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Analysis of Changes in Sediment Concentration on the Coast of Sidoarjo Regency with Landsat 8 Satellite Image Data

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Abstract

Total Suspended Solid (TSS) is all solids (sand, silt, and clay) or particles suspended in water and can be in the form of living (biotic) components such as phytoplankton, zooplankton, bacteria, fungi, or dead (abiotic) components such as detritus and inorganic particles. The concentration of TSS can affect the level of quality in waters and can hinder the ability to produce organic substances in these waters. The dense activity on the coast of Sidoarjo Regency results in increased turbidity of the waters, which can trigger an increase in TSS levels due to the additional supply of materials from the land. Therefore, it is necessary to calculate the analysis of changes in TSS concentration on the coast of Sidoarjo Regency which can later be used as information for better management of coastal areas. This study will compare four algorithms, namely the Syarif Budiman algorithm (2004), the Ety Parwati algorithm (2006), the Guzman & Santaella algorithm (2009), and the Hendrata Wibisana algorithm (2019). The satellite data used is Landsat 8 image recording from 2015 – 2024. From the results of this study, it can be concluded that the Ety Parwati Algorithm model has a correlation value of 0,126, which means it has a high level of relationship with in-situ data. In this study, the largest Total Suspended Solid (TSS) concentration value was obtained in 2020 with a value of 30,787 mg/L to 35,722 mg/L and the smallest in 2023 with a value of 16,008 mg/L to 22,946 mg/L. The results of this Total Suspended Solid (TSS) data processing analysis can be used as reference material in further research.

Keywords*: Landsat 8, Satellite Image, Total Suspended Solid*

INTRODUCTION

A coastal zone is an area where land and ocean influences meet. The land influence area includes certain regions where the impact of the ocean is still felt (sea breeze, temperature, plants, seabirds, etc.). At the same time, the ocean influence area includes areas of the sea where the influence of land activities is still felt or still visible (e.g., the appearance of pollutants, sedimentation, and watercolor) (Diraputra, 2009). Sidoarjo Regency is one of the districts in East Java Province, Indonesia, which has a coastal area that residents directly utilize for fishing to meet their daily needs.

A beach erodes, sediments, or remains stable depending on the sediments that enter and leave the beach. Sedimentation can reduce the function of beaches or coastal buildings, such as deposition in estuaries that can interfere with river flow and shipping traffic, as well as deposition in ports and shipping lanes (Triatmodjo, 2000). Total suspended solids are all solids (sand, mud, and clay) or particles suspended in water. They can be in the form of living (biotic) components such as phytoplankton, zooplankton, bacteria, and fungi, or dead (abiotic) components such as detritus and inorganic particles. The distribution of suspended solids in the sea is influenced by inputs from the land through river flow or from the air and displacement due to the resuspension of sediment due to erosion (Tarigan & Edward, 2003).

Based on previous research conducted in the waters of Awur Bay using Landsat 8 imagery, the highest suspended sediment content was found in Teluk Awur Village and Demaan Village. The highest content was ± 67.54 mg/L, and the further away from the coast, the concentration decreased. The mixing process and rainfall intensity influence the high suspended sediment content (Subarjo, 2020). Another study was conducted in Lamong Bay with the development of the Total Suspended Solid (TSS) algorithm from multitemporal satellite image data, and in-situ data obtained the results of TSS values varying between 1-472 mg/L. The water quality status of Surabaya Lamong Bay waters based on the Decree of the Minister of Environment No. 115 of 2003

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on the East Coast of Surabaya is, on average, at a value of 0 ≤ pollution index ≤ 1, which means it meets quality standards (good condition) (Hariyanto, 2019). In research conducted in the shipping channel of Patimban Port, Subang, West Java using Landsat 8 OLI imagery, it was found that the TSS concentration value in-situ had an average concentration value of 157,86 mg/l (Tangeb, 2023).

The reason for this research is to analyze changes in sediment concentrations on the coast of Sidoarjo Regency within ten years, from 2015 to 2024. The coastal area of Sidoarjo Regency is a dense area of human activity. In addition, the coast of Sidoarjo Regency is the mouth of the river, which affects the balance of the ecosystem around the waters. All materials from these activities enter the water and settle to the bottom of the water. The resulting impact is an additional supply of materials that are quite detrimental to coastal areas. The method used in analyzing changes in sediment concentration on the coast of Sidoarjo Regency is using remote sensing technology using Landsat 8 satellite image data.

METHOD

This study uses Landsat 8 satellite image data for a period of 10 years, namely 2015 to 2024. In addition to image data, this study also uses in-situ data from as many as 20 points of seawater samples taken from the coast of Kalanganyar, Sedati District, Sidoarjo Regency. The in-situ data will be compared with Landsat 8 satellite image data processed using four algorithms. The algorithms used are the Ety Parwaty algorithm with the TSS (mg/l) = 3,3238 * (exp(34,099 * (Red-Band))) algorithm model (Parwati et al., 2006), the Nurahida Laili algorithm with the TSS (mg/l) = 31,42 * (log(Rrs(Blue-Band)) / log(Rrs(Red-Band))) – 12,719 algorithm model (Laili et al., 2015), the Jaelani algorithm with TSS (mg/l) = 1,5212 * (log(Rrs(Blue-Band)) / log(Rrs(Green-Band))) – 0,3698 algorithm model (Jaelani et al., 2016), and the Hendrata Wibisana algorithm with TSS (mg/l) = 637,52 * (Red-Band) – 7,8454 algorithm model (Wibisana et al., 2019).

Of the four algorithm models used to process Landsat 8 satellite image data for 2015-2024, the best algorithm model was taken by conducting a validation test by comparing processed image data with in-situ data in the field. This validation test is carried out using simple linear regression, which aims to determine the relationship between the results of image data processing and field data. After obtaining the best algorithm model, the algorithm model is used to calculate the concentration value of Total Suspended Solid (TSS) on the coast of Sidoarjo Regency.

The Total Suspended Solid (TSS) concentration values that have been calculated will be carried out ANOVA test to determine whether or not there is a difference in TSS values in 2015 - 2024. The change in TSS value will be seen more clearly on the TSS concentration distribution map. Mapping of Total Suspended Solid (TSS) concentration values on the coast of Sidoarjo Regency in 2015 - 2024 was carried out using the Seadas application. the seadas application used is the latest version so that the mapping results have better quality.

RESULTS AND DISCUSSION

In-Situ Data

In-situ data was taken on May 23, 2024, at 08.30 AM at Kalanganyar Beach, Sedati District, Sidoarjo Regency, by taking 20 water samples and recording the coordinates of the sampling point. In-situ data sampling can be seen in the following table:

Table 1. In-Situ Data Collection Results

Point	Geographic Coordinates		TSS *in-situ* mg/L
	X	Y	
1	112.837	-7.407	12
2	112.837	-7.409	18
3	112.837	-7.411	17
4	112.837	-7.414	24
5	112.837	-7.416	12

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Point	Geographic Coordinates		TSS *in-situ* mg/L
	X	Y	
6	112.837	-7.418	14
7	112.837	-7.420	12
8	112.837	-7.422	12
9	112.837	-7.424	18
10	112.837	-7.427	23
11	112.838	-7.426	26
12	112.839	-7.423	20
13	112.839	-7.421	19
14	112.839	-7.419	22
15	112.839	-7.417	16
16	112.839	-7.414	18
17	112.839	-7.412	39
18	112.839	-7.410	12
19	112.839	-7.408	23
20	112.839	-7.406	26

Landsat 8 Satellite Imagery Data 2015 - 2024

Landsat 8 satellite image data was taken from the web page https://earthexplorer.usgs.gov/ with a selection time close to May 23, 2024, in accordance with the date of sampling of Total Suspended Solid (TSS) levels in the field. The Landsat 8 satellite image data from 2015 - 2024 that will be used are listed in the following table:

Table 2. Landsat 8 Satellite Imagery Data 2015 - 2024

No	Date	File Name
1	May 15, 2015	LC08L1TP118065201505152020090902T1
2	May 17, 2016	LC08L1TP118065201605172020090702T1
3	May 20, 2017	LC08L1TP118065201705202020090402T1
4	May 23, 2018	LC08L1TP118065201805232020090102T1
5	May 26, 2019	LC08L1TP118065201905262020082802T1
6	April 26, 2020	LC08L1TP118065202004262020082202T1
7	May 15, 2021	LC08L1TP118065202105152021052502T1
8	May 2, 2022	LC08L1TP118065202205022022051102T1
9	May 21, 2023	LC08L1TP118065202305212023060202T1
10	May 23, 2024	LC08L1TP118065202405232024052302RT

The Landsat 8 satellite image map was taken from the web page https://earthexplorer.usgs.gov/. After taking the Landsat 8 satellite image, a cropping process was carried out on the image so that a map of the research location was obtained. Cropping is needed to minimize and focus the area under study.

Data Processing of Landsat 8 Satellite Imagery for 2015 - 2024

Landsat 8 satellite image data processing is calculated using a predetermined algorithm. Where to get the reflectance value, you must choose electromagnetic waves to be processed. The selected waves include Band 2 (blue color), Band 3 (green color), and Band 4 (red color) according to the algorithm used. The reflectance value is obtained by entering the pin manager and selecting the pixel data filter; after that select the band, then the Digital Number (DN) will appear. The Digital Number (DN) will be converted to the reflectance value with the formula (Reflectance = (2 * 10^{-5} * DN) – 0,1). The resulting reflectance values in 2015 - 2024 as shown in the following table:

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Table 3. Band 2 Reflectance Values 2015 - 2024

Point	Band 2									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	0.097	0.099	0.102	0.097	0.087	0.098	0.094	0.095	0.096	0.102
2	0.097	0.100	0.102	0.100	0.092	0.099	0.094	0.103	0.096	0.104
3	0.099	0.098	0.104	0.102	0.094	0.098	0.095	0.100	0.092	0.103
4	0.099	0.100	0.104	0.100	0.089	0.100	0.093	0.095	0.092	0.106
5	0.097	0.101	0.105	0.099	0.090	0.099	0.096	0.093	0.093	0.106
6	0.097	0.100	0.102	0.087	0.088	0.100	0.093	0.094	0.093	0.106
7	0.092	0.101	0.099	0.086	0.089	0.100	0.091	0.094	0.093	0.104
8	0.090	0.103	0.098	0.084	0.088	0.101	0.094	0.092	0.089	0.102
9	0.090	0.103	0.100	0.086	0.086	0.101	0.094	0.093	0.094	0.102
10	0.091	0.102	0.101	0.086	0.085	0.099	0.095	0.088	0.092	0.101
11	0.087	0.102	0.098	0.094	0.087	0.098	0.094	0.090	0.090	0.100
12	0.087	0.099	0.099	0.092	0.087	0.102	0.093	0.092	0.088	0.102
13	0.087	0.096	0.099	0.092	0.088	0.101	0.095	0.091	0.088	0.101
14	0.089	0.097	0.100	0.080	0.088	0.103	0.091	0.092	0.089	0.104
15	0.089	0.101	0.099	0.081	0.087	0.103	0.093	0.091	0.093	0.105
16	0.089	0.099	0.099	0.081	0.087	0.101	0.094	0.088	0.091	0.105
17	0.088	0.098	0.098	0.082	0.087	0.100	0.095	0.092	0.091	0.103
18	0.088	0.099	0.098	0.084	0.088	0.099	0.096	0.095	0.092	0.102
19	0.088	0.099	0.101	0.086	0.088	0.099	0.096	0.092	0.096	0.102
20	0.087	0.097	0.100	0.086	0.088	0.099	0.096	0.092	0.095	0.101

Table 4. Band 3 Reflectance Values 2015 - 2024

Point	Band 3									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	0.088	0.088	0.091	0.081	0.080	0.092	0.087	0.085	0.083	0.084
2	0.087	0.089	0.091	0.087	0.084	0.093	0.086	0.093	0.084	0.085
3	0.088	0.088	0.090	0.091	0.086	0.090	0.086	0.091	0.081	0.084
4	0.089	0.090	0.093	0.091	0.082	0.093	0.086	0.085	0.081	0.087
5	0.087	0.090	0.092	0.089	0.083	0.093	0.088	0.085	0.083	0.086
6	0.086	0.090	0.091	0.077	0.082	0.094	0.086	0.086	0.082	0.087
7	0.082	0.090	0.088	0.076	0.081	0.093	0.084	0.086	0.082	0.082
8	0.080	0.092	0.087	0.073	0.081	0.094	0.085	0.082	0.077	0.082
9	0.080	0.091	0.087	0.077	0.078	0.093	0.085	0.082	0.081	0.082
10	0.081	0.092	0.088	0.076	0.078	0.090	0.085	0.073	0.080	0.081
11	0.078	0.088	0.083	0.083	0.080	0.093	0.084	0.076	0.079	0.081
12	0.077	0.083	0.084	0.083	0.080	0.093	0.085	0.080	0.076	0.082
13	0.077	0.081	0.086	0.082	0.080	0.094	0.086	0.080	0.075	0.080
14	0.079	0.083	0.087	0.069	0.079	0.093	0.083	0.080	0.077	0.082
15	0.079	0.090	0.088	0.071	0.079	0.094	0.086	0.080	0.080	0.085
16	0.079	0.086	0.088	0.070	0.079	0.093	0.087	0.077	0.080	0.086
17	0.079	0.084	0.085	0.071	0.078	0.092	0.088	0.080	0.079	0.084
18	0.079	0.088	0.083	0.075	0.079	0.092	0.089	0.084	0.080	0.084
19	0.078	0.084	0.088	0.077	0.079	0.093	0.089	0.081	0.082	0.083
20	0.076	0.081	0.089	0.077	0.080	0.093	0.089	0.083	0.081	0.082

Table 5. Band 4 Reflectance Values 2015 - 2024

Point	Band 4									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	0.070	0.063	0.069	0.067	0.055	0.067	0.064	0.060	0.051	0.060
2	0.069	0.066	0.070	0.075	0.064	0.069	0.065	0.071	0.052	0.061

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Point	Band 4									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
3	0.073	0.066	0.074	0.080	0.067	0.069	0.064	0.069	0.054	0.060
4	0.071	0.068	0.073	0.078	0.059	0.070	0.063	0.061	0.053	0.063
5	0.069	0.068	0.075	0.077	0.062	0.069	0.067	0.061	0.057	0.063
6	0.068	0.068	0.070	0.058	0.059	0.069	0.062	0.063	0.056	0.063
7	0.063	0.068	0.065	0.055	0.060	0.069	0.060	0.061	0.054	0.059
8	0.060	0.069	0.063	0.053	0.058	0.069	0.063	0.056	0.048	0.058
9	0.059	0.067	0.060	0.057	0.056	0.067	0.062	0.057	0.056	0.058
10	0.061	0.069	0.064	0.056	0.056	0.068	0.064	0.048	0.052	0.057
11	0.056	0.063	0.054	0.069	0.058	0.065	0.061	0.051	0.049	0.056
12	0.055	0.056	0.055	0.066	0.058	0.067	0.061	0.054	0.047	0.058
13	0.055	0.053	0.057	0.065	0.057	0.067	0.063	0.054	0.046	0.056
14	0.057	0.056	0.061	0.047	0.057	0.068	0.060	0.054	0.047	0.059
15	0.057	0.065	0.062	0.049	0.056	0.069	0.061	0.053	0.050	0.062
16	0.056	0.062	0.061	0.048	0.055	0.069	0.062	0.051	0.051	0.062
17	0.056	0.060	0.057	0.049	0.053	0.069	0.063	0.055	0.050	0.061
18	0.056	0.063	0.054	0.053	0.054	0.067	0.063	0.058	0.050	0.060
19	0.055	0.060	0.060	0.056	0.054	0.069	0.063	0.055	0.050	0.059
20	0.053	0.055	0.065	0.055	0.054	0.069	0.063	0.056	0.049	0.059

After obtaining the reflectance value of the specified year, the value will be calculated for the Total Suspended Solid (TSS) value with a predetermined algorithm. The calculation uses Microsoft Excel software.

Comparison of TSS Values of Landsat 8 Satellite Imagery with In-situ TSS Values

The results of processing Landsat 8 satellite images recorded on May 23, 2024, using four predetermined algorithms, namely the Ety Parwati Algorithm, the Nurahida Laili Algorithm, the Jaelani Algorithm, and the Hendrata Wibisana Algorithm. Then, the Total Suspended Solid (TSS) value is obtained, which is shown in the following table:

Table 6. Results of Landsat 8 Satellite Image TSS & In-situ TSS Values

Point	Geographic Coordinates		TSS Ety Parwati mg/l	TSS Nurahida mg/l	TSS Jaelani mg/l	TSS Hendrata Wibisana mg/l	TSS *in-situ* mg/l
	X	Y					
1	112.837	-7.407	25.961	12.826	1.032	30.584	12
2	112.837	-7.409	26.752	12.777	1.029	31.145	18
3	112.837	-7.411	26.085	12.773	1.030	30.674	17
4	112.837	-7.414	28.601	12.827	1.027	32.395	24
5	112.837	-7.416	28.194	12.791	1.027	32.127	12
6	112.837	-7.418	28.856	12.798	1.026	32.561	14
7	112.837	-7.420	24.516	12.388	1.011	29.513	12
8	112.837	-7.422	23.970	12.423	1.014	29.093	12
9	112.837	-7.424	24.266	12.519	1.020	29.322	18
10	112.837	-7.427	23.501	12.473	1.017	28.723	23
11	112.838	-7.426	22.713	12.397	1.018	28.085	26
12	112.839	-7.423	23.840	12.470	1.018	28.991	20
13	112.839	-7.421	22.697	12.303	1.010	28.072	19
14	112.839	-7.419	25.176	12.508	1.012	30.011	22
15	112.839	-7.417	27.027	12.634	1.021	31.337	16
16	112.839	-7.414	27.604	12.738	1.023	31.732	18

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Point	Geographic Coordinates		TSS Ety Parwati mg/l	TSS Nurahida mg/l	TSS Jaelani mg/l	TSS Hendrata Wibisana mg/l	TSS *in-situ* mg/l
	X	Y					
17	112.839	-7.412	26.210	12.735	1.026	30.763	39
18	112.839	-7.410	25.592	12.752	1.029	30.317	12
19	112.839	-7.408	25.125	12.716	1.030	29.972	23
20	112.839	-7.406	24.583	12.724	1.028	29.564	26

From the table above, it is known that the TSS value calculated using the Ety Parwaty Algorithm ranges from 22,697 mg/L to 28,856 mg/L, for the TSS value computed using the Nurahida Algorithm ranges from 12,303 mg/L to 12,827 mg/L, for the TSS value calculated using the Jaelani Algorithm ranges from 1,010 mg/L to 1,032 mg/L. In comparison, the TSS value computed using the Hendrata Wibisana Algorithm ranges from 28,072 mg/L to 32,561 mg/L. The following is a graph of the application using 4 different algorithms in 2024 with the in-situ Total Suspended Solid (TSS) listed as follows:

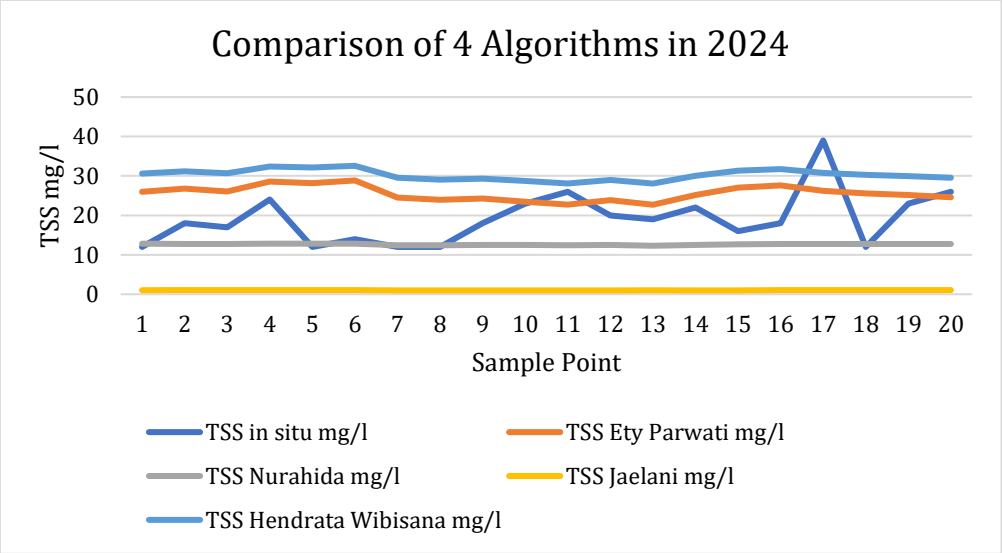

Figure 1. Comparison of 4 Algorithms in 2024

Validation Test of Image Data Processing Results with In-situ Data

The validation test was conducted using Landsat 8 image data on May 23, 2024, at the same time as the in-situ data collection. In the validation test, a correlation calculation was carried out by comparing processed image data with in-situ data in the field. This validation test is carried out using simple linear regression, which aims to determine the relationship between the results of image data processing and field data. The results of the image data correlation test and in-situ data are as follows:

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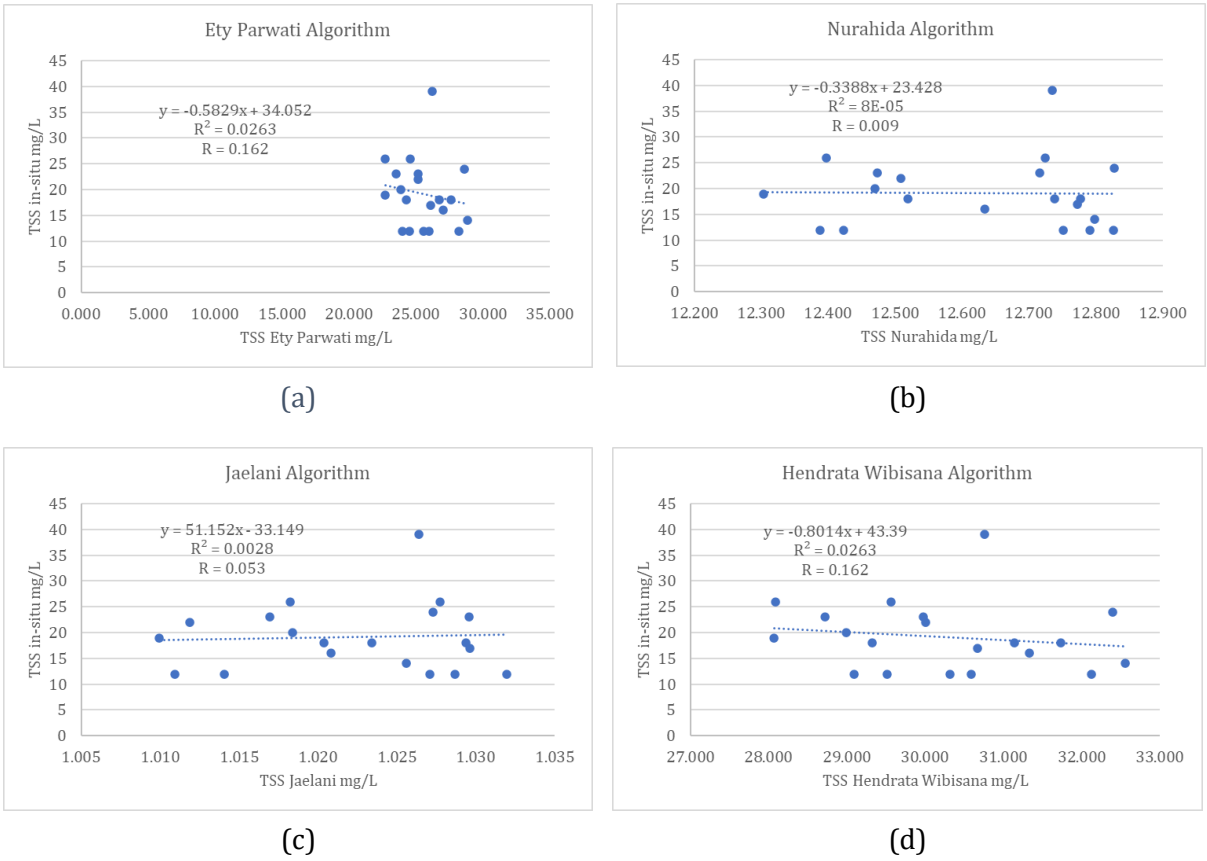

Figure 2. Correlation Chart of In-Situ Data and Landsat 8 Image Data (a) Ety Parwati (b) Nurahida (c) Jaelani (d) Hendrata Wibisana

The correlation test of in-situ data with Landsat 8 image data using the Ety Parwati algorithm has a correlation coefficient value of R = 0,162, the Nurahida algorithm has a correlation coefficient value of R = 0,009, the Jaelani algorithm has a correlation coefficient value of R = 0,053, and the Hendrata Wibisana algorithm has a correlation coefficient value of R = 0,162. A recapitulation of the correlation value can be seen in the following table:

Table 7. Recapitulation of Correlation Results

No	Algorithm	R Values
1	Ety Parwati Algorithm	0,162
2	Nurahida Algorithm	0,009
3	Jaelani Algorithm	0,053
4	Hendrata Wibisana Algorithm	0,162

In the table above, the largest r value with a value of R = 0,162 is the Ety Parwati and Hendrata Wibisana algorithm, which means that the algorithm has a fairly strong relationship with the in-situ data. Since the two algorithms have the same R-value, it will be seen from the comparison of the average TSS value of the two algorithms to the in-situ TSS value. The average TSS value in-situ is 19,150 mg/L, while the average TSS value of Ety Parwaty is 25,563 mg/L, and the average TSS value of Hendrata Wibisana is 30,249 mg/L. Thus, Ety Parwati's algorithm will be used to calculate the TSS value of Landsat 8 images for 2015-2024.

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Total Suspended Solid (TSS) Concentration Value

Furthermore, the Landsat 8 Total Suspended Solid (TSS) value for 2015-2024 was calculated using the Ety Parwati algorithm. This calculation is done to determine the condition of the concentration of Total Suspended Solid (TSS) in Kalanganyar Beach, Sedati District, Sidoarjo Regency at that time. The results of the calculation of Total Suspended Solid (TSS) in 2015 - 2024 are in the following table:

Table 8. Total Suspended Solid (TSS) Value Results 2015 - 2024

Point	TSS Image 2015 (mg/l)	TSS Image 2016 (mg/l)	TSS Image 2017 (mg/l)	TSS Image 2018 (mg/l)	TSS Image 2019 (mg/l)	TSS Image 2020 (mg/l)	TSS Image 2021 (mg/l)	TSS Image 2022 (mg/l)	TSS Image 2023 (mg/l)	TSS Image 2024 (mg/l)
1	36.411	28.777	35.094	32.602	21.639	32.892	29.735	25.82	19.166	25.961
2	35.286	31.019	36.485	42.973	29.372	34.879	30.061	37.189	19.817	26.752
3	40.608	31.104	40.719	49.964	33.072	35.166	29.573	35.142	20.757	26.085
4	37.802	33.458	39.651	47.797	24.532	35.722	28.718	26.264	20.171	28.601
5	35.455	33.39	42.161	45.321	27.398	35.19	32.358	26.121	22.946	28.194
6	34.29	33.618	36.114	24.003	24.852	35.214	27.064	28.368	22.62	28.856
7	27.964	33.779	30.787	22.011	25.453	34.501	25.453	26.624	21.244	24.516
8	25.262	35.046	28.915	20.089	24.349	35.31	28.06	22.132	17.009	23.97
9	25.074	32.624	25.401	23.198	22.298	32.513	27.567	22.915	22.071	24.266
10	26.389	34.808	29.836	22.62	22.589	34.103	29.132	17.29	19.522	23.501
11	22.087	28.465	20.971	35.142	24.299	30.787	26.318	18.624	17.599	22.713
12	21.332	22.041	21.728	31.531	24.283	32.117	26.425	21.158	16.283	23.84
13	21.802	19.939	23.04	30.599	23.533	32.736	28.484	20.63	16.008	22.697
14	22.899	22.283	26.264	16.529	23.04	34.196	25.785	21.129	16.733	25.176
15	22.884	30.599	27.51	17.432	22.497	35.479	26.953	20.062	17.951	27.027
16	22.744	27.045	26.282	16.848	21.536	34.856	27.323	18.777	18.726	27.604
17	22.314	25.401	22.899	17.552	20.476	34.336	27.964	21.463	18.136	26.21
18	22.589	28.718	21.043	20.226	20.786	32.915	28.484	24.167	18.222	25.592
19	21.892	25.401	25.505	22.132	20.857	34.595	28.329	21.61	18.049	25.125
20	20.518	21.802	30.411	21.966	21.129	34.383	28.699	22.42	17.756	24.583

Based on the Total Suspended Solid (TSS) value in the Table above, it can be seen that in 2015 the highest TSS value was 40,608 mg/L and the lowest was 20,518 mg/L, in 2016 the highest TSS value was 35,046 mg/L and the lowest was 19,939 mg/L, in 2017 the highest TSS value was 42,161 mg/L and the lowest was 20,971 mg/L, in 2018 the highest TSS value was 49,964 mg/L and the lowest was 16,529 mg/L, in 2019 the highest TSS value was 33,072 mg/L and the lowest was 20,467 mg/L, in 2020 the highest TSS value was 35,722 mg/L and the lowest was 30,787 mg/L, in 2021 the highest TSS value was 32,358 mg/L and the lowest was 25,453 mg/L, in 2022 the highest TSS value was 37,189 mg/L and the lowest was 17,290 mg/L, in 2023 the highest TSS value was 22,946 mg/L and the lowest was 16,008 mg/L, and in 2024 the highest TSS value was 28,856 mg/L and the lowest was 22.697 mg/L. The average TSS value can be seen in the table:

Table 9. Average Total Suspended Solid (TSS) Value 2015-2024

No	Year	Average TSS Value (mg/L)
1	2015	27.280
2	2016	28.966
3	2017	29.541
4	2018	28.027
5	2019	23.900
6	2020	34.095
7	2021	28.124
8	2022	23.895

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No	Year	Average TSS Value (mg/L)
9	2023	19.039
10	2024	25.563

Based on the Presidential Regulation of the Republic of Indonesia Number 22 of 2021 concerning seawater quality standards for marine biota, the TSS value that meets is ± 20 mg/L. In the table above, it can be seen that the seawater quality standards in the coastal areas of Sidoarjo Regency still meet the criteria for marine biota.

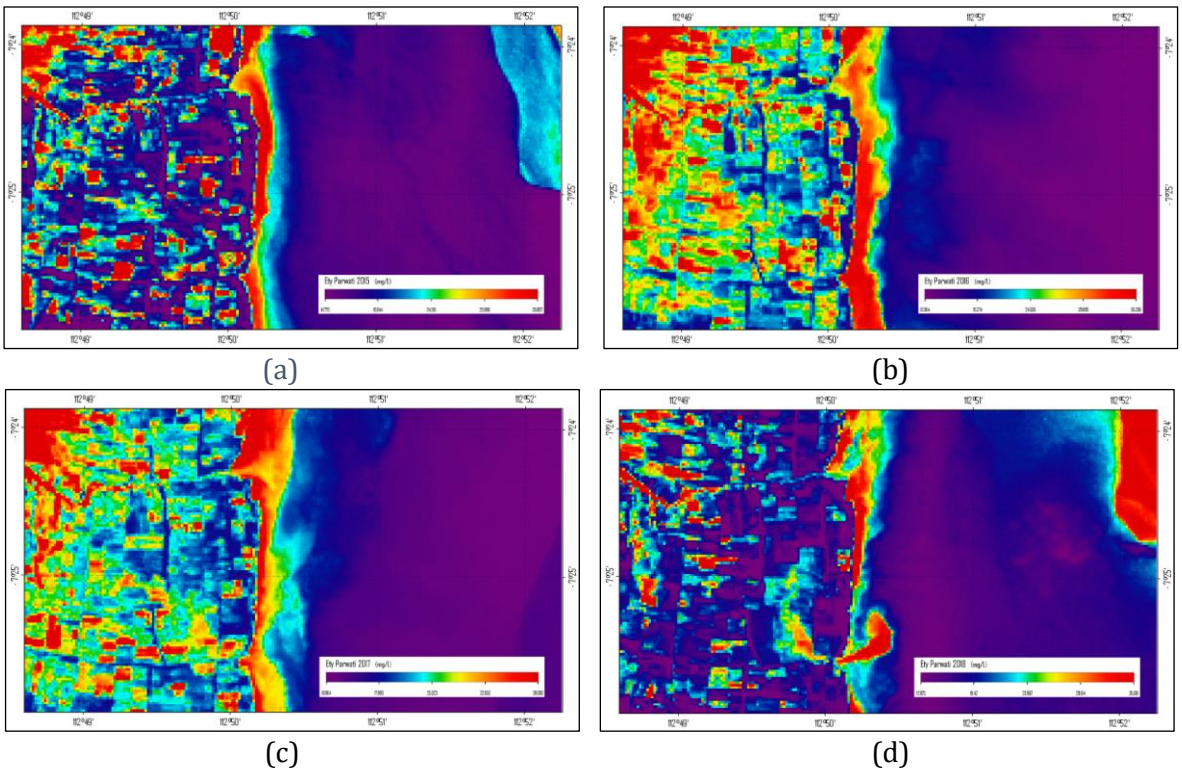
From the Total Suspended Solid (TSS) value from 2015 - 2024, it can also be seen that the TSS value does not always increase, but some have decreased at several observation sample points. In the table above, it can also be seen that the highest Total Suspended Solid (TSS) value was in 2018, reaching 49,964 mg/L at observation point number 3, while the lowest TSS value occurred in 2023, reaching 16,008 mg/L at observation point number 13.

Furthermore, an ANOVA test will be conducted to determine whether or not there is a difference in the TSS value for 2015 - 2024 for the Ety Parwaty algorithm model. The ANOVA test results are summarized in the following table:

Table 10. Anova Test Result of Total Suspended Solid (TSS) Value 2015 - 2024

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	2369.09	19	124.69	7.2352	5.118E-14	1.648
Columns	2949.78	9	327.75	19.018	8.805E-22	1.935
Error	2946.98	171	17.234			
Total	8265.86	199				

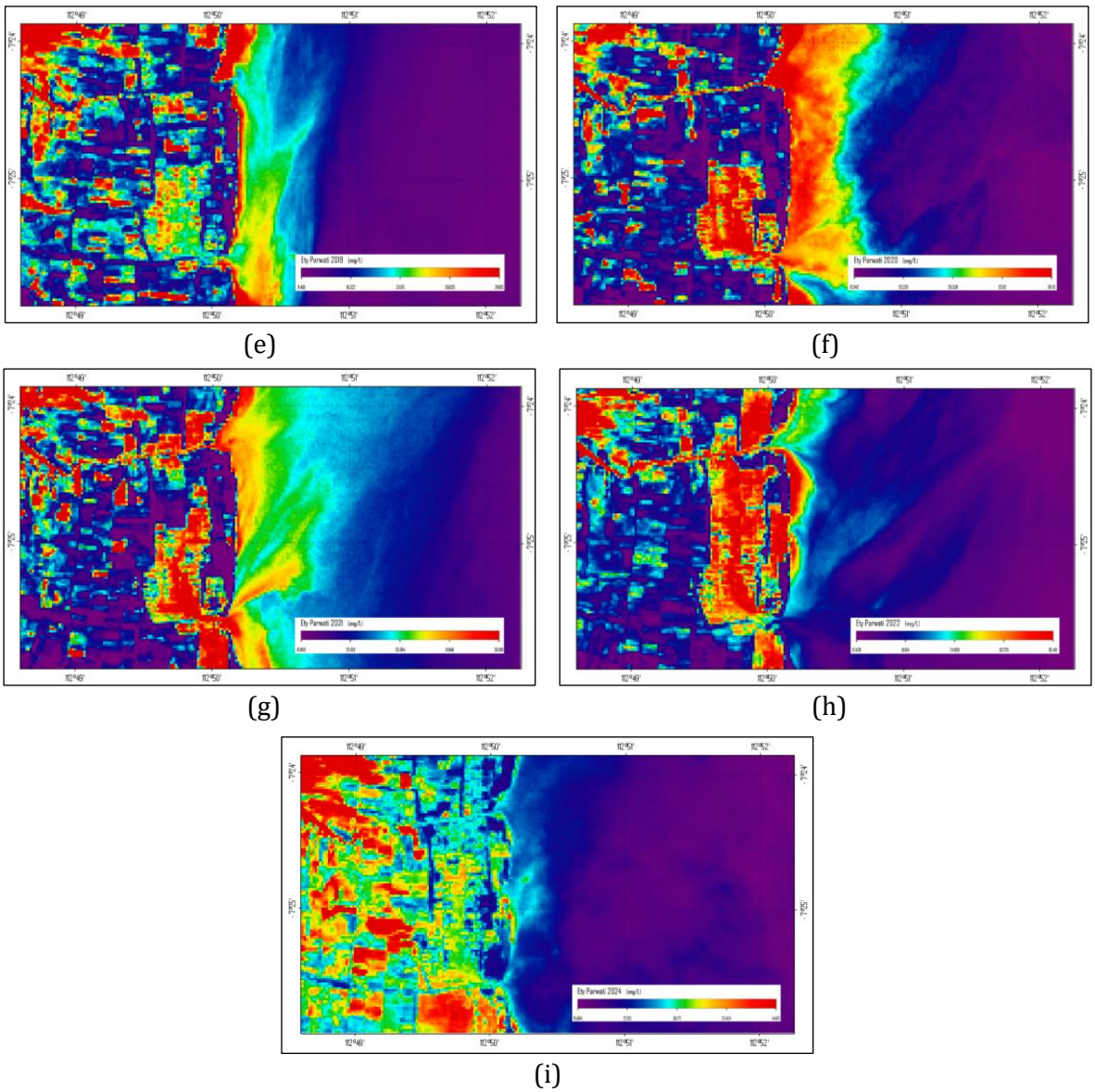
In rows, F count = 7,2352 > F table = 1,648, then H_0 is rejected, and H_1 is accepted, meaning that there is a difference between TSS values at each point. While in columns, F count = 327,75 > F table = 1,935, then H_0 is rejected, and H_1 is accepted, meaning that there is a difference in the TSS value in 2015 - 2024 for the Ety Parwaty algorithm model. Changes in TSS values from year to year can be seen in the TSS concentration distribution map as follows:



(a) (b)

(c) (d)

DOI: https://doi.org/10.62017/tektonik



(e) (f)

(g) (h)

(i)

Figure 3. Map of Total Suspended Solid (TSS) Concentration in (a) 2015 (b) 2016 (c) 2017 (d) 2018 (e) 2019 (f) 2020 (g) 2021 (h) 2022 (i) 2024

For the Total Suspended Solid (TSS) concentration map in 2023, it was not detected in May and the months closest to it. From the map of the distribution of Total Suspended Solid (TSS) concentration in 2015 - 2024 from the processing of Landsat 8 satellite imagery above, it can be analyzed that the value and distribution of TSS concentration in Kalanganyar Coastal Area, Sedati District, Sidoarjo Regency does not always increase every year. There is a decrease in the concentration value of Total Suspended Solid (TSS) in 2021 and 2023. Tides, currents, and wind can cause the changing value of Total Suspended Solid (TSS) concentration.

CONCLUSION

Based on the results of the above research, it can be concluded that the best algorithm model is the Ety Parwaty algorithm model, with a value of R = 0,162. The algorithm model is used to calculate the TSS value and to map the TSS value on the coast of Sidoarjo Regency. The highest TSS value was in 2018, reaching 49,964 mg/L, while the lowest TSS value was in 2023, reaching 16,008 mg/L. Changes in TSS concentration values can be seen in the TSS concentration map image above.

SUGGESTION

During the time interval between image recording and field data collection, it is important to pay attention to changes in tides, currents, and wind so as not to affect the calculation of Total Suspended Solid (TSS) concentration values. Special attention and handling of the problem of changes in the concentration of Total Suspended Solid (TSS) is needed because, if left unchecked, it will result in a very severe sedimentation impact on the Kalanganyar Coast, Sedati District, Sidoarjo Regency.

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