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Evaluation of the Water Quality Status of the Kedunguling River Using the Pollution Index Method in Durung Banjar Village, Sidoarjo

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Abstract

The Kedunguling River is a water body that functions as a drainage channel and supports community activities in Durung Banjar Village, Sidoarjo Regency. Increased domestic and industrial activities around the river have the potential to reduce water quality through the entry of organic and inorganic pollutants. This study aims to analyze the water quality of the Kedunguling River based on the parameters of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Lead (Pb), Chromium (Cr), pH, and Total Dissolved Solids (TDS), and determine the water quality status using the Pollution Index (IP) method. The study was conducted with a quantitative descriptive approach using the grab sampling method at five observation points representing conditions before and after the pollution source. Sampling was carried out twice with a two-week interval. The test results showed that the BOD value ranged from 3.69–7.90 mg/L, COD 12.30–26.40 mg/L, Pb <0.0195 mg/L, Cr <0.0193 mg/L, pH 7.3–7.7, and TDS 288–300 mg/L. Most parameters still meet the water quality standards for class III according to Government Regulation Number 22 of 2021. The results of the Pollution Index calculation showed that all points in the 1st week had a status that met the quality standards with an IP value of 0.56 and in the 3rd week with an IP value of 0.73. This condition indicates an increase in the load of organic pollutants at certain locations which is suspected to originate from domestic activities and environmental runoff around the river.

Keywords Water Quality, River, Pollution Index, Kedunguling River

INTRODUCTION

Water is a natural resource that plays an important role in supporting human life, living creatures, and environmental sustainability (Desti & Ula, 2021). Adequate water availability, both in terms of quantity and quality, is a key factor in supporting domestic, agricultural, fisheries, and industrial activities. One of the surface water sources most widely utilized by the community is rivers. Rivers function as a natural

means of water transportation, flood control, irrigation source, habitat for aquatic organisms, and support various social and economic activities (Amaral et al., 2025). However, population growth and urban development are putting increasing pressure on river water quality.

Sidoarjo Regency is one of the regions experiencing rapid development in the residential, commercial, and industrial sectors. This growth has an impact on environmental conditions, particularly water bodies that receive various waste inputs from human activities. One such body of water potentially experiencing environmental stress is the Kedunguling River, located in Durung Banjar Village. This river is used by the community as a drainage channel and as a recipient of runoff from surrounding residential areas and economic activities. Domestic activities are a major contributor to water pollution. Household wastewater containing food scraps, detergents, oils, organic materials, and other chemicals is often discharged directly into waterways without prior treatment (Anwar, 2025). Furthermore, the presence of industrial areas around the Sidoarjo area also has the potential to contribute to the influx of pollutants into the river. The accumulation of this waste can increase the concentration of organic matter, heavy metals, and dissolved substances, ultimately degrading water quality (Murtadho, 2016).

River water quality can be assessed by measuring several physical and chemical parameters. Commonly used parameters include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), heavy metals Lead (Pb), Chromium (Cr), pH, and Total Dissolved Solids (TDS).[5]In addition to organic pollutants, heavy metals are also important parameters because they are toxic and can accumulate in the environment. Lead (Pb) and chromium (Cr) are heavy metals commonly found in industrial waste and urban activities (Rumoey et al., 2022). The accumulation of these two metals in water can negatively impact aquatic organisms and human health. Additionally, pH and TDS are used as supporting indicators to determine the physical and chemical conditions of water.

Water quality evaluation is not sufficient simply by comparing each parameter to quality standards. A method is needed that can describe the overall water quality condition (Romdania et al., 2018). One of the methods widely used in Indonesia is the Pollution Index (IP) method based on the Decree of the Minister of Environment Number 115 of 2003. This method integrates various water quality parameters into one index value, thus facilitating the interpretation of water quality status (Anggraeni et al., 2025).

The Pollution Index Method has several advantages, including being able to describe the level of pollution comprehensively, being easy to apply, and being able to be used as a basis for decision making in environmental management (Jannah et al., 2025). The resulting index value can indicate whether a body of water still meets quality standards, is lightly polluted, moderately polluted, or heavily polluted (Agustin, 2024). Research on the water quality of the Kedunguling River is still relatively limited, particularly those that integrate organic, heavy metal, and supporting parameters into a single evaluation using the Pollution Index method. Therefore, this study is novel in that it assesses the quality status of the Kedunguling River based on a combination of BOD, COD, Pb, Cr, pH, and TDS parameters at several observation points representing conditions before and after the pollution source. The urgency of this research lies in the importance of information on river water quality as a basis for environmental management and pollution control. The data obtained can be used as a basis for consideration by local governments, communities, and related parties in planning efforts to preserve water quality and control pollution sources.

METHODS

The equipment used in this study included sample bottles, a cool box, a long-handled dipper, a distilled water spray bottle, a pH meter, a Total Dissolved Solids (TDS) meter, stationery, and sample labels. The materials consist of distilled water, water samples collected from the Kedunguling River, and chemical reagents for the analysis of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), chromium (Cr), and lead (Pb). River water samples were collected using the grab sampling method in accordance with SNI 6989.57:2008 concerning Surface Water Sampling Methods. This method involves collecting water samples directly at a specific location and time to represent the existing water quality conditions. Five sampling points were predetermined based on geographic coordinates, and weather conditions during sampling were recorded. Before sample collection, each sample bottle was rinsed two to three times with river water to minimize contamination. Water samples were then collected at a depth of approximately 30 cm below the water surface and transferred into labeled sample bottles. All samples were immediately stored in a cool box containing ice packs to maintain sample integrity during transportation to the laboratory. Meanwhile, water temperature, pH, and Total Dissolved Solids (TDS) were measured directly at each sampling location using portable field instruments (in situ).

The water quality status was evaluated using the Pollution Index (PI) method, as specified in the Decree of the Indonesian Minister of Environment No. 115 of 2003. The Pollution Index is a water quality assessment approach designed to classify the level of water pollution by comparing measured water quality parameters with the applicable water quality standards. This method provides a comprehensive evaluation of overall water quality conditions by integrating multiple physicochemical parameters into a single pollution index value. The Pollution Index was calculated using the formula specified in the Ministerial Decree, and the resulting values were used to classify the river water into categories ranging from meeting the water quality standards to lightly, moderately, or heavily polluted.

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

Information:

IPj : Pollution Index designation j

Ci : Concentration of parameter test results

Lij : Concentration parameters for j allocation

(Ci/Lij) M: Maximum Ci/Lij value

(Ci/Lij) R: Average Ci/Lij value

Meanwhile, for temperature and pH which have a range of quality standards, use the following formula:

If Ci<Li is the average quality standard:

$$\frac{Ci}{Lij} = \frac{Ci - Li\ rata - rata}{Li\ min - Li\ rata - rata}$$

If Ci>Lij is the average quality standard:

$$\frac{Ci}{Lij} = \frac{Ci - Li\ rata - rata}{Li\ min - Li\ rata - rata}$$

Pollution index values are categorized into 4 classes, namely:

1. Meet quality standards : IP ≤ 1
2. Lightly contaminated : 1 <IP≤ 5
3. Moderately contaminated : 5 <IP≤ 10
4. Heavily polluted : IP ≤ 10

The assessment of river water quality in this study referred to Government Regulation of the Republic of Indonesia No. 22 of 2021 concerning the Implementation of Environmental Protection and Management. According to this

regulation, water quality standards are classified into four categories based on their designated uses. Class I water is intended for raw drinking water sources and other uses requiring equivalent water quality. Class II water is designated for water-based recreational activities, freshwater aquaculture, livestock, irrigation, and other purposes similar requiring water quality. Class III water is intended for freshwater aquaculture, livestock, irrigation, and other activities with equivalent water quality requirements. Class IV water is designated primarily for irrigation and other activities requiring the same level of water quality. In this study, the measured physicochemical parameters were compared with the applicable water quality standards specified in Government Regulation No. 22 of 2021 to determine the compliance of the Kedunguling River water with its designated water use classification.

FINDINGS AND DISCUSSION

This research was conducted in the Kedunguling River, located in Durung Banjar Village, Candi District, Sidoarjo Regency, East Java. The research location was selected based on the presence of community activities and land use around the river, which have the potential to affect water quality. The Kedunguling River functions as a drainage channel that receives flow from residential areas, agricultural land, and various anthropogenic activities in the surrounding area. Therefore, a water quality study is necessary to determine the condition of the water quality and the level of pollution. The following is a map of the sampling locations in Figure 1 and the coordinates in Table 1.

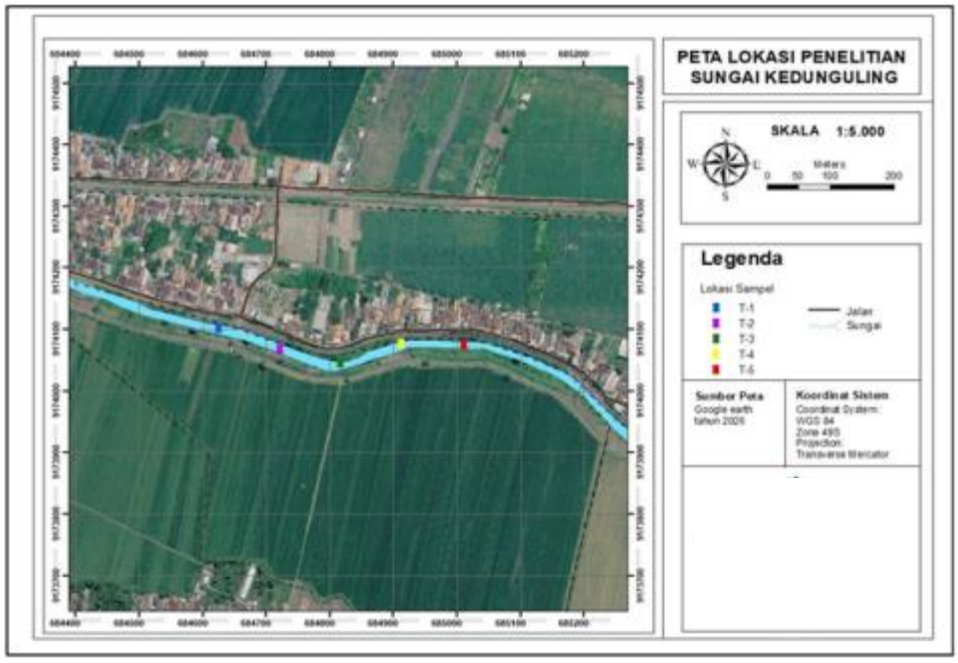

Figure 1. Map of Sampling Point Locations

Table 1. Coordinate Points of Sampling Locations

Sample Code	Coordinate Points	Distance of Each Point	Information
T-1	7°28'06.93"S 112°40'22.99"E	0	Center Point
T-2	7°28'08.03"S 112°40'26.15"E	100	Before the Center Point
T-3	7°28'08.77"S 112°40'29.25"E	200	After the Center Point

Sampling was conducted at five observation points determined by grab sampling based on environmental characteristics and potential pollution sources along the river. These points were selected to represent conditions from upstream to downstream and to illustrate changes in water quality due to activities around the river. Sampling was conducted over two periods, the first and third weeks of June 2026. The distribution of sampling locations in the Kedunguling River is presented in Figure 2-6.

Figure 2. Location point 1

Point 1 is located in the upstream part of the Kedunguling River and is dominated by agricultural land and vegetation around the riverbanks. The environmental conditions are relatively far from residential activities, resulting in low pollution pressure at this location. Water quality analysis results showed that the BOD value increased from 3.83 mg/L in week 1 to 5.27 mg/L in week 3. This increase indicates an additional load of organic matter entering the river body during the observation period. The COD value also increased from 12.9 mg/L to 17.6 mg/L, indicating an increase in organic compounds that can be chemically oxidized.

Pb and Cr concentrations were <0.0195 mg/L and <0.0193 mg/L, respectively, at both sampling times, remaining below the applicable quality standards. The pH value decreased slightly from 7.4 to 7.3 but remained neutral. Meanwhile, TDS increased from 297 mg/L to 298 mg/L. Overall, the water quality at Point 1 still meets quality standards and indicates relatively good water conditions.

Figure 3. Location point 2

Point 2 is located in a river segment still dominated by agricultural land with fairly dense vegetation along the riverbanks. The presence of agricultural activities in the area has the potential to contribute to the entry of organic matter and dissolved substances into the water body through surface runoff.

The test results showed that the BOD value increased from 3.69 mg/L in week 1 to 5.47 mg/L in week 3. This increase indicates an increase in organic matter content during the observation period. The COD value also increased from 12.3 mg/L to 18.2 mg/L. Despite the increase, both parameters were still below the Class III quality standard. The concentrations of Pb and Cr did not change, namely <0.0195 mg/L and <0.0193 mg/L, respectively. The pH value decreased slightly from 7.7 to 7.6, while the TDS decreased from 291 mg/L to 288 mg/L. The relatively low TDS value indicates that the amount of dissolved solids at this location is still in a safe condition. In general, the water quality at Point 2 is still considered good and meets the established quality standards.

Figure 4. Location point 3

Point 3 is the location with the lowest water quality compared to the other points. Based on field observations, this location is in an area affected by human activity and potential runoff from the surrounding environment. These conditions increase the potential for organic pollutants to enter the river. The BOD value increased significantly from 4.51 mg/L in week 1 to 7.90 mg/L in week 3. This value exceeded the Class III quality standard of 6 mg/L. This increase indicates a high organic content that requires oxygen for decomposition by microorganisms. Furthermore, the COD value also increased from 15 mg/L to 26.4 mg/L. Although still below the quality standard, the COD value at this point was the highest compared to all observation locations.

Pb and Cr concentrations remained at the same values, namely <0.0195 mg/L and <0.0193 mg/L, respectively. The pH value remained at 7.6 in both sampling periods, while the TDS decreased slightly from 300 mg/L to 297 mg/L. The high BOD and COD values indicate that Point 3 received a greater organic pollutant load than other locations. This condition is also in line with the results of the Pollution Index calculation, which showed that Point 3 had the highest level of pollution during the study. Based on the Pollution Index (PI) calculations, Sampling Point 3 exhibited the highest level of pollution throughout the study period. To determine the initial water quality conditions at the study site, water samples were collected from three sampling points during the first week of the study. The concentrations of BOD, COD, and TSS obtained from laboratory analyses are presented in Tables 2 and 3.

Table 2. Calculation of IP for week 1

Parameter	Sampling Point	Concentration	Regulation Limits	Description
BOD (mg/L)	1	3.83	6	Complied
	2	3.69	6	Complied
	3	4.51	6	Complied
COD (mg/L)	1	12.9	40	Complied
	2	12.3	40	Complied
	3	15	40	Complied
Cr (mg/L)	1	<0.0193	0,05	Complied
	2	<0.0193	0,05	Complied
	3	<0.0193	0,05	Complied

Table 3. Calculation of IP for week 3

Parameter	Sampling Point	Concentration	Regulation Limits	Description
BOD (mg/L)	1	5.27	6	
	2	5.47	6	
	3	7.9	6	
COD (mg/L)	1	17.6	40	
	2	18.2	40	
	3	26.4	40	
Cr (mg/L)	1	<0.0193	0,05	
	2	<0.0193	0,05	
	3	<0.0193	0,05	

Table 4. Results of Pollution Index Calculation for Week 1

Parameter	Cij	Lij (grade 3)	Cij/Lij	New Cij/Lij
BOD (mg/L)	4.38	6	0.73	0.73
COD (mg/L)	14.62	40	0.36	0.36
Cr (mg/L)	0.0096	0.05	0.19	0.19
Max	0.73			
Average	0.42			
IP	0.59			
Status	Meet Quality Standards			

Table 5. Results of Pollution Index Calculation for Week 3

Parameter	Cij	Lij (grade 3)	Cij/Lij	New Cij/Lij
BOD	5.83	6	0.97	0.97
COD	19.46	40	0.48	0.48
Cr	0.0096	0.05	0.19	0.19
Max	0.97			
Average	0.54			
IP	0.78			
Status	Meet Quality Standards			

The determination of the water quality status of the Kedunguling River was carried out using the Pollution Index (IP) method in accordance with the Decree of the Minister of Environment Number 115 of 2003. This method is used to evaluate the overall water quality condition by comparing the measurement results of each parameter to the class III water quality standard. Based on the calculation results presented in Tables 4 and 5, the IP value obtained was 0.56 in the 1st week and 0.73 in the 3rd week.

In the first week, the maximum value of the ratio between the parameter concentration and the quality standard (Ci/Lij) was 0.73 derived from the BOD parameter, while the average value of all parameters was 0.31. Based on these calculations, the IP value was obtained at 0.56, indicating that the water quality of the Kedunguling River was still in the category of meeting the quality standard. The BOD value of 4.38 mg/L was still below the quality standard of 6 mg/L, as were the COD, Pb, Cr, pH, and TDS parameters, all of which met the requirements for class III water quality. This condition indicates that the pollutant load entering the river body was still relatively low so that it had not caused a significant decline in water quality.

In the third week, there was an increase in the values of several water quality parameters, especially BOD and COD. The BOD value increased to 5.83 mg/L with a Ci/Lij ratio of 0.97, while COD increased to 19.46 mg/L with a ratio of 0.48. The increase in the values of these two parameters caused the average Ci/Lij value to rise to 0.37 and resulted in an IP value of 0.73. Despite the increase compared to the first week, the IP value was still in the range of $0 \leq IP \leq 1$ so that the water quality status was still categorized as meeting quality standards.

The increase in the IP value from 0.56 to 0.73 indicates a trend towards an increase in organic pollutant load during the observation period. This is indicated by the increase in BOD and COD values, which reflect the increasing organic matter content in the water. This condition is thought to be influenced by domestic activities of people around the river, runoff from agricultural land, and the influx of organic matter carried by surface flow. However, the heavy metal parameters Pb and Cr remain relatively low and far below the quality standard, so the contribution of heavy metal pollution to the water quality of the Kedunguling River can be said to be insignificant.

CONCLUSION

The water quality of the Kedunguling River based on BOD, COD, Pb, Cr, pH, and TDS parameters generally still meets the water quality standards of class III. BOD values ranged from 3.69–7.90 mg/L, COD 12.30–26.40 mg/L, Pb <0.0195 mg/L,

Cr <0.0193 mg/L, pH 7.3–7.7, and TDS 288–300 mg/L. The parameter that showed the most significant increasing trend was BOD, especially at Point 3 in the 3rd week which reached 7.90 mg/L and exceeded the quality standards. The results of the Pollution Index analysis showed that all observation points in the first week met the quality standards with an IP value of 0.56 and in the third week with an IP value of 0.73. Overall, the quality status of the Kedunguling River is still considered good, but monitoring and control of organic pollutant sources is needed to prevent an increase in pollution levels in the future.

REFERENCES

Desti and A. Ula, "Analisis Sumber Daya Air," Jurnal Sains Edukatika Indonesia (JSEI), vol. 3, no. 2, pp. 17–24, 2021.

M. H. S. Amaral, K. Jonathan, and J. J. S. Dethan, "Pemanfaatan Sumber Daya Air Sungai Batas Negara di Desa Alas Selatan Kecamatan Kobatiga Timur," Jurnal Nusa Sylva, vol. 25, no. 2, pp. 51–61, 2025, doi: 10.31938/jns.v25i2.853.

Y. Widyadhana Anwar, "Pengaruh Pencemaran Air Sungai terhadap Kesehatan Lingkungan dan Masyarakat: Literature Review," Jurnal Kesehatan Tambusai, vol. 6, no. 2, pp. 5061–5073, 2025.

R. A. Murtadho, "Kandungan Logam Berat Timbal (Pb) dan Seng (Zn) pada Cangkang, Insang dan Daging Kerang Simping Placuna placenta di Perairan Kecamatan Gresik Kabupaten Gresik," Skripsi, Universitas Brawijaya, Malang, 2016.

D. Lestari Saptarini, A. Rizani, and P. Negeri Banjarmasin, "PEMERIKSAAN KEHADIRAN LOGAM DAN KADAR TERCEMARNYA AIR BAKU SEBAGAI DAMPAK PENGGUNAAN WC APUNG KOTA BANJARMASIN," Jurnal Impact : Implementation and Action, vol. 7, no. 1, pp. 1–7, 2024.

D. S. Rumoey, "Perbandingan Konsentrasi Logam Berat (Cr, Cd, Pb) dalam Air dan Kerang Antar Ekosistem Sungai, Muara, dan Pantai di Perairan Sungai Talio Makassar," Universitas Bosowa, 2022.

Y. ROMDANIA, A. Herison, G. E. Susilo, and E. Novilyansa, "KAJIAN PENGGUNAAN METODE IP, STORET, dan CCME WQI DALAM MENENTUKAN STATUS KUALITAS AIR," Jurnal SPATIAL Wahana Komunikasi dan Informasi Geografi, vol. 18, no. 1, pp. 1–13, 2018, doi: 10.21009/spatial.181.05.

W. D. Anggraeni, N. Santi, T. T. Putranto, and D. A. Widiarso, "Analisis Kualitas Air Tanah Akuifer Bebas Menggunakan Metode Indeks Pencemaran (IP) dan Water Quality Index (WQI) di Kota Semarang, Jawa Tengah," Jurnal Geosains dan

Remote Sensing, vol. 6, no. 1, pp. 53–64, May 2025, doi: 10.23960/jgrs.ft.unila.417.

A. Arrayanul Jannah, Mertiara Ratih Terry Laksani, M. Zainuri, and A. Farid, "Analysis of Water Quality in Pangeranan Estuari, Bangkalan, Madura Using the Pollution Index and Storet Methods," Journal of Marine and Coastal Science, vol. 14, no. 3, pp. 174–183, 2025, doi: 10.20473/jmcs.v14i3.76538.

K. Pencemaran Sungai Yonanda Surya Agustin and Y. Surya Agustin, "Analisis Kualitas Air serta Status Mutu dengan Metode Indeks Pencemaran (IP) di Anak Sungai Gajah Putih Studi Kasus RT 02 RW 07 Kelurahan Sumber, Surakarta," Jurnal Ekosains, vol. 26, no. 1, pp. 1–7, 2024.