Load Capacity of Water Pollution of Jaing River in Tabalong

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Abstract—Jaing River is part of the 39 km long Barito watershed in South Kalimantan which disembogues into Tabalong River. Jaing River is classified as class I (one) river that is designated as a source of drinking water. The large number of activities in the bank of the river has a potential to reduce the quality of the river. Field observations revealed that some activities created several pollutions and also run off of production waste into the river. Thus, the purpose of this study was to analyze the load capacity of pollution of Jaing River. The study was carried out in Jaing River as far as 39 Km in Tabalong Regency and the river water quality was analyzed at 3 sampling points using physical, chemical and biological parameters. The analysis of quality and determination of load capacity of water pollution used Mass Balance Method. Finally, the results obtained from this study are (1) the BOD pollutant load value of 418.87 kg/day, the value of COD pollution load of 2018.90 kg/day and the value of TSS pollution load of 1698.14 kg/day. (2) The value of pollution load capacity (DTBP) for BOD parameters is 246.07 kg/day, COD parameters are 1154.90 kg/day and for the TSS parameters are 2621.86 kg/day.

Keywords—Jaing River, load capacity of pollution, mass balance method.

I. INTRODUCTION

The rapid development in Tabalong Regency has a significant impact, both positive and negative. The river becomes the media that received this impact as a result of the intense exploration of natural resources.

Sahabuddin et al (2014) stated that the input of waste to the environment from human activities without regarding to the ability of supporting capacity and load capacity of the environment causes a negative influence on the quality of ecosystems either physical, chemical or biological as well as the sustainability of the aquatic environment.

The life of the people of Tabalong Regency cannot be separated from the existence of river; most of them use river water as a source of clean water. Jaing River is one of the rivers that pass in Tabalong Regency with a length of 39 km which disembogues into Tabalong River. The Jaing watershed has an area of ± 298 km² as parts of the Barito watershed in South Kalimantan. Jaing River is classified as class I (one) river that is designated as a source of drinking water and other purposes which require the same quality (Tabalong Regency Environmental Agency, 2017).

Transfer of land functions is quite large around Jaing River watersheds, for land clearing of coal mining sector, oil and gas sector, industrial sector, plantation and agriculture sector. The large number of these activities causes the river potentially experiences a decline in quality. Data from the Tabalong Regency Environmental Service stated that the water quality of Jaing River has decreased every year. Field observations show that some activities have the potential to incorporate pollutants into the Jaing River which is likely to dispose of production waste directly or run off of production waste into the river. Sources of run off pollutants tend to be difficult to control because they are scattered.

Pollution is the entry or inclusion of living things, substances, energy, and/or other components into the environment, or it also means changes in the environment by human activities or natural processes so that the quality of the environment drops to a certain level which causes the environment to become less or unable to function anymore in accordance with its designation. Pollutant sources or pollutants are substances or materials that can cause pollution to the environment either pollution of water, air, soil or others. If it is true that there is a decrease in the quality of Jaing River water, of course this will bring many problems that arise for the community around the banks of the Jaing River, both in terms of the level of health and quality of life of the community. Based on this problem, the purpose of this study is to analyze the load capacity of water pollution of Jaing River.
II. LITERATURE REVIEW

Water Pollution and Pollution Sources

Effendi (2003) said that pollution loads (pollutants) are materials that are foreign to nature or materials that originate from nature itself that enter an ecosystem order that disrupts the designation of the ecosystem. In contrast to Effendi, Suratmo defined water pollution as starting from a certain concentration of pollutants in water for a long time which is able to cause certain influences (Sahabuddin, Hartina, Harisuseno, & Yuliani, 2014).

Water pollution is a result of human activities and actions, which are motivated by various things. Because of pollution, the environmental management of the water is disrupted. Water ecosystems become polluted and damaged after receiving the presence of contaminants originating from humans by their actions (Susila, 2011). Water pollution can occur intentionally or unintentionally from human activities in a water that has been clearly designated (Herlambang, 2006).

Manan (1977) stated that river water quality problems are mainly caused by sediment content in river water due to erosion in the watershed, especially in the upstream. Water quality is the level of suitability of water for certain uses in meeting the needs of human life, starting from water to meet immediate needs, namely drinking water, bathing and washing, irrigation water or agriculture, livestock, recreation and transportation.

Capacity of Pollution Load

The terminology of environmental capacity in regulation in Indonesia is usually carried out with environmental supporting capacity. Environmental supporting capacity is the ability of the environment to support human life, other living things, and the balance between the two things. Meanwhile, the capacity of the environment is the ability of the environment to absorb substances, energy, and/or other components that enter or are inserted into it (Abdi et al., 2010).

In terms of load capacity of the pollution refers to the Decree of the Minister of Environment Number 110 of 2003, it is the ability of water in a water source to receive input from pollutant loads without causing the water to become polluted. The pollution load itself is the amount of a pollutant contained in water or waste water (Sahabuddin et al., 2014).

There are 2 (two) calculation methods used in determining the load capacity of water pollution on water sources, namely (1) Mass Balance Method and (2) Streeter-Phelps Method.

III. STUDY METHODS

A. Place and Time of Study

The study area was carried out in Jaing River as far as 39 Km in Tabalong Regency, South Kalimantan Province by dividing it into 3 (three) segments, namely upstream, middle and downstream. The sampling location can be seen in Table 1 below.

Table 1. Locations of Water Quality Sampling in Jaing River

<table>
<thead>
<tr>
<th>Segment</th>
<th>Location</th>
<th>Latitude (S)</th>
<th>Longitude (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>upstream</td>
<td>Pangelak Village, Upau District</td>
<td>02°04'21.1</td>
<td>115°37'25.4</td>
</tr>
<tr>
<td>middle</td>
<td>Kasiau Village, MurungPudak District</td>
<td>02°07'41.6</td>
<td>115°27'20.1</td>
</tr>
<tr>
<td>downstream</td>
<td>Masukau Village, MurungPudak District</td>
<td>02°07'05.9</td>
<td>115°25'21.7</td>
</tr>
</tbody>
</table>
The time for conducting this study was 4 (four) months, namely from January to April 2019 and the river water sampling period took place 3 (three) times starting from February to March.

The parameters analyzed include physics, chemistry and microbiology parameters with the analytical method adjusted for the parameters studied as shown in the following table.

**Table 2. Physical, chemical, water biology parameters and their analytical methods**

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Analysis Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Temperature</td>
<td>°C</td>
<td>SNI 06-6989.23-2005</td>
</tr>
<tr>
<td>2</td>
<td>pH</td>
<td></td>
<td>SNI 06-6989.11-2004</td>
</tr>
<tr>
<td>3</td>
<td>DHL</td>
<td>μmhos/cm</td>
<td>SNI 06-6989.1-2004</td>
</tr>
<tr>
<td>4</td>
<td>Dissolved Oxygen (DO)</td>
<td>mg/L</td>
<td>SNI 06-6989.14-2004</td>
</tr>
<tr>
<td></td>
<td><strong>Laboratory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Suspended Solid</td>
<td>mg/L</td>
<td>SNI 06-6989.3.2004</td>
</tr>
<tr>
<td>6</td>
<td>BOD</td>
<td>mg/L</td>
<td>SNI 6989.72-2009</td>
</tr>
<tr>
<td>7</td>
<td>COD</td>
<td>mg/L</td>
<td>SNI 6989.2-2009</td>
</tr>
<tr>
<td>8</td>
<td>Phosphate</td>
<td>mg/L</td>
<td>SNI 06-6989.31-2005</td>
</tr>
<tr>
<td>9</td>
<td>Fecal Coliform</td>
<td>mg/L</td>
<td>MP N</td>
</tr>
<tr>
<td>10</td>
<td>Total Coliform</td>
<td>mg/L</td>
<td>MP N</td>
</tr>
</tbody>
</table>
B. Determination Analysis of Load Capacity of Jaing River Pollution

Analysis of capacity determination is carried out by the Mass Balance method.

\[ C_R = \frac{\sum C_i Q_i}{\sum Q_i} = \frac{\sum M_i}{\sum Q_i} \] ................................ (1)

Where:
- \( C_R \) = The average concentration of constituents for the combined flow
- \( C_i \) = Concentration of constituents in the i-th flow
- \( Q_i \) = i-th flow rate
- \( M_i \) = Constituent mass in the i-th flow

To determine the load capacity using the Mass Balance Method, the steps that must be taken are as follows:
1. Measuring the concentration of each constituent and the flow rate in the stream before mixing with pollutant sources,
2. Measuring the concentration of each constituent and the flow rate in each pollutant source stream,
3. Determine the average concentration in the final flow after the flow mixes with the pollutant source by calculating:

\[ C_R = \frac{\sum C_i Q_i}{\sum Q_i} = \frac{\sum M_i}{\sum Q_i} \] ................................ (2)

In another source, the method for calculating pollution load was based on measurements of river water flow and river waste concentration based on the equations of Mitsch and Goesselink (1993) in Appendix II of the Regulation of the Minister of Environment No. 1 of 2010.

\[ BPs = Qs \times Cs (j) \times f \] ................................ (3)

Pollution load capacity (DTBP) can be determined using the following equation:

\[ DTBP = \text{Pollution Load According to Quality Standards - Measured Load Pollution} \]

IV. RESULTS AND DISCUSSION

The analysis of the calculation of pollution load capacity (DTBP) of river water is carried out on 3 (three) parameters, namely BOD (Biological Oxygen Requirement), COD (Chemical Oxygen Requirement) and TSS (Total Suspended Solids). The selection of pollution load capacity parameters (DTBP) is based on the key parameters for the representativeness of Jaing River water quality conditions while also representing the dominant source in Jaing watershed.

Calculation of pollution load capacity (DTBP) of river water shows the amount of existing or actual pollutant load currently entering the river flow. In addition, it also showed the amount of pollution load allowed to enter as well as the amount of pollution load that needs to be lowered or the allocation of pollution loads so that the improvement of the quality of the water for these parameters can be achieved.

A. Inventory and Identification of Pollution Loads in Jaing River

Output from the process of inventory and identification of pollutant sources is the amount of pollutant load estimated to be produced by pollutant sources entering into the river flow that potentially enters and pollutes. The results of the inventory and identification of pollution loads entering Jaing River are shown in the following table 3.

<table>
<thead>
<tr>
<th>No.</th>
<th>Sector</th>
<th>Existing BOD (kg/day)</th>
<th>Existing COD (kg/day)</th>
<th>Existing TSS (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mining</td>
<td>-</td>
<td>-</td>
<td>4868.51</td>
</tr>
<tr>
<td>2</td>
<td>Oil and Gas</td>
<td>1.665</td>
<td>2.978</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Rubber Industry</td>
<td>6.915</td>
<td>15.543</td>
<td>15.543</td>
</tr>
<tr>
<td>4</td>
<td>Agriculture</td>
<td>263.12</td>
<td>-</td>
<td>0.35</td>
</tr>
<tr>
<td>5</td>
<td>Farm</td>
<td>56.84</td>
<td>137.76</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Fishery</td>
<td>0.136</td>
<td>0.203</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Waste</td>
<td>28.731</td>
<td>43.096</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Household</td>
<td>930.656</td>
<td>1279.652</td>
<td>884.123</td>
</tr>
</tbody>
</table>
Table 3 shows the value of pollution load from pollutant sources that enter Jaing River flow is a cumulative pollution load from 2 (two) Districts crossed by Jaing River namely MurungPudak District and Upau District. The results of the calculation of the pollution load above shows for the BOD parameter that household activities are the highest contributors to pollutants than other types of activities, then agricultural and livestock activities generally contribute to the second and third pollutant loads. Meanwhile, the waste sector makes a fourth contribution. The smallest contributor is fishery activities, for the exception of mining activities because the data obtained by mining activities do not produce types of waste with BOD parameters.

The results of the calculation of pollution load for COD parameters indicate that household activities are the highest contributors to pollutants than other types of activities, and then livestock activities and general waste contribute to the second and third pollutant loads. Meanwhile, the rubber and oil and gas industry sector contribute the fourth and fifth. The smallest contributor is fishery activities, for the exception of mining activities because the data obtained by mining activities do not produce types of waste with BOD parameters.

Table 4 shows the value of pollution load from pollutant sources that enter Jaing River flow is a cumulative pollution load from 2 (two) Districts crossed by Jaing River namely MurungPudak District and Upau District. The results of the calculation of the pollution load above shows for the BOD parameter that household activities are the highest contributors to pollutants than other types of activities, then agricultural and livestock activities generally contribute to the second and third pollutant loads. Meanwhile, the waste sector makes a fourth contribution. The smallest contributor is fishery activities, for the exception of mining activities because the data obtained by mining activities do not produce types of waste with BOD parameters.

TSS parameters from the calculation of pollution load shows that there are only 4 (four) sectors that contributed to pollution costs, the highest pollutant contributor is mining activities, then household activities and the rubber industry generally contribute the second and third pollutant loads. Meanwhile, the smallest contributor is agricultural activities.

B. Determination of Load Capacity of Water Pollution of Jaing River

Determination of load capacity of water pollution (DTBP) of Jaing River uses the Mass Balance method. Jaing River is divided into 3 (three) parts, namely upstream, middle and downstream parts. The section describes the existing points and conditions of Jaing River. The data used for this method uses water quality results for BOD, COD and TSS parameters. In addition to water sampling for water quality, river flow measurements are also carried out in 3 (three) sampling points.

Table 4. Calculation of Load Capacity of Pollution (DTBP) in Jaing River with Mass Balance Method

<table>
<thead>
<tr>
<th>Pollutant Load (kg/day)</th>
<th>BOD</th>
<th>COD</th>
<th>TSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jaing River</td>
<td>418.87</td>
<td>2018.90</td>
<td>1698.14</td>
</tr>
<tr>
<td>Quality Standard (Class 1) mg/L</td>
<td>2</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Quality Standard (Class 1) (kg/day)</td>
<td>172.8</td>
<td>864</td>
<td>4320</td>
</tr>
<tr>
<td>DTBP (kg/day)</td>
<td>-246.07</td>
<td>-1154.90</td>
<td>2621.86</td>
</tr>
</tbody>
</table>

Table 4 shows that the BOD and COD concentrations in all sampling points in Jaing River have passed the Class I (one) water quality standard, so it can be said that the Load Capacity of Pollution (DTBP) of Jaing River has passed BOD and COD parameters. The results of calculations using the mass balance method show that the total BOD pollutant load that has entered the Jaing River from upstream to downstream is estimated at 418.87 kg/day which is distributed almost evenly in 3 (three) segments. Furthermore, the total COD pollution load that has entered the Jaing River from upstream to downstream is estimated at 2018.90 kg/day and the total TSS pollution load that has also entered Jaing River from upstream to downstream is estimated at 1698.14 kg/day.

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Based on the South Kalimantan Governor's Regulation No. 5 of 2007 concerning Allotment and Quality Standards of River Water shows the load capacity of pollution (DTBP) of Jaing River water at three monitoring points for BOD and COD parameters (Table 29) has exceeded Class I Water Quality Standards (one) even it has no more capacity. The exceeded value of load capacity of pollution (DTBP) of the river for BOD parameters is 246.07 kg/day and the COD parameter is 1154.90 kg/day. For TSS parameters in Jaing River it still has capacity or is still within the limits of Class I (one) Water Quality Standards which are permitted according to established regulations which are equal to 2621.86 kg/day.

V. CONCLUSION

Based on the results of study and analysis, it can be concluded that the Load Capacity of Pollution (DTBP) of Jaing River Water for BOD and COD has exceeded Class I parameters (one) Water Quality Standard and even it has no more capacity. The exceeded value of the load capacity of pollution (DTBP) of Jaing River for BOD parameters is 246.07 kg/day and the COD parameter is 1154.90 kg/day. The TSS parameters that are permitted according to established regulations are equal to 2621.86 kg/day.

VI. SUGGESTION

For the Government of Tabalong Regency, the results of this study can be used for programs and activities for Jaing River pollution control as the development of
integrated sanitation system, animal manure processing system, and waste infrastructure.

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