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Mapping of Total Suspended Solids on the Coastal of Bangkalan Madura Using Satellite Image Data

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Abstract- Total suspended matters or often called total suspended solid (TSS) is a fine material that is spread in the main body of water in coastal areas and river flow. This material is a parameter that is widely used to detect sedimentation or erosion on the coast. The mapping of the distribution of suspended solids has been carried out by many researchers in various parts of the world, and on this research satellite technology will be used in mapping the suspended solids on the Bangkalan coast of Madura island. The method used in this study is the calculation of an algorithm of the reflectance values of satellite images with the TSS field data with reflectors at RGB(red, green,blue) wavelengths, and the satellite images used in this study are Aqua Modis images acquired on June 17, 2019. The results obtained indicate that Aqua Modis imagery can be used to map the distribution of the total value of suspended solids (TSS) with a high enough accuracy, both for linear algorithms and for exponential algorithms. The conclusion from this research is that the distribution of the total value of suspended solids is greater in the coastal area compared to the waters in the Madura Strait, in other words it can be concluded that the distribution of TSS gets closer to the coast, the value will be even greater.

Keywords- *Total Suspended Solid (TSS), Aqua Modis, Remote Sensing, Reflectance*

I. INTRODUCTION

Total suspended solid is one of the parameters that is widely used as a detection of sedimentation or erosion on the coast or river flow. The amount of sedimentation in the river will cause a reduction in the volume of water flowing from the river, vice versa if there is accumulation of sedimentation on the shoreline will cause a sustainable sedimentation and if it takes place for a long time will result in protruding the shoreline and other consequences will occur geographical changes from the coast which is marked by a change in coastline [1-3]. Total suspended solids or sea solids abbreviated as TSS have been widely studied by marine, maritime and civil engineering researchers [4-6]. Along with the development of technology in the field of remote sensing, monitoring of sedimentation on the coast becomes easier, this is due to the ability of remote sensing that can map vast areas, so that it will be able to save costs if done by direct field measurements that are currently felt already ineffective. Besides remote sensing can also map the distribution of a natural phenomenon such as total suspended solids [7], chlorophyll-a, phytoplankton distribution [8], [9], sea surface temperature [10-12], sea water salinity [13], and so on which if done in "ground truth" it will take a lot of time and money. Satellite imagery has different wavelengths depending on the sensor that carries it. Like Aqua Modis which has several wavelengths including wavelengths in the visible region known as RGB (Red, Green, Blue). Total suspended solid can form sediments in the current time period, where the sediments that are formed will determine the formation of new land so that within an annual period it will be possible for an area to experience changes in land morphology in coastal areas which means it will also change the geographical position of the area. The purpose of this study is to map the distribution of total sea solids occurring on the coastline of Bangkalan beach of Madura Island, so that by knowing the TSS distribution map it will be known which beach location points will be affected by sedimentation and which will be affected by an erosion, and after that the mapping management policies can be taken to the beach for the future.

II. MATERIAL & METHOD

A. Research Location

This study took place in the Bangkalan coastal area of Madura island as shown in Figure 1. Where the coordinates of the area are 696000 meters to 726000 meters for longitude and 9192000 meters to 9208000 meters for latitude. The Bangkalan coastline is bounded by the Madura Strait in the south and Bangkalan district in the north, east is bordered by the coast of Surabaya and west by the Sampang district. Bangkalan is the most dynamic area of several regencies on Madura island, this is due to the Suramadu bridge access that connects the city of Surabaya with Bangkalan district so that there is an urbanization and trip generation of Bangkalan residents who work in Surabaya.

B. Calculation of The TSS

In this study the total value of dissolved solids was obtained by taking samples in the field in the form of 1 liter of seawater

at a depth of 20 cm from the surface of the water and then brought to the laboratory for TSS testing using the Gravimetri method. This method is done by depositing dissolved solids by pouring liquid into filter paper that has previously been weighed. After filtering, the wet filter paper is dried in an oven at 80oC for 4 hours to be weighed again and the results compared between before and after drying. The total value of suspended solids is obtained from the total weight after drying reduced by the weight of the initial filter paper.

C. Retrieval of Satellite Images

The satellite imagery used is Aqua Modis imagery with the file name A2019168055500.L2_LAC_OC.nc, where the name A is the notation for fashionable aqua, 2019 is the notation for the year of acquisition, 168 is the notation for the acquisition month, i.e. based on Julien Days, June 17, whereas sequence 055500 is a notation for a time that starts with minutes and seconds, so it can be said that the shooting time is 5 am past 55 minutes.

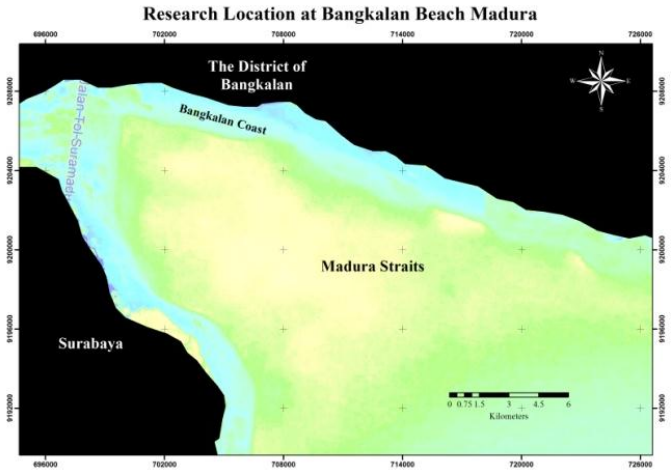

Figure 1. Research Location at Coastal of Bangkalan Madura

TABLE I. COORDINATE OF THE DATA AND SATELLITE IMAGES REFLECTANCE OF AQUA MODIS 2019

Name	Longitude	Latitude	Rrs_412	Rrs_531	Rrs_667	TSS (mg/l)
pin_1	113.03412	-7.23954	0.011402	0.026048	0.013356	137.2
pin_2	113.04523	-7.23949	0.009240	0.023770	0.010720	108.5
pin_3	113.05638	-7.25052	0.009248	0.022598	0.009558	92.4
pin_4	113.06749	-7.25047	0.008342	0.021470	0.008108	76.3
pin_5	113.07859	-7.25042	0.008672	0.022038	0.008328	78.7
pin_6	113.08970	-7.25037	0.007690	0.020878	0.007224	72.5
pin_7	113.10081	-7.25032	0.006210	0.017964	0.005212	54.3
pin_8	113.11191	-7.25027	0.004888	0.015444	0.003758	43.8
pin_9	113.12302	-7.25022	0.005642	0.017382	0.004982	51.6
pin_10	113.13412	-7.25017	0.004412	0.013632	0.003014	44.2
pin_11	113.14523	-7.25011	0.006294	0.018190	0.006022	56.9
pin_12	113.15633	-7.25006	0.008696	0.021352	0.009714	87.6
pin_13	113.03422	-7.26172	0.010720	0.023852	0.010920	127.4
pin_14	113.04533	-7.26167	0.009320	0.022452	0.009340	88.2
pin_15	113.05644	-7.26162	0.008774	0.020860	0.006930	56.3
pin_16	113.06754	-7.26157	0.007870	0.019528	0.006146	61.7
pin_17	113.07864	-7.26152	0.007032	0.018568	0.005724	55.2
pin_18	113.08975	-7.26146	0.006726	0.018150	0.005372	51.9
pin_19	113.10085	-7.26141	0.006552	0.018140	0.005058	47.4
pin_20	113.11196	-7.26136	0.005706	0.016092	0.003910	48.2
pin_21	113.12307	-7.26131	0.004596	0.013792	0.002946	46.3
pin_22	113.13417	-7.26126	0.003854	0.010664	0.001786	37.4
pin_23	113.14528	-7.26120	0.003774	0.011366	0.002044	41.8
pin_24	113.15639	-7.26115	0.005408	0.016092	0.004266	56.3
pin_25	113.16749	-7.26110	0.007560	0.019850	0.007674	64.8

III. RESULT & DISCUSSION

A. Retrieval of Reflectance Data and TSS

In this research, the data generated is reflectant data from Aqua Modis satellite imagery for visible wavelengths of 412 nm, 531 nm and 667 nm, where 412 is wavelength from blue, 531 is wavelength in green, while 667 is wavelength Red. The results obtained are tabulated in Table 1, which for the last column is the total concentration of suspended solids (TSS) data in milligrams per liter (mg / l).

B. Algorithm Calculation of Satellite Images

For the calculation of satellite imagery algorithms, Aqua Modis reflectant data is used at wavelengths of 412 nm, 531 nm and 667 nanometers. The results of the mathematical model calculations of the algorithm used are shown in Table 2, Table 3, Table 4 and Table 5., respectively for linear mathematical models, exponential models, logarithmic models and power models. From the results of algorithm analysis for existing mathematical models, it can be seen that the wavelength of 667 nanometers has a fairly high correlation with the total concentration of suspended solids, where the conclusions are based on comparison of the R2 numbers or correlations that exist in each mathematical model calculated at scatter diagram with "trend analysis" analysis.

TABLE II. CALCULATION RESULT OF ALGORITHM MATHEMATICAL MODELS AT 412 NM WAVELENGTH

No	Algorithm	Mathematic Models	R2
1	Linear	y = 13255x - 29.67	0.826
2	Exponential	y = 18.01e172.6x	0.869
3	Logaritmic	y = 92.78ln(x) + 526.7	0.742
4	Power	y = 28566x1.233	0.813

Source: Calculation from excel

Table 2. shows the results of the calculation of reflectance of satellite images with TSS concentrations (mg / l) on several algorithms with mathematical models of linear, exponential, logarithmic and power, from the Table shows that the exponential algorithm has the most optimum R2 correlation of 0.869, so for long the 412 nanometer wave algorithm that is suitable for TSS mapping is exponential with the form of a mathematical model:

$$TSS\left(\frac{mg}{l}\right) = 18.01.\, e^{172.6*Rrs\_412}$$

TABLE III. CALCULATION RESULT OF ALGORITHM MATHEMATICAL MODEL AT 531 NM WAVELENGTH

No	Algorithm	Mathematic Models	R2
1	Linear	y = 7945.x - 86.26	0.825
2	Exponential	y = 8.422e104.6x	0.888
3	Logaritmic	y = 147.6ln(x) + 651.9	0.761
4	Power	y = 15545x1.969	0.841

Source: Calculation from excel

Table 3 shows a resume of mathematical models for wavelengths of 531 nanometers. From this table it can be seen that the exponential algorithm has the most optimum R2 value with a value of 0.888 which is calculated at a wavelength of 531 nm. For this reason, for wavelength 531 an exponential algorithm is taken as a temporary reference for TSS mapping in the Bangkalan Madura coast with the following mathematical model:

$$TSS\left(\frac{mg}{l}\right) = 8.422 * e^{104.6*Rrs\_531}$$

Table 4 shows a resume of the mathematical model of the same algorithm as before for a wavelength of 667 nanometers, and from the results shown the exponential algorithm has the most optimum R2 correlation value of 0.961. This shows that statistically there are 96.1% of the calculated data representing the hypothesized model that is the exponential model, where the mathematical model can be written as follows:

$$TSS\left(\frac{mg}{l}\right) = 27.8 * e^{124.1*Rrs\_667}$$

TABLE IV. CALCULATION RESULT OF ALGORITHM MATHEMATICAL MODEL AT 667 NM WAVELENGTH

No	Algorithm	Mathematic Models	R2
1	Linear	y = 9616.x + 3.067	0.929
2	Exponential	y = 27.80e124.1x	0.961
3	Logaritmic	y = 62.89ln(x) + 387.1	0.821
4	Power	y = 4464.x0.836	0.9

Source: Calculation from excel

From the results shown for the correlation value R2 at each wavelength either 412 nm, 531 nm or 667 nm, the highest correlation value among the optimum values of each wavelength is the value owned by the wavelength of 667 nm, so To draw a thematic map of the total distribution of suspended solids in the Bangkalan coastline a mathematical model with a wavelength of 667 nm is used as a reference, besides that as a comparison a thematic map for a mathematical model with a linear algorithm at a wavelength of 667 nm which has a correlation value of R2 0.929 is used as a reference. statistically it is sufficient to represent the suitability of the measurement data with the model represented namely the model:

$$TSS\left(\frac{mg}{l}\right) = 9616 * Rrs_{667} + 3.067$$

C. Thematic Map of TSS Distribution

The results of this study are a thematic map of the distribution of TSS concentrations (mg / l) in the Bangkalan Madura coastal area using linear and exponential algorithms at 667 nm wavelength.

Figure 3 is a thematic map display depicting the distribution of TSS (mg / l) in the Bangkalan Madura coastal area using spatial data from Aqua Modis satellite imagery in June 2019. The algorithm used is linear at a wavelength of 667 nanometers, which for the Bangkalan coastal area the color

indicates dark blue-purple so that from the legends shown it can be seen that the color is in the range of values of 101 to 135 milligrams per liter of dissolved solid suspension. Figure 4 is a thematic map display of the distribution of TSS values (mg / l) for an exponential algorithm at the same wavelength where for the exponential algorithm the range values shown in the figure are at 120 to 150 milligrams per liter of suspended solids.

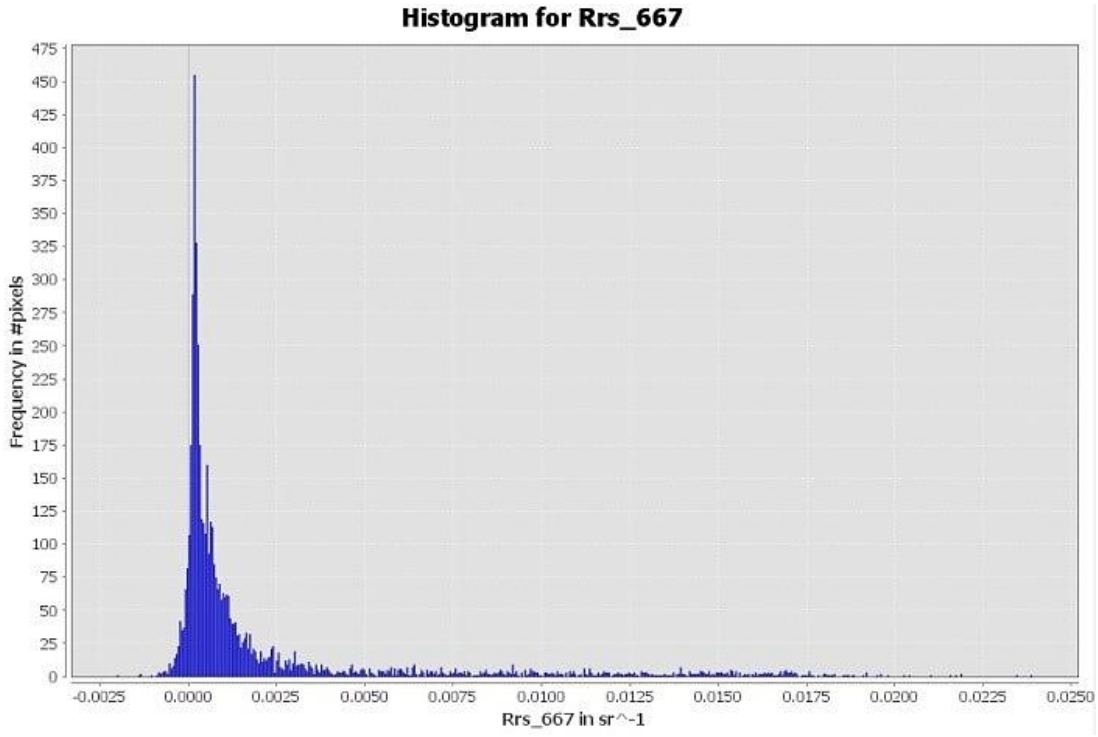

Figure 2. The Histogram of Reflectance at the 667 nm Wavelength

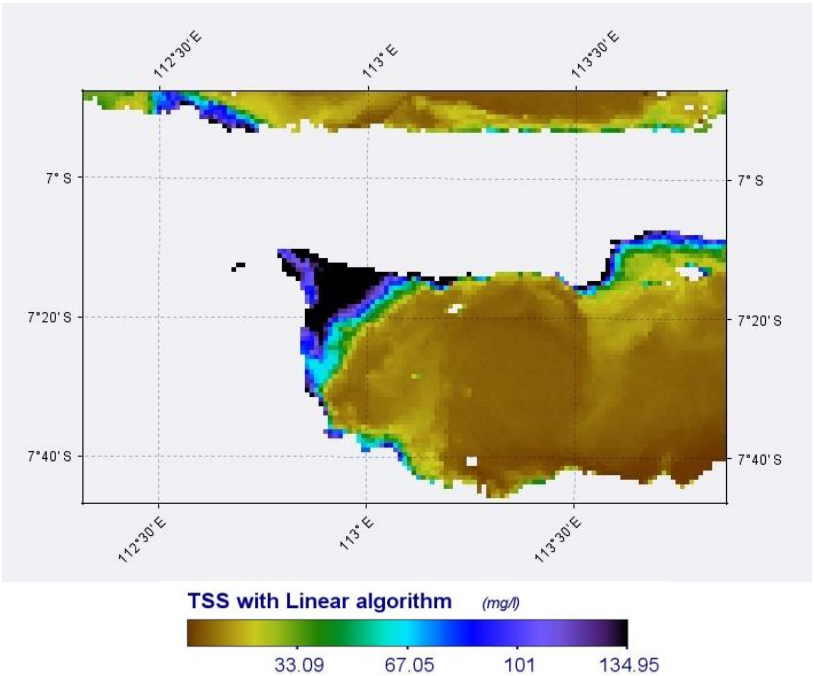

Figure 3. Thematic Map of TSS spread (mg/l) in Coastal of Bangkalan Madura With Linear Algorithm at 667 nm Wavelength

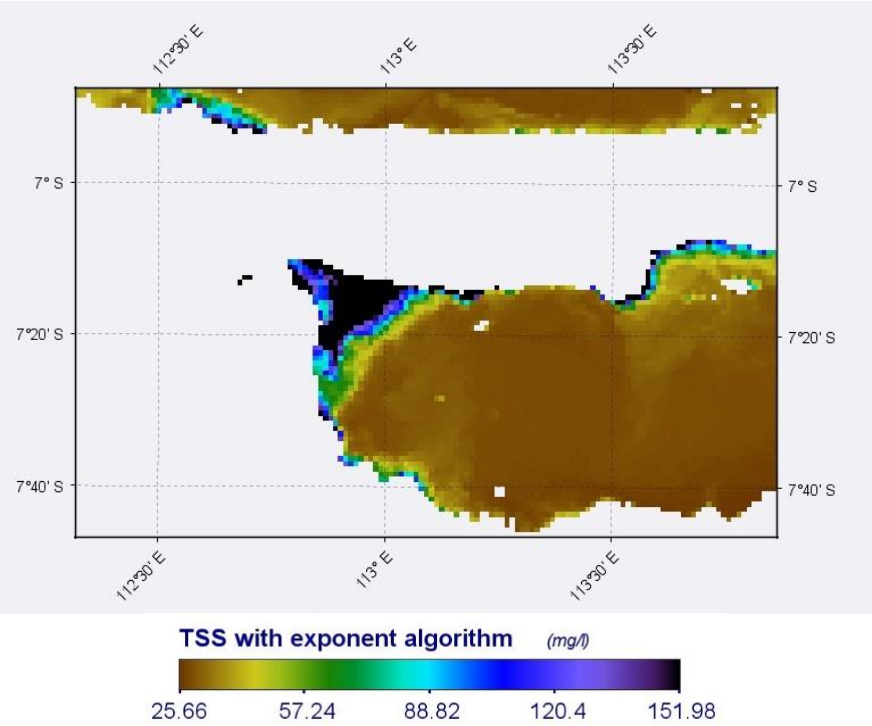

Figure 4. Thematic Map of TSS spread (mg/l) in Coastal of Bangkalan Madura With Exponential Algorithm at 667 nm wavelength

IV. CONCLUSION

1. Aqua Modis satellite imagery can be used as scientific material for mapping digital data such as total suspended solid, where the data is processed with a package of satellite image processing programs such as SeaDAS.
2. Total suspended solids or TSS have a range of values of 45 mg / l to 120 mg / l for the Bangkalan Madura coastal area. This value indicates that the waters of the Bangkalan coast are still within normal limits for a sloping coastal condition with shallow water columns.
3. The most appropriate algorithm for the research area in the Bangkalan coast is exponential at a wavelength of 667 nanometers which represents the red color of the RGB electromagnetic waves.

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