Method Article

Modeling Total Suspended Solid (TSS) AndDistribution Of Heavy Metal PbUsing Sentinel-2A

ABSTRACT

Research has been carried out on modeling the concentration of Pb and Total Suspended Solid (TSS) of laboratory test results with Sentinel-2A image data in the Suwung estuary, Denpasar city. The method used is the correlation method of laboratory measurements (in situ) with the results of measurements of Sentinel-2A image pixels resulting from the application of the TSS algorithm and band matching for Pb (remote sensing). The number of samples measured was 30 samples. There are differences in the concentration measurement results for both TSS and Pb derived from the results of laboratory measurements with the pixel values of the application images for TSS and band matching for Pb.The resulting mathematical model for TSS is y=1.0213x – 0.2921 where the variable y represents the TSS measured by laboratory measurements while the variable x represents the TSS measured in Sentinel-2A image pixels. The mathematical model for the potential Pb concentration is p=33,757q – 1.1345 where the variable p represents the potential Pb concentration from laboratory measurements, while the variable q represents the potential Pb concentration measured in Sentinel-2A image pixels.

Keywords: Total suspended solid (TSS), Potensial Pb, Suwung Estuaries, Sentinel-2A

1. INTRODUCTION

Total Suspended Solid (TSS) and heavy metal concentrations of Plumbum (Pb) can be used as indicators of the level of sedimentation and pollution which is often the main problem for reservoirs (river estuaries) in Indonesia in providing clean water. The estuary of the Suwung Bali, apart from being the mouth of the Badung river, is also known as a provider of clean water for the southern Bali area. As it is known that, most of the southern part of Bali is a tourist area and new settlements, so it is very important to pay attention to the condition/quality of the water on a regular and sustainable basis. For this reason, we need a technology that can provide data and information related to monitoring water conditions on a regular and continuous basis.

Researches related to monitoring to provide an assessment of water quality through physical parameters such as TSS, temperature or turbidity in various regions in Indonesia outside Bali using remote sensing satellite technology image data (SPOT, Landsat 8,

Sentinel, Wordview 3) has been widely carried out ([1],[2],[3],[4],[6],[8],[11],[12]. Although most of the results of these studies discuss the prediction of the distribution and concentration of TSS parameters, they do not reach the point of reviewing and conducting periodic assessments. An effective routine and continuous monitoring method can be carried out with an approach, namely building a mathematical model related to water quality assessment. This mathematical modeling can be derived from remote sensing technology data which is correlated with in-situ data.

Predictive modeling such as the spatial distribution of TSS concentration and the potential presence of heavy metal Pb, extracted from the response spectral reflectance of remote sensing image data, such as Sentinel-2 in the Bottom of Atmosphere (BOA) through an algorithm. The spectral reflectance response of the object surface involves radiometric and atmospheric corrections determined by the Dark Object Subtraction (DOS) method [9]. The aims of this study were to determine a mathematical model to predict the concentration of TSS and Pb in Suwung estuary, Bali, using image data Sentinel-2A, and to predict the spatial distribution of TSS and Pb concentrations in Suwung estuary, Bali.

2. METHODOLOGY

The image data used in this research is Sentinel-2A obtained from USGS and the study area of the Suwung estuary is located in the South Denpasar sub-district, Denpasar city which is astronomically located at 8° 43' 26" – 8° 44' 04" South Latitude and 115° 11' 16" – 115° 11' 22" East Longitude [13].

Research activities started from surveys, collecting primary (water samples) and secondary data (Sentinel-2A image data). The location of water sampling in the study area was carried out at random geographical coordinates, then the TSS concentration and Pb potential were measured in the laboratory. Sentinel-2A image processing using software TerrSet 18.21 with the stages in outline are as follows:

1) Convert raw image pixel data to reflectance value on BOA (Bottom of Atmosphere)
2) Geometric, radiometric, atmospheric correction DOS (Dark Object Subtraction)
3) Cropping the image that covers the research area
4) Application of TSS algorithm Equation : and band matching for Pb

$$TSS\left(\frac{mg}{l}\right) = 31.42\,\frac{(Log\,(R_{RS}\ Blue))}{(Log\,(R_{RS}\ Red))} - 12.719 \qquad (1)$$

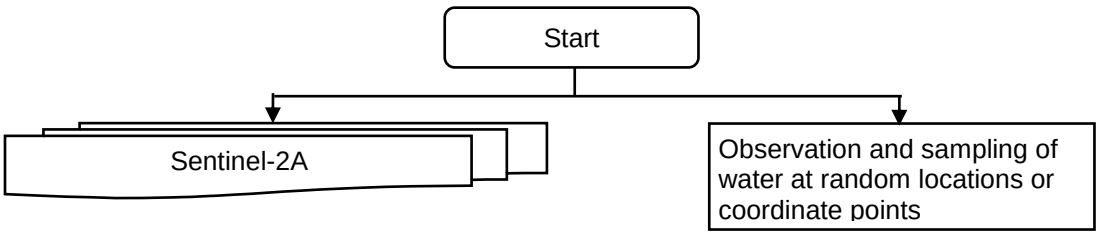
Where :

R_{RS} Blue is a blue band of reflectance remote sensing

R_{RS} Red is a red band of reflectance remote sensing

5) Determination of Pb in the image using band matching

Statistical and descriptive analysis were carried out through correlation analysis and validity of TSS and Pb in situ data as the dependent variable with Sentinel-2A data as independent variables. The strength of the correlation and the validity of the mathematical model obtained were tested using the regression method and the validation test with RMSE (Root Mean Square Error) [5].Detailed research activities are presented in a flow chart as shown in Figure 1.



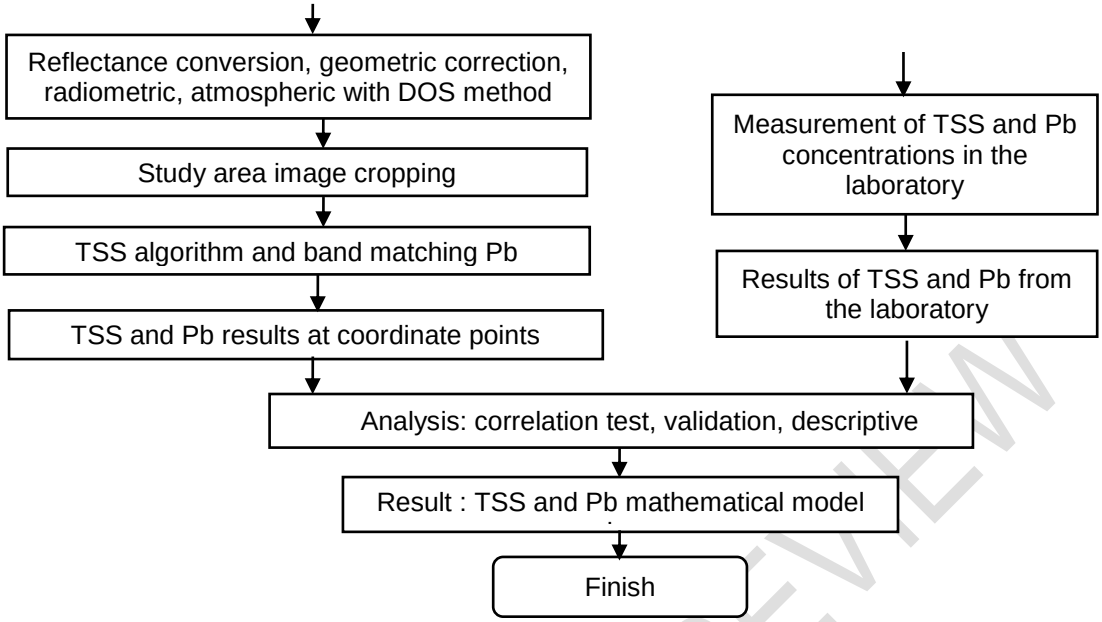


Figure 1. Research flow chart

3. RESULTS AND DISCUSSION

The number of water samples taken in the Suwung estuary is 30 and taken at the selected coordinate points. The concentration of TSS and Pb of this water sample was measured in the laboratory (In-situ). The results of measurements of TSS and Pb concentrations from the laboratory at a wavelength of 510 nm and from pixels in Sentinel-2A images that have been applied to the Equation 1 algorithm for TSS and band matching for Pb concentrations, namely band 3 with a wavelength of 560 nm are presented in Table 1. Spatial information generated and represented in the form of a map of the distribution of TSS concentrations is presented in Figure 2a, while the distribution of potential Pb concentrations is presented in Figure 2b.

Table 1. Results of measurements of TSS and Pb from In-situ and Sentinel-2A

No.	Coordinates (m)		TSS (mg/L)		Concentration of Pb (mg/L)	
	Latitude	Longitude	In-situ	Sentinel-2A	In-situ	Sentinel-2A
1	300605.65	9034626.56	15.50	15.85	.037	.037
2	300631.85	9034464.69	16.00	15.91	.089	.038
3	300858.86	9034622.19	16.20	15.98	.123	.039
4	300610.02	9034700.94	16.25	16.10	.223	.039
5	300950.54	9034315.94	16.35	16.26	.248	.040
6	300592.56	9034674.69	16.35	16.27	.263	.041
7	300601.29	9034661.56	16.37	16.32	.287	.041
8	300675.52	9034276.56	16.40	16.30	.293	.042
9	300588.19	9034919.69	16.65	16.73	.332	.042
10	300837.03	9034193.44	16.75	16.69	.378	.042
11	300749.72	9034805.94	16.75	16.68	.390	.044

12	300688.61	9034884.69	16.80	16.76	.438	.047
13	300579.46	9034683.44	16.85	16.74	.454	.047
14	300596.92	9035239.06	16,90	16.79	.480	.048
15	300810.84	9034140.94	17.00	16.85	.487	.048
16	300610.02	9034814.69	17.00	16.92	.519	.049
17	300684.24	9034919.69	17.15	17.08	.528	.050
18	300701.69	9034989.69	17.45	17.31	.528	.051
19	300732.26	9034932.81	17.50	17.42	.530	.051
20	300579.46	9035116.56	17.50	17.49	.592	.051
21	300719.16	9034976.56	17.60	17.57	.601	.052
22	300692.97	9035029.06	17.65	17.50	.613	.053
23	300714.79	9034994.06	17.70	17.63	.627	.053
24	300666.77	9035155.94	17.90	17.84	.635	.055
25	300662.41	9035120.94	18.00	17.92	.639	.055
26	300671.14	9035169.06	18.15	18.06	.707	.055
27	300671.14	9035195.31	18.25	18.17	.793	.056
28	300575.09	9035309.06	18.35	18.19	.810	.057
29	300557.63	9035379.06	18.55	18.45	.924	.058
30	300610.02	9035357.19	18.90	18.84	.936	.059

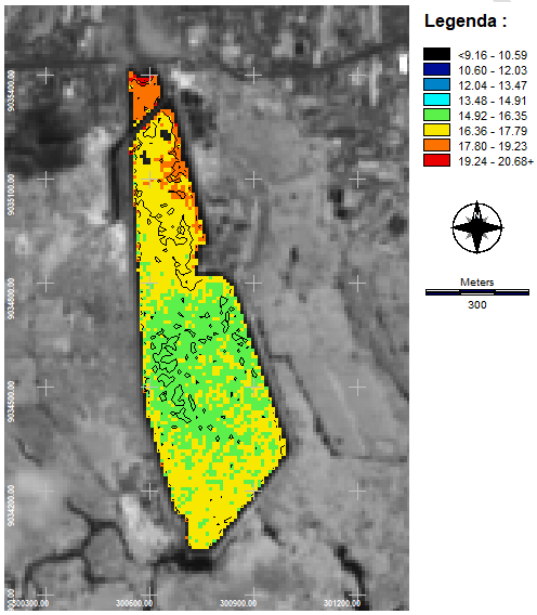


Fig 2a. Distribution of TSS concentration

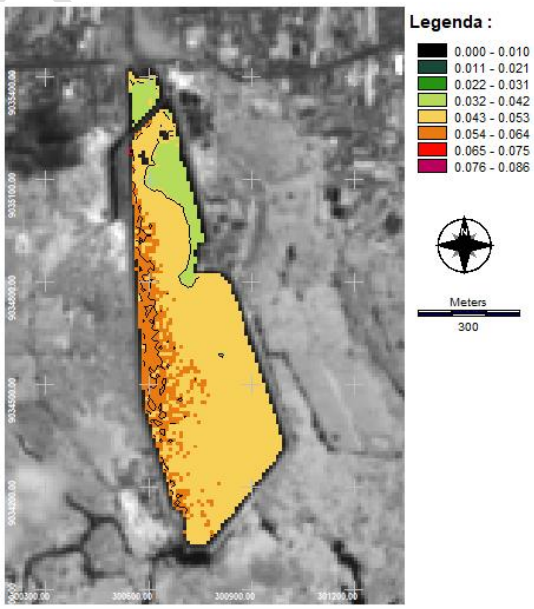


Fig 2b. Distribution of Pb concentration

Test and data analysis to obtain a mathematical model of the correlation between TSS measurement results and the potential distribution of Pb from the Laboratory with Sentinel-2A image data was carried out by statistical regression analysis. The results of this regression analysis will also show the correlation between Sentinel-2A image data and

laboratory data obtained from the field and the extent to which the proximity or goodness of the image data used in determining the regression equation model is obtained. From the data in Table 1, a graph of the correlation between TSS and Pb can be made from the results of the Lab measurements with the pixel measurements of the Sentinel-2A image as presented in Figures 3a and 3b.

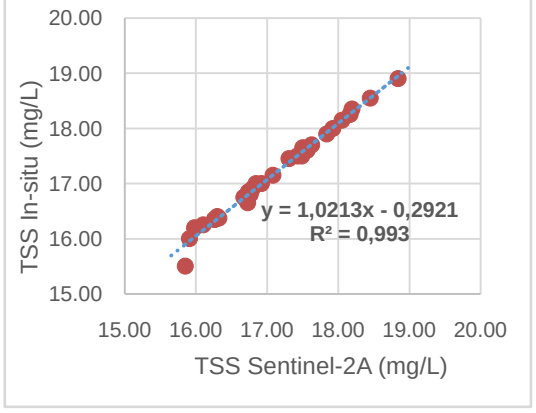


Fig 3a. The TSS correlation graph

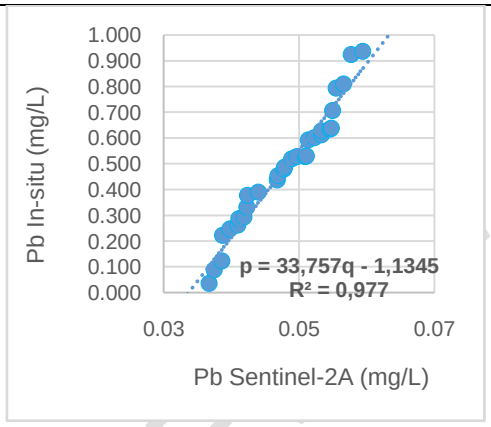


Fig 3b. The Pb correlation graph

In Figure 3a, it can be seen that the coefficient of determination (R^2) produced is 0.993 or its correlation coefficient, which is R, is 0.996. This explains that there is a very strong relationship or correlation between the value of the TSS measurement results from Sentinel-2A data and the results of laboratory data measurements. The resulting regression equation that represents the mathematical model for the TSS is y=1.0213x – 0.2921. In this case, the variable y represents the TSS measured by laboratory measurements, while the variable x represents the TSS measured in the Sentinel-2A image pixels. In Figure 3b, it can be seen that the coefficient of determination (R^2) produced is 0.977 or its correlation coefficient, which is R, is 0.988. This explains that there is a very strong relationship or correlation between the value of the Pb concentration measurement results from Sentinel-2A data and the results of the laboratory data measurements. The resulting regression equation that represents the mathematical model for Pb concentration is y=33,757x – 1.1345. In this case, the variable p represents the potential Pb concentration as a result of laboratory measurements, while the variable q represents the potential Pb concentration measured in Sentinel-2A image pixels.

4. CONCLUSION

The resulting mathematical model for TSS is y=1.0213x – 0.2921 where the variable y represents the TSS measured by laboratory measurements while the variable x represents the TSS measured in Sentinel-2A image pixels. The mathematical model for the potential Pb concentration is p=33,757q – 1.1345 where the variable p represents the potential Pb concentration from laboratory measurements, while the variable q represents the potential Pb concentration measured in Sentinel-2A image pixels.

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