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ANALYSIS OF THE STATUS OF THE GIRIAN WATERSHED IN BITUNG CITY DUE TO HOUSEHOLD WASTE POLLUTION

Rivaldo Tompoh[1], A. Arrijani[2], Nova L. I. M. Ogi[2]

[1)]Student of Biology Departement, Faculty of Matehematics and Natural Science, Manado State University, Indonesia
[2)]Biology Departement, Faculty of Matehematics and Natural Science, Manado State University, Indonesia

**Corresponding author: rivaldotompoh22@gmail.com*

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Abstract

The Girian watershed with a length of 17.5 km is the longest river in Bitung City which flows through a densely populated area as well as various industries such as smoked fish, tofu and tempeh, animal husbandry, agriculture, and industrial fish factories whose waste goes directly to the Girian watershed. The great deal of population activities can have an impact on water quality and the Girian watershed ecosystem. This study aims to analyse the water quality of the Girian watershed caused by domestic waste. This study uses a quantitative descriptive approach and the method used in this study is the Indonesian National Standard (SNI) according to the water quality parameters that have been determined. The results of the analysis of water quality upstream to downstream show that there is a decrease in water quality. Upstream is classified as good when compared to the parameters that have been determined. Densely populated areas begin to experience a decrease in water quality, namely with DO and Oil and Fat that exceeds the predetermined quality standard. As well as estuaries that have concentrations of TSS, NH3-N, Oils and Fats, COD, and BOD that exceed the specified quality standards. The results of the calculation of the pollution index show that station point 1 upstream is classified as good in 4 groups, station point 2 in densely populated areas shows lightly polluted results in group 2, and The Station 3 estuary shows moderate pollution results in group 3.

Key words: *Girian Watershed, Water Quality, Pollution Load.*

INTRODUCTION

A watershed is an area whose land is an integral part of a river and other tributary, which aims to accommodate, drain and store rainfall water naturally (Peraturan Pemerintah, 2011). Meanwhile, a river is a natural and/or artificial water container or path that starts from the upstream and reaches the estuary (Peraturan Pemerintah, 2011). The river is a place for the flow of water whose conditions cannot be separated from human activities in the watershed (Agustiningsih & Sasongko, 2012). A river area is a unit of water resource management area in river flows and or small islands with an area of less than 2,000 km2 (Menteri , 2015).

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Water is used by humans for various needs, clean water is a basic human need for consumption or in use for mobilization. The quality of water in the river is strongly influenced by the quality of the water forces coming from the catchment area, while the quality of the water supply from the catchment area is related to the human activities in it (Wiwoho, 2005). Changes in water quality conditions in river flows are the impact of disposal and existing land use (Tafangenyasha & Dzinomwa, 2005). In addition, changes in the use of watershed land as residential land and industrial activities have resulted in a decrease in the quality of river water.

The increase in population growth and activity which ultimately causes the area to continue to develop and take place very quickly which results in the opening of new land, increasing facilities and infrastructure, but decreasing water and other natural resources. Until there appears the behaviour of disposing of household waste and waste from industrial activities to watersheds. Community and industrial waste has the meaning of all pollutant materials produced, such as the disposal of waste that is difficult to degrade into nature, to the disposal of waste from industrial activities.

The Girian watershed has a length of 17.50 km and is the main supplier of PDAM Duasudara to Bitung City, which is the longest in Bitung City (RPIJM 2015-2019, 2019). And flows through densely populated and industrial areas from Ranowulu sub-district to empties into Girian District. So many settlements and production houses along the waters of the girian watershed, directly and indirectly have an impact on the girian watershed ecosystem.

MATERIALS AND METHOD

Tools and materials Research

The tools used in this study were DO Bottles, Lead, Incubator, 5 L – 10 L glass bottles, volumetric pipette, 100 mL volumetric flask; 200 mL; and 1000 mL, pH meter, DO meter, shaker, blender, oven, Analytical balance, Digestion vessel, Heating block, Micro Burette, Erlenmeyer, Beaker, Magnetic stirrer, glass bottle, Analytical balance, Technical balance, 2000 mL separating funnel, Funnel filter, Centrifuge, 2.5 m filter paper, Vacuum system, Spectrophotometer.

The materials used in this research are Aquadest, Potassium Hydrogen phosphate (KH2PO4). Disodium hydrogen phosphate heptahydrate (Na2HPO.7H2O), Ammonium chloride (NH4Cl), Magnesium sulfate (MgSO4.7H2O), Calcium Chloride (CaCl2), Ferric chloride (FeCl3.6HO), Microbial seeds, Phosphate buffer, Glucose (C6H12O6), Acid glutamate (C5H9NO4), Sulfuric acid (H2SO4), Sodium sulfite (Na2SO3), Allylthiourea (C4H8N2S), Acetic acid (CH3COOH), Potassium iodide (KI), Starch, Powder or Crystal (Ag2SO4), Digestion Solution, Potassium dichromate (H2Cr2O7), Phenanthroline monohydrate (C12H11ClN2O), Ferrous sulfate, heptahydrate (FeSO4.7H2O), Ferrous ammonium sulfate (FAS) (FeH8N2O8S2), Sulfamic acid (NH2SO3H), Potassium hydrogen phthalate (HOOCC6COOK, KHP), Hydrochloric acid (HCl), n -hexane, acetone (CH3COCH3), hexadecane (C16H3), stearic acid (C17H35CO2H), silica gel, micro glass-fiber filter with porosity size of 0.7 m to 1.5 m.

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Research Method

This research was conducted using a quantitative descriptive method. Descriptive methods and quantitative approaches in this study were used to describe the condition of the water quality of the Girian Watershed (DAS) in Bitung City caused by community and industrial activities. This research was conducted from October to November 2021 along the Girian watershed starting from upstream to downstream.

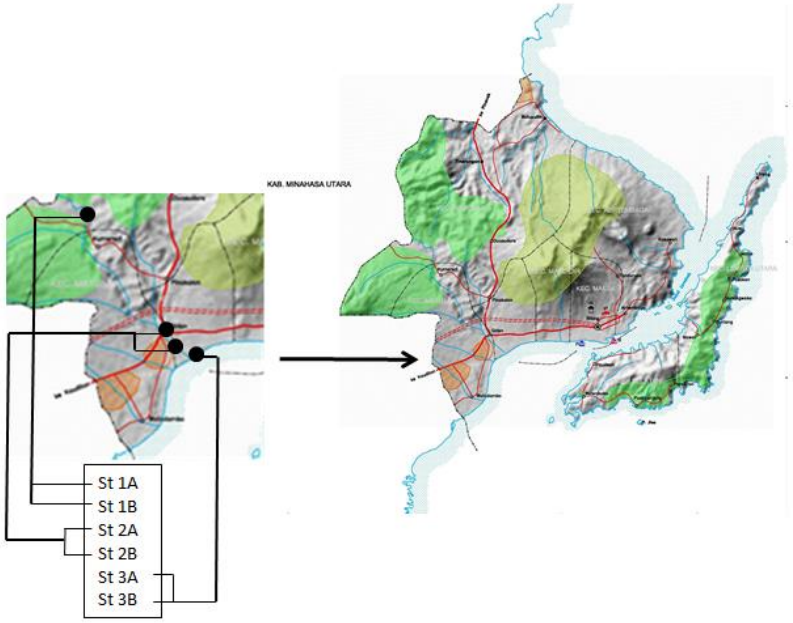

Figure 1. Location of Water Sampling

Water samples were taken using a purposive sampling method at three sampling stations from upstream to downstream. At each point of the water sampling station, 2 representative water samples were taken to take the average value.

1. Station point 1 : Upstream sampling under the Apela One Village Bridge.
2. Station point 2 : Sampling of water under the Girian Bridge and under the Girian Bridge.
3. Station point 3: Sampling at the lower girian estuary.

Data Analysis Method

Table 1, Water Quality Analysis Methods for the Girian Watershed

No	Parameter	Unit	Quality Standard	Test Method
1.	pH	-	6 – 9	SNI 06-6989. 11-2004
2.	DO	mg/L	-	SNI 06-6989. 14-2009
3.	TSS	mg/L	30	SNI 06-6989. 3-2004
4.	NH3-N	mg/L	10	Method 8038 Nesseler method/hach
5.	Oil and Fat	mg/L	5	SNI 6989. 10-2011
6.	COD	mg/L	100	SNI 06-6989. 2-2009
7.	BOD	mg/L	30	SNI 06-6989. 72-2009

Source : Peraturan Menteri LHK RI No 68 Tahun 2016

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Table 2, Quality Standard PP RI No 82 Tahun 2001

No	Parameter	Unit	Quality Standard Class			
			I	II	III	IV
1.	TSS	mg/L	50	50	400	400
2.	pH	-	6 – 9	6 – 9	6 – 9	5 – 9
3.	DO	mg/L	6	4	3	0
4.	NH3-N	mg/L	0,50	-	-	-
5.	Oil and Fat	µg/L	1000	1000	1000	-
6.	COD	mg/L	10	25	50	100
7.	BOD	mg/L	2	3	6	12

Source : Peraturan Pemerintah RI No 82 Tahun 2001

Then the test results of these parameters will be compared with the quality standards that have been set in the (PERMEN LHK-RI 68, 2016), regarding Domestic Waste Quality Standards, and (Peraturan Pemerintah Republik Indonesia No 82 Tahun 2001). Analysis of water quality in the Girian watershed uses water quality standards based on classes I – IV, and uses the Pollution index (PI) method based (Keputusan Menteri Lingkungan Hidup No. 115 Tahun 2003. (PI) value The pollution index can be used as a reference to determine whether the value of river water quality is suitable for its designation and as a basis for improving river water quality in the event of pollution. The calculation of the pollution index can be done by the following formula:

$$PIj = \sqrt{\frac{(\mathrm{Ci}/\mathrm{Lij})2\mathrm{M} + (\mathrm{Ci}/\mathrm{Lij})2\mathrm{R}}{2}}$$

Where:

PIj : pollution index for the designation j

Ci : concentration of water quality parameter i

Lij : concentration of water quality parameter I listed in the water designation standard j

M : Maximum

R : Average

There is a pollution index value (PI) which is determined by the value and the ratio of the average concentration value of each parameter to the quality standard value, there are 4 value classes (PI) which are shown in table 3 as follows:

Table 3, Grade Class (PI)

PI Value	Water Quality
0 – 1,1	(good)
1,1 – 5,0	(slightly polluted)
5,0 – 10,0	(fairly polluted)
>10,0	(heavily polluted)

Source : Keputusan Menteri LH No. 115 Tahun 2003

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RESULTS AND DISCUSSION

Girian Watershed Water Quality Analysis

In this study, the scope of research was carried out along the Girian Watershed in Bitung City starting from upstream to downstream. To determine the level of domestic waste pollution, in this case household waste, on the water quality of the Girian Watershed Bitung City and divided into 3 sampling stations, starting from upstream, densely populated areas, and downstream. At each station 2 samples were taken representatively at the same location and then the average value was taken and it was hoped that it would represent the condition of a sampling point.

Table 4, Girian Watershed Water Quality Measurement Results

No	Parameter	Unit	The Result		
			ST 1	ST 2	ST 3
1.	TSS	mg/L	10.5	36.5	94.5
2.	pH	-	6.69	7.2	6.78
3.	DO	mg/L	7.11	5.08	5.14
4.	NH3-N	mg/L	0.18	0.32	0.72
5.	Oil and Fat	mg/L	0.1	0.2	0.35
6.	COD	mg/L	3	1.67	18.5
7.	BOD	mg/L	1.5	1.5	4.5

TSS (Total Suspended Solid)

The results of the Girian Watershed TSS measurement at station 1 were 10.5 mg/L, station 2 36.5 mg/L and at station 3 were 94.5 mg/L. TSS parameter measurement results show an increase in TSS concentration from upstream to downstream and exceeds the water quality standard according to (PERMEN LHK-RI No 68 Tahun 2016) with a quality standard of 30 mg/L at stations 2 and 3, and passes the class II quality standard at station 3 according to predetermined quality standards (PP No 82 Tahun 2001).

Although not toxic, excessive suspended materials can increase the turbidity value and have the effect of blocking light penetration into the water which causes inhibition of the rate of photosynthesis (Effendi, 2003). According to Alabaster & Llioyd, (1982) in (Effendi, 2003), the concentration of TSS water in the Girian Watershed in Bitung City has little effect (10.5 – 94.5 mg/L) fishery interests.

pH

The results of the measurement of pH parameters in the Girian watershed ranged from 6.69 to 7.2. Based on the results of the measurement of pH parameters in the upstream to downstream of the Girian watershed, it shows controlled results because to have a life condition the pH concentration must be between 6.5 - 7.5. If the pH concentration is < 7, then the water is acidic and pH > 7. Wastewater can affect the pH concentration of the water so that it can affect aquatic biota that is sensitive to changes in pH. Most of the aquatic biota are sensitive to changes in pH and prefer a pH in the range of 7 – 8.5. The

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pH value greatly influences the biochemical processes in a waters, for example, the nitrification process will end at a low pH (Effendi, 2003).

Dissolved Oxygen (DO)

Based on the measurement results, the DO value at station points 1 – 3 shows a value between 5.08 – 7.11 mg/L. at station points 2 – 3 the DO concentration reaches 5.08 – 5.14 mg/L and is classified as class I based on (PP No 82 Tahun 2001). Low and decreasing DO concentrations indicate that there is pollution by organic materials produced by community activities in the resident area located at sampling points at stations 2 – 3. Low and decreasing DO concentrations indicate that there is pollution by organic materials produced by community activities in the area population at the sampling point of station 2.

Generally, DO concentration in water is only temporary or seasonal and fluctuates. Usually aquatic biota such as fish require dissolved oxygen between 5.8 mg/L (Priambodho, 2005). Dissolved oxygen from waters is influenced by the process of decomposition of organic matter and oxidation of inorganic materials (Effendi, 2003). It is indicated that the decrease in dissolved oxygen content in the Girian watershed, Bitung City is influenced by the increase in the decomposition process of organic matter and the oxidation of inorganic materials caused by waste disposal.

Ammonia (NH3-N)

The concentration of NH3-N from the measurement results from upstream to downstream Girian watershed in Bitung City shows an increase in the concentration of NH3-N from upstream to downstream. The lowest concentration is at station 1 with 0.18 mg/L and the highest concentration is at station 3 with a value of 0.72 mg/L which has exceeded the quality standard set by (PP No. 82 Tahun 2001). An increase in the concentration of NH3-N is indicated by industrial, residential, livestock and waste disposal activities. This is in accordance with the statement (Effendi, 2003) by stating that the high concentration of NH3-N is indicated by the presence of contamination of organic matter originating from domestic waste, industry, and agricultural fertilizers.

Water conditions containing NH3-N cause fish to become stressed, weak, decrease immunity, and have low appetite. Which ultimately inhibits the rate of growth and even causes death. Fish cannot survive with high NH3-N because high NH3-N concentrations can interfere with the oxygen binding process by the blood and eventually cause death in fish (Yudha, 2009) in (Arifin. M. Y, 2017).

Oil and Fat

The results of the measurement of oil and fat parameters upstream to downstream of the Girian watershed in Bitung City showed values of 0.1 – 0.4 mg/L, or 1000 – 4000 µg/L. The increase in the concentration of oil and fat is indicated to be influenced by community and industrial activities in the Girian Watershed in Bitung City. Excessive oil and fat in the water can block the penetration of light in the water which inhibits the rate of photosynthesis and prevents the entry of free O2 in the water.

Chemical Oxygen Dissolved (COD)

The results of measuring COD parameters of water at stations 1 – 3 of the Girian Watershed as shown in table 3 show an increase that exceeds the class I water quality standard that has been set in

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(PP No. 82 Tahun 2001), namely at station 3. COD is the total amount required for chemical oxidation, organic substances that decompose (biodegradable) and cannot be decomposed (non-biodegradable) into CO2 and H2O, and cause DO in water bodies to be low and even depleted.

Biochemical Oxygen Dissolved (BOD)

The test results show that the BOD value ranges from 1.5 to 4.5 mg/L. BOD values tend to increase from upstream to downstream and exceed group II BOD quality standards that have been determined in (PP No. 82 of 2001). The BOD value tends to increase from upstream to downstream because it is influenced by industrial and community activities in the Girian watershed area of Bitung City. When the concentration of BOD increases, it can cause a decrease in the concentration of DO in the water and will result in the death of aquatic organisms.

Results of the Pollution Index (PI) Analysis of the Girian Watershed

Water quality status is the level of water quality conditions that can indicate the condition of waters whether it can be classified as polluted or in good condition from water source that has been tested based on predetermined parameters and methods. In calculating the status of water quality in this study, it is based on the parameters specified in (PERMEN LHK-RI No. 68 Tahun 2016) concerning Domestic Waste Quality Standards and (PP No. 82 Tahun 2001) concerning Water Quality Management and Water Pollution Control. Then the results of the calculation of the Pollution Index Value are in accordance with (Kep-MENLH No. 115 Tahun 2003) concerning Guidelines for Determining Water Quality Status.

Table 5, Pollution Index (PI) of the Girian Watershed

No	Point	Class I		Class II		Class III		Class IV	
		PI	Water Quality Status	PI	Water Quality Status	PI	Water Quality Status	PI	Water Quality Status
1.	ST1	0.60	Good	0.57	Good	0.98	Good	0.53	Good
2.	ST2	1.61	Slightly polluted	3.36	Slightly polluted	0.53	Good	0.74	Good
3.	ST3	18.9	Heavily polluted	4.04	Slightly polluted	7.36	Fairly polluted	0.56	Good

Based on the results of the calculation of the pollution index in table 5, it can be concluded that the water quality of the Girian watershed in Bitung City from upstream to downstream has decreased in water quality (increased pollution index value) which in the downstream area (sampling point 3) is moderately polluted. In class III qualification. This is because the concentrations of TSS, pH, DO, NH3-N, Oils and Fats, COD, and BOD have exceeded the specified quality standards.

Table 6. Classification of water quality

Class	Allotment
I	Drinking water raw water
II	Water recreation facilities/facilities, freshwater fish cultivators, animal husbandry, water for irrigating crops
III	Freshwater fish cultivators, livestock, water for irrigating crops
IV	Watering plants.

Source : PP No. 82 Tahun 2001

Based on (PP No. 82 Tahun 2001), that the water quality in the upstream Girian Watershed in Bitung City can be used as drinking water and has been used by PDAM Duasudara of Bitung City as a source of irrigation for the people of Bitung City. And sampling station point 2 is in a densely populated area, good enough to be used for freshwater fish cultivation, livestock farming, and water for irrigating crops. Meanwhile, sampling point 3 is that the sampling of the estuary is only sufficient to irrigate crops and cannot be used as a source of water for freshwater fish cultivation and animal husbandry.

CONCLUSION

1. The condition of water quality in the Girian Watershed in Bitung City has decreased from upstream to downstream due to community and industrial activities in densely populated areas up to the mouth of the Girian watershed. From the results of water quality measurements, the value of TSS 10.5 mg/L, pH 6.69, DO 7.11 mg/L, NH3-N 0.18 mg/L, Oil and Fat 0.1 mg/L, COD 3 mg/L, BOD 1.5 mg/L quality according to the quality standards that have been determined. TSS 36.5 mg/L, pH 7.2, DO 5.08 mg/L, NH3-N 0.32 mg/L, Oils and Fats 0.2 mg/L, COD 1.67 mg/L, BOD 1.5 mg/L in densely populated areas and TSS 94.5 mg /L, pH 6.78, DO 5.14 mg/L, NH3-N 0.72 mg/L, Oils and Fats 0.35 mg/L, COD 18.5 mg/L, BOD 4.5 mg/L. and most of them exceed the quality standards that have been set in (PP No. 82 Tahun 2001) and (PERMEN LHK-RI No. 68 Tahun 2016).
2. From the results of the analysis of the pollution index (PI) in the upstream area of the Girian Watershed (DAS), Bitung City is classified as good in 4 groups and can be used as raw water for drinking water. In densely populated areas, the results are mildly polluted in group II and can be used enough for recreation, freshwater fish farming, animal husbandry, and irrigating crops. As well as the quality of water in the estuary of the Girian watershed which can only be used to irrigate crops and cannot be used in the fisheries, animal husbandry, and agriculture sectors.

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