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by Thalia Sunaryo

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Analysis of pollutant index in Gunung Putri Pond, West Java Province, Indonesia

M A Siregar, M F Fachrul, S M P Marendra* and D I Hendrawan

Department of Environmental Engineering, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta, Indonesia

*sheilla@trisakti.ac.id

Abstract. Gunung Putri Pond is one of the lakes in Bogor Regency that functions as water reservoir, agricultural irrigation, fisheries activities, which has an area of 120,645 m² and a depth ranging from 0.5 to 1.7 m. Gunung Putri Pond is surrounded by residential areas, agricultural land, and several industries which discharge their waste into the lake's water bodies, including the motorcycle manufacturing industry, industrial equipment suppliers, the automotive industry, and construction companies which directly or indirectly pollute the waters of the lake. The aims is identify pollutant sources that have the potential to pollute waters, analyze water quality, and quality status for Gunung Putri Pond. The research was carried out in March 2023-July 2023. Water sampling was carried out at 6 points using the grab sampling method. The parameters analyzed in this study were temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate (NO₃-N), Phosphate (PO₄), Iron (Fe), Lead (Pb) and E. coli. The results of water quality Gunung Putri Pond for parameters COD, Fe, Pb and E. coli exceed the quality standards of Government Regulation No. 22 Year 2021 Class 2. The water quality status of Gunung Putri Pond used Pollutant Index (IP) method with an average value of 2.78, which is lightly polluted category.

1. Introduction

There are not enough studies about water quality and lake management, while the number of lakes experiencing damage is increasing. Based on field observations using visual interpretation of lake conditions and remote sensing data, in Bogor Regency there are 106 lakes, but 101 can be identified with 23 damaged, 26 moderate, and 52 good conditions [1]. The damage that occurred in Bogor Regency lakes was generally in the form of a decrease in water holding capacity caused by a decrease in area and sedimentation. In previous research regarding the water quality status of Gunung Putri Pond in 2020, the water quality status of Gunung Putri Pond was in lightly polluted category with a value of 1.84 [2].

Area of Gunung Putri Pond has 120,645 m² and a depth ranging from 0.5 to 1.7 m. Gunung Putri Pond surrounded by residential areas, agricultural land, and several industries which discharge their waste into the waters, including the motorcycle manufacturing industry, industrial equipment suppliers, the automotive industry, and construction companies which directly or indirectly pollute the waters [3]. Activities around Gunung Putri Pond can reduce water quality, one of the managements can be done to maintain water quality so as not to decrease, namely by identifying sources of pollution from activities surrounding area and determine water quality starting from physical, chemical, and biological quality. The Pollution Index method has advantage of being able to determine status of monitored water quality with only one data series, so it requires relatively little time and money. The weakness is because the data that is calculated is a single data, it often happens that the single data does not adequately represent



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the actual condition of water quality [4]. This article paper aim to identify pollutant sources that have the potential to pollute waters, analyze water quality, and quality status for Gunung Putri Pond. This research is to get an idea of capacity pollutan loads in Gunung Putri Pond and as information material for managing strategy in Gunung Putri Pond.

2. Methods

2.1. Location determination and research sampling

Determination of water sampling points is based on a preliminary survey conducted in the study area. It was conducted by looking at several considerations, namely sources of activities that are suspected of providing a pollution load such as residential areas, industry and other human activities, as well as input from drainage. Sampling was carried out every month from the end of March – July 2023, with 6 sampling points with 2 repetitions (duplo). In this study, the waters of Gunung Putri Pond divided into 3 segments to determine the concentration of the mixture in each segment. Segment division based on the inlet, middle and outlet areas of Gunung Putri Pond.

2.2. Water sampling

Water sampling was carried out using the grab sampling method. The procedure for taking surface water samples refers to Indonesia National Standard (SNI) 6989.57:2008 concerning Surface Water Sampling Methods. At each sampling point, 2 times or duplicates were taken to prevent mistakes made when taking water samples. The water sample has been taken 2 liter, then put into a cooler box to inhibit the rate of chemical reaction so the content of the parameters measured does not change due to the influence of temperature. Then the samples were analyzed at the Environmental Laboratory, Universitas Trisakti. The sampling locations can be showed in Figure 1 and Table 1.

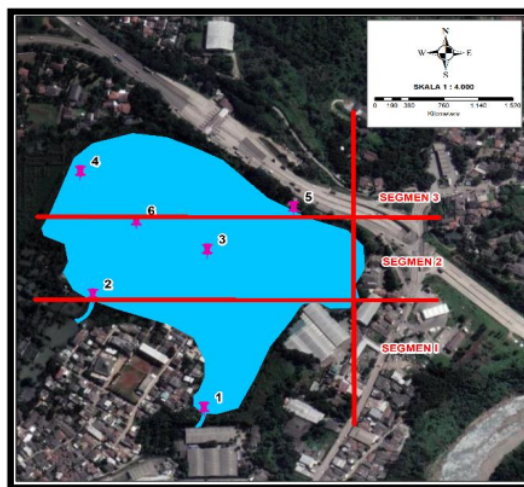


Figure 1. Sampling locations and segment.

Table 1. Coordinate locations.

Sampling point	Coordinate		Location
	LS	BT	
1	6°27'56.11"S	106°53'21.13"T	Inlet (industry) Gunung Putri Pond
2	6°27'50.32"S	106°53'15.66"T	Inlet (residential) Gunung Putri Pond
3	6°27'48.41"S	106°53'21.07"T	Middle Gunung Putri Pond
4	6°27'43.98"S	106°53'14.31"T	Outlet (irigation) Gunung Putri Pond
5	6°27'46.47"S	106°53'26.35"T	Outlet Gunung Putri Pond
6	6°27'47.90"S	106°53'17.00"T	Middle Gunung Putri Pond

2.3. Water quality

Water quality from Gunung Putri Pond were obtained through analysis of water samples at the Environmental Laboratory using methods according to SNI. The results of laboratory analysis for each parameter studied are compared with the existing quality standards in Government Regulation No. 22 of 2021. The results of the analysis are tabulated, displayed in graphical form and analyzed descriptively. The parameters and measurement methods to be used in this study are listed in Table 2.

Table 2. Parameters analysis method.

No	Parameter	Unit	Measurement tool	Measurement type
A	Physic			
1.	Temperature	°C	Thermometer	In situ
B	Chemical			
1	pH	-	pH meter	In situ
2	DO	mg/L	DO meter	In situ
3	COD	mg/L	Titrimetric	Ex situ
4	BOD	mg/L	Titrimetric	Ex situ
5	Phosphate PO ₄	mg/L	Spectrophotometric	Ex situ
6	Nitrate NO ₃ -N	mg/L	Spectrophotometric	Ex situ
7	Iron (Fe)	mg/L	Spectrophotometric	Ex situ
8	Lead (Pb)	mg/L	Spectrophotometric	Ex situ
C	Biology			
1	E. coli	MPN/100mL	Plate Count	Ex situ

2.4. Water quality status

The Pollutant Index method is used to determine the level of pollution relative to the permitted water quality standards and is used to improve water quality. As an index-based method, the Pollutant Index method has 2 (two) quality indices, namely the average index (IR) which shows the average pollution level of all parameters in one observation and the maximum index (IM) which shows one type of dominant parameter, which causes a decrease in water quality at one observation [5]. The Pollution Index method uses the following formula:

$$IP_j = \sqrt{\frac{\left(\frac{Ci}{Lij}\right)^2 M + \left(\frac{Ci}{Lij}\right)^2 R}{2}} \quad (1)$$

Where:

IP_j : Pollution index for designation j

C_i : Concentration of water quality parameters i

L_{ij} : Concentration of water quality parameter i listed in the water allotment standard j

M : Maximum

R : Average

The parameters needed to calculate pollutant index status are DO, BOD, COD, Nitrate, Phosphate, Iron, Lead (Pb) and E.Coli. The water quality status values using Pollution Index (IP) method are classified into 4 classes as shown in Table 3 below.

Table 3. Water quality status assessment based on pollutant index [6] .

Pollutant Index (IP)	Measurement type
$0 \leq P_{ij} \leq 1.0$	Good
$1.0 \leq P_{ij} \leq 5.0$	Lightly polluted
$5.0 \leq P_{ij} \leq 10$	Moderately polluted
$P_{ij} \geq 10$	Heavily polluted

3. Result and Discussions

Gunung Putri Pond is utilized as a water reservoir, agricultural irrigation, fishing activities, and a tourist area. Based on the area calculations that have been carried out, currently Gunung Putri Pond has an area of 120,645 m². In Table 4 there is data on the physical characteristics of Gunung Putri Pond based on the measurements that have been made.

Table 4. Physics characteristic of Gunung Putri Pond.

Segment	Average Width (m ²)	Average Depth (m)	Area Segment (m ²)	Volume (m ³)	Discharge (m ³ /sec)	Area Pond (m ²)	Depth Pond (m)	Volume Max (m ³)
1 (Inlet)	30.29	1.40	42	3,002	0.62			
2 (Middle)	40.31	3.86	155	19,294	1.54	120,645	2.37	221,978
3 (Outlet)	43.56	1.84	80	5,154	2.43			

Based on the results of analysis on Gunung Putri Pond which has an area of 120,645 m² and 2.37m of depth. By being divided into 3 segments where segment 1 is the inlet, segment 2 is the midpoint, and segment 3 is the outlet of Gunung Putri Pond.

Segment 1 has an area of 42 m², a volume of 3,002 m³, with a inlet discharge of 0.62 m³/second. Segment 2 has an area of 155 m², a volume of 19,294 m³, with a mid discharge of 1.54 m³/second. Segment 3 has an area of 80 m², a volume of 5,154 m³, with a outlet discharge of 2.43 m³/second.

3.1. Sources of pollution in Gunung Putri Pond

Gunung Putri Pond area is surrounded by settlements, the paper industry, the cement industry, shops, junior high schools, high schools and places of worship such as mosques and churches. Currently Gunung Putri Pond is used a fishing and tourism spot. The source pollutant in Gunung Putri Pond from Domestic and non-domestic activities around Gunung Putri Pond.

Pollution in river can worsen due to increased discharge of untreated waste before entering river, this can cause eutrophication due to water receiving excessive nutrients originating from runoff from settlements and agricultural land [7]. Gunung Putri Pond is in a residential, industrial and toll road area. The water Gunung Putri Pond waters currently comes from rainwater, small rivers and residents' drainage channels. Gunung Putri Pond has two inlets, the first inlet comes from the drainage channel around the industry which measures 150 cm and the second inlet comes from residential areas which measures 100 cm and the Gunung Putri Pond outlet measures 200 cm.

3.2. Water quality in Gunung Putri Pond

Water quality can determine function and use in an area. Polluted waters will reduce the value of water even further impact on aquatic ecosystems and health humans due to the presence of excess or toxic chemical waste [8]. The parameters analyzed at Gunung Putri Pond consisted of physical parameters namely temperature, chemical parameters namely pH, DO, BOD, COD, Nitrate, Phosphate, Iron (Fe) and Lead (Pb) and biological parameters namely E.Coli. The results of the analysis water quality of Gunung Putri Pond will be compared with the Pond/Lake water quality standards based on Government Regulation Number 22 of 2021 for class II designations, namely water that can be used for water recreation infrastructure/facilities, freshwater fish cultivation, animal husbandry, water for irrigation, plantations, and/or other uses that require the same quality of water as those uses. The results of measuring the water quality of Gunung Putri Pond can be seen in Table 5.

Table 5. Results of Gunung Putri Pond water quality analysis.

Table 5: Results of Sampling Point 10 and water quality analysis.												
Water Quality												
No	Parameters	Unit	Unit	Sampling						Max	Min	Average
				1	2	3	4	5	6			
A				Physic								
1	Temp	C	Deviation 3	28.1	28.3	30	27.8	27.2	30.4	30.4	27.2	28.63
B				Chemical								
2	pH	-	9	6.70	6.90	7.11	6.67	6.90	7.10	7.11	6.67	6.90
3	DO	mg/L	4	6.81	6.66	6.84	5,11	6.66	6.76	6.84	5.11	6,47
4	BOD	mg/L	3	2.10	2.17	2.05	2,05	2.10	1.70	2.17	1.70	2,3
5	COD	mg/L	25	4.60	40.00	36.80	36.80	40	38.40	41.60	36.80	38.93
6	Nitrate	mg/L	10	0.10	0.11	0.11	0,08	0.08	0.07	0.11	0.07	0.09
7	Phosphate	mg/L	0.75	0.20	0.23	0.14	0,36	0.46	0.18	0.46	0.14	0.26
8	Iron (Fe)	mg/L	0.30	0.54	0.69	0.65	0.55	0.54	0.52	0.69	0.52	0.58
9	Leak (Pb)	mg/L	0.03	0.10	0.03	0.04	0.04	0.13	0.09	0.13	0.03	0.07
C				Biology								
10	E.coli	MPN/100ml	5,000	16,300	17,100	10,700	13,200	11,800	13,500	17,100	10,700	13,766

Based on Table 5, parameters that exceed quality standards are COD, Iron (Fe), Lead (Pb), E.Coli. The highest COD at Gunung Putri Pond was obtained at sampling point 1 with a COD value of 41.60 mg/L and the lowest was obtained at sampling point 3 with a COD value of 36.80 mg/L. High COD can also affect several water quality parameters supporting phytoplankton life such as DO and pH are not good for phytoplankton survival [9]. The highest iron (Fe) in Gunung Putri Pond was obtained at the sampling point 2 with a value of Iron (Fe) of 0.69 mg/L and the lowest was obtained at sampling point 6 with a value of Iron (Fe) of 0.52 mg/L. The properties of heavy metals are difficult to degrade, so they easily accumulate in the aquatic environment and their presence naturally is difficult to remove [10]. The highest lead (Pb) in Gunung Putri Pond was obtained at sampling point 5 with a lead value of 0.13 mg/L and the lowest was obtained at sampling point 2 with a Lead value of 0.03 mg/L. Lead (Pb) is a pollutant

in the aquatic environment which is often questioned because it is toxic and harmful to aquatic biota, and has an indirect impact on humans who consume it. [11]. The highest concentration of E. Coli was found at sampling point 2, which is 17,100 MPN/100ml and the lowest at sampling point 3, which is 10,700 MPN/100ml.

3.3. Status water in Gunung Putri Pond

Determination of water quality status is carried out to determine the quality description of a waters, results of calculations and analysis of the water quality status of Gunung Putri Pond can be shown in Table 6.

Table 6. Water status of Gunung Putri Pond.

Period	Sampling						Water Quality Status Value	
	1	2	3	4	5	6		
May-23	2.79	2.94	2.24	2.39	2.77	2.76	2.59	Lightly Contaminated
June-23	3.63	3.10	3.01	2.99	3.27	3.38	3.18	Lightly Contaminated
July-23	2.87	2.82	2.18	2.43	3.21	2.69	2.58	Lightly Contaminated
	Average						2.78	Lightly Contaminated

Based on Table 5, it can be concluded during 3 (three) sampling times, the water quality status of Gunung Putri Pond is classified as lightly polluted waters with a value of 2.78. In May 2023 sampling, water quality status of Gunung Putri Pond was lightly polluted category with a value of 2.59, the second sampling, in June 2023, water quality status of Gunung Putri Pond was lightly polluted category with a value of 3.18, and the third sampling in July 2023, water quality status of Gunung Putri Pond is slightly polluted category with a value of 2.58. This showed that the water quality of Gunung Putri Pond did not change significantly during those 3 (three) months.

4. Conclusion

Gunung Putri Pond is located in Gunung Putri District, Bogor Regency, West Java. Gunung Putri Pond has an area of 120,645 m² and 2.37m of depth; volume 221,978 m³; inlet discharge 0.62 m³/second; and outlet discharge of 2.43 m³/second. Results of the water quality values of Gunung Putri Pond for parameters COD, Iron (Fe), Lead (Pb) and E. coli exceed the quality standards of Government Regulation No. 22 Year 2021 Class 2. The water quality status of Gunung Putri Pond used Pollutant Index (IP) method with an average value of 2.78, which is lightly polluted category.

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