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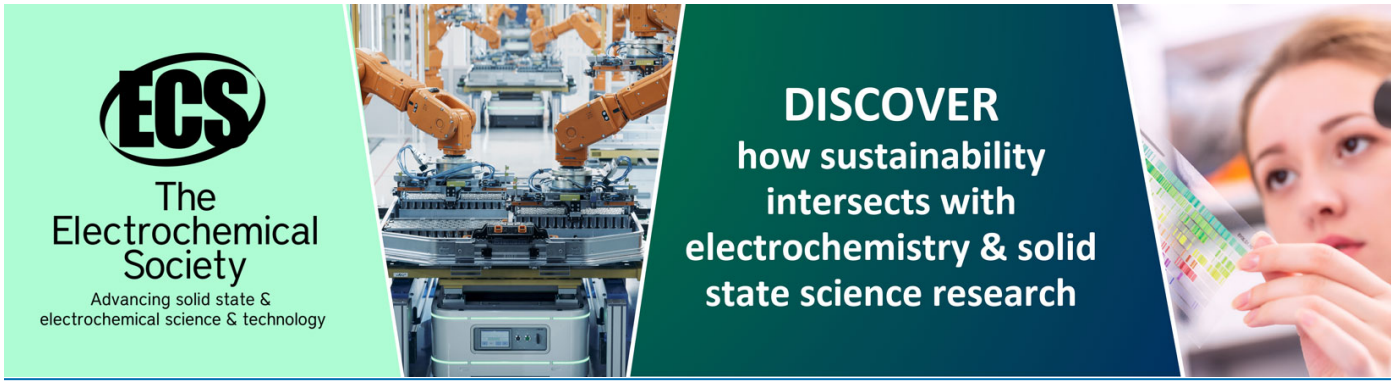

Analysis of river water quality in the upstream of the Code River, Indonesia

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Abstract. The Code River is one of the main rivers of the Opak watershed that crosses the center of Yogyakarta City, Indonesia. Commercial buildings and densely populated areas dominate the basin of the Code River. This condition affects the decline of water quality because people throw their waste into the river. Therefore, it is necessary to know the status of water quality and the class of the river. This research was conducted to find out the water quality and its designation on the upstream of the Code River. The methods used in determining water quality are the pollutant index of the Ministry of Environment Decree No.15 of 2003 and National Sanitation Foundation-Water Quality Index (NSF-WQI). The parameters used in this study are turbidity, DO, BOD, pH, TDS, Total Phosphate, Nitrate, and Fecal Coliform. The result of water quality in the upstream of the Code River, according to the pollutant index method, revealed that the value obtained was 5 - 16, with the status of water quality, was medium polluted and heavily polluted. Whereas according to NSF WQI, the value was at the range of 48 - 56 with the status of water quality was medium to bad.

Keyword: river, water quality, upstream, code river

1. Introduction

Water is a vital part of human life [1]. A river is a groove or container of natural water and or artificial in the form of a network of water flow, from the upstream to the estuary, with the right and left sides restricted by the boundary line [2]. The river is a source of life that functions as a water resource, recreation, irrigation, and transportation. As a water resource, the river must meet the standard of clean water. An action such us solid or liquid waste disposal in the form of bathroom waste, livestock dung, garbage, and others to the river, will give a significant impact and changes to the quality of water and ecosystem in it. Research on surface water (river) quality has been widely carried out by researchers. Kalayciand Kahya [3] conducted research on water quality trends in the rivers of Susurluk watershed. Mazlum et al.[4], they conducted research on the factors that determine variations in water quality in the Poruk River in the Sakarya watershed.

Sengorurand Isa [5] conducted a study of 42 water quality parameters obtained monthly from 1992 to 1996 at Monitoring station on the Sakarya River. Bakan and Sene [6] conducted research on sediment and water quality from the Mert Stream to the Black Sea. According to Arfan and Sutjiningsih [7], the change in land use into commercial buildings, residential, and irrigation areas will produce waste that causes a decrease in water quality. The amount of waste in the river will cause pollution and the enormous negative impacts on water quality and ecosystem life [8]. An increasing population and community activities can cause environmental damage [9].

The decrease in water quality can be determined by using method of National Sanitation Foundation Water Quality Index (NSF-WQI), which is based on nine parameters of water quality, such as temperature, BOD, DO, total phosphate, nitrate, turbidity, total solids, pH, and fecal coliform [10]. The determination of water quality status can also be determined by using the regulation of the Ministry of Environment Decree No.15 of 2003 by the storey method and pollutant index [11]. However, according to the BLH of DIY, the method needs to be reviewed because the results are not in accordance with the original conditions in the field [12]. Hou et al. (2016) explain that the use of the Water Quality Index method as a tool is expected to help the community to make the decision evaluation of water quality for drinking water [13].

The Code River is one of the main rivers of the Opak watershed that crosses the center of Yogyakarta City. According to Brontowiyono et al. [14], the Code River is the limelight due to passes strategic places such as Tugu, Malioboro, Kraton, and others, but that causes the decline in water quality due to dense population settlements, changes in land use, and economic development activities. The main factors of the decline in water quality along the watershed of the Code River are dominated by a large number of commercial buildings and densely populated area who throw waste directly into the river. Shoolikhah et al.[15] conducted research on Code River that in some locations the parameters do not meet water quality standards, this caused by waste enter into the river [15]. According to Brontowiyono, et al. [16], Code River has the worst water quality compared to other rivers due to the high coliform content and the lowest oxygen content.

In 2019, Muryanto et al. [17], conducted research on nitrate content around Code River, it is known that human activity affects the nitrate content, where the nitrate content in groundwater can be a source of polluted in Code River. According to Fajri et al. [18], Dry wet season has a very high influence on increasing some parameters that above government standard, but during dry season the sources of anthropogenic pollutants do not decrease due to low water flow. Therefore, it is necessary to analyze how the influence of waste on water quality and its designation in the upstream of the Code River.

2. Materials And Methods

The determination of water quality can be done by various methods and regulations. Water quality analysis was conducted to determine the water condition of the river by knowing the status of the water quality. In this study, the methods used in determining water quality are the pollutant index of the Ministry of Environment Decree No.15 of 2003 and National Sanitation Foundation Water Quality Index (NSF-WQI). Then, the class of the river was determined based on Government Regulation No. 82 of 2001 [20]. The use of these methods aims at finding out the designation of the river. The methods used in the analysis of calculations as follows:

2.1. Pollutant Index

Pollutant index is an analysis calculation to determine the status of water quality using the Ministry of Environment Decree No.115 of 2003. There are several steps of analysis to produce the pollutant index value. Then it compared with a table of water quality status. Criteria for the status of water quality according to the pollutant index method:

Table 1. Pollution Index Criteria

PI Score	Criteria
0 – 1.0	Good
1.0 – 5.0	Lightly polluted
5.0 – 10	Medium polluted
> 10	Heavily polluted

2.2. National Sanitation Foundation Water Quality Index (NSF-WQI)

NSF-WQI is a method used to determine the water quality status based on nine water quality parameters. The physical parameters are temperature, turbidity, and TDS. The chemical parameters are pH, BOD, DO, total phosphate, and nitrate, while microbiology parameter is fecal coliform. Sub-index value is obtained from the sub-index chart of each parameter based on the journal of Muslims (2013) and Effendi et al. (2015). Criteria for the status of water quality according to NSF-WQI method is:

Table 2. Classification of NSF-WQI

NSF-WQI Score	Criteria
0 – 25	Very bad
26 – 50	Bad
51 – 70	Medium
71 – 90	Good
91 - 100	Very good

2.3. Research Location

The research was conducted at The Upstream Code River, Yogyakarta, with a length of 3.5 km. The location is divided into three testing points, that are Kamdanen Bridge with coordinates of 7° 43' 22.4724" N latitudes, 110° 23' 21.5016" E longitudes and elevation 212.526 meters above sea level, Plemburan Bridge with coordinates of 7° 44' 45.4236" S latitudes, 110° 22' 37.8444" E longitudes and elevation 165.152 meters above sea level, and Ring Road Al-Azhar Bridge with coordinates of 7° 45' 6.4836" S latitudes, 110° 22' 29.8704" E longitudes and elevation 151.218 meters above sea level.

2.4. Water Sample

The water sampling utilized jerry cans and sterile glass bottles. The particular microbiology sample called fecal coliform employed the glass bottles. This water sampling was performed at each test point and then tested in the laboratory.

2.5. Laboratory Test

The laboratory test was performed at BBTLPY. The testing was done with several parameters and different methods. Table 3 presents the test results.

3. Results and Discussion

3.1. Temperature

Water quality standard for temperature is ±3°C from the air temperature. According to the Minister of Health Regulation No. 492, good water is when the temperature of the water is more or less the same as the temperature of the surrounding air [19]. The water temperature of Code River is at the normal condition because it is the same as the air temperature.

3.2. Turbidity

Water quality standard for turbidity is 5 NTU for class I, if the value is greater than 5 - 25 NTU, it means the river is in a turbid state. Effendi et al. [9] explain that turbidity comes from suspension materials in rivers such as mud, sand, organic/inorganic, and so on. Turbid river is not recommended to its designation as drinking water or clean water. Turbidity values in each location at the upstream of the Code River are below 5 NTU. Therefore, it can be concluded that the river water is in a clear condition. If compared with the vision directly at the location, the water is not turbid. Therefore, it can be used as clean water for fisheries or irrigation.

3.3. DO

The average DO value of the upstream of Code River is more than 6 mg/L. DO is the amount of dissolved oxygen in the water. The higher the DO value, the greater the amount of oxygen in the water, Conversely, if the oxygen level in the water is low, it will affect the living beings or biota in the water such as death.

3.4. BOD

The BOD contained in the upstream of the Code River is below 2 mg/L for both Kamdanen and Al-Azhar bridges. While in the Plemburan Bridge is 5.7 mg/L. It is because of population or livestock waste that affects the number of bacteria in the water. However, in Al-Azhar Bridge the BOD value is small due to the decomposition of bacteria or the addition of oxygen in the water.

3.5. pH

Normal pH of water is 7. Good water is usually between the range 6.5 - 8.5, and the pH value in the upstream of the Code River is in the range of 7.9 and 7.8. Therefore, it is not polluted.

3.6. TDS

Mutmainah and Adnan (2018) explain that TDS is the number of dissolved elements in the water which are in the form of organic or non-organic, and TDS content is directly proportional to water turbidity [20]. TDS in the Code River is in the range of 89 - 115 mg/L from three locations. While the water quality standard for TDS is 1000 mg/L, so that the TDS in the Code River in three locations has little solid waste.

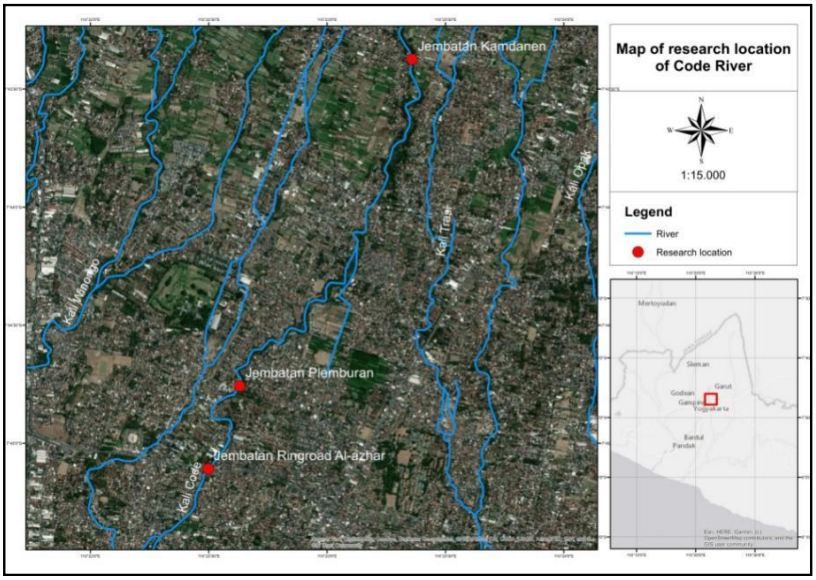

Figure 1. Map of Research Location of Code River, Indonesia

Table 3. The Laboratory Results of Water Quality in the upstream of Code River

No	Parameter	Unit	Kamdanen	Plemburan	Al-Azhar	Test method
1	Temperature	(^{o}C)	27	26	26	SNI 06-6989.23-2005
2	Turbidity	NTU	1.4	2	2	SNI 06-6989.25-2005
3	DO	mg/L	7.6	7.4	7.4	APHA 2012,section 4500-OG
4	BOD	mg/L	0.2	5.7	0.3	SNI 6989.72-2009
5	pH		7.9	7.8	7.8	SNI 6989.11-2004
6	TDS	mg/L	89	109	115	In house Methode
7	Total phosphate	mg/L	0.194	0.234	0.398	APHA 2012,Section 4500 P-D
8	Nitrate	mg/L	3.87	5.56	6.73	APHA 2012, Section 4500 - NO3B
9	Fecal Coliform	mg/L	46.10^{3}	240.10^{5}	46.10^{5}	APHA 2012,9221-E

3.7. Total Phosphate

According to Sutamihardja et al. (2018) if the content of phosphate compounds is low, then the growth of the organism in the water is inhibited [8]. On the contrary, if the content is high, the growth of organisms in the water becomes unlimited, and it causes damage to the sustainability of the aquatic ecosystem. Moreover,phosphate content is affected by livestock, agriculture, domestic, and industrial waste. The standard for total phosphate in the water is around 0.2 - 5 mg/L. The analysis result shows that total phosphate in the Code River meets the requirement for water quality standards.

3.8. Nitrate

The standard of water quality for nitrate is 10 mg / L. The value of nitrate in the Code River from the three locations is below the water quality standard requirements. Mutmainah and Adnan (2018) [21] explain that nitrate comes from the oxidation of nitrogen/ammonia compounds in aerobic conditions by nitrobactery bacteria in the water [20]. Nitrate is needed for water plants and algae as nutrients. It is originated from domestic waste, livestock, agriculture, and soil erosion [9].

3.9. Fecal `Coliform

The results of fecal coliform are far from the water quality standard with a maximum of 2000 MPN/100 mL. The results obtained are in the range of 10.000 to 1.000.000 of MPN/100 mL. It can be concluded that fecal coliform in the upstream of the Code River is large. The source of the pollutant can be either from human feces or livestock, organic waste, and so on.

3.10.Water Quality Status

From the analysis of water quality status using the pollutant index method, the results reveal that Plemburan Bridge has the highest IP value. This is because the densely populated areas and commercial buildings around area that produce and throw the waste into the river. Whereas in the Al-Azhar Bridge the value decreases because there are dilutions for several parameters that reduce the pollutant value along the river from the Plemburan Bridge to the Al-Azhar Bridge.

Table 4. Status of Water Quality in the Upstream of the Code River based on Pollutant Index Method

No	Sampling	PI Score	Status	Class
1	Kamdanen Bridge	5.60	Medium Polluted	III
2	Plemburan Bridge	15.30	Heavily Polluted	IV
3	Ringroad Al-Azhar Bridge	12.70	Heavily Polluted	IV

Table 5. Status of Water Quality in the Upstream of the Code River based on NSF-WQI Method

Sampling	NSF-WQI Score	Water quality status	Class
Kamdanen Bridge	55.35	Medium	III
Plemburan Bridge	48.31	Bad	IV
Ringroad Al-Azhar Bridge	52.57	Medium	IV

WQI value of each location has an adjacent value, but the status obtained is different. These analysis results of water quality are close to the real condition in the field in which the worst water quality is at the second location, which is the Plemburan Bridge. It is due to a large amount of garbage floating, and the waste from bathrooms and livestock manure create a terrible smell in the water of the river.From the analysis of water quality using the pollutant index and NSF-WQI methods. It is found that there was a decline in water quality status to a certain status.

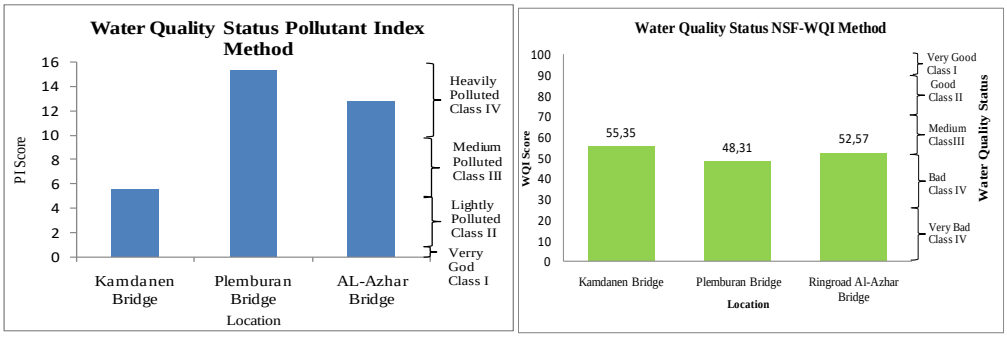

Figure 2. Water Quality Status in the Upstream of the Code River

Figure 3. Piles of Garbage on the Riverbank in the Plemburan Bridge

The disposed waste were in the form of solid and liquid waste from dirty bathroom water which were discharged directly into the river through pipes or liquid waste livestock from chicken coops and so on. In the Plemburan Bridge, there were piles of floating garbage and carried by the flow of the river and piled up on the riverbank. Based on the river class of the Government Regulation No.82 of 2001, the watershed of the Code River belonged to class III and IV, where it is intended for the cultivation

of freshwater fish, livestock, water irrigation, and or other allotments with water quality requirements equal to those uses. Whereas in the Al-Azhar Ringroad Bridge, according to NSF-WQI the status of water quality is heavy pollution, and according to the pollutant index it is medium, with the river class of IV and III.

4. Conclusions

According to the Ministry of Environment Decree No.115 of 2003 pollutant method, water quality index value of the upstream of the Code River was from 5.60 - 15.3 with water quality status of medium polluted and heavily polluted. The result of water quality analysis according to the NSF-WQI method revealed that the value of water in the Code River was 48.31 to 55.35 with water quality status of medium and bad.

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