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Analysis of Total Suspended Solid Algorithm on Tuban Coast with 2 Channel Approach of Visible Light Wavelength Satellite Image

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Abstract. Satellite image channels have been widely used by researchers from various countries to map and analyze variables that have a lot of influence on ecosystem changes including the total suspended solid levels scattered on the coast. The use of 1 channel in satellite images provides many results with various good correlations, but in this study, we want to try to use a 2-channel approach to get more optimal results from total suspended solid mapping. The area of interest for research is the Tuban coastline which has a fairly flat and not hilly coastal morphology so that sea currents that carry solids have characteristics in their growth over time. The method used to construct the algorithm of these 2 channels is the use of reflectance values of visible light wavelengths in blue, green and red channels. The results obtained from the calculation of the 2-channel algorithm show a fairly good suitability and correlation, especially in the comparison of the blue channel with the red channel with an R2 value of 0.76 so that it can be used as a reference to monitor total suspended solids as well as a comparison for the calculation of 1 channel. The conclusion obtained is that the channels from satellite images have their own characteristics in providing reflectance values for objects on earth so that with the right combination of channels will be able to obtain accurate results in mapping total suspended solids.

Keyword: total suspended solid, satellite image band, band ratio, coast of Tuban

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1 Introduction

Remote sensing is one technology that can be applied by utilizing sensors and instruments installed on aircraft or satellites to collect information about the earth's surface remotely. Seawater quality monitoring by utilizing remote sensing has been widely used because it provides global, continuous, and continuous reach, which is much cheaper to obtain than through conventional methods [1], [2].

Monitoring of seawater quality with the use of remote sensing can be done on various phenomena of ecosystem changes on the coast, mainly in the erection of Sea Surface Temperature which is very important for understanding temperature change patterns, identifying ocean currents [3]–[7], and also determine zones with upwelling potential, monitoring Chlorophyll Levels related to phytolactone content as well as monitoring seawater pollution can be done by detecting existing phytolactone content [8]–[13], monitoring of oil pollution, availability of food resources in the form of fish growing and developing in aquatic environments and distribution of total suspended solids to measure the health of a body of water [14]–[18].

Applications to monitoring marine pollution can be done in identifying sources of marine pollution such as river flows that carry industrial and agricultural waste into the sea. This data helps governments and environmental agencies monitor and control the impact of pollution.

Remote sensing enables efficient and accurate monitoring of seawater quality, thus playing an important role in the sustainable management and protection of the marine environment. The data obtained from these applications helps scientists, fishermen, and policy makers in taking appropriate actions to safeguard marine ecosystems and reduce negative human impacts on the marine environment.

For the development of mathematical models based on remote sensing algorithms, so far many have been done using 1 channel so it is a challenge to use 2 channels with the aim of later producing a better and more accurate mathematical model compared to measuring 1 channel [19]–[23], because objects on earth have their own specificity in absorbing wavelengths so that it is expected to make a real contribution in the development of remote sensing algorithms for monitoring ecosystems in coastal areas, especially the coast of Tuban.

2 Material and Method

2.1 Research Location

For the research location of the area of interest is the coast of Tuban which has a sloping structure and not many steep cliffs so it is suitable to be used as a study material on the growth of total suspended solids based on remote sensing technology by taking data

from satellite images, the location is shown in Figure 1 which is located at coordinates 113° 32'14" to 114°12'56" east longitude and 6°13' 17" to 7°15'48" south latitude.

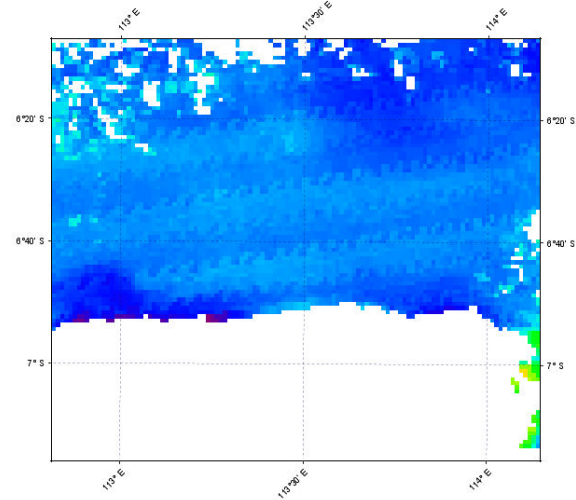


Fig. 1. Research Location from Aqua MODIS at coast of Tuban.

2.2 Satellite Images

The satellite image used is Aqua (EOS PM-1) with the existing instrument MODIS (Moderate Resolution Imaging Spectroradiometer). This image is used because Aqua MODIS is good for observing and monitoring the condition of the earth, including monitoring water resources, environmental monitoring, monitoring forest fires, sea surface temperatures, as well as chlorophyll and sediment levels in waters.

The specifications of the Aqua MODIS image are Spatial Resolution which has several available in the MODIS instrument, including 250 m, 500 m, and 1 km for the optical channel, in addition to the optical range of this image has the ability to detect light at various wavelengths, including optical channels covering the spectrum from ultraviolet to infrared.

With these specifications, Aqua MODIS has become an invaluable tool in environmental monitoring and scientific research, providing the data necessary to understand climate change, water quality, and Earth's surface conditions globally.

2.3 Remote Sensing Algorithm

For the algorithm used in this study using 2 channels of visible light wavelength, namely the blue channel with a wavelength of 412 nm, the green channel with a wavelength of 531 and for comparison, the red channel is 645 nm, 667 nm and 678 nm. The ratio of comparison between blue channels with red and green with red is given in the example of the formulation of mathematical models of wavelengths 412 and 645 nm as follows:

$$TSS \left(\frac{mg}{l} \right) = a * \left(\frac{Rrs412}{Rrs645} \right) + b \quad (1)$$

$$TSS \left(\frac{mg}{l} \right) = a * \exp \left(b * \left(\frac{Rrs412}{Rrs645} \right) \right) \quad (2)$$

$$TSS \left(\frac{mg}{l} \right) = a * \ln \left(\frac{Rrs412}{Rrs645} \right) + b \quad (3)$$

$$TSS \left(\frac{mg}{l} \right) = a * \left(\frac{Rrs412}{Rrs645} \right)^b \quad (4)$$

Where a and b are the coefficients in the mathematical model.

The results obtained from this calculation are then compared with one another and taken the ratio value that provides the largest correlation seen from the value of R2 given in the calculation results.

3 Result and Discussion

From the measurement of total suspended solids in the field, the results are obtained as shown in Table 1, where the table contains latitude and longitude coordinates corresponding to the sample taken.

Table 1. Total Suspended Solid Data with Coordinate

Longitude	Latitude	TSS (mg/l)
113,7623	-6,8350	76,4
113,7737	-6,8349	58,2
113,7851	-6,8462	62,7
113,7965	-6,8462	48,1
113,8078	-6,8347	55,7
113,8191	-6,8347	52,4
113,8306	-6,8460	64,2
113,8419	-6,8459	62,8
113,8532	-6,8345	66,1
113,8646	-6,8344	73,6
113,8645	-6,8117	62,9
113,8531	-6,8118	66,7
113,8418	-6,8232	52,6
113,8304	-6,8233	63,7
113,8190	-6,8120	45,2
113,8076	-6,8120	74,8
113,7963	-6,8235	81,8
113,7850	-6,8235	82,1
113,7735	-6,8122	79,7
113,7622	-6,8123	88,3

Source: measurement results

The next stage of obtaining Aqua Modis satellite imagery obtained from the www.glf.nasa.gov website for April 2023 is processed with the SeaDAS program until reflectance data is obtained from satellite images that match the area of interest with coordinates that have been entered into the program.

From the reflectance value obtained then the calculation of the remote sensing algorithm is carried out according to the desired mathematical model, then the results are obtained in accordance with the

calculation of the wavelength ratio where the results are given in Table 2.

Table 2. Ratio of Images Satellite Band from 412, 531 with 645, 667 and 678 and Correlation Value

No	Algorithm	Linear	Exp	Logarit hmic	Power
1	Ratio band (412/645)	0,332	0,281	0,294	0,249
2	Ratio band (531/645)	0,382	0,328	0,351	0,301
3	Ratio band (412/667)	0,311	0,261	0,273	0,229
4	Ratio band (531/667)	0,358	0,304	0,322	0,274
5	Ratio band (412/678)	0,316	0,266	0,278	0,234
6	Ratio band (531/678)	0,363	0,310	0,329	0,281

Source: measurement results

From Table 2 it can be seen that for linear algorithms the largest R2 value is at the ratio Rrs 531/645 and the smallest at the ratio Rrs 412/667, while in the exponent algorithm the largest R2 correlation value is the ratio Rrs 531/645 and the smallest at the ratio Rrs 412/667, the same can also be seen in the logarithmic and power algorithms where the highest correlation value is at the ratio Rrs 531 / 645 is the ratio of the green channel to the red channel for the selected wavelength 645, the wavelength of the red channel for 645 nm turned out to have a significant power to the ratio of the green channel 531 nm compared to other red channels namely 667 and 678 nm. This comparison is the optimum value in expressing the total distribution value of suspended solids on the coast of Tuban.

For the comparison of the blue channel with the red channel, it does not give significant results when compared to the ratio of the green channel, it can be seen in Table 2 that the ratio value of Rrs 412 to the red channel both wavelengths 645, 667 and 678 is in the bottom position for the correlation value compared in the Table.

4 Conclusion

The comparison between the channels in the Aqua Modis satellite image in mapping the distribution of total suspended solids on the coast of Tuban has a fairly high diversity, where the ratio of the ratio of blue canals to red canals or green channels to red canals has their own characteristics, so that the correlation value that occurs can be compared and obtained the fact that the ratio of green channels to red canals has the highest correlation value among others in describing the distribution of the total value of suspended solids.

The ratio of the channel from green to red represented by the wavelength of 645 nm is the largest and most optimal ratio with the following mathematical equation model:

$$T_{SS} \left(\frac{mg}{l} \right) = a * \left(\frac{Rrs531}{Rrs645} \right) + b \quad (5)$$

Where the values a and b obtained from the calculation are:

$$A = 5,9452$$

$$B = 42,743$$

So that the model produces the following formula:

$$T_{SS} \left(\frac{mg}{l} \right) = 5,9452 * \left(\frac{Rrs531}{Rrs645} \right) + 42,743 \quad (6)$$

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