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ANALISYS OF POLLUTION LOAD CAPACITY AT GLADAKSIKUR RIVER IN KALISAT REGION JEMBER DISTRICT

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ABSTRACT
Bedadung River has many tributaries, one of Gladaksikur Rivers. The tributaries have an important role to supply the water requirement. Therefore, it was necessary to measure pollution load capacity to determine the ability of the river to receive pollution load. Measurement of pollution load capacity can be solved by modeling using Streeter-Phelps method. Data for Streeter-Phelps modeling were discharged, dissolved oxygen (DO), and biological oxygen demand (BOD). The result of the research showed that Gladaksikur River had the biggest DO of 7.07 mg/l and BOD of 0.785 mg/l. The largest pollution load on the Gladaksikur River was in the fifth point of 110.92 kg/day. The pollution load of the Gladaksikur River was below maximum tolerated.The Gladaksikur River have an average BOD, deoxygenation rate, reaeration rate, critical point, critical distance and critical oxygen deficit, for all of parameters above were 0.602 mg/l, 0.056 mg/l.day, 6.351 mg/l.day, 0.451 day, 8,406 km, and 0,040 mg/l respectively. From the Streeter-Phelps modelling it can be stated that average re-aeration rate of 6,351 mg/l.day and de-oxygenation rate of 0,056 mg/l.day, the pollution load capacity of Gladaksikur River is still able to accept BOD load. The maximum BOD load that was allowed on the Gladaksikur River was 92.4 mg/l.

Keywords: River, Pollution Load, Pollution Load Capacity, Streeter-Phelps

INTRODUCTION

Watershed is the area that is confined by mountain or mountain ridges where rainwater in that area will flow into the main river. The flow in watershed comes from runoff at soil surface, trences, small river, and main river (Triatmodjo, 2013:7). One of the watersheds in JemberDistric was Bedadung Watershed. Bedadung River has many tributaries, some of this which is Gladaksikur River. These tributaries have an important role to supply the water requirement. The human activity will produce domestic waste and agricultural runoff. Therefore, it was necessary to measure pollution load capacity to determine the ability of the river to receive pollution load.

The aim of this research was to examine the condition of water quality in rivers based on the dissolved oxygen and biological oxygen demand parameters, calculate the pollution load,

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and pollution load capacity of Gladaksikur River. Measurement of pollution load capacity can be solved by using Streeter-Phelps method. Data for Streeter-Phelps modelling were discharged, dissolved oxygen (DO), and biological oxygen demand (BOD) were monitored.

MATERIALS AND METHODS

Place and Time of Research

Experiment were conducted at the Gladaksikur River Kalisat Region, Jember District and Environmental and Conservation Management Laboratory Agricultural Engineering, Department of Agricultural Engineering, Faculty of Agricultural Technology, University of Jember from January to April 2017.

Materials and Tools of The Research

The materials used are river water samples, aquades, Mangan Sulfate solution 36.4%, Alkali Iodide Azida 66%, 98% Concentrated Sulfuric Acid, Sodium Tiosulfate 0.025 N, and starch Indicators. Tools used in this research included current meter, rollmeter, cool box, pegs, raffia straps, winkler bottle, burette, volumetric pipette, erlenmeyer, injection pipette, suction ball, and funnel.

Location and Segmentation

The location was selected by dividing the river into five segments and six sampling points with the same distance. The same distance was selected based on pollutant sources at the river thatnon-point sources.

Measurement of Discharge

Measurement of discharge was done by using profile method (cross section). Existing data were wet cross-sectional area, current flow, and discharge.

Sampling

Sampling was done by using grap sampling method at some point. The samples that have been taken are preserved by using coolbox.

Measurements of DO, BOD, and Temperature

Measurements of DO and BOD used the winkler method, while the temperature measurement was carried out by using a thermometer.

Data Analysis

The data analysis included determination of water quality condition based on DO and BOD parameters, and pollution load capacity using Streeter-Phelps method.

RESULT AND DISCUSSION

Quality of River Water

The measurement of water quality parameters was dissolved oxygen (DO) and biological oxygen demand (BOD). From the measurements made in both rivers the results was shown in Table 1.

Table 1. Result of Measurement of BOD and BOD

Point	Gladaksikur River			
	r_R mg/l.h	r_D mg/l.h	DO (mg/l)	BOD (mg/l)
1	2,367	0,064	6,30	0,667
2	11,732	0,059	6,36	0,628
3	13,502	0,048	6,56	0,510
4	8,813	0,047	6,54	0,510
5	4,634	0,071	5,99	0,785
6	6,922	0,046	6,36	0,510
Average	6,351	0,056	6,35	0,602

On the Gladaksikur River, the largest DO at the third point of 6.56 mg/l and the largest BOD at the fifth point of 0.785 mg/l. From Table 1, it can be made the relation of re-aeration rate, de-oxygenation rate, DO, and BOD of Gladaksikur River as shown in Figure 1.

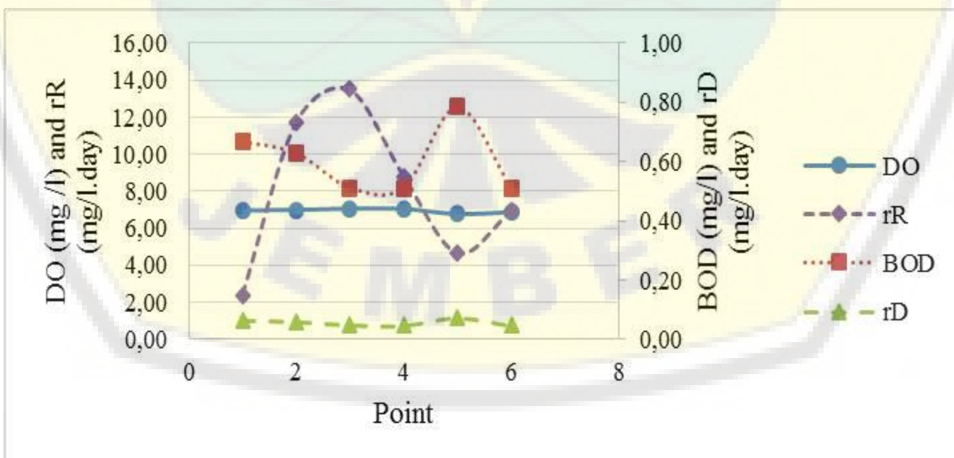

Figure 1. Relation of Reaeration Rate, Deoxygenation Rate, DO, andBOD at River Gladaksikur

According to the Figure 1, the DO does a straight line with the re-aeration rate and inversely proportional to the BOD and de-oxygenation rate. The increase of DO was caused by the re-aeration in the river while the decline of DO was caused by pollutant input into the

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river. Organic pollutants can be oxidized by aerobic bacteria in the river using dissolved oxygen, so the DO decreases and the BOD increases. This is in accordance with the statement of Alaerts and Santika (1987: 160) which states that BOD was formed over the oxidation reaction of organic substances with oxygen in water.

The Gladaksikur River had smallest DO and the largest BOD at the fifth point. This indicates that the fifth point occurs pollutant input. Pollutants that enter the river come from domestic waste. Location of the fifth point on the Gladaksikur River was located after the settlement. Pollutants from domestic waste will cause the decrease in DO while the BOD increases. This was in accordance with the research of Hera et al. (2012) which states that the more residential areas, the pollution on the river was greater. When the organic substance was exhausted then the re-aeration rate will be greater than the de-oxygenation rates while the BOD decreases and DO increases again at the sixth point.

Pollution Load

The pollution load was influenced by discharge and pollutant in the river. The pollutant load on the Gladaksikur River comes from non-point source so the pollution measurements are carried out directly on the river. The results of discharge measurements and pollution load calculations on the Gladaksikur River are presented in Table 2.

Based on Table 2, it was known that the largest pollution load on the Gladaksikur River was at the fifth point of 110.92 kg/day. The relationship of discharge, BOD, and pollution load was presented in Figure 2.

Table 2 Discharge, BOD, and Pollution Load at Gladaksikur River

Point	**Gladaksikur River**		
	Discharge (m^3/s)	**BOD (mg/l)**	**Pollution Load (kg/day)**
1	1,23	0,667	70,84
2	1,53	0,628	83,15
3	1,60	0,510	70,59
4	1,65	0,510	72,57
5	1,63	0,785	110,92
6	1,71	0,510	75,25
Average	1.56	0.602	80.55

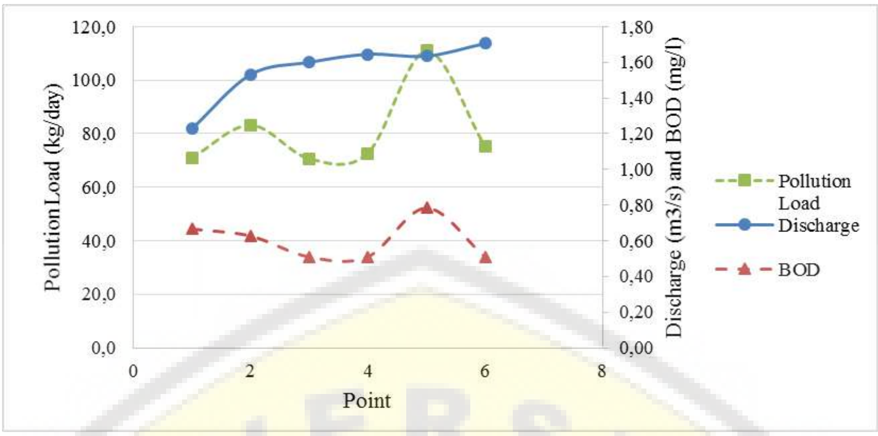


Figure 2. Relation of Discharge, BOD, and Pollution Load

Based on Figure 2, it can be known that discharge on the Gladaksikur River increased from the first point to the sixth point. This was caused by the input of water from agriculture or from underground water that cannot be detected. In addition, it is also known the relationship between discharge and BOD to calculate pollution load.

Pollution Load Capacity Base on Streeter-Phelps Equation

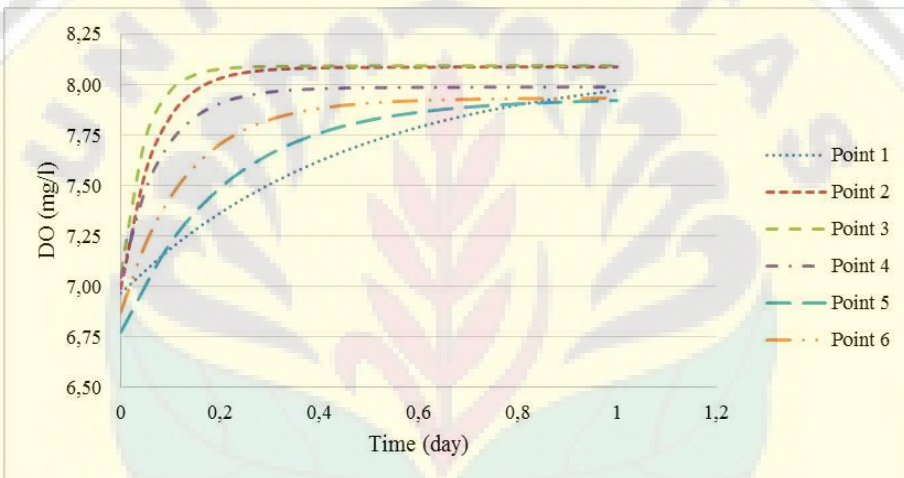
The pollutant source on the Gladaksikur River was non-point source. In the research area, pollutant sources come from domestic and agricultural waste. Some parameters to determine the pollution load capacity according to the Streeter-Phleps equation, were de-oxygenation rate (rD), re-aeration rate (rR), time reaches critical point (tc), distance reaches critical point (xc), and critical oxygen deficit (Dc) presented in Table 3.

Table 3. Parameters to Determination of Pollution Load Capacity at the Gladaksikur River

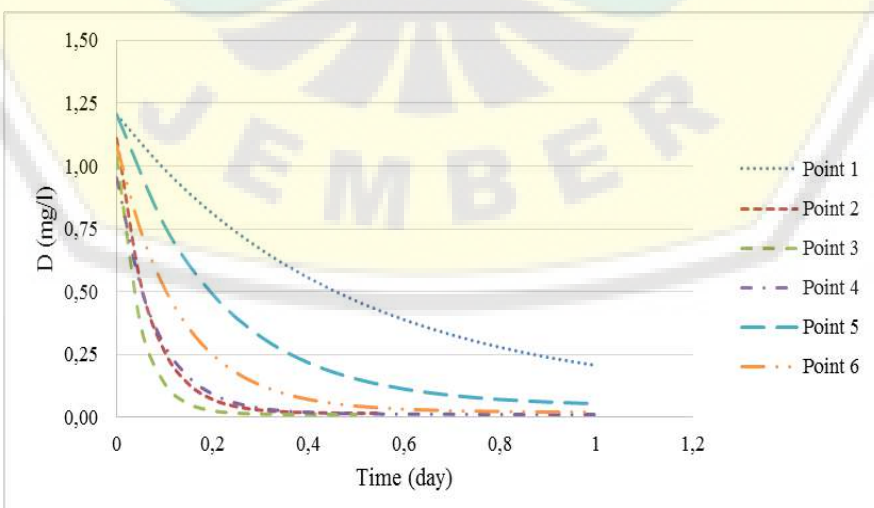
Point	r_D	r_R	tc	xc	Dc
	mg/ l.day	mg/ l.day	day	km	mg/l
1	0,064	2,367	0,878	1,397	0,097
2	0,059	11,732	0,283	0,390	0,020
3	0,048	13,502	0,250	0,241	0,013
4	0,047	8,813	0,320	0,633	0,019
5	0,071	4,634	0,549	0,668	0,065
6	0,046	6,922	0,426	0,521	0,026
Average	0,056	6,351	0,512	0,752	0,045

The de-oxygenationrate was influenced by BOD and bacteria in the river. The re-aeration rate was influenced by flow velocity and water level. The re-aeration rate was proportional to the flow rate and inversely proportional to the water level. A greater flow rate will increase the re-aeration rate while the greater of water level will be a little re-aeration that caused the smaller re-aeration rate. Based on the data presented in Table 3, it can be made oxygen sag curve and deficit oxygen sag curve as shown in Figure 3.

Based on Figure 3, it was known that the third point was faster achieving DO saturation. This was caused by re-aeration rate at the third point was greater than the other point. The pollution load of the Gladaksikur River was below maximum tolerated.The curve in Figure 3 showed that DO continuously increasing for a certain time to approach DO saturation while the oxygen deficit was getting smaller.In this conditions belong to the recovery zone. The decrease of oxygen deficit was caused by the re-aeration in the river that causes oxygen to increase and the oxygen deficit decreases. From the six sampling points in the Gladaksikur River can be obtained the average value to determine the pollution load capacity.



(a) Oxygen Sag Curve



(b) Deficit Oxygen Sag Curve

Figure 3. Oxygen Sag Curve and Deficit Oxygen Sag Curve at Gladaksikur River

DO sag curve and deficit oxygen sag curve The Gladasikur River was presented in Figure 4. Based on Figure 4 it can be known that DO not decreased because the pollution load capacity was still able to accommodate the BOD load. In the Gladaksikur River with an average of BOD of 0.602 mg/l, the de-oxygenation rate of 0.056 mg/l.day, and the re-aeration rate of 6.351 mg/l.day will reach critical oxygen deficit for 0.438 days, with a distance of 0.626 km, and an oxygen deficit of 0.034 mg/l.

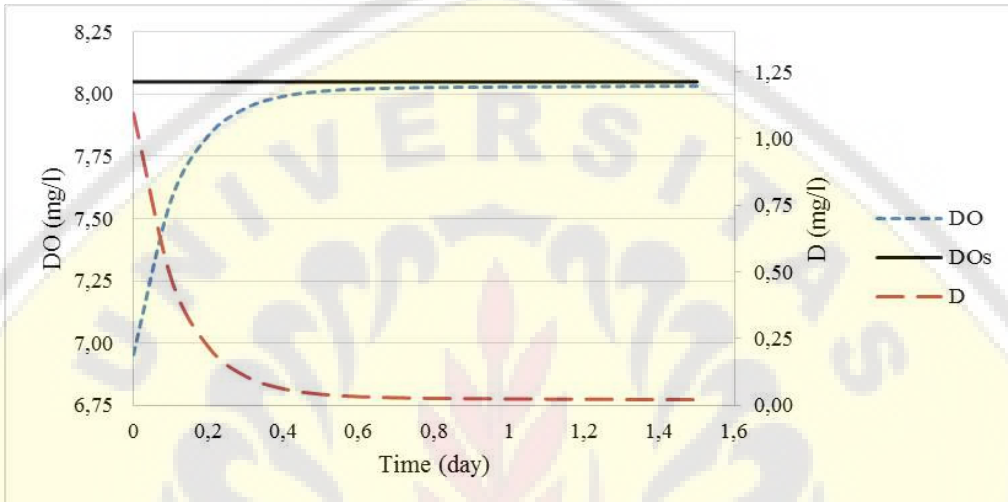


Figure 4. DO Sag Curve and Deficit Oxygen Sag Curve at Gladaksikur River

From the modeling using the Streeter-Phelps equation, it was known that the maximum allowed load on the Gladaksikur River. Gladaksikur River used for daily activities such as bathing, washing, and other activities, so the maximum capacity determination uses second class water quality according to Goverment regulation No. 82/2001 with a minimum DO of 4 mg/l. From the calculation, on Gladaksikur River obtained maximum allowable BOD load that was equal to 92.4 mg/l with minimum DO model that was 4 mg/l. The maximum load modeling results are presented in Figure 5.

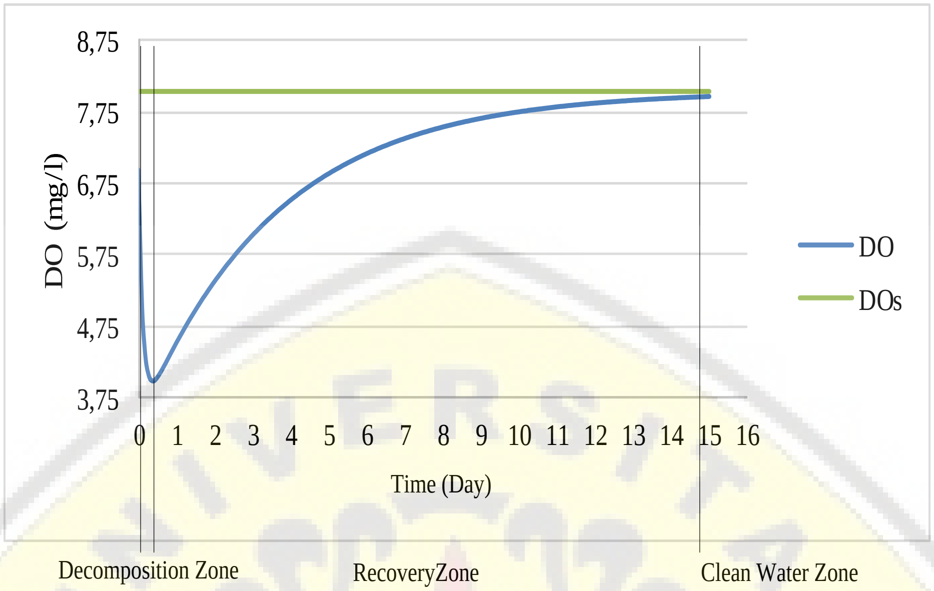


Figure 5. Maximum of Pollution Load at Gladaksikur River

Based on Figure 5, it was known that from day 0 to reach a critical point including into decomposition zone where organic pollutants will be oxidized by aerobic bacteria using dissolved oxygen and DO decreases. If the BOD was exhausted, it will be entered into the recovery zone until it approaches the DO saturation and reaches the clean water zone for 15 days.

CONCLUSIONS

Based on the results and discussion can be concluded as follows:

1. Gladaksikur River has the largest DO at the third point of 6.56 mg/l and the largest BOD on the fifth point of 0.785 mg/l.
2. The largest pollution load on Gladaksikur River occurred at the fifth point of 110,92 kg/day.
3. With the average reaeration rate of 6,351 mg/l.day and deoxygenation rate of 0,056 mg/l.day, thepollution load capacity of Gladaksikur River still able to accept BOD load. The maximum BOD load that allowed on the Gladaksikur River was 92.4 mg/l.

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