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Conference Paper

Analysis of The Distribution of Total Suspended Solids on The Coastal Sampang Coast Due To The Blega River Flow Using Satellite Image Data

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ABSTRACT

The total suspended solids in the river flow are the source of the sedimentation process, which will lead to the river mouth, namely the coast, which will experience this process on an ongoing basis. In this research, the case study investigated is the flow from the Blega River, which carries the total suspended solids to the coast of Sampang Regency, Madura, where the suspended solids will dissolve in the Sampang coastal waters to the Madura Strait. The purpose of this research is to find out and analyze whether the accumulation of suspended solids is more towards the east or west of the coast of Sampang so that later it can be done to forecast changes in the coastline of the coast. The method used in this research is to utilize remote sensing technology using satellite image data. The results obtained from the measurement of total suspended solids with Aqua MODIS satellite image data in March 2022 showed that more sediment was accumulated in the western part of the coast, so from this phenomenon, it can be predicted that the western coast approaching Bangkalan district will receive sedimentation contributions which will affect the coastline of Bangkalan district in the future. It can also be concluded that the reflectance data of satellite imagery can be used to create an algorithm for the distribution of total suspended solids in sloping coastal areas such as the coast of Sampang, Madura.

Keywords: Total suspended solid, reflectance data, Aqua MODIS, Coast of Sampang district

Introduction

Total suspended solids are one of the parameters that harm life on the coast, especially in the ecosystems found in the area. A high concentration of suspended solids, over time, will cause gradual sedimentation on the coast, where suspended solids and other dissolved solids transfer the existing sediment to accumulate and be deposited, which in turn causes silting on the coast. (Miller et al., 2011; Vassilakis & Papadopoulou-Vrynioti, 2014; Baby, 2015; Laju et al., 2017).

Researchers from various countries have researched the distribution of dissolved and suspended solids. The total suspended solids concentration in shallow water environments is quite large compared to steep water types. Therefore, with remote sensing technology, which is currently supported by information technology development, it is possible to conduct a variety of research on total suspended solids using various sensors. In addition, the algorithms developed have also snowballed involving the use of channels from satellite imagery, both Aqua MODIS (Neukermans et al., 2009; Cherukuru et al., 2020; Wibisana et al., 2020), Terra MODIS (Ju et al., 2010; Ody et al., 2016; Zainab et al., 2020), SPOT (El-Asmar & Hereher, 2011; Yang et al., 2011), and Landsat 8 (Herbreteau et al., 2007; Iswari, 2016; Ody et al., 2016; Liu et al., 2020).

The accumulation of suspended solids also occurs due to transport from the river to the estuary. As a result of the transport process, these suspended solids will move towards the estuary and will mix with seawater on the coast, gradually settling, and sedimentation will occur (Vassilakis & Papadopoulou-Vrynioti, 2014; Zhang et al., 2017; Safaval et al., 2018).

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Madura Island in the south has the Blega river flow, which empties into the Madura strait, and the mouth of this river is in the Sampang district. The flow of rivers that empties into carrying solids is interesting to study because the flow pattern will impact the speed of accumulating suspended solids in the estuary area and adjacent areas vertically and horizontally.

This study aims to measure and observe the distribution of the total suspended solids carried by the Blega river. This suspended solid will be measured, and seen the direction of movement of the suspended solids, whether more to the right side of the river which will later spread to the Bangkalan district, or whether moving more to the left will give the distribution of turbidity in Pamekasan district.

Material and Methods

Acquisition of satellite image

The satellite image used in this study is a medium resolution, namely Aqua MODIS, with a resolution of 1 kilometer per pixel. The image extracted from the https://oceancolor.glfc.nasa.gov/ website has the file name A2022076063000.L2_LAC_OC.nc, where A is the initials of Aqua MODIS and the four digits following is the year of acquisition, which is 2022. The display of the Aqua MODIS image scene is intact and can be seen in Figure 1.

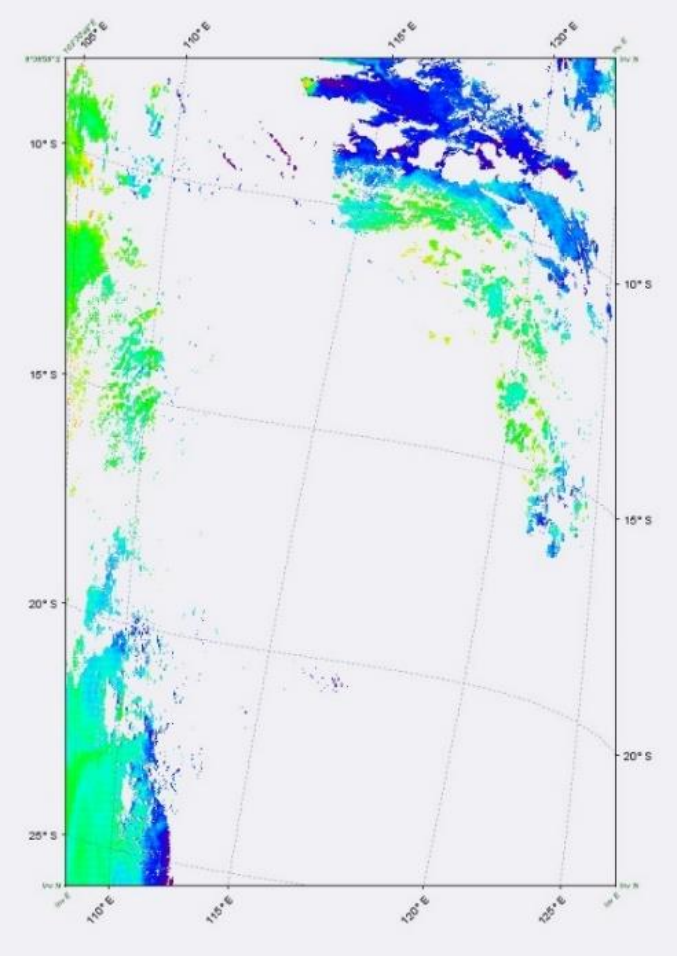

Figure 1. Scene of Aqua MODIS with the central area of Java Indonesia

Research study location

This study took place in the Sampang Regency, Madura Island, where there is an estuary of the Blega River. The observation point takes the coordinates of UTM 9199532 South to 9199872

South and 740015 East to 728274 East. The location at the estuary of the sampan district was taken to compare the distribution of the total suspended solids concentration on the left and right sides of the Blega river estuary. Furthermore, from the observations and calculations carried out later, it will be concluded that the highest suspended solids phenomenon is in the east or west position in terms of the flow of the Blega river, which leads to the estuary to the waters of the Madura Strait.

TSS Data Retrieval (mg/l)

TSS data retrieval was carried out by filling a 1-liter sample bottle with sea water at a predetermined coordinate position with GPS Navigation equipment. The TSS data taken is cloudy seawater which is then taken to the laboratory for Gravimetric Analysis to obtain suspended solids per liter of solution. The measurement results of total suspended solids (TSS) for 10 points in the area to the left of the estuary can be seen in Table 1 with a column for the corresponding coordinates. And for the following 10 points taken in the area to the right of the estuary can be seen in Table 2.

Table 1. TSS field data (mg/l) obtained along the coast of Sampang Madura district to the left of the Blega river estuary

Point	South	East	TSS (mg/l)
S1	9199534 S	740016 E	74,9
S2	9199938 S	742043 E	83,6
S3	9200226 S	743847 E	79,5
S4	9200190 S	745715 E	93,2
S5	9200179 S	747675 E	87,4
S6	9198757 S	739711 E	128,4
S7	9199057 S	741894 E	114,5
S8	9199422 S	743816 E	143,8
S9	9199281 S	745814 E	126,7
S10	9199178 S	747892 E	133,2

Table 2. TSS field data (mg/l) obtained along the coast of Sampang Madura district to the right of the Blega river estuary

Point	South	East	TSS (mg/l)
S11	9199892 S	736176 E	83,1
S12	9199502 S	734032 E	75,2
S13	9199253 S	732058 E	78,1
S14	9199512 S	729865 E	69,4
S15	9199871 S	728273 E	66,2
S16	9198808 S	728163 E	93,5
S17	9198487 S	729991 E	87,3
S18	9198177 S	732130 E	85,1
S19	9198072 S	734338 E	78,6
S20	9198476 S	736391 E	57,3

TSS Data Analysis

Measurements were made on 20 samples where each sample was measured for the TSS value by Gravimetry (Baxter, 2017; Tan et al., 2017), and the results were in milligrams per liter. At the

coordinate point where the TSS sample was taken, reflectance data were collected from the Aqua MODIS satellite image with the help of SeaDAS software 7.5.2 version. Data analysis was carried out using the statistical t-test technique to compare two treatments between the left and right sides of the Blega river estuary. Besides that, remote sensing algorithm calculations were also carried out to obtain the most suitable mathematical model to describe the distribution conditions of the TSS.

Thematic map creation

To obtain a thematic map of the distribution of TSS in milligrams per liter, satellite imagery channel analysis was carried out from the mathematical model, which was predicted to be most accurate by looking at the correlation value of R2 and the validation of the mathematical model that had been formed and the magnitude of the correlation value shown. The model with the highest correlation value from the previous validation is used as a reference model in processing the "math band" of satellite imagery during processing with SeaDAS software. The result of the "math band" processing is a thematic map that can provide a spatial description of the distribution of TSS in the waters of the Madura canoe district.

Satellite image processing

Aqua MODIS satellite imagery must be processed further to get the desired research area. Furthermore, the existing projection on the image with the MODIS sensor still needs to be reprojected. The first stage is cutting the image where the Aqua MODIS image in Figure 1 is cut according to the research area. The results of the first stage of cutting can be seen in Figure 2, where the visible area is only the Madura strait with the southern coast of the Madura island and the northern coast of Sidoarjo, Pasuruan, and Probolinggo.

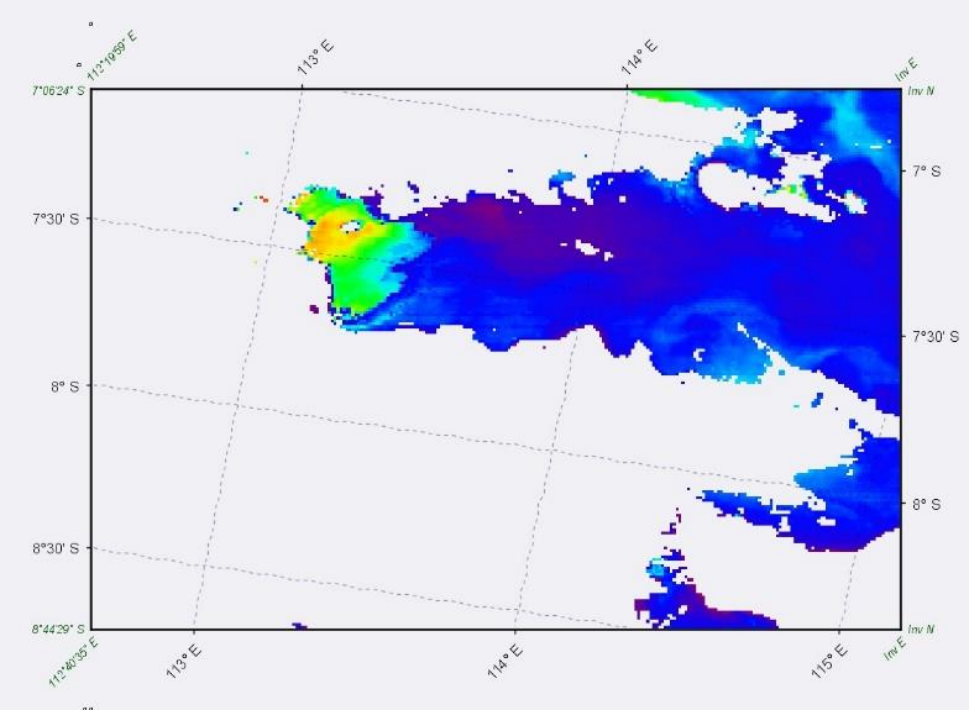

Figure 2. The results of cutting the Aqua MODIS satellite image in the Area of interest (AOI) namely the coast of the island of Madura

The next stage is to compile a re-projection from satellite imagery where the WGS 84 projection system and display coordinates are geographic coordinates. The results of the re-projection to obtain vertical coordinates can be seen in Figure 3.

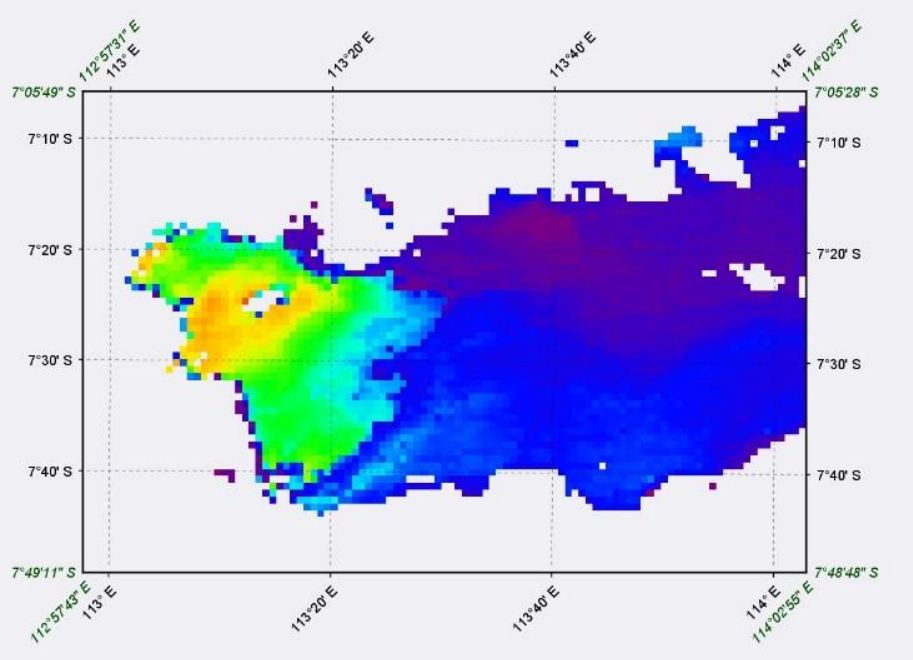

Figure 3. The results of the rearrangement of satellite image projections on the WGS 84 system with Geographical coordinates in the coastal area of the southern region of the island of Madura

Results and Discussion

From the results of remote sensing algorithm processing for image data by calculating trend analysis between the reflectance of satellite imagery and TSS field data, several mathematical models are obtained that can be compared with each other to obtain the most appropriate correlation with the in situ TSS data curve description. Furthermore, from the acquisition of the correlation value of R2, it was found that the wavelength of 412 nanometers is the wavelength that has the best correlation among other wavelengths in the Aqua MODIS satellite image. The algorithm at the 412 nm wavelength is given in Table 3, with the correlation value of each mathematical model obtained.

Table 3. Algorithm on satellite imagery for a wavelength of 412 nm with a correlation value of R2

No	Algorithm	Mathematical model	R2
1	Linear	$y = 17228x - 94.753$	0.6869
2	Exponent	$y = 12.687e^{179.86x}$	0.756
3	Logarithmic	$y = 175.9\ln(x) + 889.26$	0.6491
4	Power	$y = 381058x^{1.8446}$	0.7207

Source: Calculation results

The model obtained in Table 3 needs to be validated to see the suitability of the model with the in situ data, namely the existing TSS distribution, and from the validation calculation between the remaining 5 data from the in situ TSS measurement with the help of excel, the TSS correlation value of each mathematical model is obtained from the TSS in situ data. The validation results are shown in Table 4.

Table 4. The calculation result of the TSS value validation between the in situ data and each mathematical model

TSS insitu	Linear	Exponent	Logarithmic	Power
93.5	110.708	108.374	110.192	107.868
87.3	89.931	87.241	91.440	88.661
85.1	82.971	81.126	84.683	82.549
78.6	76.045	75.468	77.691	76.713
57.3	66.432	68.261	67.501	68.938

Source: Calculation results

To be able to say whether or not the existing model is sufficient with the in situ TSS data and also to see the suitability of the existing curve from the model to the in situ data, a correlation analysis is carried out for each column represented by the TSS data of each mathematical model with the in situ TSS data column. The results of the calculation of correlation analysis with the help of excel can be seen in Table 5.

Table 5. Calculation data for the correlation of each mathematical model with in situ TSS data

	TSS insitu	*Linear*	*Exponent*	*Logarithmic*	*Power*
TSS insitu	1				
Linear	0.8660	1			
Exponent	0.8297	0.9973	1		
Logarithmic	0.8642	0.9992	0.9936	1	
Power	0.8542	0.9994	0.9991	0.9973	1

Source: Calculation results

In Table 5, the results of the correlation analysis show that the in situ TSS has a good correlation with all existing mathematical models. The highest value, which can be seen in column 1 in table 5, is used to choose the best and can represent the data on the distribution of TSS in the waters of the Sampang district. In this column, it can be seen that the in situ TSS correlates well with the linear model with a correlation value of 0.8660 and the logarithmic model with a correlation value of 0.8642.

From the correlation value of R2, which is shown when calculating the remote sensing algorithm between the reflectance data and the TSS value (mg/l) and by looking at the value of the correlation analysis of the mathematical model data to the in situ TSS, it can be seen that the linear model and the logarithmic model are then used as a reference in making a thematic map of the distribution of TSS values on the coast of Sampang district. The results of processing the Aqua MODIS satellite image using the appropriate mathematical model can be seen in Figure 4, which shows a map of the distribution of TSS (mg/l) using a linear algorithm at a wavelength of 412 nanometers, and Figure 5 which shows a map of the distribution of TSS (mg/l). with a logarithmic algorithm at the same wavelength of 412 nm.

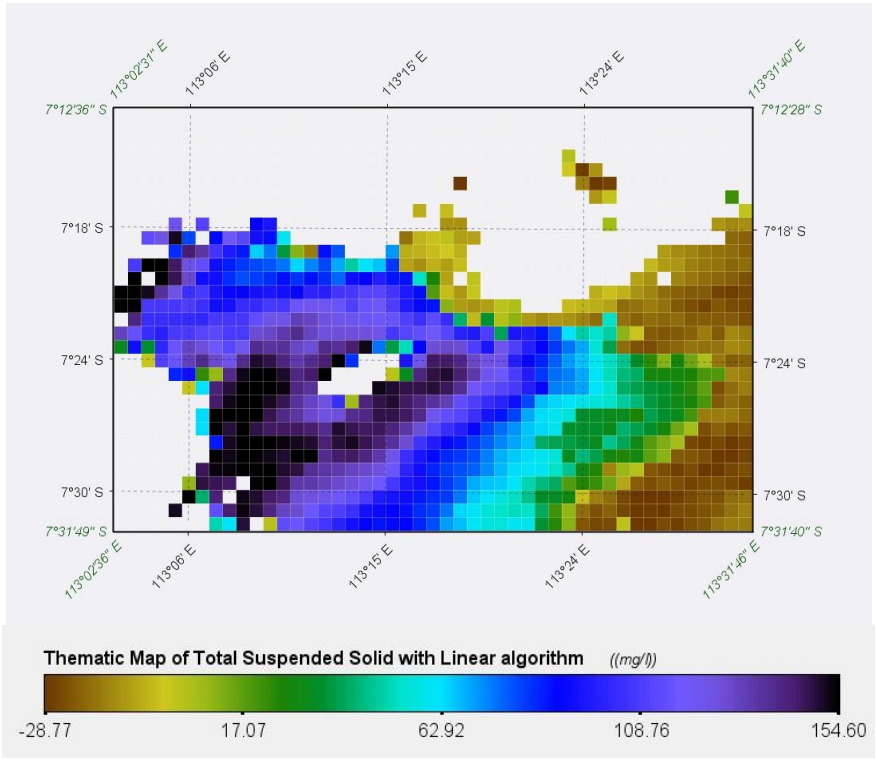

Figure 4. Thematic map of TSS (mg/l) with linear algorithm at 412 nm

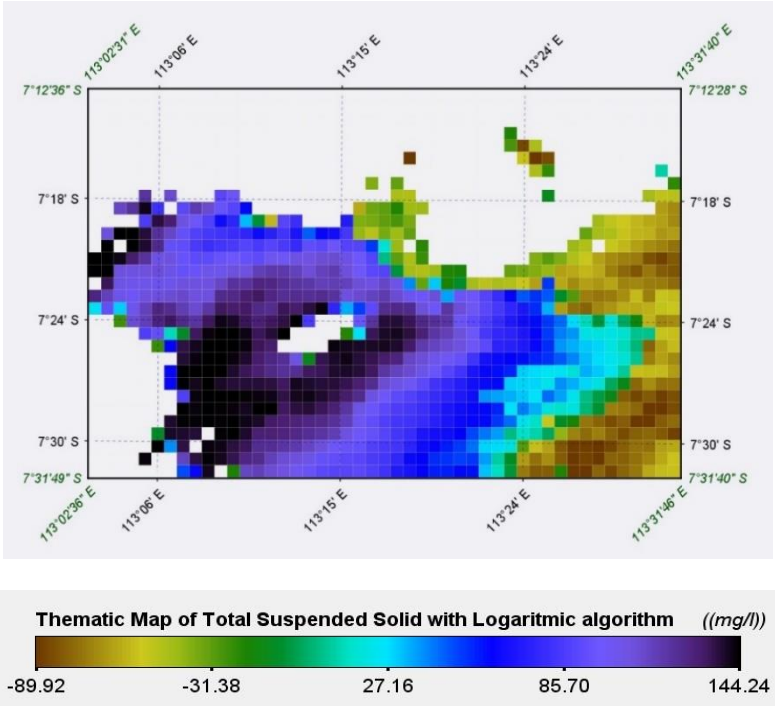

Figure 5. Thematic map of TSS (mg/l) with logarithmic algorithm at 412 nm

Conclusion

From the calculation of the distribution of suspended solids concentration, it can be seen that the distribution of turbidity is more directed to the right side of the Blega river flow. On the right side, the accumulation of total suspended solids has a higher value than on the left side, which leads to the Pamekasan district. This can not be separated from the wind direction during the day, where data collection was carried out, and the current direction from the Madura Strait, which contributed to the accumulation of turbidity from suspended solids towards the Bangkalan district.

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