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Analysis and Mapping of Chemical Oxygen Demand Value in *Pasuruan* Coastal Coast with Landsat 8 Satellite Image Data

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Abstract:- *Pasuruan* coast is a fairly dynamic area. The life of the fishermen in the area is also relatively prosperous. Along with the large number of people who inhabit the coast, the previously stagnant ecosystem will change due to the activities of the local community. This study explores the role of Chemical Oxygen Demand on seawater quality standards that are directly related to the lives of fishermen. The technology used to monitor the distribution of COD values is remote sensing using Landsat 8 satellite imagery. The method developed is to formulate the most suitable mathematical model to describe the distribution of COD values in the coastal area with scatter diagrams and trend analysis, which will determine the R2 value of each observation. The results of this study indicate that the green wavelength (channel 3) from Landsat 8 satellite imagery has the most optimal correlation compared to other wavelengths. In addition, from the wavelength, a logarithmic model has an optimal value that can describe the distribution of COD on the Pasuruan coast. In conclusion, the ecosystem on the Pasuruan coast is still within reasonable limits and has not been contaminated with pollutants, as indicated by the COD value significantly. Furthermore, Landsat 8 satellite imagery can be used as an alternative to mapping the parameters affecting global coastal ecosystem changes.

Keywords:- *Chemical oxygen demand (COD); Remote sensing; Landsat 8, Pasuruan Coast*

I. INTRODUCTION

The coast is the area where land meets the ocean. Life in the coastal areas of the *Pasuruan* district is quite dynamic. Most coastal communities have a livelihood from fishing and ponds. The quality of seawater in coastal areas greatly determines the quality of water suitable for the life of aquatic biotas, such as fish and other aquatic plants that depend on sunlight, seawater salinity, turbidity, and acidity.

The value of salinity and acidity of seawater is highly dependent on many things, one of which is the contamination of Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD). High COD and BOD values will cause the water content on the coast to decrease in quality so that it can be said to be contaminated. This phenomenon is usually the result of factory wastewater, industrial wastewater, and household waste from the local community.

Monitoring the COD and BOD concentrations that have entered a water body requires a large number of funds because it requires several tens of samples from each point in an extensive area, more than one square kilometer. So, it is necessary to have a technology that can map the distribution of concentrations of COD and BOD globally. Knowing the concentration means appropriate and fast handling because the information is comprehensive and global. The technology used here is remote sensing, using satellite imagery to record and monitor the distribution of COD concentrations.

Many overseas researchers have used this technology for monitoring natural resources, especially ecosystem resources on the coast [1]. However, there are still few studies that explain the distribution of COD in coastal areas. What has often been conducted is research on sea surface temperature mapping [2]–[4], total dissolved solids [5]–[7], seawater salinity [8], [9][10], [11] and the distribution of seawater acidity. To address the gap, this research is focused on mapping the value of Chemical oxygen demand (COD) on the coast of *Pasuruan* in order to obtain accurate and global information in a relatively short period of time so that in the future, it can be used as a reference for better coastal process management for coastal communities in *Pasuruan*.

II. MATERIALS AND METHOD

- *The Acquisition of Satellite Image*

The satellite image is a Landsat 8 image recorded in February 2022.

This satellite image was taken on the website http://eartheexplorer.usgs.gov/. The image is a Level 2 satellite image that has been geometrically and radiometrically corrected. Furthermore, satellite images are processed the same way as previous researchers for Landsat image processing (Hendrata, 2019), namely image cropping, setting the projection to UTM, and retrieving reflectance data from satellite images [12], [13].

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➢ *The Research Site*

The location of this research is the coast of Pasuruan Regency with latitude coordinates 7º 23' 34" to 7º 12' 54" and longitude coordinates 113º 14' 27" to 113º 34' 21". This location was chosen by taking advantage of the low waves from the north coast. Data collection can be carried out properly without interference from big waves due to using fishing boats.

➢ *The COD measurement*

The measurement of COD is intended to determine how much oxygen content can be oxidized by oxidizing reagents such as potassium bichromate to decompose. The COD content in seawater will vary depending on where the water is taken. Due to the comprehensive coverage of the *Pasuruan* coast, the COD value may vary depending on the occupancy level and the presence of building units or businesses that produce wastewater contaminated with organic and inorganic materials. This compound contains oxygen which bichromate oxidizing agents can oxidize [14], [15].

III. RESULTS

The figure 1 below is the cropping image result from the Landsat 8 images. The data result shows that the area of Pasuruan district map.

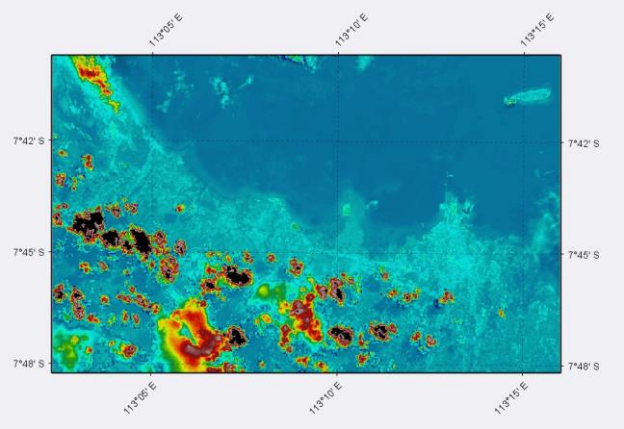

Fig 1:- Scene of Landsat 8 images with the area of *Pasuruan* district after cropping the image

Longitude	Latitude	COD (mg/l)
113,1165	-7,7189	16,8
113,1184	-7,7216	22,3
113,1238	-7,7213	24,1
113,1295	-7,7207	20,6
113,1333	-7,7221	18,5
113,1374	-7,7226	17,8
113,1426	-7,7234	18,2
113,1461	-7,7274	15,3
113,1494	-7,7320	17,8
113,1551	-7,7350	17,3
113,1606	-7,7320	15,7
113,1570	-7,7282	16,2
113,1540	-7,7247	15,8
113,1507	-7,7220	16,2
113,1466	-7,7193	17,4
113,1420	-7,7174	16,6
113,1385	-7,7158	16,8
113,1327	-7,7142	15,9
113,1276	-7,7137	16,3
113,1202	-7,7113	17,2

Table 1:- COD data from laboratory analysis correspond with Longitude and Latitude

The results of the calculation of COD data that have been processed in the laboratory are presented in Table 1. It shows the remote sensing algorithm for four mathematical models that have been calculated, namely linear, exponential, logarithmic, and power. Table 1 shows the highest R2 correlation values for the exponential and power models of 0.6324 and 0.6205, respectively. These results are obtained on the blue channel wavelength from Landsat 8 satellite imagery.

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No	Algorithm	Mathematical models	R2
1	Linear	y = 551,29x - 35,436	0,5993
2	Exponent	$y = 1,074e^{28,997x}$	0,6324
3	Logarithmic	y = 52,628ln(x) + 140,85	0,5869
4	Power	$y = 11481x^{2,7701}$	0,6205

Table 2:- Mathematical model of the blue channel of Landsat 8 satellite imagery and the value of R2
Source: the calculation results

Table 2 shows the COD calculation results for remote sensing algorithms on the green channel. In this channel, statistically significant results were obtained, and the highest R2 correlation value was obtained in the linear and logarithmic models, respectively 0.7116 and 0.7151.

No	Algorithm	Mathematical models	R2
1	Linear	y = 410.5x - 10.954	0.7116
2	Exponent	$y = 3.8928e^{21.441x}$	0.698
3	Logarithmic	y = 30.572ln(x) + 99.208	0.7151
4	Power	$y = 1256x^{1.6054}$	0.7075

Table 3:- Mathematical model of the green channel of Landsat 8 satellite imagery and the value of R2
Source: the calculation results

Comparing the R2 correlation values between Table 1 and Table 2 shows that the remote sensing algorithm for the green wavelength is more dominant than the blue one. This can be seen by acquiring the most significant value in the logarithmic model with R2 = 0.7151, the green wavelength. The results of the graphs for each mathematical model and the correlation value of R2 can be seen in Figures 1 to 4 below. Figures 1 to 4 shows a graph of the reflectance value of the satellite image as the x-axis with the COD value as the y-axis

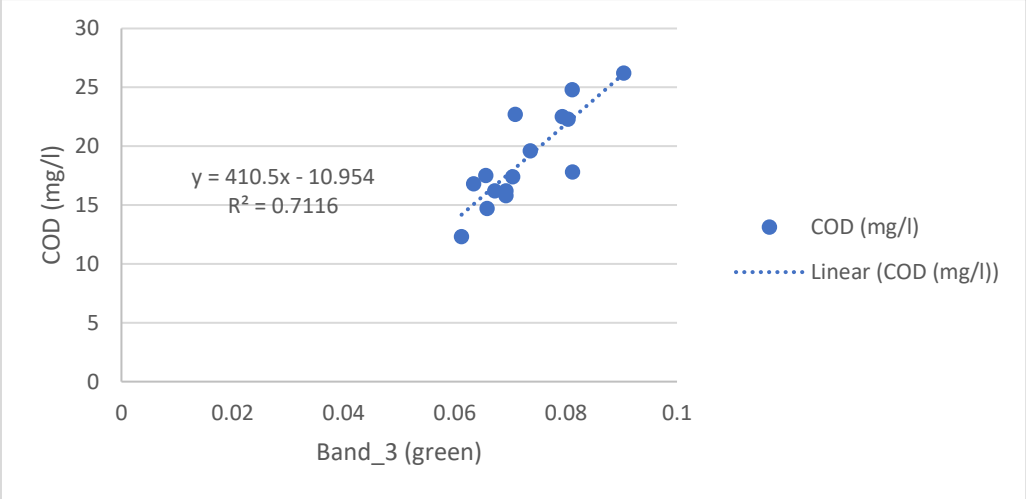

Fig 2:- The reflectance of band-3 (green) on COD values (mg/l) in the coastal area of *Pasuruan* for the linear model

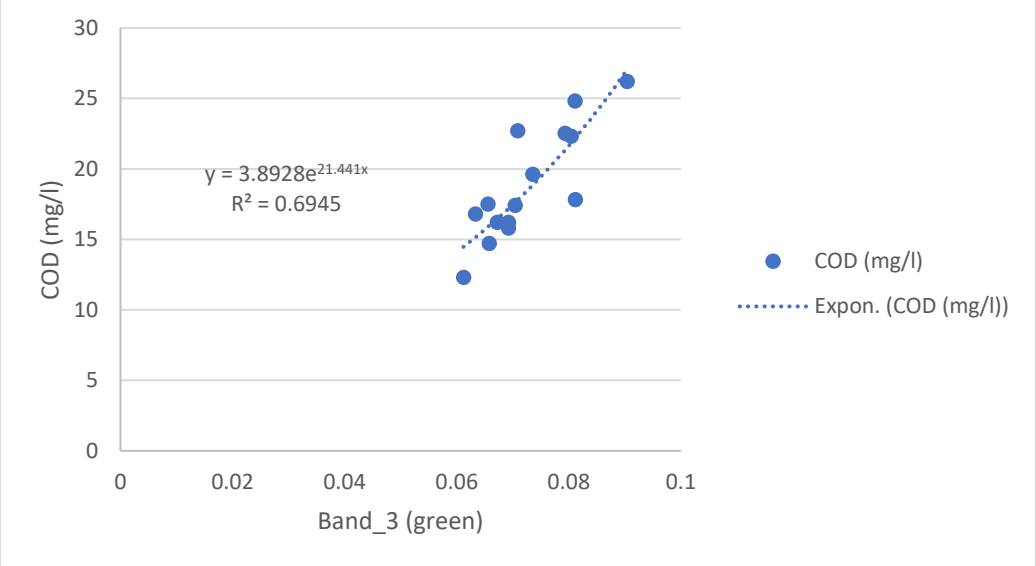

Fig 3:- The reflectance of band-3 (green) on COD values (mg/l) in the coastal area of *Pasuruan* for the exponential model

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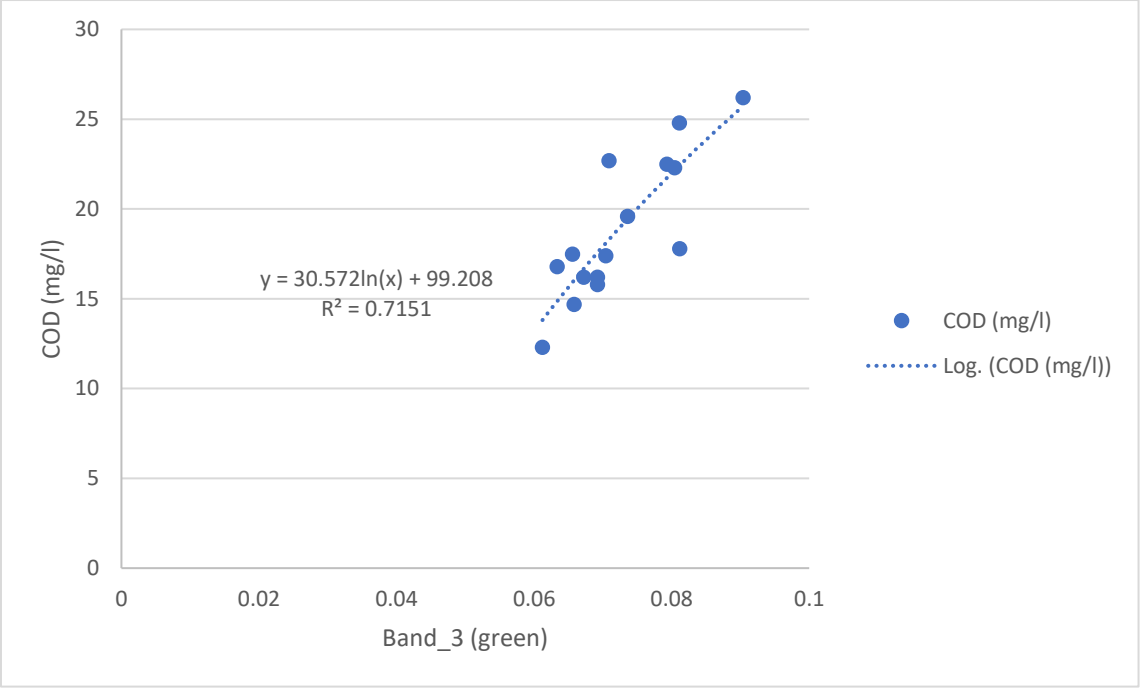

Fig 4:- The reflectance of band-3 (green) on the COD value (mg/l) in the coastal area of *Pasuruan* for the logarithmic model

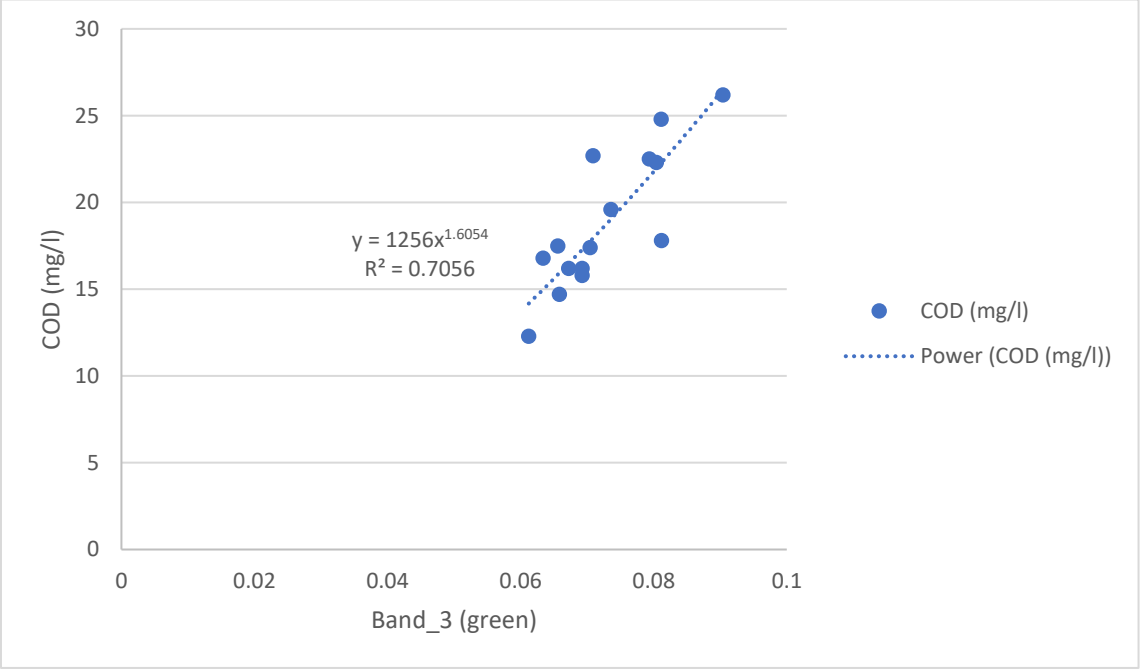

Fig 5:- The reflectance of band-3 (green) on the COD value (mg/l) in the coastal area of *Pasuruan* for the power model

No	Algorithm	Mathematical models	R2
1	Linear	y = 129,37x + 9,8608	0,2325
2	Exponent	$y = 11{,}545e^{6{,}9258x}$	0,2305
3	Logarithmic	y = 8,1513ln(x) + 40,632	0,2364
4	Power	$y = 59{,}891x^{0{,}436}$	0,2349

Table 4:- Mathematical model of the red channel of Landsat 8 satellite image and the value of R2
Source: the calculation results

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IV. DISCUSSION

The result of this study as shown on Table 3, it shows the calculation results on the red wavelength from the Landsat 8 satellite image. The calculation of the remote sensing algorithm in the table gives less than optimal results compared to Table 1 and Table 2, in which the R2 correlation value shown is below 0.5 or 50%. Overall, it can be seen that the model has a correlation value of only about 23%. So to make a thematic map of the distribution of COD, the red wavelength is no longer used as a reference.

In this study also can show the validation result of the 5 data from the field research that was taken from the Pasuruan coast. In the table 4 shows the validation results of the remaining 5 data from field data for testing the model obtained on the green channel as the reference channel with the best correlation to describe the COD map on the *Pasuruan* coast.

COD (mg/l) in situ	COD (mg/l)			
	Linear	Exponent	Logarithmic	Power
16.6	16.139	16.026	16.110	15.991
16.8	15.211	15.268	15.045	15.121
15.9	13.799	14.183	13.349	13.833
14.3	12.724	13.408	11.991	12.881
17.2	14.119	14.422	13.742	14.121

Table 5:- Validation of COD values for the remaining 5 data from field measurements (in situ) with the chosen mathematical model
Source: the calculation results

Table 4 presents data that is very diverse and has almost the same value in each mathematical model calculation. So to ensure the most suitable model or in accordance with the water conditions in *Pasuruan*, further calculations are used, namely correlation analysis of each COD data calculated from satellite imagery with COD data obtained from analysis in the laboratory. The overall calculation results are shown in Table 5.

	COD (mg/l) in situ	*Linear*	*Exponent*	*Logarithmic*	*Power*
COD (mg/l) in situ	1				
Linear	0.70983	1			
Exponent	0.69224	0.999615	1		
Logarithmic	0.72294	0.999776	0.99881	1	
Power	0.70181	0.999919	0.99989	0.99943	1

Table 6:- Calculation of the correlation of each mathematical model with in situ COD data (mg/l)
Source: the calculation results

Table 5 shows that the logarithmic model has a relatively high correlation with in situ COD data compared to other models. So that statistically, for the existing correlation, the logarithmic model is considered the most suitable for describing the thematic map of the distribution of COD values on the *Pasuruan* coast with a calculation result of 0.7229 for the in situ COD value against COD validation results of satellite image data. Thus, for making thematic maps, a logarithmic model of the remote sensing algorithm is taken with the assumption that the value of 72.29% of the field measurement data can be correlated with the logarithmic model of calculations on Landsat 8 satellite imagery data.

From this study we can conclude that the remote sensing algorithm that can be developed to describe the distribution of COD values is a logarithmic model at the green wavelength at a value of 500 nanometers. This study also shows that Landsat 8 can produce a thematic map of a coastal area according to reality with high resolution scenes image.

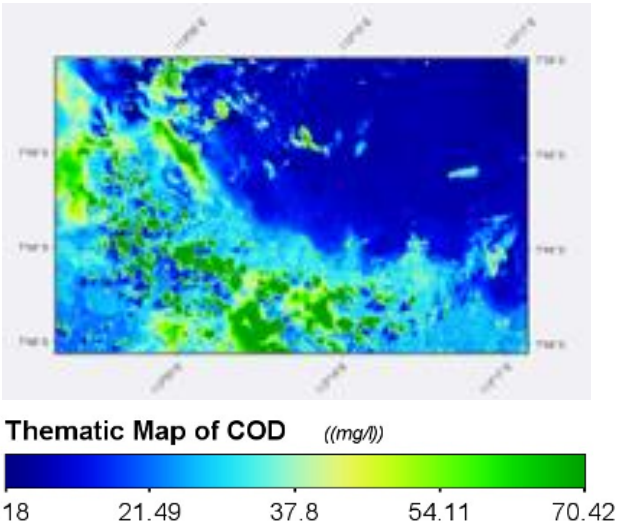

Fig 6:- Thematic Map

V. CONCLUSION

The distribution value of COD concentration (mg/l) on the coast of *Pasuruan* ranged from 5.18 to 70.42 (mg/l), while for areas parallel to the coast, the average COD was 20 mg/l. When viewed from the COD-BOD reference standard from the *Pasuruan* district government, the value of 20 mg/l is still within the safe limit because chemicals have not polluted the coastal water bodies from community activities.

The remote sensing algorithm that can be developed to describe the distribution of COD values is a logarithmic model at the green wavelength at a value of 500 nanometers.

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