Mapping The Water Quality Status and Pollution Load of Seloatap River in Galengdowo Village, Wonosalam, Jombang

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Abstract. *Seloatap River is a creek of Brantas River passing through Galengdowo Village, Wonosalam District, Jombang Regency. The majority of people in this area work as farmer and cowman. Unfortunately, its waste of farming has not been well-managed yet. Therefore, a study on the status of river water quality by IP (Index of Pollution) method based on The Ministerial Decree of Environment No. 115 in 2003 and The Government Regulation No. 82 in 2001 is necessary. This research aimed at mapping the results of analyzing the water quality status and pollution load of Seloatap River. This research was carried out in three phases i.e. preliminary survey, river water sample collection, and data analysis. The preliminary survey was for investigating Galengdowo Village location, pollutant type entering the river, river location, and coordinate data collection when the water of Seloatap River was taken. Meanwhile, the sample collection aimed at investigating the pollutant contents that were tested by some parameters namely DO, pH, TSS, BOD, COD, and Total Ammonia (NH3-N). The last, data analysis was for analyzing the obtained data to yield a map. The results of research demonstrated that the calculation using IP method gained from 0.63 (fulfilled the quality standard) to 5.33 (medium pollution). Accordingly, the mapping process of pollution load and water quality status of Seloatap River indicated that this river was in polluted condition and had high pollution load resulted from farming sector.*

Keywords: *pollutant load, Index of Pollution (IP), STORET method, water quality status*

1. Introduction

Many sectors that depend on the water resources of the river, while on the other hand the condition of the river decreases caused by various kinds of sewage into water bodies resulting from a variety of activities / business, apart from the activity / business lack of understanding of environmental awareness and especially on the manner of use of water and waste disposal. Of course, this can cause water pollution in water resources and water bodies due to water contaminants that exceed the load receiving supportability [1-3]. Water pollution in question in this case is the introduction of living creatures, substances, energy, and or other components into the water by human activity so that the water quality drops to a certain level which causes the water no longer function in accordance with the designation [4-6].

Seloatap river is one of the tributaries of the Brantas River that passes through the village of Galengdowo. Galengdowo village is a village located in District Wonosalam Jombang. The village is located on the slopes of most of the population working Anjasmara as a cattle rancher and farmer [7]. Waste from farms located in the area is less well managed is therefore required an act to overcome these problems. Another example is from structural design based on the implementation of home product industry of cold-formed steel which is given a chemical ion concentration in the water [8-10].

Water quality management and water pollution control are expected to maintain the quality of water that can be utilized in accordance with Government Regulation No. 82 of 2001 [11]. Therefore it is necessary to do research on the status of river water quality by using IP (Pollution Index) to determine the contamination level relative to water quality parameters are permitted in accordance with the Environment Decree No. 115 of 2003 and the calculation of river water pollution load [12-13].

2. Literature study

2.1. Status of water quality

Status of Water Quality is the level of water quality conditions that indicate the condition of polluted or good condition at a water source in a given time by comparing water quality standards have been set [2]. Determination of the status of water quality is one of the initial steps in the process of monitoring and prevention of water quality deterioration. Determination of the status of water quality can be achieved by Pollution Index. In the Annex II of the Environment Decree No. 115 of 2003 proposes an index associated with the pollution compounds meaningful for an allotment. This index is expressed as Pollution Index (Pollution Index) which is used to determine the contamination level relative to water quality parameters are allowed [14]. Pollution Index or so-called IP is determined to a designation, then can be developed for some allotment for all parts of the water body or part of a river. The formula used is as follows:

$$IPj = \sqrt{\frac{\left(Ci/_{Lij}\right)2M+\left(Ci/_{Lij}\right)2R}{2}} \quad (1)$$

Description

IPj	:	Pollutant Index for designation
Ci	:	The concentration of water quality parameter survey results
Li	:	The concentration of quality parameters parameters included water quality standard designation (j)
(Ci/Lij)M	:	Value Ci / Lij Maximum
(Ci/Lij)R	:	Value Ci / Lij Average

Table 1. Determination of the score system IP method Calculation

Results	**Water Quality Status**
0 ≤ IP ≤ 1.0	Meets Quality Standards
1.0 <IP ≤ 5.0	Mild polluted
5.0 <IP ≤ 10	Medium polluted
IP> 10	heavy polluted

According to the PP RI No. 82 of 2001 the pollution load is the amount of a pollutant elements contained in water or wastewater. How pollutant load calculations based on measurements of river discharge and pollutant concentrations [15].

2.2. Load Pollution and water quality parameters

$$BP = Q \times C \quad (2)$$

Description

BP = Load Pollutants (ton / month)

Q = Debit River Water (m3 / s)

C = Concentration of Pollutants (mg / liter)

To obtain the pollutant load in tonnes / month it is necessary to perform the conversion in a way multiplied by 10- 6 x 3600 x 24 x 30.

Water quality is its nature and content of living creatures, substances, energy or other components in the water. Water quality also a term illustrates the sustaibility or suitability of water for a specific use, such as drinking water, fisheries, water / irrigation, industry recreation and many more.

Water quality is affected by three parameters: Physical parameters, ie the parameters that can be identified from the physical condition of the water. For example, color, odor, turbidity, temperature, TDS, and TSS.

a. Chemical parameters, ie chemical substances contained in the waste can result in losses that BOD, COD, acidity (pH), DO, nitrate, sulfate, Total Phosphate, Pb, Cu, and Hg.
b. Biological parameters, ie organisms and bacteria present in the water.

3. Research Methodology

Preliminary survey was conducted to determine village location Galengdowo, types of pollutants into the river, the location of the river, after the data obtained and data collection point coordinate water uptake seloatap river water samples.

Taking water samples done on water depth of 0.5 meters to 1.5 meters and held for 3 days and taken at the same time so as to form the data from time to time (time series data). River water samples to be tested in accordance with predetermined parameters, namely, DO, pH, Tss, BOD, COD, Total Ammonia (NH-3N). For DO parameter testing is done directly on the river Seloatap and parameters for TSS, BOD, COD, total ammonia and pH measurement is carried out in the Laboratory. Results of the Test Laboratory will be used to calculate the value of water quality status using Pollution Index (IP) and is used to determine the pollution load on the river Seloatap.

In this study aims to describe the mapping of river water conditions seloatap by creating a map of water quality status and pollution load. Stages mapping status of water quality and pollution loads using ArcGIS 10.3 software

4. Result and Discussion

4.1. River Water Sampling

Before making water samples first thing to do is determine the location or the point to be analyzed by considering the potentially polluting activity and ease of access when taking water samples. River water sampling carried out for 3 days and hours taken on this study were obtained 11 points with coordinates and direct measurements were taken to determine the width of the river, river depth and velocity of the river flow.

River flow velocity measurements done using buoys and stopwatch, to obtain meter / sec. Measurements width of a river, the depth of the river and the river flow rate used to calculate the value of discharge.

4.2. River Water Sampling

In this study using six parameters to determine the status of water quality, namely, TSS, DO, BOD, COD, total ammonia, pH. For DO analysis performed directly on the river Seloatap done by using the DO meter, while for pH analysis conducted at the Environmental Engineering Laboratory ITATS using a pH meter while for the measurement of TSS, DO, BOD and COD analysis conducted by Mitralab Buana.

Data from the analysis results will be used to determine the status of water quality by using method IP method,then in this study using the Indonesian Government Regulation No. 82 Year 2001 on Management and Control of Water Pollution as a reference and menganilis in all classes as stated in the regulation. From the measurement results obtained from the data as follows:

Table 2. Water Quality Criteria Based on Class

Standarized parameter					
Parameter	Unit	Class I	Class II	Class III	Class IV
TSS	mg/l	50	50	400	400
DO	mg/l	6	4	3	0
BOD	mg/l	2	3	6	12
COD	mg/l	10	25	50	100
Amonia Total	mg/l	0.5	-	-	-
pH	mg/l	6-9	6-9	6-9	6-9

Table 3. Result of Analysis Day-1

Point of Location	Parameter						
	TSS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Amonia Total (mg/l)	River Discharge (m3/s)
1	7.3	15.3	8	22.6	7.3	0.069	0.18
2	19.7	14.6	12	38.3	7.4	0.22	0.41
3	77.3	13.6	36	113.1	6.9	2.11	0.42
4	64.2	15	22	71	7.3	0.82	0.50
5	25.4	16.9	14	48.5	7.4	0.05	0.57
6	46.5	14.6	12	38.8	7.5	0.057	0.54
7	48	14.5	12	36.8	7.3	0.18	1.02
8	47	13.8	12	42	7.4	0.052	0.85
9	32.5	14.7	8	25.8	7.7	0.03	0.77
10	34.3	14.5	12	38.8	7.7	0.031	0.99
11	37.5	14.5	6	16.2	7.7	0.054	1.02

Table 4. Result of Analysis Day -2

Point of Location	Parameter						
	TSS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Amonia Total (mg/l)	River Discharge (m3/s)
1	8.2	14.6	10	30.5	7.3	0.08	0.18
2	25.5	14.8	16	52.7	7.6	0.5	0.43
3	80	10.5	42	150.2	6.3	2.56	0.47
4	70	13	28	100.8	6.9	1.21	0.77
5	36.5	15.1	17	62.7	7.1	0.8	1.02
6	52.3	13.4	14	48.5	7.4	0.5	0.54
7	55.2	13.1	13	44.5	7.3	0.5	1.02
8	54.8	12.6	12	43	7.4	0.3	1.70
9	45.5	13.3	12	38.8	7.5	0.05	0.77
10	46.2	13.5	13	44	7.5	0.05	0.99
11	48.3	13.5	10	19.5	7.5	0.08	2.04

Table 5. Result of Analysis Day-3

Point of Location	Parameter						
	TSS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	pH	Amonia Total (mg/l)	River Discharge (m3/s)
1	8	16	7	20.4	7.1	0.06	0.31
2	20.3	15.2	14	48.5	7.6	0.32	0.68
3	79.6	11.5	40	130.4	6.5	2.36	0.63
4	67.4	14	25	78.2	6.9	0.98	0.92
5	32.3	14.8	15	55.3	7.2	0.53	2.04
6	50.4	13.5	10	21.8	7.1	0.31	1.94
7	48.8	13.2	12	36.8	7.3	0.18	2.38
8	46.5	12.7	11	42	7.4	0.08	2.04
9	38.8	13.9	10	34.6	7.5	0.04	1.84
10	38.8	14.5	10	34.7	7.5	0.04	1.16
11	43.8	14.5	9	17.8	7.5	0.06	2.38

Results of the analysis for three days showed that the highest pollutant concentrations are at point 3 in all the parameters, it is influenced by the large number of farms which are located around Seloatap River.

4.3. Calculation Method Pollution Index (IP)

The determination of the status of water quality in this study using the method Pollution Index. This method is used by the Minister of Environment No. 115 of 2003 which states that the determination of the status of water quality in Indonesia using Storet and Index Pollution.

Table 6. Pollution Index (IP)

Point Location	Class I		Class II		Class III		Class IV	
	Score	status of water quality	Score	status of water quality	Score	status of water quality	Score	status of water quality
1	3,22	Mild polluted	2,56	Mild polluted	1,45	Mild polluted	0,50	Meet quality standards
2	3,89	Mild polluted	3,22	Mild polluted	2,07	Mild polluted	0,90	Meet quality standards
3	5,85	Medium polluted	5,06	Medium polluted	3,82	Mild polluted	2,67	Mild polluted
4	4,80	Mild polluted	3,88	Mild polluted	2,65	Mild polluted	1,51	Mild polluted
5	4,06	Mild polluted	3,38	Mild polluted	2,24	Mild polluted	1,10	Mild polluted
6	3,66	Mild polluted	2,99	Mild polluted	1,83	Mild polluted	0,71	Meet quality standards
7	3,73	Mild polluted	3,06	Mild polluted	1,88	Mild polluted	0,79	Meet quality standards
8	3,63	Mild polluted	2,98	Mild polluted	1,80	Mild polluted	0,71	Meet quality standards
9	3,20	Mild polluted	2,66	Mild polluted	1,53	Mild polluted	0,62	Meet quality standards

10	3,58	Mild polluted	2,93	Mild polluted	1,79	Mild polluted	0,72	Meet quality standards
11	3,23	Mild polluted	2,57	Mild polluted	1,47	Mild polluted	0,53	Meet quality standards

Description scores
$0 \leq IP \leq 1,0$ = Meet quality standards
$1,0 < IP \leq 5,0$ = Mild polluted
$5,0 < IP \leq 10$ = Medium polluted
$IP > 10$ = Heavy Polluted

From the results of the analysis in table 4.12. it is known that the status of class I river water quality at point 3 is in the medium polluted condition with a score of 5.85 while at other points the status of the water quality is in the mild polluted condition with a score of 3.22 - 4.80. On the status of river water quality class II at point 3 in the condition of Medium Pollution while with a score of 5.06 at other points in the condition of Light Pollution with a score of 2.56 - 3.88 this is because because point 3 has a high pollutant value than the other point . In class III, all points are in the mild polluted condition with a score of 1.45 - 3.82. In the status of river water quality class IV at points 3, 4, and 5 in mild polluted conditions with a score of 1.10 - 2.67, while at other points meet the quality standards with a score of 0.50 - 0.90.

4.4. Pollution Load

Analysis of the pollution load in the river do seloatap which is to eradicate river sub-basins. The purpose of the pollution load calculation is to measure the pollution load on the river Seloatap with each parameter with tonnes / month. Measurements carried out in all the pollution load a predetermined point.Pollution load is calculated using a formula according to Mitsch and Geoselink (1993) in Marganof et.al (2007) and to get the tons / month, the final result of pollution load converted to the value (1000 $\frac{m3}{liter}$ x 10^{-9} $\frac{ton}{mg}$ x (3600 x 24 x 30).

Table 7. Results of river pollution load

Parameter (mg/l)	Test Results Mean (ton/month)										
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Tss	7,83	21,83	78,97	67,20	31,40	49,73	50,67	49,43	38,93	39,77	43,20
BOD	8,33	14	39,33	25,00	15,33	12,00	12,33	11,67	10	11,67	8,33
COD	24,50	46,50	131,23	83,33	55,50	36,37	39,37	42,33	33,07	39,17	17,83
Amonia Total	0,07	0,35	2,34	1,00	0,46	0,29	0,29	0,14	0,04	0,04	0,06

Results seloatap river pollutant load of the river is known that the highest pollutant load averaged 3 segments, such as BOD parameters, which reached 39.33 tons / month, parameters COD 131.23 tons / month and parameters Ammonia total of 2.34 tons / month. value of pollution load affected by the amount of pollutant concentrations and discharge river water, high pollution load in three segments due to many the number of dairy farms / sources of pollution that are around the river seloatap this can be seen from the "map cattle ranches around the river seloatap".

4.4. Mapping Status of Water Quality and Pollution Charges

Mapping is a step that must be done in mapmaking. The initial step in the creation of data and then proceed with data processing and presentation in bentu map (Juhadi and Liesnoor, 2001). In this study mapping is done using software ArcGIS 10.3. Here are the results pembutan water quality status maps using ArcGIS Software 10.3

In this study, the data used in the process of making a map obtained dar Indonesia Geospatial Portal for data Map RBI Indonesia and then to coordinate point data taking water samples and data calculation of water quality status is the result of direct analysis. Data obtained are then processed into ArcGIS 10.3 software.

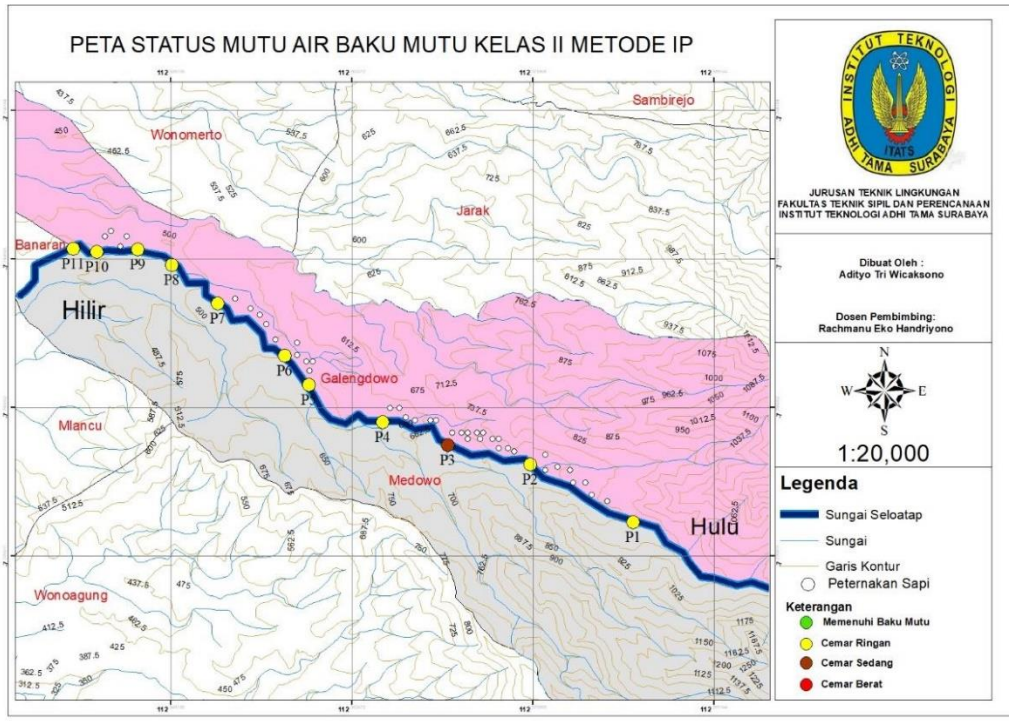

Figure 1. Map Status of Water Quality Class II

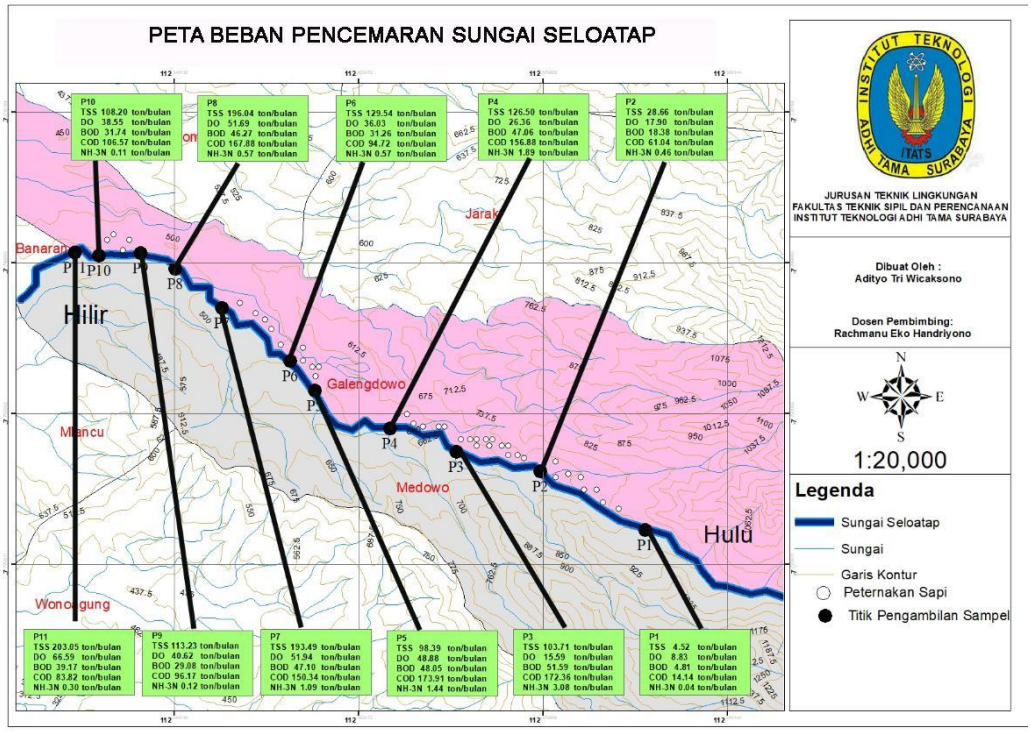

Figure 2. Pollution Load Map

5. Conclusion

Status of water quality based on the method Seloatap River Pollution Index (IP) is to meet quality standards, Mild polluted and being, as shown by the measurement results as follows:

a. Class I, the 3 segment seloatap polluted river conditions were with a score of 5.33, while the other segments seloatap Mild polluted river conditions with a score of 3.41 to 4.87.
b. Class II, in all segments seloatap Mild polluted river conditions with a score of 2.75 to 4.47.
c. Class II, in all segments seloatap Mild polluted river conditions with a score of 1.63 to 3.24.
d. Class IV, the segments 2,3, and 4 conditions seloatap Mild polluted river with a score of 1.79 to 2.09, while in other segments of the river conditions seloatap meet quality standards with a score of 0.03 - 0.90.

In addition of mapping status of water quality and pollution load in the river that have been done show that the river seloatap seloatap in polluted conditions and have a fairly high pollution load generated from the sector Ranch in the village Galengdowo, Wonosalam, Jombang, East Java.

References

[1] Effendi, Hefni. 2003. Water Quality Study: For Water Resources and Environmental Management. KANISIUS Publisher. Yogyakarta
[2] Hach, Clifford. C. R. L. Klein, Jr. C. R. Gibbs. 1997. Introduction to Biochemical Oxygen demand. Technival Information Series. No. 7. Hach Company. The USA
[3] Ministry of Environment. 2003. Guidelines for Determination of Water Quality Status. Decree of the Minister of Environment No. 115 of 2003.
[4] Marganof, Darusman LK, Riani E, Pramudya B. 2007. Analysis of pollution load, assimilation capacity and level of pollution in efforts to control water pollution in Lake Maninjau. Journal of Fisheries and Maritime Affairs. Vol.12, No, 1: 8-14.
[5] Government Regulation of the Republic of Indonesia. 2001. Water Quality Management and Water Pollution Control. Government Regulation Number 82 Year 2001.
[6] Priyambada IB, Oktiawan W, Suprapto RPE. 2008. Analysis of the effect of different land use functions on the river BOD pollution load (case study of the Serayu River in Central Java). Precipitation Journal. 5 (2): 55-62.
[7] Rahayu, Subekti., R. H. Widodo., M. van Noordwijk., I. Suryadi., B. Verbist. 2009. Monitoring of Water in Watersheds. World Agroforestry Center. Bogor.
[8] I. Komara, E. Wahyuni, P. Suprobo, A study on Cold-formed Steel Frame Connection: A review, IPTEK The journal for technology and science, 28, 3, 83-89 (2017).
[9] I. Komara, E. Wahyuni, P. Suprobo, T. Kivanc. Assessing the Tensile Capacity of Cold-Formed Steel Connections using Self-Drilling Screws and Adhesive Materials. IJASEIT. 8, 2, 397-404 (2018).
[10] Wahyuni, E., Suswanto, B., Komara, I. Effect of angle of inclination cables on the performance of submerged floating tunnel under hydrodynamic load. The 5th ETMC, Vol. 5, No.GC/015, pp. 3-11, 2015
[11] Salmin 2005. Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) As One Indicator To Determine Aquatic Quality. Oseana Journal, Volume XXX, Number 3: 21-26
[12] Simon SB, Hidayat R. 2008. Control of water source pollution with ecotechnology (artificial wetland). Journal of Water Resources. Vol.4, No.2: 111-124.
[13] Sofia Y, Tontowi, Rahayu S. 2010. Research on river water treatment that is polluted by organic matter. Journal of Water Resources. Vol.6, No.2: 145-160.
[14] Supangat, A. B. 2008. Effect of various Land Use on River Water Quality in the Pine Forest Area in Gombong, Kebumen, Central Java. Journal of Forest Research and Nature Conservation. Vol.5, No.3. 267-276
[15] Suwari, Riani E, Pramudya B, Djuwita I. 2010. Determination of Surabaya River Water Quality Status using the STORET Method and Pollution Index. Widya Scientific Magazine. Vol.27, No.297: 59-63.