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Water Quality Analysis of Batangtoru River in South Tapanuli District, North Sumatra Province

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ABSTRACT

Water is a natural resource whose quality needs to be maintained. In order to protect against pollution or achieve good river water quality, it is necessary to make good water management efforts to maintain water functions in accordance with water quality standards. The purpose of this research is to analyze the water quality of the Batangtoru River and the factors that affect the water quality of the Batangtoru River. This research was conducted in the river located in South Tapanuli Regency, North Sumatra Province, Indonesia, for two months in November and December 2020 with test parameters Total Suspended Solid (TSS), Biological parameters in the form of Biological Dissolved Oxygen (BOD), E.Colli, and chemical parameters in the form of Copper (Cu), Zinc (Zn), Cadmium (Cd), Nitrite (NO2-N), and Ammonia (NH3- N). The research results showed that the water quality of the Batangtoru river was: TSS 50 mg/L, BOD 3 mg/L, Cu 0.02 mg/L, Zn 0.05 mg/L, Cd 0.01 mg/L, NO2-N 0.06 mg/L, NH3-N and E. Colli 0 mg/L. These results based on PP 82 of 2001 show that the test parameter values have exceeded water quality standards. And it is included in class II, which means that the quality of the Batangtoru River is experiencing light pollution.

Keywords: *Batangtoru River, Industrial activities, Water Quality*

1. Introduction

A Watershed is an area surrounded and limited by topography in the form of ridges or mountains, while the river is an elongated surface water flow, the river is part of the watershed (Asdak, 2007). Batangtoru River has an area of ± 2800 km^2, the upstream of Batangtoru River is located at Humbang Hasundutan Regency. flows through North Tapanuli Regency, and crosses South Tapanuli Regency with the river downstream at Lake which empties into the Indian Ocean (North Sumatra Provincial Environment Agency, 2020).

The Batangtoru watershed area has a variety of land uses, including plantations, mining, roads, commercial, offices, settlements, and the Batangtoru Hydroelectric Power Plant. This land use causes changes in the environment, both plants and animals other changes also occur in the water sources found in this area, both the physical chemical, and biological conditions of the Batang Toru River (Sasongko, 2006). Residents widely use the Batangtoru River for their daily lives, including agricultural needs, plantations, industry in the form of gold mining, and household waste disposal (Setiowati & Endang, 2015).

Some river pollution is of course caused by the life around it, both the river itself and human behavior as river users. The dominant influence of pollution that is very visible is the damage caused by humans depending on their lifestyle in utilizing nature. Every river bank that is close to a factory or industrial area will certainly see waste channels leading to the river body. Industrial growth demands the provision of large amounts of land, water, air and energy as a place or medium for carrying out its activities, followed by an increase in waste and effluent which have the potential to become environmental pollution (Suharto, 2010)

In addition to being used for the benefit of the population, the Batangtoru watershed receives wastewater from activities that develop in the surrounding environment. Some of this wastewater is directly discharged into the river without treatment and some has been treated before being discharged into the river. Sources of wastewater include those from class C excavation activities, gold mining, oil palm plantations, hospitality and tourism activities, and resident wastewater (domestic waste). Various land use activities in the Batangtoru watershed are thought to have affected river water quality. Based on the description above, it is necessary to analyze the water quality in the Batangtoru River due to the activities of big companies and residents in the area.

2. Research Methodology

The research was conducted on the Batangtoru River in South Tapanuli Regency, North Sumatra Province, Indonesia. This research was conducted in November and December 2020. The research results were obtained quantitatively by analyzing or measuring Batangtoru River water at three points representing activities around the Batangtoru River while secondary data was obtained from several related technical agencies.

2.1 Sampling Method

The method of taking test samples (Batangtoru River water samples) using the SNI 6989.57.2008 method. where the method of taking test samples is carried out by grab sampling, namely taking test samples with two repetitions carried out with an interval of one month in the second (second) week of each month, in November and December (Hernaningsih, 2020).

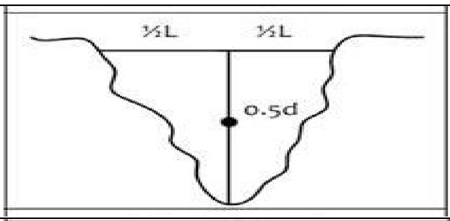
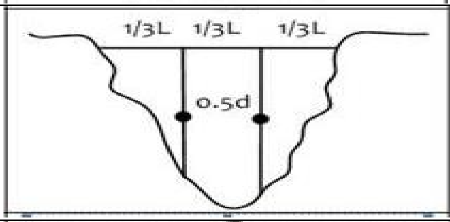
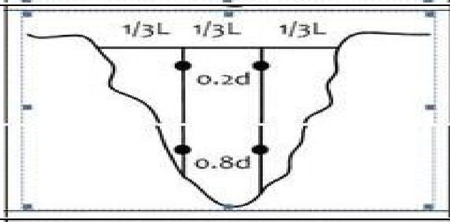
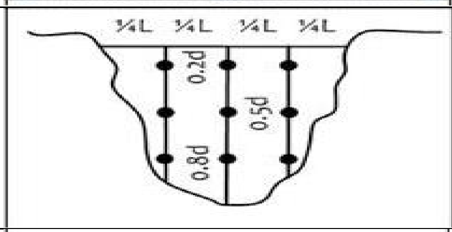
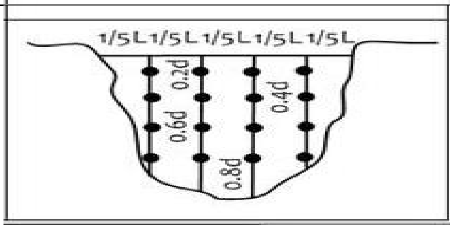
Determination of the sampling point is based on the width of the river, the nature and characteristics of the river, the depth of the river, and the activities around the location. Sampling or test samples several things must be considered, among others, the nature and characteristics of the sample, test parameters (analysis parameters that represent physics, chemistry, and biology), test sample containers, and sample preservation. The analysis parameters (test samples) that will be analyzed must be able to represent all activities around the research location so that from these parameters it can be identified sources of pollution that can reduce the water quality of the Batang Toru River and the steps of environmental management that must be taken (Hadi, 2015).

Table 1. Estimated perfect mixing distance of river water.

Average width (m)	Average depth (m)	The approximate distance of complete mixing (km)
5	1	0,08 – 0,70
	2	0,05 – 0,30
	3	0,03 – 0,20
10	1	0,30 – 2,70
	2	0,20 – 1,40
	3	0,10 – 0,90
	4	0,08 – 0,70
	5	0,07 – 0,50
20	1	1,30 – 11,0
	3	0,40 – 4,00
	5	0,30 – 2,00
	7	0,20 – 1,50
50	1	8,00 – 70,0
	3	3,00 – 20,0
	5	2,00 – 14,0
	10	0,80 – 7,00
	20	0,40 – 3,00

Source: (Hadi, 2015)

Table 2. Number of river water sampling points.

Average annual discharge (m^3/det)	River Classification	Total Depth	Number of Sample Points
< 5 (Average depth < 1m)	Very Small	1	
< 5 (Average depth > 1m)	Small	1	
5 – 150	Medium	2	
150 - 1000	Large	3	
> 1000	Very Large	4	

Source: (Hadi, 2015)
Note: d = river water depth, L = river width

The test parameters in this study are Physical parameters in the form of Total Suspended Solid (TSS), Biological parameters in the form of Biological Dissolved Oxygen (BOD), E.Colli, and chemical parameters in the form of Copper (Cu), Zinc (Zn), Cadmium (Cd), Nitrite (NO_2-N), Ammonia (NH_3-N). and preservation of these parameters is carried out so that the Batang Toru river water samples taken are not damaged or contaminated. The following test parameters along with containers and preservation are contained in the table as follows:

Table 3. Parameters, procedures for preservation and storage of test Samples or samples.

No.	Parameters	Minimum Storage Container	Minimum sample amount required (mL)	Preservation	Length of storage Maximum recommend ed SNI	Duration storage maximum storage length according to EPHA	Information
1	Physics						
	Total Suspended Solid (TSS)	G	1000	Cooling	Two Days	Four Days	Lab analysis

No.	Parameters	Minimum Storage Container	Minimum sample amount required (mL)	Preservation	Length of storage Maximum recommended SNI	Duration storage maximum storage length according to EPHA	Information
2.	Chemistry						
	pH	P, G	-	Analyzed immediately	Two hours	Two hours	Insitu (field measurement)
	Biological Oxsigen Demand (BOD_5)	G, P	1000	Cooling	Six hours	Two Days	Analyzed in the lab, (Dissolved Oxygen measured in the field)
	Nitrate (NO_2)	P, G	200	Add right Sulfuric Acid until pH < 2, cool right	-	Twenty-eight days	Lab analysis
	Ammonia (NH_3)	P, G	500	Add right Sulfuric Acid until pH < 2, cool right	seven days	Twenty-eight days	Lab analysis
	Metals in General, Cu, Cd, Zn, Pb, As, Ni, Cr, Hg	G, P	500	For metals dissolved the water sample is filtered immediately with more right Nitric Acid until pH < 2 Cool add the right Nitrit Acid sampai until pH < 2 chill	Six Months	Six Months	Lab analysis
	Biology						
	Ecolly	P	100	Cooling, rinse alcohol	twenty-four hours	twenty-four hours	Lab analysis

Source SNI 6989.58.2008 and EPHA Method 1. (1996)
Description: - P: Poly Ethylene - G: Glas Ware (Glass Bottle)

2.2 Data Analysis Methods

Water quality status is the level of water quality conditions that indicate polluted conditions or good conditions in source water within a certain time by comparing the results of the analysis with the water quality standards set based on Government Regulation No. 82 of 2001 concerning water quality management and water pollution control. The parameters monitored in this study are TSS, BOD, Cu, Zn, Cd, NO_2-N, NH_3-N, and E.Colli.

3. Result and Discussion

3.1 Batang Toru River Water Quality Monitoring Location

The sampling location is in the Batang Toru River, South Tapanuli Regency, North Sumatra Province, Indonesia, where the sampling location is divided into three sampling locations. Specifically, the sampling locations are at stations and or sampling points (ST):

1. Station one (ST1) with coordinates North latitude 1º28'4.54" and East Longitude: 99º03'16.41"
2. Station two (ST2) with coordinates North latitude 1º28'5.50" and East Longitude: 99º03'10.95"

3. Station four (ST4) with coordinates North latitude 1º28'6.65" and East Longitude: 99º02'57.49"

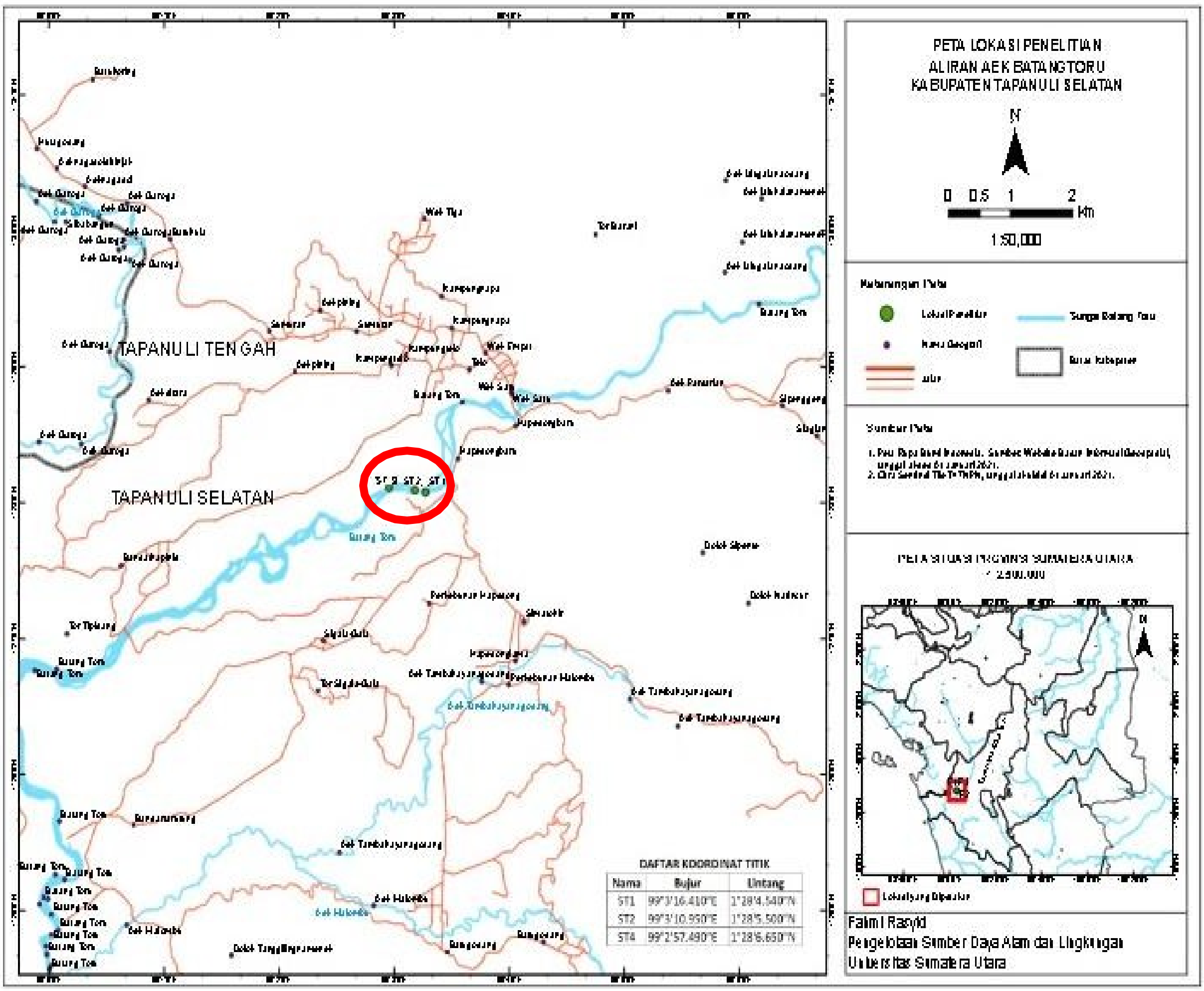


Figure 1. Sampling location map.

Water quality parameters were tested physically, chemically, and biologically. Some water quality parameters can be analyzed directly at the research site (in situ) and some parameters are analyzed or tested in the laboratory to determine the value of each parameter. The laboratory analysis results for Physical parameters in the form of Total Suspended Solid (TSS), Biological parameters in the form of Biological Dissolved Oxygen (BOD), E.Colli, and chemical parameters in the form of Copper (Cu), Zinc (Zn), Cadmium (Cd), Nitrite (NO_2-N), Ammonia (NH_3-N). The conditions at the time of the research to take test samples are conditions where the Batangtoru River has a small river discharge and is not in a state of rainfall and there is a land median on the Batangtoru River at the research location. The following are the results of the laboratory analysis:

3.2 Total Suspended Solid Analysis (TSS)
A Based on the sampling results and the results of laboratory analysis carried out for the value and/or TSS levels at the research location as follows:

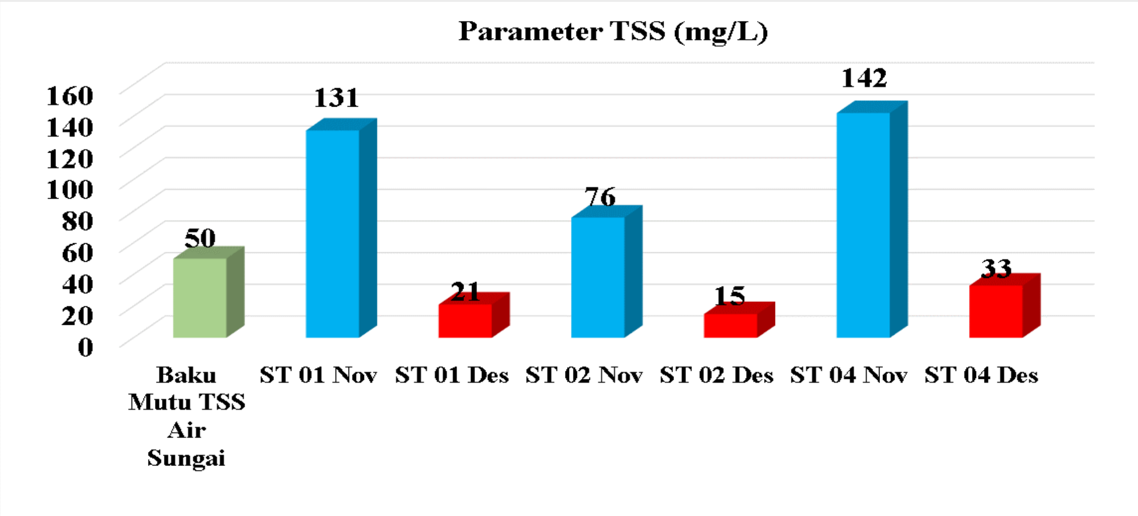


Figure 2. Concentration total suspended solid analysis (TSS).

In Figure 2 from the results of laboratory analysis, it can be seen that the Total Suspended Solid (TSS) value in November 2020 at the research locations (ST 1, ST 2, and ST 4) exceeded the quality standards based on PP 82 of 2001 with a TSS value of 131 mg/L at the ST 01 research location, a TSS value of 76 mg/L at the ST 02 research location and 142 mg/L at the ST 04 research location and the TSS value in December 2020 did not exceed.

The high TSS value of Batangtoru river water in November was due to the siltation of the river, a decrease in river discharge and soil erosion that was carried to the riverbed, the excavation of non-metallic mineral and/or rock mines (excavation C) around the Batangtoru river. According to the TSS concentration in the Batangtoru watershed exceeds the quality standard set by PP No. 82 of 2001 class II (> 50mg/L) due to the presence of type C mining excavations. Furthermore, according to (Muchlisin, 2012) and (Nicola, 2015) TSS is solid material such as sand, mud, microorganisms, soil, and heavy metals suspended in water areas as a result of soil erosion and waste disposal that is carried into water bodies. Suspended solids consist of particles that are smaller in weight and size than sediment. These solids can settle immediately because they do not dissolve in water.

Based on field data and field observations, the high TSS value is due to sand extraction activities in the upstream area which is precisely above the ST 1 research location, and at the ST 4 location, there is mobilization of river sand and gravel materials taken from the Batangtoru river.

3.3 Analysis Biological Oxygen Demand (BOD)

Based on the sampling results and the results of laboratory analysis conducted for the value and/or level of Biological Oxygen Demand at the research location as follows:

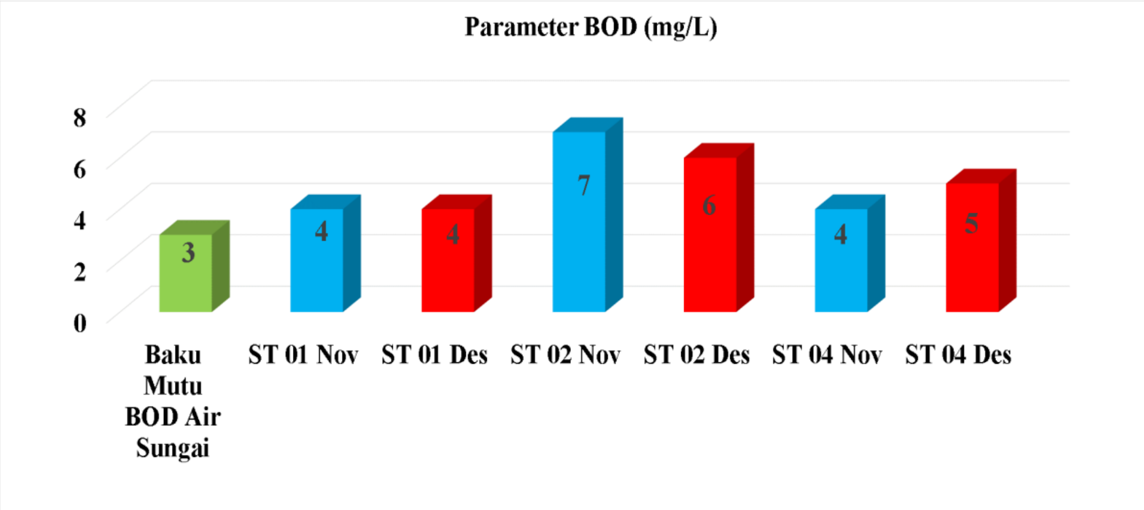


Figure 3. Concentration biological oxygen demand (BOD).

In Figure 3 it can be seen that based on the results of the analysis, the Biological Oxygen Demand value in the Batangtoru River at all sampling points exceeds the quality standard, indicating that there is organic waste discharged into the river body. According to (Rahmawati, 2011), organic waste materials are generally in the form of waste that can be decomposed or degraded by microorganisms, so when discharged into waters will increase Biological Oxygen Demand

The value of Biological Oxygen Demand greatly affects the ability of the river to recover. The incoming pollutant load must not exceed the ability of the river to perform self-purification If more, then the river will be polluted and not by its designation (Suwari, 2010)

According to (Chan et al, 2013) palm oil liquid waste has the potential as an environmental pollutant because it contains Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and high suspended solids so that it can reduce the fertility of the water body.

3.4 Copper Metal Analysis (Cu)

Based on the results of laboratory analysis for the value of Copper can be seen in the following graph:

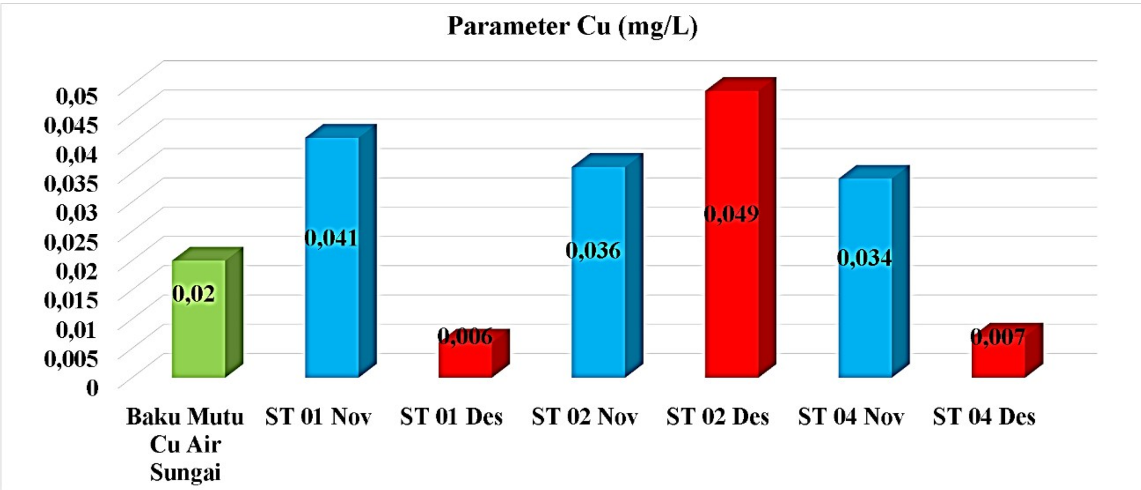


Figure 4. Concentration copper (Cu).

In Figure 4 it can be seen that the Copper value in November for both ST 01, ST 02, and ST 04 exceeded the quality standard, with values of 0.041 mg/L, 0.036 mg/L, and 0.034 mg/L. At the same time, the highest Copper value that exceeded the quality standard in December was ST 02 at 0.049 mg/L, whereas the Copper Quality Standard set based on PP 22 of 2021 is 0.02 mg/L.

Copper is a micro-element that is needed by organisms, both terrestrial and aquatic, but in small amounts. The presence of Copper in public waters can come from industrial areas around the waters. This metal will precipitate and be absorbed by aquatic biota on an ongoing basis if its presence in the water is always available. The existence of the mining industry environment around the Batangtoru River is suspected to be a contributor to the input of waste in the form of heavy metals, especially copper (Cu) into the Batangtoru watershed. The copper content in sediments tends to be high, this is due to the nature of heavy metals that settle over some time and then accumulate at the bottom of sediment waters.

Based on the results of research by (Cahyani et al, 2012), the disruption of aquatic ecosystems is due to the increase in industrial waste discharges from several factories, including heavy metal waste. Furthermore, based on the results of research by (Sirait & Wahyuningsih, 2013) on heavy metal content in fish species in the Batangtoru River, states that the level of Copper metal accumulated in the body of fish found in Puntius lateristriga fish at 3 ppm.

3.5 Zinc Metal Analysis (Zn)

Based on the sampling results and the results of laboratory analysis carried out for the value and/or level of Zinc at the research location, the following results were obtained:

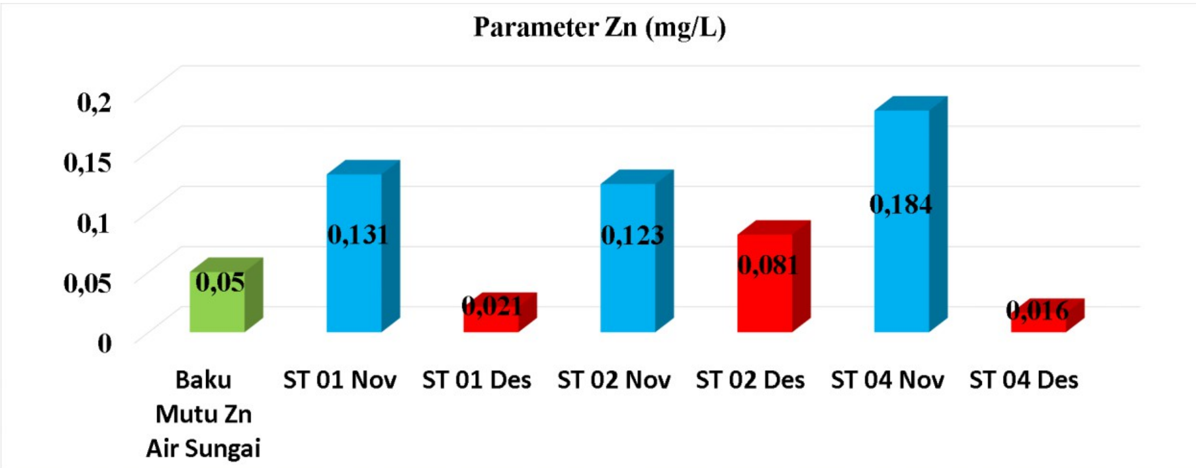


Figure 5. Zinc (Zn) concentration.

In Figure 5 it can be seen that the Zinc value in November at ST 01, ST 02, and ST 04 exceeded the Zinc quality standard for river water with values of 0.131 mg/L, 0.123 mg/L, and 0.184 mg/L. At the same time, the highest Zinc value in December was ST 02 at 0.081 mg/L with the quality standard set based on PP 82 of 2001 for a Zinc value of 0.05 mg/L.

Zinc (Zn) heavy metal is a shiny bluish-white metal that is quite reactive when reacting with oxygen and is a type of metal that does not break down easily in water. Overall, the water in the Batangtoru River has higher levels of zinc than other metals. This may also be due to mining activities in the area and waste disposal into the river. Zinc heavy metal is usually required as a chemical additive in the final refinement process of mine processing.

According to (Hutagalung, 1984), zinc heavy metal pollution can come from industrial activities and nature. Water pollution can be in the form of salts of heavy metals and heavy metals that form toxic compounds. This is in line with research conducted by (Mahyudin et al, 2015) and (Nugraha, 2007) on the Kaligarang River, namely the quantity of Zinc pollution in Kaligarang River is caused by domestic waste from communities around the river and industrial waste which is relatively high every day.

According to (Widowati et al, 2008), zinc on earth is very abundant. One cubic meter of seawater is estimated to contain 1 ton of zinc, while 1 mile of the earth's crust under the ground contains 224 billion tons of zinc. Zinc levels in the earth's crust are 75 ppm. In addition, high levels of zinc come from residential waste because zinc is widely used to mix household appliances and objects that are often used by humans such as paint, rubber products, cosmetics, medicines, floor coatings, plastics, printing, inks, batteries, textiles, electronic equipment, chemicals, solder, and roofing.

3.6 Cadmium Metal Analysis (Cd)

Based on the results of laboratory analysis for the value of Cadmium at the research location can be seen in the following graph:

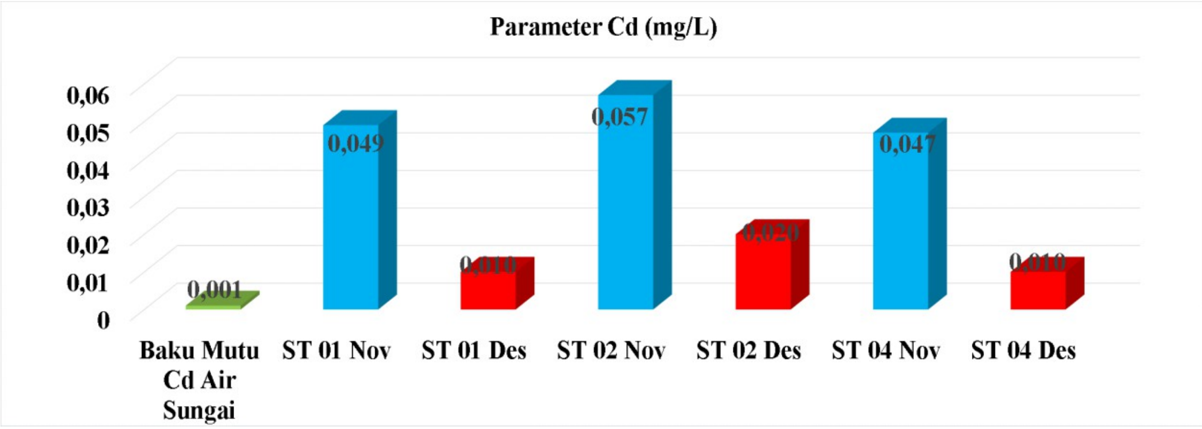


Figure 6. Cadmium (Cd) concentration.

In Figure 6 it can be seen that the Cadmium values in November and December at all sampling stations and/or research sampling points exceeded the Cadmium quality standard in river water. The highest Cadmium value in November was at ST 02 of 0.057 mg/L and the highest Cadmium value in December was at ST 02 of 0.020 mg/L.

Cadmium heavy metal is often used as a paint colorant, PVC/plastic, and nickel cathode. The main source of cadmium contamination is industry (Darmono, 1995). The source of heavy metal Cadmium in water is related to human activities, namely industrial waste discharges and household waste that flow into river bodies. At the time of sampling the condition of the river media, there is land with a river width of only 0.5 m to 1.5 meters, and there is land + 27 meters with a total river width of 49.5 meters (There is flowing river water and not flowing river water) and relatively small river discharge. This is consistent with the situation in the Batangtoru River, there are industrial activities and waste discharged into the river.

According to (Paramitha et al, 2017), the concentration of heavy metals in sediments will always be higher than the concentration of heavy metals in water. This is because heavy metals have properties that easily bind to organic matter and settle to the bottom of the waters, then unite with sediments, so heavy metal levels in sediments will be higher when compared to metal levels in water where at the time of sampling the river conditions were in a state of ebb with a small river water discharge. So that dissolved Cadmium levels can accumulate.

3.7 Nitrite Analysis (NO_2-N)

Based on the results of laboratory analysis the value of Nitrite at the research location can be seen as follows:

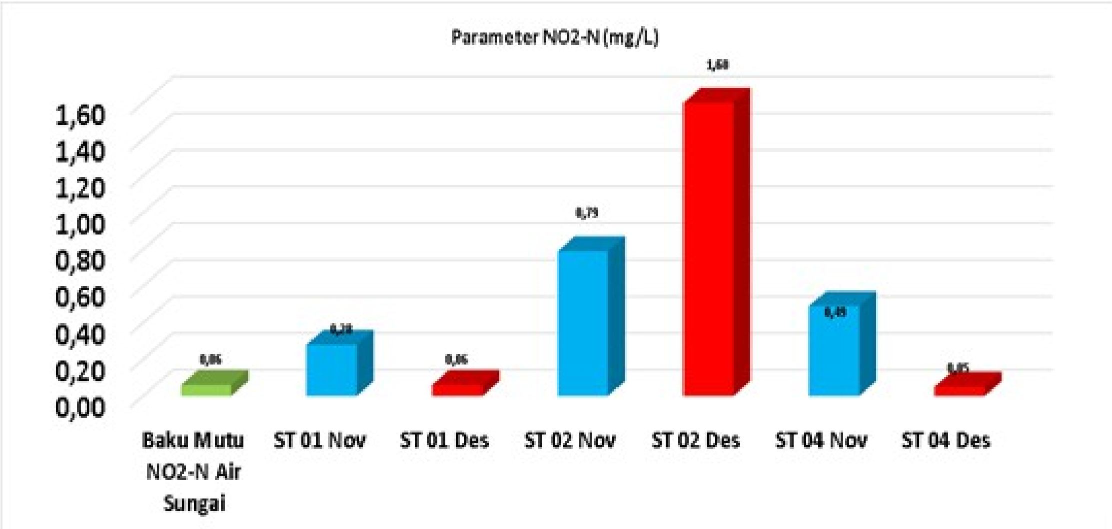


Figure 7. Nitrate (NO_2-N) concentration.

The results of Nitrate analysis at ST 01 in November obtained a level of 0.28 mg/L and for ST 01 in December obtained a value of 0.06 mg/L, at ST 02 in November and December obtained Nitrate values of 0.79 and 1.60 mg/L as well as at point ST 04 with Nitrate values in November and December of 0.49 and 0.05 mg/L with a Quality Standard value of 0.06 mg/L.

According to (Connell & Miller, 1995), nitrogen compounds (nitrite, nitrate, and ammonia) in waters naturally come from the metabolism of aquatic organisms and the decomposition of organic materials by bacteria. In addition, nitrite and nitrate in nature can be produced naturally or from human activities. The source of nitrite and nitrate is the nitrogen cycle while the source from human activities comes from the use of nitrogen fertilizers, industrial waste, and human organic waste.

3.8 Ammonia Analysis (NH_3-N)

The results of laboratory analysis on the Ammonia parameters at the study site are as follows:

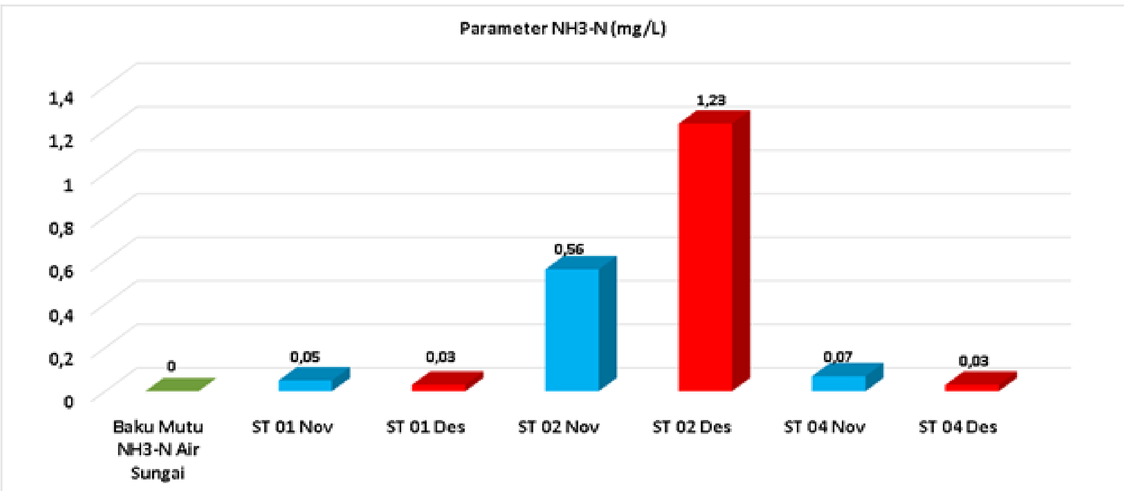


Figure 8. Ammonia (NH_3-N) concentration.

In Figure 8 it can be seen that the amount of Ammonia value at the ST 1 research location in November and December obtained Ammonia values of 0.05 mg/L and 0.03 mg/L, for ST2 obtained Ammonia values in November and December 0.56 and 1.29 mg/L and at the ST 04 location obtained values of 0.07 mg/L in November and 0.03 mg/L in December. The quality standard of river water quality in PP 82 of 2001 Ammonia value in class I is 0.5 mg/L and for classes II, III, and IV is not regulated.

According to (Wardana, 2001), ammonia content usually increases when polluted by organic, agricultural, and domestic waste because ammonia is found in urea fertilizers and detergents. However, ammonia content can decrease if a water body contains high dissolved oxygen (DO) content. So ammonia content is usually not found in water bodies that have an adequate supply of oxygen in the water.

According to (Wage, 2004), ammonia content usually increases when polluted by agricultural organic waste and domestic and according to (Rusyidi et al, 2015), the continuous use of inorganic fertilizers can hurt the environment, especially the quality of groundwater and surface water, resulting in water pollution. The impact on the environment itself is the increasing concentration of pollutants that absorb into the soil surface and then spread to low-pressure areas which are then carried by water.

3.9 E.Coli Analysis

The results of laboratory analysis on the E.Coli parameters at the study site are as follows:

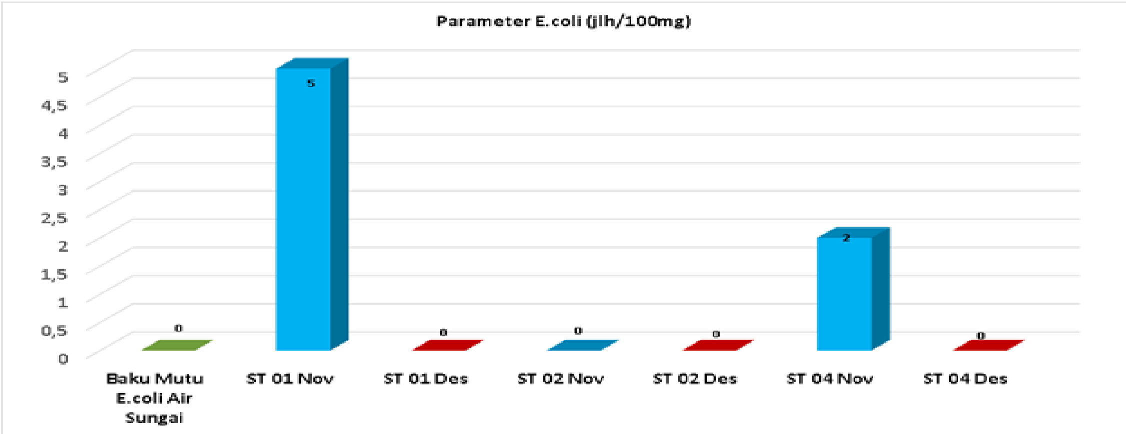


Figure 9. E.Coli concentration.

Figure 9 based on the results of the analysis it can be seen that the highest E.Coli value is at ST 01 in November obtained a value of 5 counts/100 ml and at ST 4 in November obtained a value of 2 counts/100 ml, for quality standards the value of E.Coli in PP 82 of 2001 is not regulated.

Escherichia coli is one of the bacteria classified as Coliform and lives normally in human and animal feces. Therefore, it is also called fecal Coliform. Escherichia coli is a gram-negative bacterium, rod-shaped, and does not form spores (Fardiaz, 1992). Furthermore, according to (Piranti et al, 2020) the presence of coliform bacteria in water bodies can be an indication of the presence of pathogenic bacteria such as E. Coli which are harmful to health. humans if utilized as a clean water source.

According to (Ali et al, 2015), E. coli is an indicator of fecal contamination from humans and animals. Furthermore, the determination of fecal coliform is an indicator of pollution because the number of colonies must be positively correlated with the presence of pathogenic bacteria.

4. Conclusion

From the results of research conducted from November 2020 to December 2020 with three research location points, it was found that the water quality of the Batangtoru river was: TSS was 50 mg/L, BOD was 3 mg/L, Cu was 0.02 mg/L, Zn was 0.05 mg/L, Cd was 0.01 mg/L, NO2-N was 0.06 mg/L, NH3-N and E. Colli was 0 mg/L. From the results of research conducted from November 2020 to December 2020 with three research location points, it was found that the water quality of the Batangtoru river was: TSS was 50 mg/L, BOD was 3 mg/L, Cu was 0.02 mg/L, Zn was 0.05 mg/L, Cd was 0.01 mg/L, NO2-N was 0.06 mg/L, NH3-N and E. Colli was 0 mg/L. The factor that causes TSS is the excavation of mineral mines around the Batangtoru river. The BOD levels are due to organic waste that is thrown into river bodies. The biggest contributor to Cu, Zn and Cd levels is due to the existence of the mining industry environment around the Batangtoru river. There is ammonia content due to organic and agricultural waste. So, it is known that the factors that influence the water quality of the Batangtoru river are waste from gold mining companies, palm oil factories, C excavations, agricultural and plantation waste (oil palm and rubber) as well as domestic waste from communities around the river. Some of this waste goes through a processing process first, such as waste disposed of by gold mining companies, but for other waste it is not processed first before being discharged into river bodies, causing a decrease in river water quality.

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