The preliminary study of river water quality evaluation: case study of Gerong River, South Sumatera

Paulina M Latuheru[1], Fisca Dian Utami[1*], Yulia Puspita Sari[1], Noor Sulistiyono[1], and Dimas Pratama Yuda[1]

[1]Politeknik Transportasi Sungai Danau dan Penyeberangan Palembang, Indonesia
*email: fisca.dian.utami1@gmail.com

Abstract. The Gerong River is one of the rivers in the South Sumatra region of Indonesia. There are many industrial areas from oil refineries, dyeing to palm oil processing in the area. Currently, many of the river waters are polluted by waste, both household and industrial waste. One of the impacts is that the water looks cloudy and not clear and waste substances are found dissolved in the water body. Interpretation of contaminants is an important step that must be taken immediately as input for future environmental restoration efforts. Therefore, it is very important to quickly assess water quality using instruments that can quickly determine pollution levels. Water quality monitoring is necessary to assess the impact on ecosystems in water bodies. From the investigation results, it was found that the water quality parameters fulfilled class III water quality standards for agricultural, fisheries and livestock as regulated in Government Regulation No. 82 of 2001. The water pollution index needs to be used to produce a preliminary assessment of water quality condition.

Keywords: Preliminary Assessment, Water Quality, Gerong River.

1 Introduction

Water is an important element of natural resources and is vital for the survival of organism including humans, animals and plants. All life forms, from microorganisms to more complex organisms, use water as a primary component. Water is also needed to preserve ecosystems and natural habitats. Water supports diverse forms of life. Maintaining clean water supplies and aquatic ecosystems clean is key to preserving biodiversity and natural beauty. Water is also the main resource in various sectors such as agriculture, food production and industry. Sources of water include groundwater, lakes, rivers, precipitation, glaciers, etc. Water resources are essential for human live besides for drinking water, it's useful for many economic sectors, including agriculture, forestry, fisheries, hydropower generation, cattle production, industry, and other activities [1] [2].

As the main element of life, water quality is a determining factor in the quality of human

P. M. Latuheru et al. (eds.), *Proceedings of the International Conference of Inland Water and Ferries Transport Polytechnic of Palembang on Technology and Environment (IWPOSPA-T&E 2023)*, Advances in Engineering Research 236,
https://doi.org/10.2991/978-94-6463-484-6_17

life. 3.1% of deaths are due to non-compliant and poor water quality. Therefore, the necessity of preserving water quality and measuring water quality targets is included in the Sustainable Development Goals (SDGs) 6 plan to be achieved by 2030. Human environmental awareness is necessary because water quality is strongly influenced by human activities and population growth [3]. Human activities, including agriculture, mining, industry and poor urban waste management, contribute significantly to water pollution [4]. Water pollution can be caused by human activities that discharge waste directly into water bodies such as rivers, lakes and the environment without treating them, thereby disrupting the existing biota and ecosystem. This condition is common in developing countries, particularly Indonesia, where sanitation and wastewater treatment facilities are still very minimal and substandard, so access to clean drinking water is difficult to obtain [5]. All chemical, physical and biological factors whose levels exceed permitted standards for health and impact the aquatic environment are all included in the category of water pollution.

The household, industrial, radioactive and pharmaceutical waste has been found accumulating in several of locations of water bodies such as rivers and lakes which has proven to be dangerous for human survival. These wastes include phenolic compounds, surfactants, dyes, petroleum, pesticides, herbicides, antibiotic compounds, amino groups, sulfates, petroleum, and other organic substances which are found in amounts exceeding standards. These substances cause serious and dangerous diseases such as cancer, decreased immunity, acute poisoning, genetic mutations, reproductive failure, skin and kidney problems and infectious diseases such as cholera. Referring to these conditions, measuring the concentration of pollutant substances is a crucial step that must be conducted immediately to inform future environmental recovery efforts. Therefore, it is imperative to quickly assess water quality using instruments that can determine pollution levels rapidly. Investigating of the water quality is prominent to assess its impact on the ecosystem's health. Lakes and rivers are the most researched ecosystems because they provide people with easier access to freshwater [6]. It is necessary to use a water pollution index to produce the preliminary assessment of water quality condition.

2 Research methodology

Water sampling was carried out from the Gerong River, South Sumatra. Many people in this region interact directly with rivers to obtain water sources and meet their daily sanitation needs. However, many home textile industries discard remaining dyes into rivers. We took samples on site to check the water content and pollution level of the river. Then, these samples were tested ex-situ in the ministry of industry laboratory with the appropriate method according to table 1. Additional Data (sunter river, river and lake around IPB Darmaga and Jayapura Rivers) were from literature study that were being processed. The outcomes of the laboratory tests were compared with the legal requirements of the Indonesian water quality standard regarding water quality management and water pollution control as stated in Government Regulation No. 82 of

2001.

Quantification for Water pollution index (P_i) points to the Regulation of the Environment Ministerial Decree No 115/2003 on Standards for Determination of Water Quality Status.

$$P_{ij} = \sqrt{\frac{\left(\frac{Ci}{Li}\right)^2_{max} + \left(\frac{Ci}{Li}\right)^2_{average}}{2}}$$

- P_i : Water Pollution index
- C_i : Assesed Water quality parameter
- L_i : Standard water quality for each parameter
- If Ci/Li greater than 1, we will use Ci/Li new with formula 1 + P log (Ci/Li)

Table 1. Criteria of Water Quality Level

Water Pollution Index	Water Quality Level
$0 \leq P_i \leq 1.0$	Good (Meet the quality standards)
$1.0 < P_i \leq 5.0$	Lightly Polluted
$5.0 < P_i \leq 10$	Moderatedly Polluted
$P_i > 10$	Heavely Polluted

3 Results and Discussion

Gerong River Surface water test results can be seen at Table 2. Water quality parameters tested include hardness total, pH, temperature, TDS, turbidity, Pb, Zn, Fe, Mn, cyanide, fluoride, NO^{2-}, NO^{3-}, surfactant, organic substance and E. Coli bacteria. Water Pollution Index quantification can be seen at table 3. According to Table 3, the water temperature in the Gerong River is approximately 23 ^oC, which is marginally below Indonesia's Class III water quality standard value. This is influenced by the weather conditions at the time the sample was taken [7]. Sampling was carried out in the afternoon under cloudy conditions and the intensity of sunlight reaching the water body was relatively low. It is crucial to test pH as well. The dissolved hydrogen ion potential (pH) indicates the acidic or basic nature of a solution [7] which has a range of values between 0 and 14 [8]. The water from the Gerong River has a pH of 7, according to the measurements (Table 2). This value still meets the tolerance limits of Class III water quality standards in Indonesia, which range from 6 to 9. Several studies show that this value is suitable for agricultural and household water needs [9, 10]. For aquatic biota, the ideal pH value ranges from 7.0 to 8.7 [11]. Hence, it can be stated that the pH

of Gerong River water is within the useable range for household and agricultural purposes to help support the life of aquatic biota.

Table 2. Gerong River Surface Water Test Result

Parameter	Unit	Class III	Results	Methods
		GR 82/2001	SB021601001004 003014	
Temperature	ºC	24-30	23	SNI 06.6989.23-2005
TDS	mg/L	1000	162	SNI 6989.27:2019
pH	-	6-9	7	SNI 6989.11:2019
Turbidity	NTU		137	SNI 06-6989.25-2005
Pb	mg/L	0,03	0,0036	SNI 6989.46.2009
Zn	mg/L	0,05	< 0,02	SNI 6989.84:2019
Fe	mg/L	0,3	1,1	SNI 6989.84:2019
Mn	mg/L		< 0,02	SNI 6989.84:2019
Colour	TCU		58,7	SNI 6989.80:2011
Taste	-		Tasteless	Organoleptik
smell	-		odorless	Organoleptik
cyanide	mg/L	0,02	0,012	MU.8.23.(4).40 (Soektrofotometri)
fluoride	mg/L	1,5	0,36	SNI 06.6989.29-2005
NO_{2-}	mg/L	0,06	0,008	SNI 06.6989.9-2004
NO_{3-}	mg/L	20	6,5	MU.8.23.(4).44 (Soektrofotometri)
Total Hardness	mg/L		17,8	SNI 06-6989.12:2004
Detergent	mg/L	0,2	0,8	SNI 06-6989.51:2005
Organic Substance	mg/L	1*	9,8	SNI 06-6989.22:2004
E. Coli	MPN/ 100	10000	110	SNI 19-3957-1995

The turbidity is measured at 137 NTU. The turbidity of Gerong River water is mostly influenced by erosion along the river's inflow streams. Many river transportation activities occur along this river, and ships dock at the river pier. Pb, Zn, Fe, Mn, Cyanide, Fluoride, NO^{2-}, NO^{3-}, E. Coli, and Total Hardness levels still meet Indonesian class III quality standards. Meanwhile, detergents and organic contaminants were identified in considerable concentrations in the Gerong River, above the level authorized by Indonesia's class III quality requirements. Based on this data Water pollution Index for gerong river is 4,4 or lightly polluted. Pollutant contribution on this river are organic subtance, detergent and Fe. This is likely due to relatively high human activities such as washing and mining activities in this river.

Table 3. Gerong River Water Pollution Index Quantification

Parameter	Unit	Ci	Li	Ci/Li	Ci/Li new
Temperature	ºC	23	24-30	1,333333	1,624694
TDS	mg/L	162	1000	0,162	0,162
pH	-	7	6-9	0,333333	0,333333
Pb	mg/L	0,0036	0,03	0,12	0,12
Zn	mg/L	< 0,02	0,05	0,4	0,4
Fe	mg/L	1,1	0,3	3,666667	3,821357
cyanide	mg/L	0,012	0,02	0,6	0,6
fluoride	mg/L	0,36	1,5	0,24	0,24
Nitrit NO_{2-}	mg/L	0,008	0,06	0,133333	0,133333
NitratNO_{3-}	mg/L	6,5	20	0,325	0,325
Detergent	mg/L	0,8	0,2	4	4,0103
Organic Subtance	mg/L	9,8	1*	9,8	5,95613
E. Coli	MPN/100	110	10000	0,011	0,011
$\left(\frac{Ci}{Li}\right)_{max}$					5,95613
$\left(\frac{Ci}{Li}\right)_{average}$					1,861576
P_i					4,412536

Using literature study than we compared water test results for river that relatively high human activity (sunter river), and water test results for river that relatively minimal human activity (lake and river around IPB and Jayapura Rivers) on table 4. Data Comparation for water test results can be seen at Table 4. Water pollutant for sunter river dominated by organic subtance and detergent. Water test results for IPB lake and river all parameter meet quality standars and for Jayapura River only slightly Zn pollutant above Class III Standard.

Table 4. Water Test Results for some river in Indonesia

Parameter	Unit	Class III	Results			
		GR 82/2001	Gerong River[a]	Sunter River[b]	Lake and River around IPB[c]	Jayapura Rivers[d]
Temperature	oC	24-30	23	29,72	27,54	28,375
TDS	mg/L	1000	162			92,82
pH	-	6-9	7	7,31	6,812	6,997

Parameter	Unit	Class III	Results			
		GR 82/2001	Gerong River[a]	Sunter River[b]	Lake and River around IPB[c]	Jayapura Rivers[d]
Turbidity	NTU		137			
Pb	mg/L	0,03	0,0036		<0,03	0,0225
Zn	mg/L	0,05	< 0,02		<0,05	0,119
Fe	mg/L	0,3	1,1			0,1525
Mn	mg/L		< 0,02			0,0375
Color	TCU		58,7			
Taste	-		Tidak Berasa			
smell	-		Tidak Berbau			
cyanide	mg/L	0,02	0,012		<0,01	
fluoride	mg/L	1,5	0,36		0,1264	
Nitrit NO_{2-}	mg/L	0,06	0,008		<0,01	
NitratNO_{3-}	mg/L	20	6,5	0,0663	16,11	0,5075
Tatal Hardness	mg/L		17,8			
Detergent	mg/L	0,2	0,8	4,52	<0,05	0,05825
Organic Subtance (oil and greese)	mg/L	1*	9,8	1,21	<0,01	0,56275
E. Coli	MPN/100	10000	110		1160	95

* based on the Highest Quality Standards of Organic Substances, Oils and Fats;
a. Ministry of industry laboratory test no 002588/LHU/B021601/23/IX
b. Proccess data from Y Martinus et al 2018 [12]
c. Proccess data from Hefni Effendi, 2016 [13]
d. Process data from Tanjung, Rosye Hefmi 2022 [14]

4 Conlusion

Rivers with relatively high human activity such as in sunter river and gerong river, the pollutant is dominated by organic substance and detergent. Instead the rivers with relatively minimal human activity (IPB rivers and Jayapura rivers) almost all the pollutant parameters meet quality standards based on criteria of Class III Government Regulation No 82/2001.

Reference

1. Ngoye E, and Machiwa, J F. 2004. The influence of land-use patterns in the Ruvu River watershed on water quality in the River system. *Physics and Chemistry of the Earth*, 29(15-18): 1161-1166.
2. Tyagi S, Sharma B, Singh P, and Dobhal R. 2013. Water quality assessment in terms of water quality index. *American Journal of Water Resources*, 1(3): 34-38.
3. United Nations 2016. Report of the Inter-agency and expert group on Sustainable Development Goals Indicators. 47th Session of the United Nations Statistical Commission. New York, USA.
4. Masere T P, Munodawafa A, and Chitata T. 2012. Assessment of human impact on water quality along Manyame River. *International Journal of Development and Sustainability*, 1(3):754-765.
5. Soeprobowati, T R, Tandjung, S D, Sutikno, S, Hadisusanto, S, Gell, P, Hadiyanto, H, and Suedy, S W A. 2016. The water quality parameters controlling diatoms assemblage in Rawapening Lake, Indonesia. *Biodiversitas Journal of Biological Diversity*, 17(2).
6. Alves M T R, Teresa F B, Nabout J C. 2014. A global scientific literature of research on water quality indices: trends, biases and future directions. *Acta Limnologica Brasiliensia,* 26(3): 245-253.
7. Bhardwaj, R, Gupta, A, and Garg, J K. 2018. Analysis of Physico-Chemical Characteristics of The River Yamuna, Delhi Stretch With an Assessment of Site-Specific Water Quality. Pollution Research. 37(2): 446–459.
8. Li, D, and S. Liu. 2019. Water Quality Detection for Lakes. Water Quality Monitoring and Management. 221-231.
9. Villa-Achupallas, M, Rosado, D, Aguilar, S, and Galindo-Riaño, M D. 2018. Water quality in the tropical Andes hotspot: The Yacuambi river (southeastern Ecuador). *Science of the total environment*, 633, 50-58.
10. Wu, Zhaoshi, Xiaolong Wang, Yuwei Chen, Yongjiu Cai, and Jiancai Deng. 2018. Assessing River Water Quality Using Water Quality Index in Lake Taihu Basin, China. *Science of the Total Environment*. 612: 914–922.
11. Kant, R, Tessema, A, Tesfaw, B, and Chekol, F. 2016. Assessment of water quality of lake Hyqe, South Wollo, Ethiopia. *International Journal of Fisheries and Aquatic Studies*, 4(6), 95-100.
12. Martinus, Y, Astono, W, and Hendrawan, D. 2018. Water quality study of Sunter River in Jakarta, Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 106, No. 1, p. 012022). IOP Publishing.
13. Effendi, H. 2016. River Water Quality Preliminary Rapid Assessment Using Pollution Index. *Procedia Environmental Sciences*. 33: 562-567.
14. Tanjung, R H R, Yonas, M N, Suwito, Maury, H K, Sarungu, Y, and Hamuna, B. 2021. Analysis of surface water quality of four rivers in Jayapura regency, Indonesia: CCME-WQI approach. *Journal of Ecological Engineering*, 23(1), 73-82.