies conducted by researchers from various countries on mapping the distribution of total suspended solids and their effect on environmental damage, and various technologies have been developed including the use of remote sensing technology that uses various types of existing satellite imagery, from lowresolution ones. which are widely used for natural resource monitoring such as Terra MODIS [1-3] (Brando et al., 2006; Hanintyo & Susilo, 2016; Ody et al., 2016), Aqua MODIS [2, 4, 5] (Hanintyo & Susilo, 2016; Maritorena et al., 2010; Yi et al., 2008), and also Suomi VIIRS [6, 7] (Shi et al., 2018; Vermote et al., 2016), in addition to medium resolution ones such as ASTER, Landsat 7, Landsat 8 [810] (Li et al., 2013; Marindah Yulia Iswari, 2016; Painter et al., 2012), and also SPOT.

This study aims to map the distribution of total suspended solids that occur on the coast at Ujung Pangkah Gresik on the east side which is directly adjacent to Bangkalan and Madura Strait, and from this research, a suitable mathematical model is intended to describe changes in total suspended solid concentration using imagery. Low-resolution satellites such as Aqua MODIS, where the same research was conducted on the northern coast using Landsat 8 satellite imagery [11] (Wibisana et al., 2019) also in the Bangkalan Madura area [12] (Solin et al., 2018), in addition to that from this study The distribution of TSS values in milligrams per liter will be mapped from the best mathematical model generated with Aqua MODIS image data.

2. Method

2.1. Satellite Image Data

Aqua Modis satellite image data used is a satellite image that is downloaded with the file name A2020212055000.L2_LAC_OC.nc, after processing it until it is correct for the existing projection system, the file name storage process becomes A2020212055000.L2_LAC_OC.nc_ subset reprojected. A is the initial that shows the satellite image with the Aqua Modis sensor, while the 4 digits after that are 2020, which indicates the image was taken in 2020. The satellite image view can be seen in Figure 1, the result of the recording of August 2020.

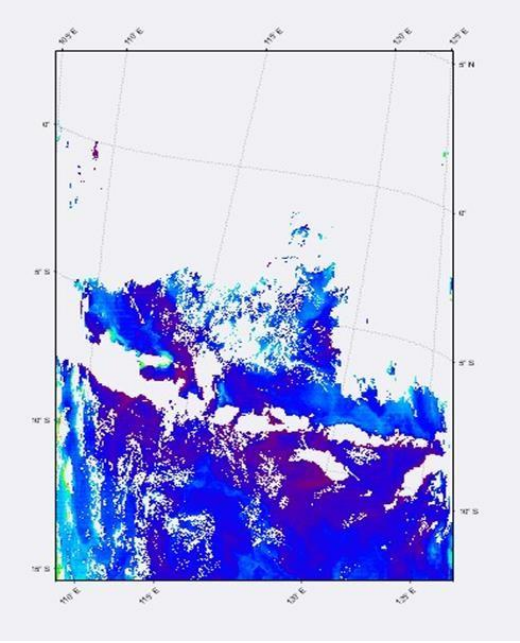

Fig. 1. Display of Aqua MODIS satellite imagery for August 2020 for Java and its surroundings

The coordinates for field data collection are shown in Figure 2. Where in the Figure the location points are marked with a PIN which is a facility of the SeaDAS program package. The points taken are

20 points spread lengthwise from the Ujung Pangkah arch to the border of Karang Rejo Gresik subdistrict.

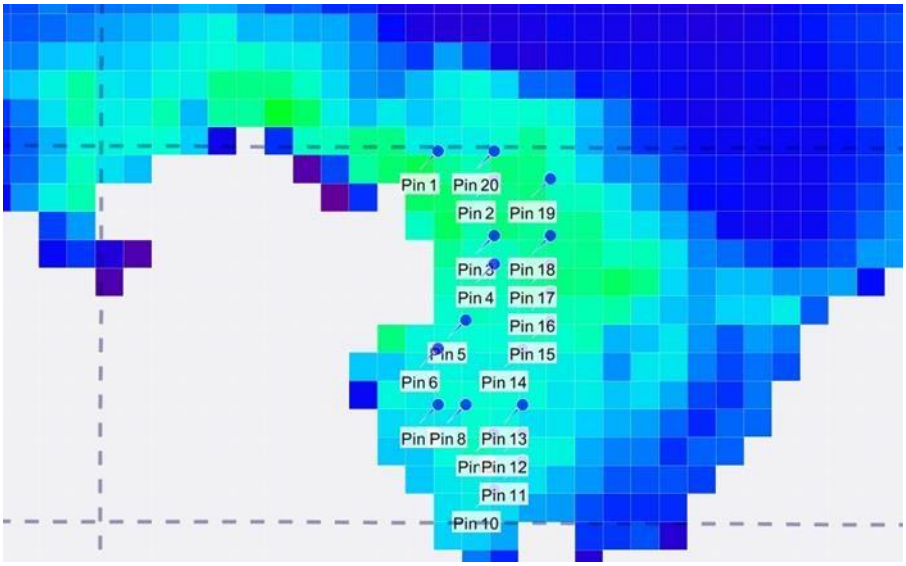

Fig. 2. Location of field TSS data collection (mg / l)

From Figure 1 which displays the Aqua MODIS image data in its entirety, the next step is to cut the image in the desired area (AOI), namely around Ujung Pangkah Gresik which is located at coordinates 112° 30' to 113° East Longitude and 6° 30' to 7° 10' South latitude as shown in Figure 3.

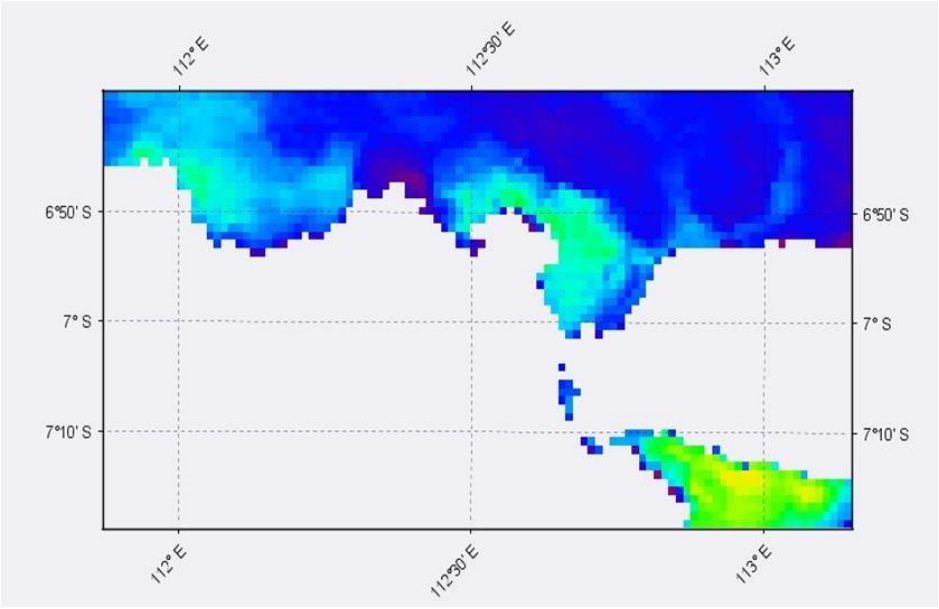

Fig. 3. Satellite image view after AOI cropping

2.2. TSS Data Field

To obtain TSS data in the field, a series of activities were carried out on the coast of Ujung Pangkah Gresik using fishing boats. Seawater at several predetermined coordinate points is taken using a plastic bottle at a depth of 20-30 centimeters, each plastic bottle is marked according to the intended coordinate point. This sample is then taken to the laboratory to be measured Gravimetrically for the TSS value content in 1 liter of seawater with the formula:

$$TSS\left(\frac{mg}{l}\right) = \frac{Weight\ of\ suspended\ solid}{Volume\ of\ sea\ water} \quad (1)$$

Seawater taken with a volume of approximately 1 liter is filtered with Whatman filter paper, the results are then put into an oven to dry at 100o Celsius for 2-4 hours. Weighing is carried out after drying is complete and the results are recorded in milligrams per liter, the results of TSS are shown in Table 1. For 20 observation points in the field.

Table 1. TSS data (mg / l) from Gravimetric weighing results

Lon	Lat	TSS (mg/l)
112.681	-6.8439	56.3
112.693	-6.8421	76.5
112.7067	-6.8506	92.6
112.7117	-6.8463	68.2
112.7133	-6.8566	73.8
112.7269	-6.8651	65.1
112.739	-6.8632	62.8
112.7527	-6.8717	59.4
112.7664	-6.8802	64.8
112.768	-6.8905	71.3
112.7802	-6.8887	102.7
112.7786	-6.8783	82.5
112.777	-6.868	82.9
112.7633	-6.8595	77.1
112.7495	-6.851	85.2
112.748	-6.8407	73.7
112.7309	-6.8471	72.9
112.7188	-6.8488	54.8
112.7172	-6.8385	75.3
112.6915	-6.8318	47.2

The TSS value data is then processed with a remote sensing algorithm to the reflectance value of the Aqua MODIS satellite imagery for August 2020 and from the process of calculating the first 15 data carried out by the linear regression method, the best mathematical model is generated from satellite imagery, namely at a wavelength of 667 nm, The remaining 5 data will be used to validate the resulting mathematical model.

3. Results and Discussion

From the results of calculations with a scatter diagram of 3 wavelengths representing visible color waves, red for 412 nm, green for 531 nm, and blue for 667 nm in the Aqua MODIS satellite image, the wavelength of 667 nm is recorded as the most optimal wavelength that can be used as a model to predict the distribution of TSS values on the coast of Ujung Pangkah Gresik, while the model involved in the wavelength of 667 nm is shown in Table 2.

Table 2. A mathematical model with correlation value R2 at a wavelength of 667 nm

No	Algorithmic	Mathematical Models	R2
1	Linier	y = 16527x - 194,68	0.8721
2	Eksponen	$y = 2{,}1935e^{215{,}63x}$	0.8641
3	Logaritma	y = 271,27ln(x) + 1191,7	0.8693
4	Power	$y = 2E{+}08x^{3{,}549}$	0.8661

In Table 2., it can be seen that the Linear mathematical model is a model that provides the most optimum correlation value with a value of 0.8721 compared to other models for the same wavelength, so this linear model will be used to create a thematic map of the distribution of TSS values. But before that, the resulting model will be tested first by performing model validation on the remaining 5 data from the 20 previously existing data. The results obtained from the model validation analysis are shown in Table 3.

Table 3. Validation of TSS values (mg / l) in various existing mathematical models

Point	In situ	Linear	Exponential	Logarithmic	Power
16	73.7	73.454	72.521	73.725	88.896
17	72.9	75.239	74.230	75.525	91.014
18	54.8	65.984	65.787	66.060	80.414
19	75.3	80.329	79.327	80.593	97.253
20	47.2	12.205	32.614	3.378	35.415

In Table 3. Validation is conducted on the reflectance value of 5 data into a mathematical model that has been selected at a wavelength of 667 nm, namely for the linear model, exponential model, logarithmic model, and power model. In the next step, from the total suspended solid value generated by each model, a correlation analysis will be implemented to examine the closeness of the relationship with the TSS data in situ and the results are shown in Table 4.

Table 4. Comparison of the correlation of the in situ TSS against existing mathematical models

	In situ	Linear	Exponential Logarithmic	Power	In situ
Insitu	1				
Linear	0.85744	1			
Eksponen	0.88659	0.99699	1		
Logaritmik	0.84841	0.99978	0.99513	1	
Powe	0.88066	0.99820	0.99984	0.99671	1

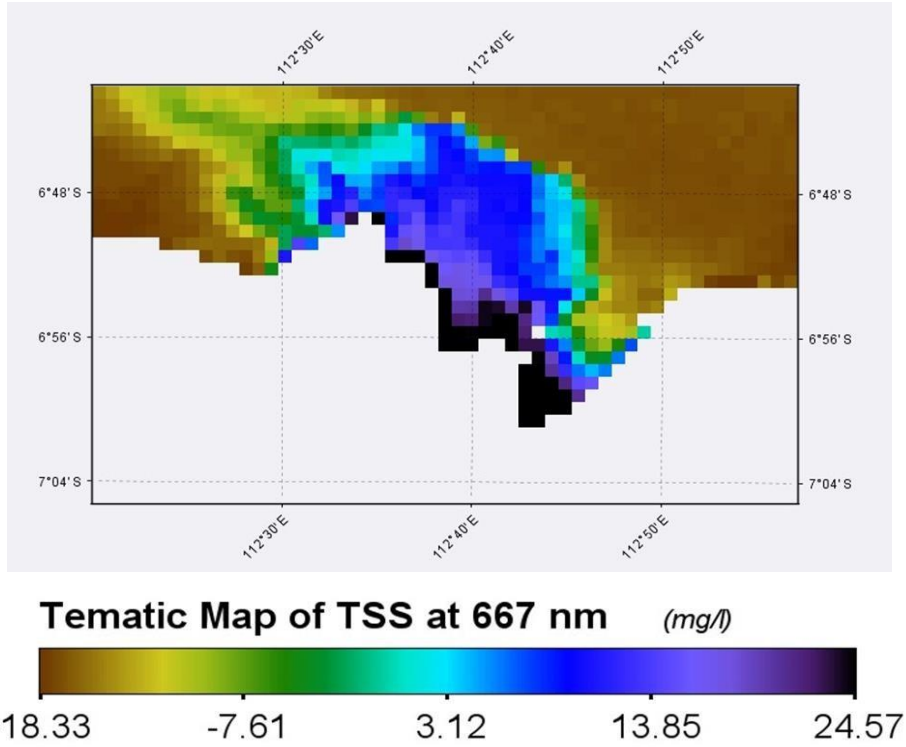

Fig. 4. Thematic maps of TSS (mg/l) at 667 nm wavelength

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4. Conclusion

Total suspended solids (TSS) mapping can be done by utilizing Aqua MODIS satellite image data, especially if it is done in a quite large area because Aqua MODIS images have good recording capabilities even though the resolution is still low. Furthermore, changes in TSS values in Ujung Pangkah Gresik throughout the year have unique characteristics, where these changes lead to the formation of sedimentation which will slowly change the shape of coastal morphology in the next 10 to 20 years.

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Declarations

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