DETERMINING RIVER WATER QUALITY STATUS BASED ON THE POLLUTION INDEX METHOD AS CONTROL OF ENVIRONMENTAL QUALITY (Case Study In The Wanggu River, Kendari City)

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ABSTRACT

The rapid pace of development in Kendari has had an inevitable negative impact on environmental quality, including water quality degradation in Wanggu River. River water quality degradation is influenced by anthropogenic activities such as felling trees for land clearing, agricultural waste, and disposal of organic and inorganic waste into river bodies. These activities certainly affect the decline in the water quality of Wanggu River. This study aims to determine the water quality status of Wanggu River based on the pollution index method. This study was conducted in September - October 2019. To find out the water sampling points, the stations were determined, namely station I, station II, and station III using the observation method. Water samples at the three stations were tested for water quality at Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Halu Oleo University, to analyze physical parameters (temperature, TDS, and TSS), chemical parameters (pH, DO, BOD, COD, Nitrate, Nitrite, Oil and Fat, Detergent), and Microbiological Parameters (Total Coliform). Determination of the water quality of Wanggu River was carried out using Pollution Index Method. Based on the results of the Analysis of Pollution Index Method, the water samples from Wanggu River at stations I, II, and III obtained pollution index values of 1.62, 1.79, and 1.73 respectively. Therefore, pollution index of Wanggu River at the three stations was at a lightly polluted quality status. In addition, some parameters that did not meet quality standards included chemical parameters, namely Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO), so that the water quality status of Wanggu River was classified as lightly polluted based on class 3 (three) water quality standards set by Government Regulation No. 82 of 2001.

Keywords*: Wanggu River, Water Quality, Environmental Quality, Pollution Index*

INTRODUCTION

Water is an essential natural resource for people's life and other living things since there is no one or thing that can live without water. Water utilization that is not carried out properly and is not in accordance with the environment can cause a decrease in water quality. The availability of clean water for the community and protection of water sources are currently still major problems. Protection of springs is one of the efforts in the drinking water supply system to maintain the source of raw water for drinking water so as not to change the quantity and quality of water from the spring (Sarbini, 2014).

River is basically one of the natural resources that has a multipurpose function for human life and livelihood. The river functions as a source of drinking water, a means of transportation, a source of irrigation, fisheries and so on. Due to human activities as well as industrial growth which can cause environmental degradation, rivers are vulnerable to water pollution (Soemarwoto, 2003).

According to Government Regulation No. 38 of 2011 on River mentions that rivers are grooves or natural and/or artificial water containers in the form of water drainage networks and water in them, ranging from upstream to estuary, with bounded right and left by border lines. Rivers can also be used for living things. Thus, without proper management, water utilization can have a negative impact on water resources, one of which is a decrease in water quality. It can cause disturbance and damage that can endanger lives that depend on water resources.

Furthermore, river water pollution is very much determined by the activities and utilization of water resources by humans in the area of the river. Article 1 paragraph 11 Government Regulation No. 82 of 2001 defines water pollution as a condition wherein creature, substance, energy and/or other components come into water or are supplied into water by human activities. Consequently, water quality decreases to a certain level which make water unable to function in accordance with its allocation. Meanwhile, evaluation and monitoring of the quality status and environmental conditions of water sources need to be done at any time. In fact, it experiences an issue of changes in the quality and environment of clean water sources, as well as factors that affect changes in water quality and its environment, such as development in Indonesia which is increasingly rapid, having an inevitable negative impact on water quality degradation (Effendi, 2003).

River water quality degradation is influenced by anthropogenic activities, including felling trees for land clearing, agricultural waste, and disposal of organic and inorganic waste into river bodies. Those activities certainly affect the decline in the water quality of Wanggu River. Therefore, it is necessary to carry out a study on Determining River Water Quality Status Based On The Pollution Index Method As Control Of Environmental Quality (Case Study In The Wanggu River, Kendari City), so that the status of the water quality in Wanggu River can be known.

METHODS

This study was conducted in two locations: Wanggu River, Kendari, Southeast Sulawesi for water sampling and Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Universitas Halu Oleo. It was carried out from September to October 2019.

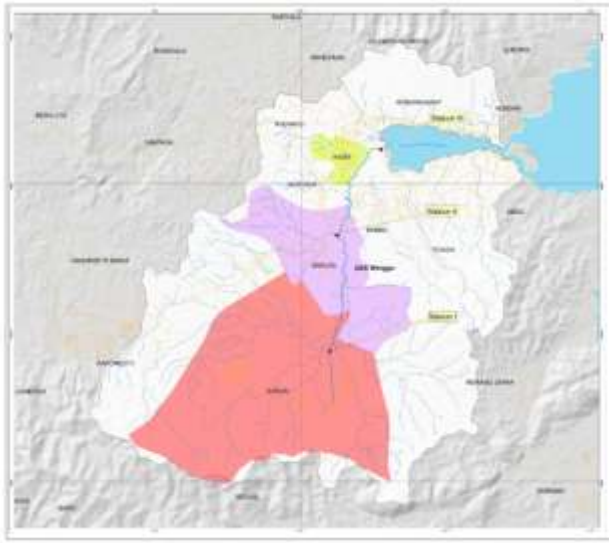

Figure 1. Map of Wanggu Watershed, Kendari

The material used in this study was a water sample obtained from Wanggu River, Kendari, Southeast Sulawesi Province. This study utilized tools which include sample holder, DO meter, camera, small container, sample bottle, cork, Global Positioning System (GPS), writing instruments, water thermometer, spectro photometer, pH meter, COD meter, BOD meter and laptop. The sample used was water obtained from station 1, station 2 and station 3 of Wanggu River, Kendari, Southeast Sulawesi.

In this study, the types of data used were quantitative data and qualitative data. Quantitative data included the result of laboratory analysis on water samples, while qualitative data were in the form of the administration of water classes to the samples that had been analyzed. Data sourced

from secondary data and primary data. Here, secondary data were pre-existing data from Watershed Management Office (BPDAS) Sampara, Southeast Sulawesi Province, Environmental Agency (BLH) of Southeast Sulawesi Province, while primary data were data taken from Wanggu River water or in the form of data obtained directly from the field.

Data collection was carried out in two stages:

a. Observation; the technique used to collect data by conducting direct action in the field.
b. Documentation; to get pictures/images during the study until it was completed.

Additionally, the following were the work procedures of this study:

a. Determination of water sampling station
   The coordinate point was determined when taking water samples by using the GPS (Global Positioning System) to specify the water sampling point. The coordinates of sampling were at station 1, station 2 and station 3 of Wanggu River, Kendari, Southeast Sulawesi Province.
b. Water Sample Collection and Handling
   Sampling was carried out at station 1, station 2 and station 3, in which at each station there was 1 sample of water from Wanggu River, Kendari, Southeast Sulawesi Province with a predetermined number of samples. After the sample was obtained, the researchers then measured several parameters including temperature, TSS, TDS, Nitrite, Nitrate, pH, and surfactant. The sample was then put into: 1) the first container in the form of a sterile sample bottle which was used to store biological parameters; 2) the second container which was aqua used to store water samples for several chemical and physical parameters; and 3) the third container, namely storage of water samples for parameters of DO, BOD, and COD. When all samples had been obtained, all of them were stored in a prepared place for sample to make sure that they were not highly contaminated with the environment.
c. Tabulation of Analysis Results
   The results of the samples that had been analyzed were then inputted and tabulated in Microsoft Excel to calculate and formulate the value of the analysis results, so that the results were the conclusions of this study.

The research variables were part of the water quality parameters tested and analyzed including:

a. Physical parameters: Temperature, TSS, and TDS
b. Chemical parameters: Oil and Fats, Surfactants/detergents, pH, DO, BOD, COD, Nitrite, and Nitrate
c. Biological parameter: Total Coliform.

More importantly, data analysis was carried out from the results of testing or measurement of water samples with three parameters, namely physical parameters, chemical parameters and microbiological parameter, with units expressed based on the parameters tested/measured. The value obtained from the measurement or testing was tabulated and then analyzed using the Pollution Index (PI) method. Water quality analysis referred to river water quality standards according to Government Regulation No. 82 on Water Pollution Control.

Besides, the status of water quality was determined using the Pollution Index method according to the Decree of the Minister of Environment Number 115 of 2003 on Guidelines for Determination of the Water Quality Status, using the following equation:

$$PI_j = \sqrt{\frac{(C_i / L_{ij})_M^2 + (C_i / L_{ij})_R^2}{2}}$$

Descriptions:

PI_j = Pollution index
C_i = Concentration of water quality parameters obtained
L_{ij} = Concentration of water quality parameters as specified in the water standard for use
(C_i/L_{ij}) M = Maximum value of C_i/ L_{ij}
(C_i/L_{ij}) R = Average value of C_i/ L_{ij}

The pollution index obtained from the calculation results was then included in water quality status. Water quality status explained whether the waters were good (met quality standards), lightly polluted, moderately polluted or heavily polluted.

RESULTS AND DISCUSSION

Wanggu River Condition

A. Station 1

The results of testing conducted at Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Halu Oleo University, Kendari, Southeast Sulawesi at station I precisely at the coordinates 04º5'23.76" SL, 122º30'10.66" EL can be seen in table 1 below. The water quality classification used in this study refers to the third class water quality classification, where the Wanggu River water can be used for freshwater fish farming, animal husbandry, to irrigate crops,

and / or other designations that require the same water quality as these uses (Government Regulation No. 82 on Water Pollution Control).

Table 1. Research parameters for station 1

Parameters	Units	Class 3 water quality standards (Government Regulation No. 82 of 2001)	Results	Notes
A. Physical Parameters				
Temperature	ºC	3	1	Meet quality standards
Total Dissolved Solids (TDS)	mg/L	1000	148.54	Meet quality standards
Total Suspended Solids (TSS)	mg/L	400	48.82	Meet quality standards
B. Chemical Parameters				
pH		6-9	6.68	Meet quality standards
Dissolved Oxygen (DO)	mg/L	3	2.43	Does not meet quality standards
Chemical Oxygen Demand (COD)	mg/L	50	32.49	Meet quality standards
Biological Oxygen Demand (BOD)	mg/L	6	15.76	Does not meet quality standards
Nitrate (NO_3)-N	mg/L	20	0.28	Meet quality standards
Nitrite (NO_2)-N	mg/L	0,06	0.007	Meet quality standards
Detergent (MBAS)	µg/L	200	16	Meet quality standards
Oil and Fat	µg/L	1000	320	Meet quality standards
C. Microbiological Parameter				
Total Coliform	CFU/100 mL	10000	64	Meet quality standards

Source: Primary Data (2019)

B. Station 2

The results of testing conducted at Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Halu Oleo University, Kendari, Southeast Sulawesi Province at station II precisely at the coordinates 03º1'34.62" SL and 122º30'23.88" EL can be seen in table 2 below.

Table 2. Research parameters for station 2

Parameters	Units	Class 3 water quality standards (Government Regulation No. 82 of 2001)	Results	Notes
A. Physical Parameters				
Temperature	ºC	3	1.14	Meet quality standards
Total Dissolved Solids (TDS)	mg/L	1000	139.87	Meet quality standards
Total Suspended Solids (TSS)	mg/L	400	35.22	Meet quality standards
B. Chemical Parameters				
pH		6-9	6.83	Meet quality standards
Dissolved Oxygen (DO)	mg/L	3	3.56	Meet quality standards
Chemical Oxygen Demand (COD)	mg/L	50	36.71	Meet quality standards
Biological Oxygen Demand (BOD)	mg/L	6	18.35	Does not meet quality standards

Parameters	Units	Class 3 water quality standards (Government Regulation No. 82 of 2001)	Results	Notes
Nitrate (NO_3)-N	mg/L	20	0.27	Meet quality standards
Nitrite (NO_2)-N	mg/L	0,06	0009	Meet quality standards
Detergent (MBAS)	µg/L	200	11	Meet quality standards
Oil and Fat	µg/L	1000	240	Meet quality standards
C. Microbiological Parameter				
Total Coliform	CFU/100 mL	10000	39	Meet quality standards

Source: Primary Data (2019)

C.Station 3

The results of testing conducted at Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Halu Oleo University, Kendari, Southeast Sulawesi Province at station III precisely at the coordinates 03º58'47.31" SL and 122º31'53.44" EL can be seen in table 3 below.

Table 3. Research parameters for station 3

Parameters	Units	Class 3 water quality standards (Government Regulation No. 82 of 2001)	Results	Notes
A. Physical Parameters				
Temperature	ºC	3	1	Meet quality standards
Total Dissolved Solids (TDS)	mg/L	1000	152.33	Meet quality standards
Total Suspended Solids (TSS)	mg/L	400	57.34	Meet quality standards
B. Kimia				
pH		6-9	6.74	Meet quality standards
Dissolved Oxygen (DO)	mg/L	3	2.92	Does not meet quality standards
Chemical Oxygen Demand (COD)	mg/L	50	34.85	Meet quality standards
Biological oxygen demand (BOD)	mg/L	6	17.42	Does not meet quality standards
Nitrate (NO_3)-N	mg/L	20	0.3	Meet quality standards
Nitrite (NO_2)-N	mg/L	0,06	0.008	Meet quality standards
Detergent (MBAS)	µg/L	200	28	Meet quality standards
Oil and Fat	µg/L	1000	360	Meet quality standards
C. Microbiological Parameter				
Total Coliform	CFU/100 mL	10000	43	Meet quality standards

Source: Primary Data (2019)

Pollution Index of Wanggu River

Water pollution index of Wanggu River in Kendari, Southeast Sulawesi can be seen in table 4.

Table 4. Pollution index of Wanggu River, Kendari

Stations	Pollution Index	Quality Status
I	1.62	Lightly Polluted
II	1.79	Lightly Polluted
III	1.73	Lightly Polluted

Source: Primary Data (2019)

Based on Table 4 above, Pollution Index of Wanggu River, Kendari from stations I, II, III shows that the water in those three stations is lightly polluted.

Discussion

Water is one of the necessities of living things to survive because water is the main source of human life and other living things. Accordingly, water must be preserved and treated properly for the survival of humans and other living things today and in the future, so that it is necessary to save and conserve water resources so as not to cause natural resources damage and, especially, water pollution. Wanggu River is one of the rivers used by the people of Kendari for their survival in agriculture, animal husbandry, freshwater fish cultivation and washing. Based on the data obtained, Wanggu River was a river used by the people of Kendari who live around Wanggu River.

This study was conducted in March 2019 in Wanggu River. Water samples were taken at each station tested at Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Halu Oleo University. This study was conducted with reference to Government Regulation No. 82 of 2001 which used class 3 water quality standards and the Decree of the Minister of Environment Number 115 of 2003 on Guidelines for Determination of the Water Quality Status by Pollution Index Method.

1. Physical Quality

The water quality of Wanggu River, based on physical quality, can be seen from several parameters including temperature, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) which have been analyzed and described as follows.

- Temperature

Temperature is a very important physical parameter for the metabolic processes of organisms in water areas. Temperature can vary depending on the season, location based on the latitude and orbit of the sun, measurement time, water depth and height to sea level. Increase in temperature by 1 °C causes oxygen consumption to increase by 10% (Brown, 1987 as cited in Effendi, 2003).

The high temperature has an effect on decreasing the solubility of gas (Effendi 2003). Cordova (2008) affirmed that increasing the temperature affects the ability of water to bind oxygen. The higher the temperature, the lower the solubility of oxygen in water, which causes oxygen to be released easily into the air.

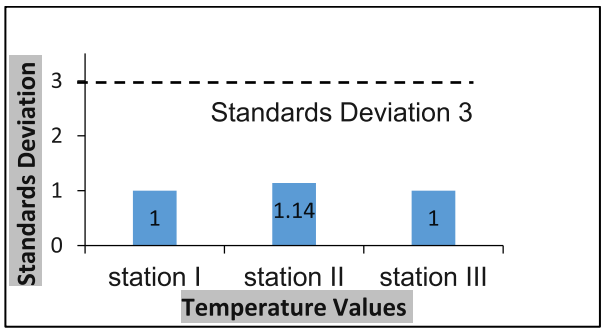

Figure 2. Temperature values at observation stations of Wanggu River

According to Rohmawati (2016), there are several points affecting the high and low water temperature: time of sampling, topography, sunlight, and rainfall. Thus, water temperature at station I or upstream which has a higher topography is generally lower than the water temperature at station III or downstream. The high temperature at the research location is related to sunlight. In this case, sunlight is the main source of heat in the waters since it is absorbed by water bodies and produces heat in the waters.

The temperature measurements carried out at the three stations, three times at each station to determine the standard deviation, obtained different values. The measurement at station I in the morning at 10.17 Central Indonesian Time (henceforth-WITA) (10.17 a.m.) obtained 25 ºC, at noon at 12.40 WITA (12.40 p.m.) obtained 27 ºC and in the afternoon at 15.58 WITA (03.58 p.m.) obtained 26 ºC, so the standard deviation value for station I was 1 ºC. Besides, the measurement done at station II in the morning at 08.15 WITA (08.15 a.m.) obtained 26 ºC, at noon at 12.20 WITA (12.20 p.m.) obtained 28 ºC and in the afternoon at 16.30 WITA (04.30 p.m.) obtained 26 ºC, so the standard deviation value for station II was 1.14 ºC. In addition, the measurement at station III in the morning at 09.42 WITA (09.42 a.m.) obtained 26 ºC, at noon at 13.30 WITA (01.30 p.m.) obtained 28 ºC and in the afternoon at 16.45 WITA (04.45 p.m.) obtained 27 ºC, so the standard deviation value at station III was 1 ºC. It can be seen from the diagram above that the temperature parameters of station I, station II and station III based on Government Regulation No. 82 of 2001 for class 3 water quality standards still met the standard deviation of quality standards.

Moreover, the distribution of temperature is also caused by river flows, while the low temperature of the water is influenced by the intensity of sunlight. Consequently, the temperature at station I, station II and station III varied. The increasing intensity of

sunlight starting from station I to station III was caused by several factors, including: differences in the height of the river water surface, river water depth and river flow, cloud cover, the presence of pollutants from human activities such as settlements, agriculture, and farms. Temperature also plays a role in controlling the condition of aquatic ecosystems (Effendi, 2003).

➢ Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) are solids that are smaller than suspended solids. These solids consist of organic and inorganic compounds that are soluble in water, minerals and salts (Fardiaz, 1992). TDS value is strongly influenced by rock weathering, runoff from soil, and anthropogenic effects (in the form of organic and industrial waste) (Effendi, 2003).

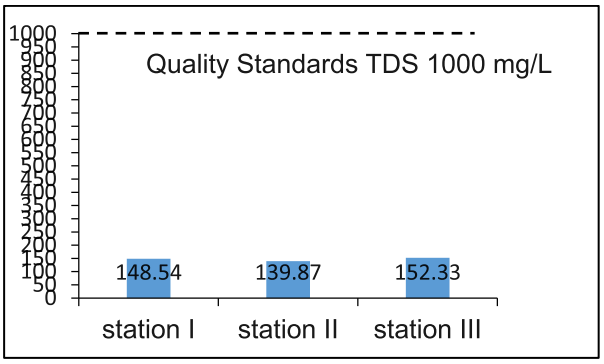

Figure 3. TDS value at observation stations of Wanggu River

TDS is an indicator of the number of particles or substances, in the form of organic and non-organic compounds that can be affected by rock weathering, runoff from soil and domestic and industrial wastes (Effendi, 2003).

Based on the results of observations at each station, the TDS at station I was 148.54 mg/L, at station II was 139.84 mg/L and at station III was 154.33 mg/L. Based on Government Regulation No. 82 of 2001, the condition of Wanggu River water for class 3 water quality standards was declared to meet quality standards, in which Wanggu River water was used in agriculture and fish cultivation as well as for clean water for the community. It can be seen in the diagram above that the TDS parameters at station I, station II and station III based on Government Regulation No. 82 of 2001 on class 3 water quality standards were still declared to meet quality standards.

➢ Total Suspended Solids (TSS)

Total Suspended Solids (TSS) are suspended materials (diameter < 1 mm) held in a millipore filter with a pore diameter of 0.45 µm. TSS consists of fine sand mud and microorganisms. The main cause of TSS value is soil erosion carried into water bodies (Effendi, 2003). The suspended solid will reduce the penetration of sunlight into the water thereby affecting oxygen regeneration and photosynthesis. Suspended solids also affect the turbidity and transparency of water (Fardiaz 1992).

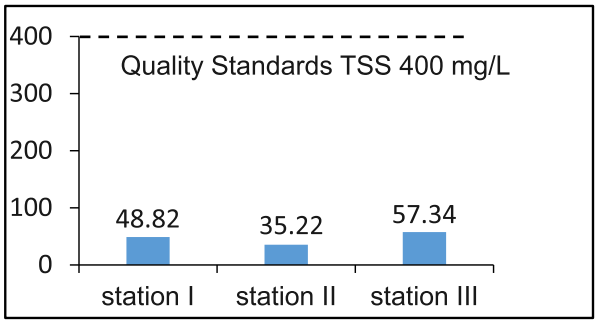

Figure 4. TSS value at observation stations of Wanggu River

Based on the results of observations at each station, the TSS obtained at station I was 48.82 mg/L, at station II was 35.22 mg/L and at station III was 57.34 mg/L. Based on Government Regulation No. 82 of 2001, Wanggu River water for class 3 water quality standards was declared to meet quality standards in which water was used in agriculture and fish cultivation as well as for clean water for the community.

Based on the measurement results of TSS parameters, the picture above shows that the highest TSS was at station III due to the large number of human activities in the form of construction and also the large amount of community waste around station III of Wanggu River. On the other hand, the lowest TSS value was at station II since the community around the river did not have too many activities in the construction sector. In addition, there was not much agricultural land around the river.

2. Chemical Quality

➢ pH

Power of Hydrogen (pH) is a unit of measurement that describes the degree of acidity and alkalinity of a solution, especially as an indicator of water quality. The pH value of a water characterizes the balance between acid and base in the water (Cech, 2005).

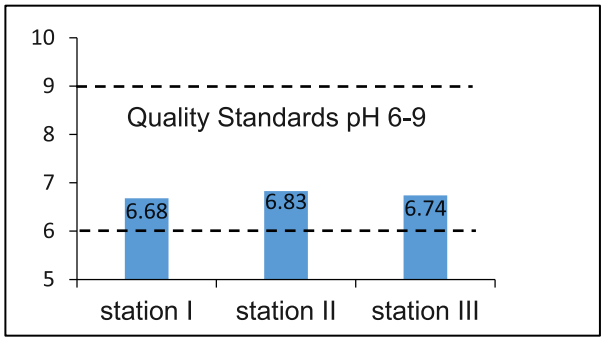

Figure 5. pH value at observation stations of Wanggu River

Based on the observations of pH parameters obtained from each station, the pH at station I was 6.68, station II was 6.83 and station III was 6.74. Based on Government Regulation No. 82 of 2001 on the criteria for class 3 water quality standards, namely around 6-9, Wanggu River still met the quality standards, so that it could still be used for freshwater fish cultivation, livestock, and agriculture.

Yuliastuti (2011) confirmed that an increase in the degree of acidity or pH is influenced by organic and inorganic waste that is discharged into the river. Thus, the increase in the pH of Wanggu River water is due to industrial, domestic and agricultural waste disposal activities that enter the river.

➢ Dissolved Oxygen (DO)

Dissolved Oxygen is the amount of oxygen contained in water and is measured in units of milligrams per liter (Sugiharto, 1987). Sidik (1993) claimed that dissolved oxygen is needed by aquatic plants, plankton, and aquatic fauna to breathe and by bacteria for the decomposition process.

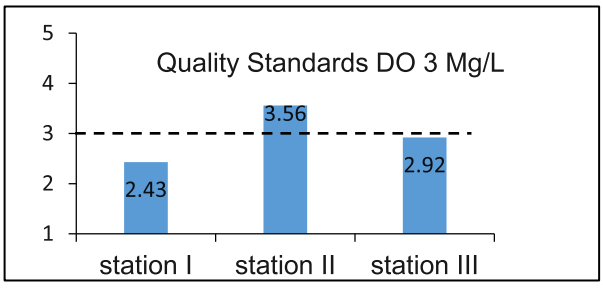

Figure 6. DO value at observation stations of Wanggu River

Based on the observations of Dissolved Oxygen (DO) parameters obtained from each station, DO at station I was 2.43 mg/L, at station II was 3.56 mg/L and at station III was 2.92 mg/L. From the data obtained, it can be seen in the diagram above that station I and station III did not meet the quality standards, while station II met the quality standards set by Government Regulation No. 82 of 2001 based on the criteria for class 3 water quality standards. The low DO at station I and station III were caused by polluted river water due to domestic and non-domestic waste discharges. Oxygen requirements are greatly influenced by temperature. The presence of excessive heavy metals in the waters can affect the respiration system of aquatic organisms, so that when dissolved oxygen levels are low and heavy metals are present with high concentrations, aquatic organisms suffer more (Tebbut, 1992).

➢ Biological Oxygen Demand (BOD)

Biological Oxygen Demand (BOD) is a parameter indicating the amount of dissolved oxygen needed by aquatic microorganisms to decompose or oxidize organic waste materials in water (Saeni, 1989). The greater the BOD value, the greater the level of water pollution by organic matter (Jaya, 1994).

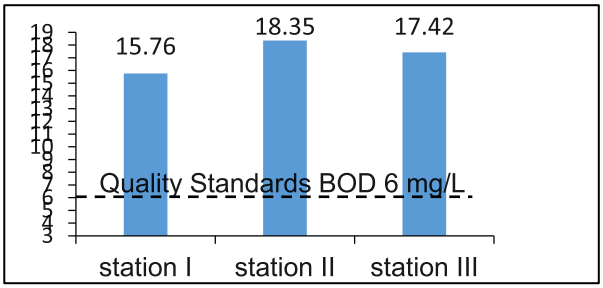

Figure 7. BOD value at observation stations of Wanggu River

Biological Oxygen Demand (BOD) is a parameter indicating the amount of dissolved oxygen needed by aquatic microorganisms to decompose or oxidize organic waste materials in water (Saeni, 1989). BOD is important to determine amounts of inorganic substances contained in wastewater. The more organic matter, the higher the BOD. The BOD value is influenced by temperature, sunlight, biological growth, water movement and oxygen levels (Metcalf & Eddy, 2003). The BOD value is the amount of oxygen needed by the bacteria to break down (oxidize) almost all dissolved organic substances and some of the organic substances suspended in water (Alaerts and Santika, 1984).

Based on the observations of the Biological Oxygen Demand (BOD) parameters obtained from each station, BOD at station I was 15.76 mg/L, at station II was 18.35 mg/L and at station III was 17.42 mg/L. The figure above shows that based on the parameters of Biological Oxygen Demand (BOD) at station I, station II and station III of Wanggu River referring to Government Regulation No. 82 of 2001 on the criteria for class 3 water quality standards,

Wanggu River was declared polluted because it had exceeded the quality standards of 6 mg/L. The BOD value that exceeds the water quality standard in the waters of the Wanggu River is influenced by temperature, plankton density, the presence of microbes, and the type and content of organic matter in the water. The presence of toxic materials in waters will interfere with the ability of microbes to oxidize organic matter in river water.

➢ *Chemical Oxygen Demand* (COD)

Chemical Oxygen Demand (COD) describes the content of organic materials that can be chemically oxidized, both biodegradable and non-biodegradable (Ishartanto, 2009).

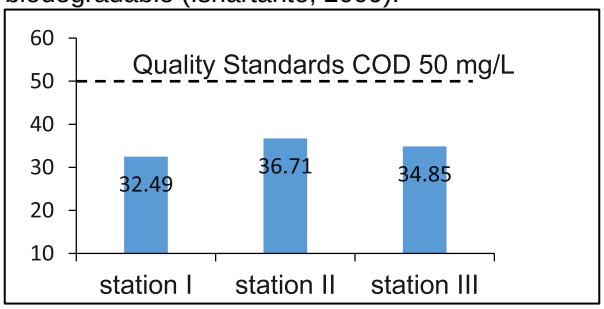

Figure 8. COD value at observation stations of Wanggu River

Based on the observations of Chemical Oxygen Demand (COD) parameters obtained from each station, COD at station I was 32.49 mg/L, at station II was 36.71 mg/L and at station III was 34.85. Based on the diagram above, it was known that the COD parameters for station I, station II and station III of Wanggu River according to Government Regulation No. 82 of 2001 on the criteria for class 3 water quality standards were still declared to meet quality standards.

➢ Nitrate NO_3-N

Nitrate in water comes from the atmosphere through rain, legume plants, erosion of natural deposits or animal or human waste. Nitrate is commonly found in agricultural activities (Surya, 2015).

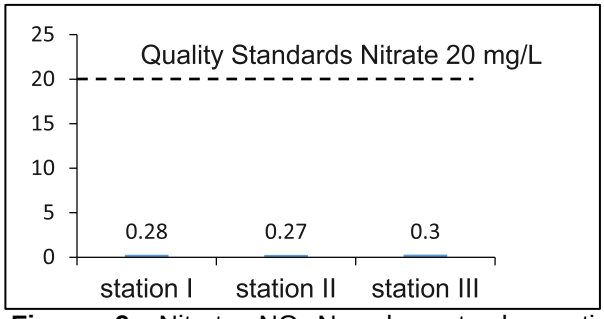

Figure 9. Nitrate NO_3-N value at observation stations of Wanggu River

Based on the observations of Nitrate NO_3-N parameters obtained from each station, Nitrate NO_3-N value at station I was 0.28 mg/L, at station II was 0.27 mg/L and at station III was 0.3 mg/L. It can be seen in the diagram above that station I, station II and station III of Wanggu River according to Government Regulation No. 82 of 2001 on class 3 water quality standards were still declared to meet quality standards.

➢ Nitrite NO_2-N

Nitrite is a form of nitrogen which is only partially oxidized. It is not found in fresh waste but in stale or old waste. Sources of nitrite can be industrial waste and domestic waste. Nitrite levels in the water are relatively small, not fixed and can be turned into ammonia or oxidized to nitrate (Ginting, 2007).

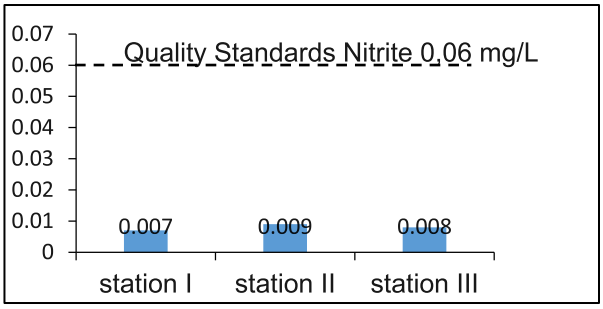

Figure 10. Nitrite NO_2-N value at observation stations of Wanggu River

Based on the observations of Nitrite NO_2-N parameters at each station, Nitrite NO_2-N at station I was 0.007 mg/L, at station II was 0.009 mg/L and at station III was 0.008 mg/L. It can be seen in the diagram above that station I, station II and station III of Wanggu River according to Government Regulation No. 82 of 2001 on class 3 water quality standards were still declared meeting the quality standards.

➢ Detergent (MBAS)

Sawyer and Mc.Carty (1967) believed that detergents or surfactants are compounds whose molecules have a specific group structure which causes these compounds to have detergent properties such as foam-causing properties. Detergent in a certain amount can pollute the environment since it can cause a lot of foam on the surface of the water, thus interfering with the diffusion of oxygen from the air into the waters which indirectly disturbs the life of the decomposing organisms (Taufik, 2006).

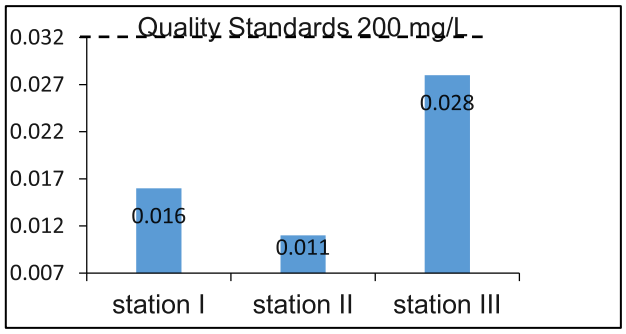

Figure 11. Detergent value at observation stations of Wanggu River

Based on the observation of Detergent (MBAS) parameters at each station, the Detergent value at station I was 0,016 mg/L, at station II was 0.011 mg/L and at station III was 0.028 mg/L. Therefore, it can be seen in the diagram above that Wanggu River, based on the Detergent (MBAS) parameters at station I, station II and station III according to Government Regulation No. 82 of 2001 on the criteria for class 3 water quality standards, still had not exceeded the quality standard so it could be said that the river was still in good condition.

- Oil and Fat

Oil waste and its products also come from industrial and household activities, most of which are wasted into rivers. It certainly pollutes the aquatic environment, while the rest will pollute other environments such as land, aquifers and air (Udiharto, 1996). Water pollution by oil and fat is very detrimental, because it can cause reduced penetration of sunlight and decreased dissolved oxygen concentration due to obstruction of the diffusion of oxygen from the air (Suriawiria, 1986).

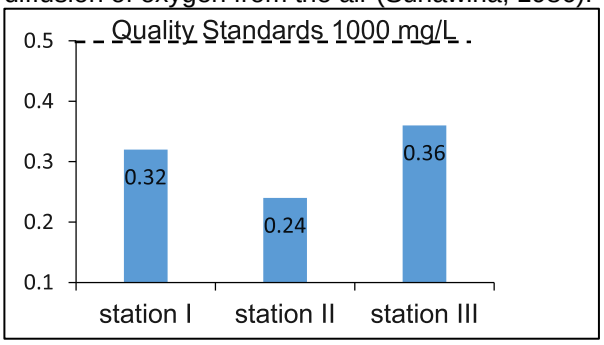

Figure 12. Oil and Fat Value at observation stations of Wanggu River

Based on the measurement of Oil and Fat parameters at each station, the value at station I was 0.32 mg/L, at station II was 0.24 mg/L and at station III was 0.36 mg/L. It can be seen in the diagram above that oil and fat parameters at station I, station II and station III of Wanggu River according to Government Regulation No. 82 of 2001 on the criteria for class 3 water quality standards were still in good condition since they did not exceed the quality standards.

3. Microbiological Parameter

- Total Coliform

Based on Government Regulation No. 82 of 2001, the classification of determining the quality standard for Total Coliform value is 5000 cfu/100ml. Figure 13 shows that Total Coliform value found in Wanggu River still met the quality standard.

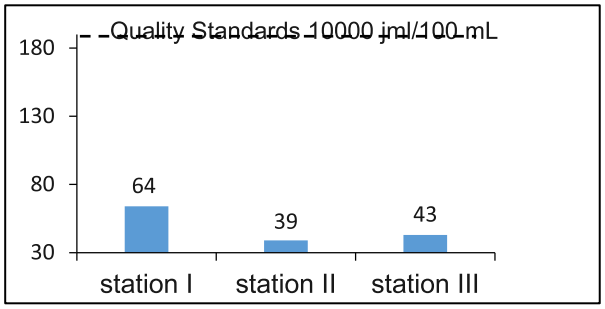

Figure 13. Total Coliform Value at observation stations of Wanggu River

Based on the results of observations of total coliform parameters at each station, the total coliform at station I was 64 jml/100 mL, at station II was 39 jml/100 mL and at station III was 43 jml/100 mL. Based on the diagram above, it can be seen that Wanggu River, based on the total coliform parameters according to Government Regulation No. 82 of 2001 on the criteria for class 3 water quality standards, was still in good condition because it did not exceed the quality standard threshold.

4. Pollution Index of Wanggu River

The results of the measurement of the Pollution Index of Wanggu River carried out were measurements based on analyzed parameters which included physical, chemical and microbiological parameters, based on Government Regulation No. 82 of 2001 on the Criteria for Water Quality Standard based on class and the Decree of the Minister of Environment Number 115 of 2003 on Guidelines for Determination of the Water Quality Status by Pollution Index Method.

- Calculation of the Wanggu River Pollution Index at station I are shows below:

$$PI_j = \sqrt{\frac{\left(C_i / L_{ij}\right)_M^2 + \left(C_i / L_{ij}\right)_R^2}{2}}$$

$$PI_j = \sqrt{\frac{(9{,}591 + 0{,}990)}{2}}$$
$$PI_j = \sqrt{\frac{(10{,}581)}{2}}$$
$$PI_j = 1{,}62$$

The results of the analysis revealed that the pollution index at station I was 1.62 which was classified as lightly polluted. The community around station I of Wanggu River utilized river water for agriculture and clean water sources. At this station, there was less vegetation so the water quality was not good. In addition, there was a lot of agricultural waste.

- Calculation of the Wanggu River Pollution Index at station II are shows below:

$$PI_j = \sqrt{\frac{\left(C_i / L_{ij}\right)_M^2 + (C_i / L_{ij})_R^2}{2}}$$
$$PI_j = \sqrt{\frac{(11{,}747 + 1{,}123)}{2}}$$
$$PI_j = \sqrt{\frac{12{,}87}{2}}$$
$$PI_j = 1{,}79$$

More importantly, the results of the analysis revealed that the pollution index at station II was 1.79 which was classified as lightly polluted. The community around station II of Wanggu River utilized river water as clean water sources. In fact, river water at station II was more polluted than at station I and station III since many local communities disposed of their household waste into river bodies. Additionally, the lack of vegetation around the river also caused higher levels of pollution.

- Calculation of the Wanggu River Pollution Index at station II are shows below:

$$PI_j = \sqrt{\frac{\left(C_i / L_{ij}\right)_M^2 + (C_i / L_{ij})_R^2}{2}}$$
$$PI_j = \sqrt{\frac{(10{,}985 + 1{,}090)}{2}}$$
$$PI_j = \sqrt{\frac{12{,}075}{2}}$$
$$PI_j = 1{,}73$$

In addition, the results of the analysis revealed that the pollution index at station III was 1.73 which was classified as lightly polluted. Wanggu River water around station III was polluted due to household waste disposal and construction around the river. Meanwhile, the community around this station used river water for fish cultivation and for collecting clams for their daily needs.

5. Efforts to Prevent and Overcome Water Pollution in Wanggu River

Based on the results, it can be concluded that Wanggu River water at station I, station II and station III is classified as lightly polluted based on class 3 water quality standards of Government Regulation No. 82 of 2001. Water pollution that occurs around Wanggu River is caused by community activities affecting the level of water pollution. Biochemical Oxygen Demand (BOD) is an empirical analysis used to detect globally the microbiological processes that actually occur in water. The BOD number is the amount of oxygen needed by bacteria to decompose (oxidize) almost all dissolved organic substances and some of the organic substances suspended in water (Alaerts and Santika, 1984). In general, the BOD parameter is widely used to determine the level of waste water pollution. Determination of BOD is very important to trace the flow of pollution from upstream to estuary levels. Without proper control and management, Wanggu River water will certainly be more polluted so that the community is threatened with no longer being able to utilize river water. Therefore, it is necessary to have good control and management of Wanggu River water to prevent further pollution so that the community around can still use Wanggu River water as their domestic needs. Some of the efforts that can be taken include planting trees, not disposing of waste into the river, and not cutting trees excessively or illegally in the catchment area of Wanggu watershed area so that water conditions are maintained properly. Local governments need to coordinate with all relevant agencies, such as the Ministry of Environment and Forestry and Regional Environmental Management Agency.

CONCLUSIONS

This study concludes that, by using Pollution Index method, water quality status of Wanggu River at station I is 1.62, station II is 1.79 and station III is 1.73. Thus, all observation stations are classified as lightly polluted. However, station II is the most polluted area because of the many community activities around this station. In addition, some stations do not meet class 3 water quality standards set by Government Regulation No. 82 of 2001 including chemical parameters of Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO). There

needs to be awareness of the community around the Wanggu River not to dispose of household waste into the river, and also not to damage the trees around the river so that they can still manage the water system properly, and the government needs to be firm in enforcing regulations so that the sustainability and quality of river water Wanggu can stay awake.

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