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Analysis of River Water Quality Based on Pollution Index Water Quality Status, Lombok District, NTB

Supardiono[1], Gito Hadi Prayitno[2], Jono Irawan[3], Lalu Adi Gunawan[1]

[1] Environmental Science Study Program, Faculty of Mathematics and Natural Sciences, University of Mataram, Mataram, Indonesia
[2] Biology Education Study Program, Faculty of Teacher Training and Education, University of Mataram, Mataram, Indonesia
[3] Laboratory of Chemistry Education Study Program, Faculty of Teacher Training and Education, University of Mataram, Mataram, Indonesia

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Corresponding Author:
Supardiono
supardiono@staff.unram.ac.id

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Abstract: Leneng River is one of the rivers in Praya City, Central Lombok Regency, which receives domestic, agricultural, and household industrial waste. Various community activities along the banks of the Leneng River have affected river water quality. Some communities on the banks of the Leneng River, from upstream to downstream, still use river water for their daily needs. This study aims to 1) analyze the water quality of the Leneng River in terms of environmental parameters (Physical, chemical, and biological) and 2) Determine the level of pollution of the Leneng River water using the Pollution Index (IP) method. River water quality measurements were carried out at 3 (three) sample points. Parameters measured and observed were physical parameters, namely Total Solid Suspend (TSS); chemical parameters, namely pH, Total Phosphate (T.PO4), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), and biological parameters namely Total coliform and Fecal Coliform. This type of research is survey research with a quantitative descriptive approach. The results showed that the TSS value at sample point 1 (upstream) exceeded the required quality standard; the highest TSS concentration value was 54 mg/L, and the lowest at sample point 2 (middle section) was 2.50 mg/L. Value parameter concentration pH 7.7-8.7, T.PO4 value 0.05 mg/L-0.29 mg/L, BOD value 0.17-0.42 mg/L, COD concentration value 8 mg/L -9mg/L, and DO value of 6.07 mg/L-7.57 mg/L, this shows that the concentration for chemical parameters still meets the class I water quality standards according to PP 22 of 2021, while the total coliform parameter value and Facel coliform have exceeded class I water quality standards. The total coliform concentration value is 10,000 - 20,000 MPN/100 mL, and the Fecal coliform value is 600 MPN/100 mL – 2,500 MPN/100 mL, while based on the Pollution Index (IP) quality status water in the upstream with a value of 2.84, the middle part of 1.97, and the downstream part of 2.84, this shows a decrease in water quality from upstream to downstream of the river, with a level of pollution in the lightly polluted category.

Keywords: Leneng River; Pollution Index; Water Quality

Introduction

The Leneng River is one of the rivers that flow into the Batujai Reservoir, which receives the domestic and sewage waste industry from settlement and trade activities. Residential development and trading activities along the banks of the Leneng River have affected water quality. A river can be polluted if it enters or enters polluting materials, which can cause disturbance to the living things in it (Ali, 2019). The high content of TSS is one indicator of the decline in water quality, but some people on the banks of the river still use river water for their daily needs. A river is said to be polluted if the water quality is not following the designation (Puckett, 1995). This water quality is based on water quality standards according to water class based on Government Regulation Number 22 of 2021 concerningAdministration, Protection and management of the environment.

Rice fields and plantations, and settlements dominate the upper reaches of the Leneng River. At the same time, in the middle part, there are various

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variations of land use, including settlements, offices, trade, workshops, clinics/hospitals, and other service activities, so this is the main consideration in determining the river. Leneng as a place of research. On average, the domestic wastewater disposal system for settlements still uses drainage channels that flow directly into the Leneng River, which results in the inability of the river's carrying capacity for domestic waste to neutralize. Therefore, it is necessary to analyze the water quality of the Leneng River to measure how much pollution is occurring in the Leneng River. According to the Decree of the Minister of Environment No. 115 of 2003 concerning Guidelines for Determining the Status of Water Quality, what is meant by water quality is the level of polluted conditions or good conditions in a water source at a certain time by comparing it with the stipulated water quality standards.

This study aims to analyze the water quality in the Leneng River using the Pollution Index (IP) method and analyze the influence of community activities in the upstream, middle, and downstream parts of the water quality in the river with the parameters TSS, pH, T. PO_4, BOD, COD, DO, Total coliform, limit *Fecal Coliform* on the water quality status of the Leneng River (Piranti et al., 2019; Rezaie-Balf et al., 2020).

The method used to determine the status of river water quality is the Pollution Index method (Kowalska et al., 2018) (Suriadikusumah et al., 2021). Management of water quality based on the Pollution Index (IP) according to the Decree of the Minister of Environment No. 115 of 2003 concerning Guidelines for Determining the Status of Water Quality can provide input to policymakers so they can take action to improve quality if there is a decrease in quality due to the presence of pollutant compounds. The evaluation of the IP value is as follows:

$0 \leq Pij \leq 1.0$ = meets the quality standard (good condition)
$1,0 < PIj < 5,0$ = light pollution
$5,0 < PIj \leq 10$ = moderately polluted
$PIj > 10$ = heavily contaminated

Method

Location and Time of Research

The research location was carried out in the Leneng River, and water sampling was carried out in the upper, middle, and lower reaches of the Leneng River. In contrast, the sampling time was carried out in July 2022.

Materials and Methods

The materials used in this study included water from the Leneng River; water samples were used to determine the concentration of water quality, while the water quality parameters measured were TSS, pH, T.PO_4, BOD, COD, DO, Total Coliform, and *fecal Coliform*. The measurement of water quality parameters was carried out at the Environmental Laboratory of the Central Lombok Environmental Service, and the method used in this study was a descriptive method with a quantitative approach.

Determination of Sampling Points

Determination of water sampling points using the sample *survey method, namely* the sampling method, is done by dividing the study area into 3 (three) segments or sample points that are expected to represent the study population (Wood, 1976). Determining water sampling points is based on ease of access to river water sampling, cost, and research time. Research Locations are shown in Figure 1.

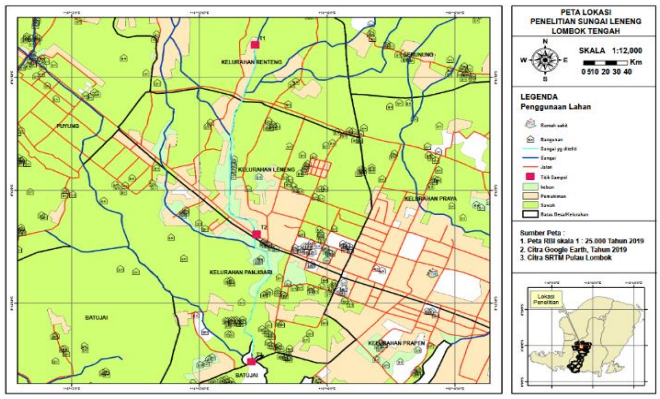

Figure 1. Map of Research Locations

The river water sampling point is divided into 3 (three) parts, namely the upstream, middle, and downstream sections, as shown in Table 1.

Table 1. Sampling Points River water

Point Locations and Coordinates	Community Activities
Point 1 (Upstream) S 8.68928° E 116.26196°	Agriculture and Settlements
Point 2 (Middle Section) S 8.70325° E 116.26205°	Settlements, services, and trade
Point 3 (Downstream) S 8.71264° E 116.26175°	Agriculture, Services, and trade

Source: LHU Central Lombok Environmental Service, Year 2022.

Data analysis

Water quality measurement data is compared with river water quality standards following Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and

Management to determine the class of river water. Water quality analysis was carried out using the Pollution Index (PI) method according to the Decree of the State Minister for the Environment No. 115 of 2003 Appendix II concerning Guidelines for Determining Water Quality Status. To determine the level of river water pollution formula is used (Kahangwa, 2022).

$$PIj = \sqrt{\frac{(\frac{ci}{Lij})^2_M + (\frac{ci}{Lij})^2_R}{2}} \quad (1)$$

Information:
Lij = concentration water quality parameters listed in the water allotment quality standard (J)
Ci =Concentration water quality parameters in the field
PIj = pollution index for designation (J)
Ci/Lij)M= Nilai, Ci/Lij maximum
(Ci/Lij)R= Value, Ci/Lij rata-rata

The Pollution Index method uses various water quality parameters, so the average value of the entire Ci/Lij value is required to measure pollution. However, this value will not be significant if one of the Ci/Lij values is >1. So this index must include the maximum Ci/Lij value. River The more polluted for a designation (J) if the value of (Ci/Lij)R and (Ci/Lij)M is greater than 1.0 if the value of (Ci/Lij)R and the value of (Ci/Lij)M is greater, then the pollution of a body of water will be even greater.

Result and Discussion

Leneng River Water Quality

The results of water quality laboratory tests based on environmental parameters (physics, chemistry, and biology) are shown in Table 2.

Table 2. The results of water quality laboratory tests

Environmental Parameters	Unit	Sampling Locations			Water quality standards			
		T1	T2	T3	Class I	Class II	Class III	Class IV
TSS	mg/L	54	2.5	10	40	50	100	400
pH	-	8.7	8.2	7.7	06-Sep	06-Sep	06-Sep	06-Sep
DO	mg/L	6.85	7.54	6.07	6	4	3	1
Total Phosphate	mg/L	0.05	0.29	0.09	0.2	0.2	1	-
BOD	mg/L	0.17	0.27	0.42	2	3	6	12
COD	mg/L	9	8	9	10	25	40	80
Total coliform	MPN/ 100mL	10,000	11,000	20,000	1000	5000	10,000	10,000
Fecal coliform	MPN/ 100mL	600	2,000	2,500	100	1000	2000	2000

Source: Central Lombok Environmental Service, 2022.

a. TSS

Suspended solids or (TSS) are solids consisting of various particles such as sand, silt, and clay or suspended particles in water and can be living (biotic) components such as phytoplankton, *zooplankton*, bacteria, fungi, or particles nonorganic or detritus. The results of water quality tests with a comparison of water quality standards are presented in Figure 1.

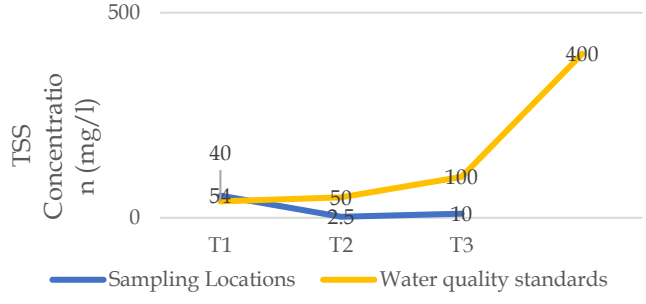

Figure 1. Comparison of TSS Parameter Test Results with Water Quality Standards

The suspended solids content as a physical parameter has value measurement different at each sampling point. The highest suspended solids (TSS) content was found at sample point 1 (upstream), reaching 54 mg/L. In accordance with Government Regulation Number 22 of 2021 shows that the TSS value at sample point 1 indicates water quality is in class 3 (three), while the TSS value at sample points 2 and 3 is 2.50 mg/l and 10 mg, respectively /l. The high TSS value at sample point 1 is due to the presence of open land around rivers and irrigation canals around rivers so that sediment pollution in the form of sand, mud, and leaf litter is carried away by the rain (*runoff*) and enters the river body.

b. pH

Based on the results of chemical parameter laboratory tests, namely, the pH at the three sample points ranged from 7.7 to 8.7. The measurement results still show compliance with water quality standards because they have stayed within the threshold value that

has been determined in accordance with PP 22 of 2021. The high pH value at Station 1 (upstream) is due to the process of photosynthesis by aquatic plants such as phytoplankton which utilizes sunlight as energy and CO_2, which is absorbed for the continuation of photosynthesis in decomposing water molecules, reducing NADP to NADPH and forming oxygen gas, so that CO levels in water decreases while the O_2 in water increases. The results of water quality tests compared to water quality standards are presented in Figure 2.

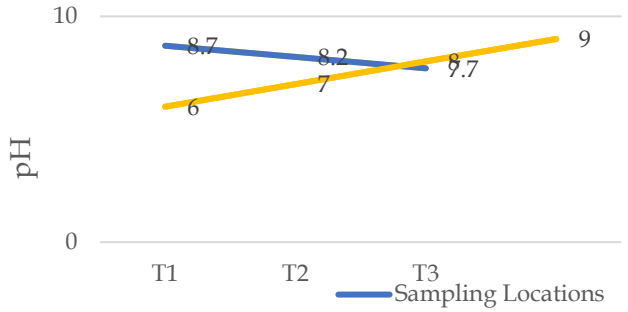

Figure 2. Comparison of pH Parameter Test Results with Water Quality Standards

The value of the pH range still allows organisms to live. According to Djoharam (2018), the pH range suitable for aquatic organisms is not the same depending on the type of organism. However, most aquatic biota are sensitive to changes in pH and have a pH tolerance of around 7 – 7.5. If the pH value is 6 - 6.5, it will cause the diversity of plankton and animals' macrobenthos will decrease. Likewise, the high pH value greatly determines the dominance of phytoplankton which affects the level of primary productivity of water where the presence of phytoplankton is supported by the availability of nutrients in the waters.

c. Dissolved oxygen (DO)

The DO content at each sample point ranged from 6.07 – 7.57 mg/L, per the water quality standards in Government Regulation 22 of 2021. The DO parameter measurement value has a minimum limit for each water class. DO is the amount of dissolved oxygen in the water. The greater the DO content value, the better the water quality. The results of water quality tests compared to water quality standards are presented in Figure 3.

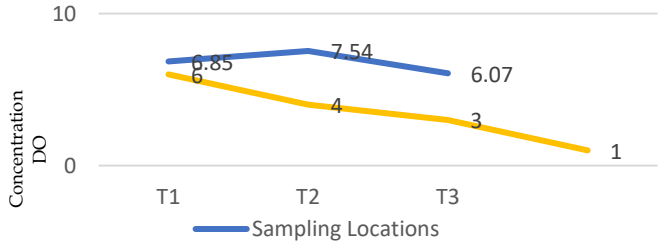

Figure 3. Comparison of DO Parameter Test Results with Water Quality Standards

The DO parameter at all sample points has met the class 1 water quality standard with a DO value of > 6 mg/L. It shows that organic waste can be diluted by river water so that it does not affect the water quality of the Leneng River. According to Pangabean (2017), the high DO value in water bodies is also caused by photosynthesis by aquatic plants such as phytoplankton which produce oxygen in the waters. Phytoplankton can produce dissolved oxygen during the process of photosynthesis. The presence of dissolved oxygen is very important because all aerobic organisms utilize dissolved oxygen for the respiration process.

d. Total Phosphate

Parameter measurement results at each monitoring point showed that total phosphate ($T.PO_4$) in Leneng River water is highest the downstream (sample point 3) and lowest in the upstream (sample point 1). The parameter concentration of total phosphate in the Leneng River ranges from 0.05 to 0.29 mg/L. Compared to the class I water quality standard based on PP 22 of 2021, which is 0.2 mg/L, the water quality conditions of the Leneng River in the central part exceed the class I water quality standard, in the upstream and downstream parts, the water quality is still categorized as good or appropriate. With class, I water quality standards. Compared with the results of laboratory tests from the Central Lombok Environmental Service in 2022, the phosphate concentration in the upstream part was 0.05 mg/L, the middle part was 0.29 mg/L, and the downstream area was 0.09 mg/L L. The results of water quality tests compared to water quality standards are presented in the following Figure 4.

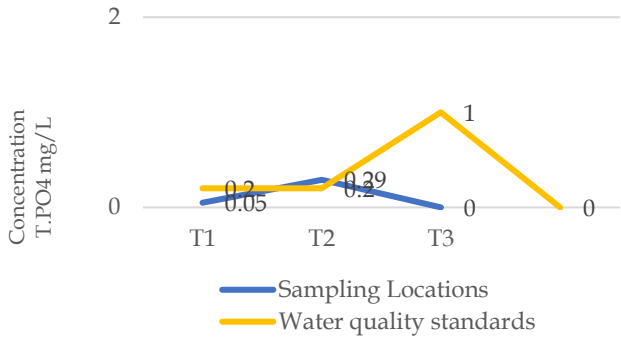

Figure 4. Comparison of Parameter Test Results in $T.PO_4$ with Water Quality Standards

The concentration of total phosphate has increased in the middle; this is because, on average, farmers in this area use more artificial fertilizers (Urea, N,P,K) and pesticides in the process of fertilizing planted plants so that the resulting waste enters the Leneng river. Besides that, domestic waste, the tofu industry, laundry, and toilets originating from detergents affect river water. It

pollutes rivers which affect phosphate concentrations in river water. The total phosphate content in natural waters rarely exceeds 1 mg/liter (Effendi, 2003). The permissible phosphorus level for drinking water is 0.2 mg/L in phosphate (PO_4). Pullanikkatil*et al*. (2015) stated that activities along the riverbanks, such as settlements and agriculture, affect water quality; the further the pollution pressure is downstream. In addition to these two activities, industrial areas that produce metals from their activities impact the environment, especially water quality (Setyaningrum*et al*., 2014). So, controlling pollution and policy direction is necessary to protect water resources (Huang *et al*., 2013). Therefore, it is necessary to study the water quality of the Leneng River.

e. Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is the oxygen required to decompose organic matter aerobically. The BOD concentration of Leneng River water obtained the highest BOD concentration value at sample point 3 (downstream), namely 0.42 mg/L, and the lowest at sample point 1 (upstream), namely 0.17 mg/L. This range of values still shows conformity with water quality standards because it has not exceeded the threshold value according to PP 22 of 2021 water quality standards. The high BOD value at sample point three (downstream) indicates the presence of organic contaminants biologically decomposed by bacteria. The results of water quality tests compared to water quality standards are presented in the following Figure 5.

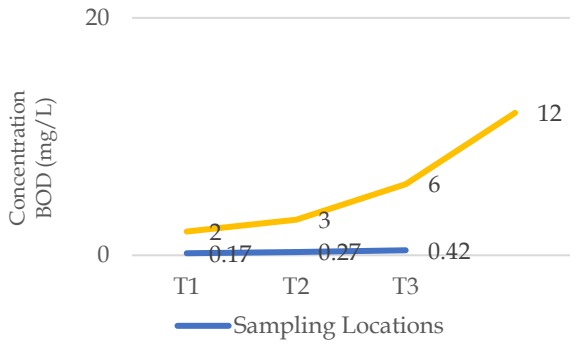

Figure 5. Comparison of Parameter Test Results in BOD with Water Quality Standards

Area settlements and trading business activities around the river are suspected of burdening organic pollution, such as food waste, toilet waste, and washing water, which are discharged into the river body, according to Anhwange*et al*. (2012). The high BOD value is due to the discharge of waste from settlements into rivers and agricultural land. Getting a bigger concentration of BOD in water, showing the concentration of organic matter in the water is also high (Yudo, 2010).

f. Carbon dioxide dissolves (COD)

The COD concentration of Leneng River water at sample point 1 (upstream) was 9 mg/L, sample point 2 (middle part) was 8 mg/L, and sample point 3 (downstream) was 9 mg/L. Compared to the measurement results with the water quality standards according to PP 22 of 2021, none of the sampling points exceeded the standard quality threshold for river water quality. They indicated that the waters were not polluted and chemicals that entered the river flow could be parsed properly. These waters can be used as a raw material for clean water for residents around the river and as irrigation and fishery water. The results of water quality tests compared to water quality standards are presented in the following Figure 6.

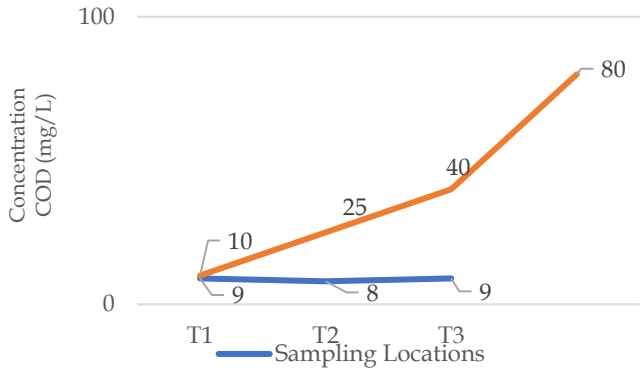

Figure 6. Comparison of Parameter Test Results in COD with Water Quality Standards

According to Sandi (2017), a high COD concentration indicates a greater level of pollution that occurs in waters. The higher the COD, the lower the dissolved oxygen content in the water (Wicheisa, 2018). Low oxygen in the waters can directly affect the life of aquatic biota because oxygen is needed for respiration, growth, and reproduction by these aquatic biota. According to Sugianti (2018), most fish in some polluted waters die not because of the direct toxicity of the waste materials but because of a lack of oxygen in the waters due to being used for degrading organic matter by microorganisms.

g. Total Coliform

The total coliform concentration of Leneng River water at sample point 1 (upstream) was 10,000 mg/L, sample point 2 (middle part) was 11,000 mg/L, and sample point 3 (downstream) was 20,000 mg/L. There was an increase in total coliform concentration from upstream to downstream, with a high increase at sample point 3 (downstream), coliform bacteria, including

bacteria that can be found in soil and water environments that have been affected by surface water and waste disposal of human and animal waste as well as from dead animals and plants. The results of water quality tests compared to water quality standards are presented in the following Figure 7.

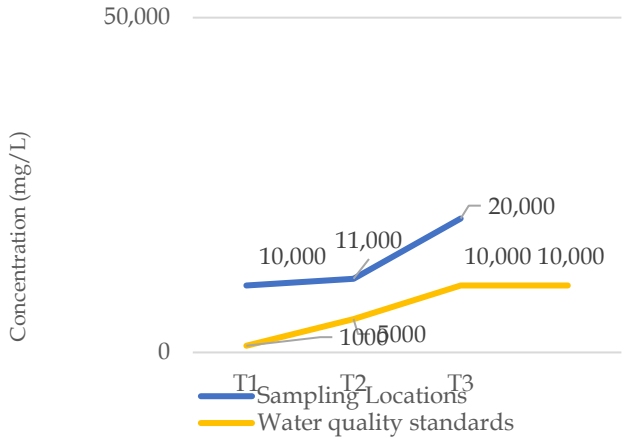

Figure 7. Comparison of Parameter Test Results Total Coliform with Water Quality Standards

The high value of Total Coliform in the Leneng River is indicated to have come from organic waste that was disposed of carelessly on the banks of the river, which rotted and then carried into the river flow. The high concentration of the microbiological indicator total coliform at sample point 3 (downstream) can be said that the Leneng River has experienced pollution from sewage. Humans, livestock, and organic waste.

h. Fecal *Coliform*

The concentration of Facel coliform in Leneng River water at sample point 1 (upstream) was 600 mg/L, sample point 2 (middle part) was 2,000 mg/L, and sample point 3 (downstream) was 2,500 mg/L. The measurement results of the three sample points are only sample point three (upstream), which meets the class II (two) water quality standard. In contrast, sample point 2 and sample point 3 have exceeded the class II quality standard according to PP 22 of 2021. *Fecal coliform* concentration *Fecal Coliform* has polluted Sungai Leneng water. The water of the Leneng River has increased so that it exceeds the class I water quality standards set according to PP 22 of 2021. From the middle to the downstream, there is an increase in the concentration *of Fecal Coliform* high enough. This pollution is caused by industrial wastewater, surrounding settlements, livestock manure, and the direct use of rivers for washing and toilets. It shows that the water of the Leneng River upstream, middle to downstream, has been polluted *with fecal Coliform*. Fecal coliform bacteria that contaminate water will interfere with human health.

The results of water quality tests compared to water quality standards are presented in the following Figure 8.

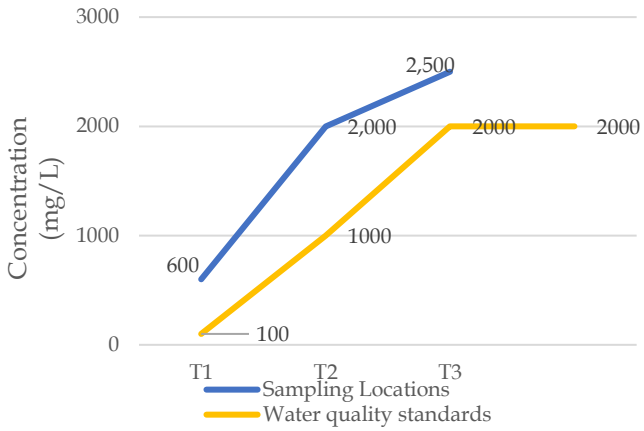

Figure 8. Comparison of Parameter Test Results Total Coliform with Water Quality Standards

The content of the pollution load in the form of feces has increased from the upstream to the downstream because livestock activities and domestic waste that enter river bodies, as well as direct use of rivers for washing and toilets, are still carried out by some people. The concentration of Fecal *Coliform* to the middle to the downstream increased, which exceeded class I water quality standards. It was due to domestic/settlement activities and livestock activities. Coliform bacteria can transmit several types of diseases through water, especially stomach diseases such as cholera and dysentery (Prihartanto & Budiman, 2007).

Leneng River Pollution Index

In determining the status of water quality in the Leneng Rivers is the Pollution Index method. A river is said to be polluted if it cannot be used following the designation normally. In this study, the parameters used to analyze the status of water quality were TSS, pH, DO, Total Pospat ($T.PO_4$), BOD, COD, total Coliform, and *fecal Coliform*, which is compared with the criteria for class I water quality based on Government Regulation Number 22 of 2021.

Based on the results of the calculation of the pollution index (IP), it can be seen that the water quality status of the Leneng River from upstream to downstream has decreased. Water quality status is with a value of 2.83 in the upstream, 1.97 in the middle, and downstream with a value of 2.84. The pollutant index values for each location in this study can be presented in full in Figure 9.

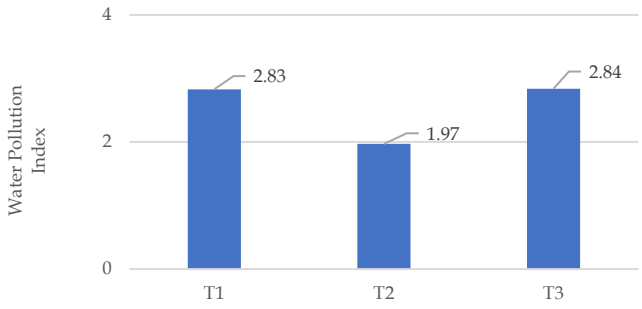

Figure 9. Pollution Index Value

Pollution index values at each sample point indicate that the Leneng River is lightly polluted. However, the BOD and COD values exceed the quality standards set following PP 22 of 2021. Pollutants originating from human activities such as settlements, agriculture, services, and trade have affected the water quality of the Leneng River. It shows that the water quality of the Leneng River cannot be utilized from following class I water allotments, namely water that can be used for freshwater fish cultivation, animal husbandry, water for irrigating plants, or for other uses that require the same water quality as those uses. In this case, it is necessary to improve the management and control of water pollution in the Leneng River so that it can be utilized and maintained so that the water quality of the Leneng River remains in accordance with water quality, namely class I water quality criteria according to Government Regulation Number 22 of 2021.

Conclusion

Based on the results of water quality analysis with physical parameters namely*Total Solid Suspended* (TSS), chemical parameters are pH, Total Pospat ($T.PO_4$), *Biological Oxygen Demand* (BOD), *Chemical Oxygen Demand* (COD), *Dissolved Oxygen* (DO), and biological parameters namely Total coliform, *fecal Coliform*, shows that TSS has polluted the upper reaches of the Leneng River. The middle and lower reaches contain concentration values of total Coliform and *fecal Coliform* which have exceeded the class I water quality standards caused by domestic activities that produce waste originating from bathrooms, toilets, kitchens, and laundry, as well as agricultural and animal husbandry activities along the banks of the Leneng River. Based on the Pollution Index (IP) calculations, the Leneng River is classified as lightly polluted with a Pollution Index value of 1.97 – 2.84.

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