An Effort to Monitor River Water Quality with Biomonitoring Method in Sumo River, Surabaya City

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Abstract. River water quality degradation due to anthropogenic activities in urban areas requires an efficient and sustainable monitoring approach. This study aims to assess the water quality of the Sumo River in Surabaya City using a biomonitoring method that integrates physico-chemical parameters (BOD, COD, pH, temperature, TDS, and turbidity) with the Shannon-Wiener diversity index (H') for *macrozoobenthos*. Water samples were collected from three river segments with varying levels of human activity. Results showed that BOD (13,4–33,23 mg/L) and COD (34,6–76,26 mg/L) exceeded Class 3 quality standards (PP No. 22 of 2021), with segment 3 showing the highest pollution load due to slower flow and poor waste management. While pH, temperature, and TDS remained within acceptable limits, turbidity in segment 3 reached 16,39 NTU. Biological analysis revealed a decline in *macrozoobenthos* diversity from segment 1 (H' = 1,0588) to segment 3 (H' = 0,5004), dominated by pollution-tolerant species such as *Tubificidae*. These findings indicate strong ecological stress from domestic and industrial waste accumulation. This study recommends implementing integrated wastewater treatment systems, enhancing community education, and adopting periodic biomonitoring to support the sustainable recovery of the Sumo River ecosystem.

Keywords: Biomonitoring, Bioindicator, Sumo River, Surabaya City, Water Quality, *Macrozoobenthos*.

1. Introduction

Basically, one of the main needs that is essential for the survival of living things is water. Along with rapid population growth, the demand for clean and safe water is increasing. So that the management of water resources becomes a very crucial challenge, because it is related to protecting the health of all forms of living things (Patel *et al.*, 2020). Rivers as one of the main sources of raw water have an important role in providing water for life, but the quality of river water must be maintained and treated so that it is safe for use by the community. River ecosystems have an important role in determining environmental balance (Utami and Fajar, 2022) (Wang and He, 2022). River ecosystems are complex systems that involve both living and non-living factors. River ecosystems include interactions between plants, animals, and microorganisms, as well as the physical and chemical characteristics of water and the surrounding landscape (Kahirun *et al.*, 2023).

The quality of river water is declining due to the existence of river ecosystems surrounded by residential, industrial, agricultural, and health sectors. One of the causes of polluted rivers is the presence of liquid waste that is discharged directly and without any treatment. In addition, liquid waste that has been treated but does not meet quality standards can also be the cause (Rosyadi and Ali, 2020). The use of river water as a source of raw water for daily needs can have a negative impact on human health and ecosystem damage if the river water used is polluted (Siahaan *et al.*, 2011). To prevent the decline of river water quality that continues to be polluted over time, water quality monitoring is a crucial step in sustainable river management and conservation.

The area along the Sumo River in Surabaya City is a dense urban environment with a high intensity of economic and social activities. This area is dominated by public and commercial facilities, such as schools, food and beverage industries, hotels, and dense residential areas. Sumo River was chosen as the sampling location because it is an urban area with dense human activities, such as settlements, food & beverage industries, lodging, and schools, which have the potential to produce large amounts of organic domestic waste. This effluent, if untreated, can increase the organic pollutant load (e.g. BOD, ammonia) in the waters, thus disrupting the community structure of aquatic biota. The biomonitoring method was chosen to measure ecological impacts through indicators such as benthic macroinvertebrate diversity and dominance of pollution-tolerant species (e.g. *Tubifex* sp. or *Chironomus* sp.), which directly reflect the level of anthropogenic pressure on the river ecosystem. The selection of this location is also supported by its characteristics as an urban river that is vulnerable to domestic pollution, so that the results of the study can serve as a basis for ecosystem-based environmental management recommendations.

Biomonitoring is a method that uses living organisms as biological indicators to determine the condition of river ecosystems. Biomonitoring is an environmentally friendly way to monitor river water quality. Organisms living in river ecosystems have many relationships with their physical, chemical, and biological environments, so it can provide a broader picture of the quality of river water (Az-Zahro, Lukito and Anasstasia, 2024). Monitoring river water quality is very important to ensure the sustainability of its ecosystem and anticipate potential pollution, where conventional methods that rely on chemical analysis often require large costs and long time. Biomonitoring using indicator organisms such as invertebrates, fish and plants as biological markers offers a more efficient and economical way of assessing the ecological condition of rivers, with changes in the population and community of these organisms providing important insights into the overall health of the river ecosystem. Changes in the populations and communities of these organisms can provide important information about the condition of the river system (Bimantio *et al.*, 2024).

By using biota indicators, river biomonitoring methods have several advantages. First, living organisms that are a direct part of the river ecosystem have the ability to integrate various environmental parameters. Second, biomonitoring methods are relatively inexpensive and can be conducted with community participation, increasing community awareness and responsibility for the river environment. Third, biomonitoring can provide data on a periodic basis, making it possible to observe trends in water quality changes over time (Hilsenhoff, 1988).

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The biolitik method, which stands for "Bio" meaning biotic and "Tilik" meaning observation, is a biomonitoring method to assess river water quality using macroinvertebrates such as aquatic insects, crabs, shrimps, snails, and worms as indicators. Biotilik provides accurate results, is easy to do, and does not require complicated and expensive equipment as does water quality monitoring by measuring physical and chemical parameters (Ni'am *et al.*, 2022). In biological water quality monitoring, especially for organic contaminants, aquatic macroinvertebrates are a group of organisms that are considered the closest to the requirements and are most widely used as bioindicators of the quality of water bodies. Therefore, assessing macroinvertebrate community reactions and associated biomonitoring indices is critical to the provision of accurate management and conservation tools for freshwater ecosystems (Case *et al.*, 2025).

Although biomonitoring methods are widely recognized for their advantages, there remain significant research gaps in the integrated application of physic-chemical and biological assessments within urban river systems in Indonesia, particularly in Surabaya City. Previous biomonitoring studies on Surabaya's rivers—such as the Kalibokor River (Ni'am *et al.*, 2022), Rolak River (Ummuzzahra *et al.*, 2022), and segments of the main Surabaya River (Chomsa, 2024)—have largely focused on single-parameter approaches or limited biological indicators without comprehensive integration with physic-chemical data. These studies also lacked systematic spatial analysis along river segments experiencing varying levels of anthropogenic pressure. Moreover, most biomonitoring efforts in Indonesian urban rivers have relied on traditional diversity indices without incorporating site-specific environmental gradient analyses. While the Shannon-Wiener diversity index is widely applied globally, its application in Indonesia remains limited, particularly in establishing baseline ecological conditions for rapidly urbanizing cities like Surabaya. Furthermore, there is a lack of studies exploring the direct relationship between specific urban activities—such as population density, food and beverage industries, and waste management infrastructure—and their impact on water quality parameters and macroinvertebrate community structures in tropical urban river systems.

This study addresses the identified research gap by providing the first comprehensive biomonitoring assessment of the Sumo River, integrating physic-chemical parameters (BOD, COD, pH, temperature, TDS, turbidity) with biological indicators (Shannon-Wiener diversity index for *macrozoobenthos*) across three river segments representing varying levels of anthropogenic pressure. The novelty of this research lies in: (1) the systematic integration of water quality parameters with macroinvertebrate community analysis in an under-studied urban river system in Surabaya; (2) the application of the Shannon-Wiener Diversity Index, with interpretation contextualized for tropical urban river systems experiencing varying levels of anthropogenic stress; (3) a spatial analysis approach linking specific urban land uses (hospitality, food and beverage industries, high-density residential areas) to corresponding ecological impacts; and (4) the development of segment-specific biomonitoring recommendations for urban river management in rapidly developing Indonesian cities. This integrated approach offers a more holistic understanding of river ecosystem health compared to previous single-parameter studies and provides a replicable methodology for assessing urban rivers in Southeast Asian contexts.

In biomonitoring, biotic indicators that can be used in can be macroinvertebrate organisms, fish, or microorganisms. These organisms are selected based on their sensitivity to changes in environmental conditions and their ability to survive in polluted water (Payung, 2017). In conducting biomonitoring to identify river pollution from its physical habitat, it needs to be done carefully and using appropriate methods. This is because the river environment is very complex and vulnerable to human disturbance. Therefore, the use of biomonitoring can help to ensure the health of the river environment and prevent further pollution (Ummuzzahra *et al.*, 2022).

2. Materials and Methods

2.1 Tools and Materials

Water sampling and biota analysis were conducted on April 24, 2025 at 06.00 – 07.00 WIB. Located in Sumo River, Surabaya City. The tools used are; (1) Hand hoe, (2) Clear plastic jar, (3) Filter, (4) Bottle for water samples. The materials used during the research were gloves. Testing of Sumo River water samples was carried out at the Environmental Engineering Laboratory of Adhi Tama Institute of Technology Surabaya. Tests were conducted to determine the value of BOD, COD, pH, Temperature, Turbidity, and TDS. Tools used for parameter test are; (1) BOD meter, pH meter, Turbidity meter, TDS meter, and COD testing with Open Reflux method using *Liebig*. Materials for the parameter test were water samples of Sumo River in each segment.

Fig. 1 Sampling Point Location

2.2 Location

The research location was conducted in Sumo River, Surabaya City, where three sampling location points were determined, namely; segment 1, segment 2, and segment 3. The determination of the three sampling location points was carried out by looking at the existing conditions around the sampling point. Water sampling at three location points was carried out at 06.00 - 07.00, water sampling was carried out in the morning to determine the condition of river water quality naturally. Morning was chosen because this period provides stable baseline conditions for physico-chemical parameters and macroinvertebrate activity, before being exposed to daily fluctuations due to algae photosynthesis or human activity.

2.3 Evaluation of Physical Characteristics of Sumo River

The observation of the physical condition of Sumo River was conducted in order to determine the existing physical condition of Sumo River and its relationship with the existence of biota around Sumo River. This procedure begins with determining the location and sampling points that will be used as the object of research, then selected based on survey results and initial guesses about the existing condition of the river. Furthermore, observations were made on the existing physical condition of the river, sedimentation patterns at each point of the river, variations in vegetation cover around Sumo River and the environmental conditions of Sumo River.

2.4 Biotic Evaluation in River Water Quality Monitoring

In biomonitoring studies, biotic components such as macroinvertebrates are important markers to assess the level of pollution of a water body. This study examines the relationship between macroinvertebrate diversity in river sediments and water quality parameters analyzed in the laboratory. Observations of macroinvertebrate quantity and species were used to determine their level of resistance to contaminants, while reflecting the condition of the aquatic ecosystem.

2.5 Methodology and Analysis of River Water Chemical Content

This study aims to evaluate river water quality by measuring the chemical parameters of pH, TDS, BOD, and COD, turbidity, and temperature in samples taken at three different locations along the river to map the quality characteristics of each segment and identify factors causing variations. Sampling was carried out using clean buckets coded according to the sampling point to prevent marking errors, then the five samples were taken to the Environmental Engineering Laboratory of Adhi Tama Institute of Technology Surabaya for analysis. Measurement of the four parameters was carried out alternately with portable equipment - pH meter, TDS meter, temperature, using the open reflux method for COD, and turbidity meter to test turbidity. Then the read values were recorded in the data sheet. The measurement data were then analyzed to compare water quality between sampling locations and identify possible sources of pollutants or environmental conditions that affect the results.Parameters measured include pH, BOD, COD, Turbidity, Temperature, and TDS.

2.6 Shannon-Wiener Diversity Index (H')

To make it easier to analyze the number of individuals of each species in a community, the diversity index (H') describes population diversity mathematically (Machrizal, Khairul and Dimenta, 2020). In this study, the Shannon-Wiener equation was used in calculating the diversity index. (Krebs, 1989).

$$H' = -\sum_{i=1}^{s} (pi.\ln pi)$$

Description: H' = Shannon-Wiener diversity index
S = Number of species
Pi = Number of individuals of each species (i = 1, 2, 3, ..)

By H' value: H' < 1,0 = Low diversity
1,0 < H' < 3,322 = Medium diversity
H > 3,322 = High diversity

3. Results

3.1 Analysis of Physical Conditions

Water sampling was conducted in three designated segments in Sumo River, Surabaya City. The physical characteristics of the site were evaluated through direct observation of the environmental conditions around the sampling points. The parameters observed included the color of the water surface and the presence of organisms living around the river flow. The observation results showed that the water in all research locations had a uniform color, which was brownish, indicating a high level of turbidity due to the content of suspended particles.

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Table 1 Existing Conditions

Sampling Site Photo	Existing Condition
Segment 1	7°17'14.8"S. 112°45'27.5"E
	Segment 1 is characterized by the presence of lodging facilities and densely populated residential areas. The water current flows swiftly, and the water appears relatively clear; however, the riverbed is exposed and emits an unpleasant odor. The riverbanks are overgrown with weeds.
Segment 2	7°17'25.6"S. 112°45'27.2"E
	Segment 2 is characterized by the presence of food and beverage industries, educational facilities, and densely populated residential areas. The water appears relatively clear, with a visible riverbed, and the flow is faster than in segment 1. Aquatic vegetation such as water hyacinths is present, along with moss and weeds along the riverbanks.
Segment 3	7°18'05.0"S. 112°45'18.2"E
	Segment 3 is characterized by the presence of a bar screen garbage container and densely populated residential areas. The water appears murky and emits an unpleasant odor. The flow in this segment is noticeably slower compared to segments 1 and 2. Along the riverbanks, there is sparse weed growth and scattered plastic waste discarded indiscriminately.

3.2 Analysis of Chemical Parameters

3.2.1 Biological Oxygen Demand (BOD)

BOD is a measure of the amount of oxygen required by microorganisms to decompose organic matter present in water. A high BOD value indicates that there is a lot of organic pollution, such as domestic waste, which can reduce dissolved oxygen (DO) levels and endanger the life of aquatic biota. This parameter is important for assessing the level of environmental degradation due to biologically degradable waste. In this study, the BOD value was calculated using a BOD meter. Based on the results of the BOD meter test, in segment 1 the BOD value was 20,1 mg/L. In segment 2, the BOD value is 13,4 mg/L. In segment 3, the BOD value is 33,23 mg/L. Based on the comparison with class 3 quality standards, the BOD value of the 3 segments in Sumo River does not meet the quality standards.

BOD parameter values that exceed quality standards, indicate high organic pollution from domestic or industrial waste. This condition causes dissolved oxygen (DO) levels to decrease, threatening the life of aquatic biota, and potentially triggering eutrophication. This is in accordance with previous research (Santoso, 2023) (Adawiyah *et al.*, 2021), in which the presence of anthropogenic activities around Sumo River originating from household waste and the food and beverage industry, that enter the water such as organic liquid waste and industrial wastewater causes an increase in BOD values in water. In addition to household waste, liquid waste from the food and beverage industry also plays a major role in increasing the BOD value in water. (Halim, Hendrarianti and Setyobudiarso, 2023).

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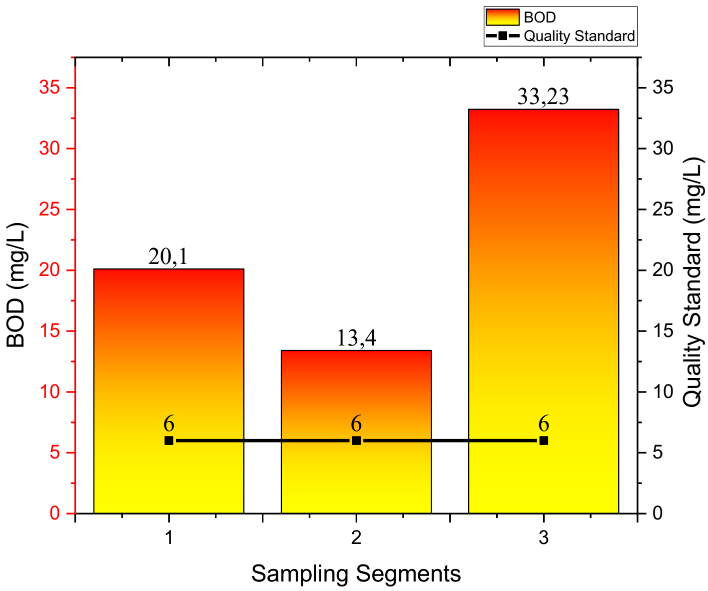

Fig. 2 Comparison Chart of BOD Test Results with Quality Standard

3.2.2 Chemical Oxygen Demand (COD)

COD is a measurement of the amount of oxygen required to chemically oxidize organic and inorganic materials. Unlike BOD, COD includes all substances that can be oxidized, including industrial wastes that are difficult to decompose naturally. High COD values indicate the potential for complex pollution from industrial activities or chemical waste. In this study, the COD value was calculated by the Open Reflux method. Based on the results of the COD parameter test, in segment 1 the COD value was found to be 50,6 mg/L. In segment 2, the COD value is 34,6 mg/L. In segment 3, the COD value is 76,26 mg/L.

Based on comparison with quality standards, segments 1 and 3 fail to meet quality standards, while segment 2 complies quality standards. COD values exceeding the quality standard in segments 1 and 3 indicate a high level of organic pollution, likely originating from food and beverage industry waste or household sources, such as detergents that are resistant to decomposition. (Santoso, 2023)(Halim, Hendrarianti and Setyobudiarso, 2023). The high value of COD reduces oxygen levels in the water and has the potential to cause eutrophication.

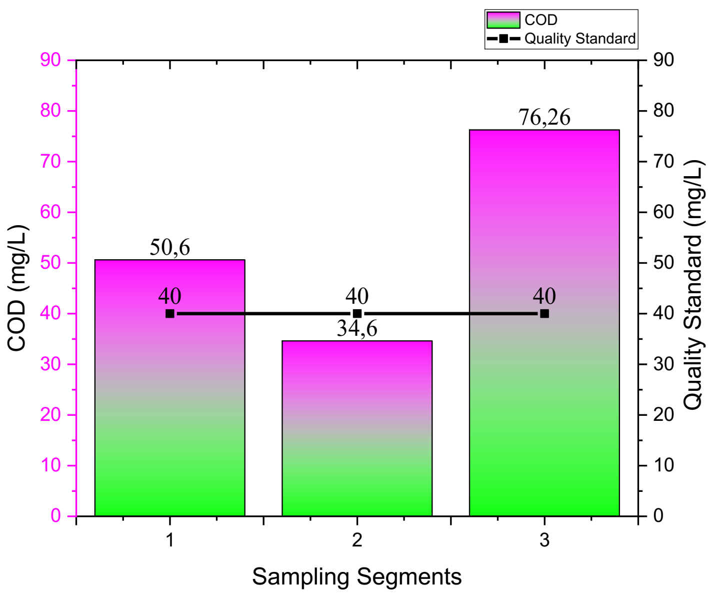

Fig. 3 Comparison Chart of COD Test Results with Quality Standard

3.2.3 pH and Temperature

The acidity or alkalinity of water is determined by measuring its pH. River water typically has a neutral pH, ranging from 6.5 to 8.5, which is necessary to support aquatic life. Significant deviations from this pH range, either towards acidity or alkalinity, can harm the ecosystem. In addition, water temperature influences the rate of chemical and biological

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reactions as well as the solubility of oxygen. Increases in water temperature resulting from thermal pollution by industrial effluents or deforestation can decrease dissolved oxygen (DO) levels and disrupt the metabolic processes of aquatic organisms. Significant temperature fluctuations may also affect the sensitivity of indicator species used in biomonitoring. In this study, pH and temperature were measured using a pH meter.

Based on the test results for pH and temperature parameters, segment 1 recorded a pH of 7.6 and a temperature of 29.5°C. In segment 2, the pH was 7.76 and the temperature was 29.6°C. In segment 3, the pH was 7.63 and the temperature was 29.6°C. Compared to the quality standards, the pH values in segments 1, 2, and 3 are still within the acceptable range of 6 to 9.

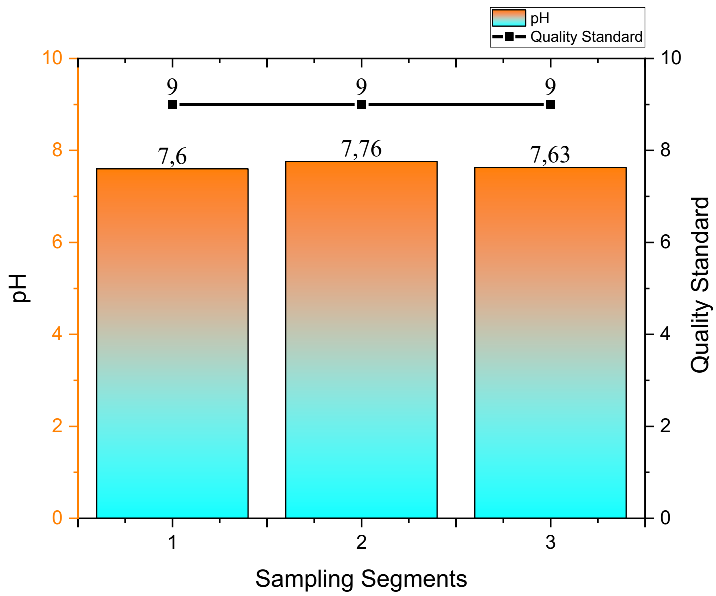

Fig. 4 Comparison Chart of pH Test Results with Quality Standards

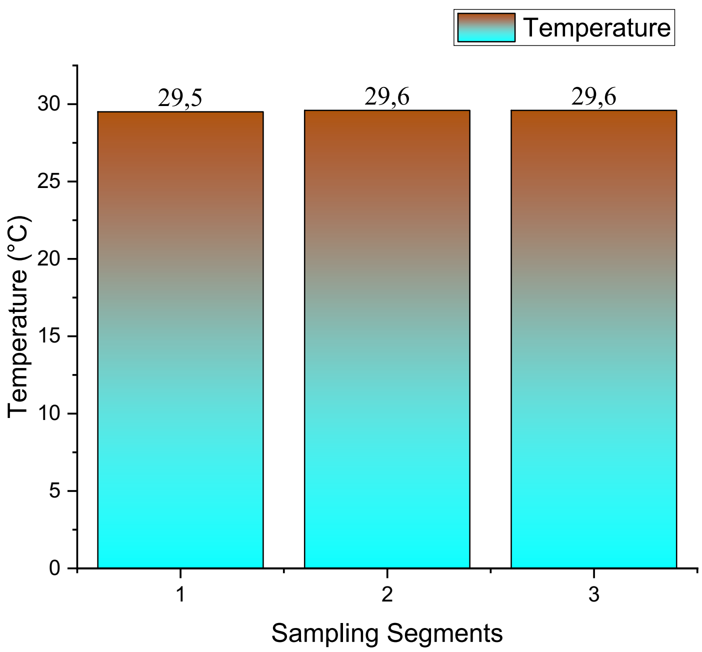

Fig. 5 Temperature Test Results Chart

3.2.4 Turbidity

Turbidity refers to the degree of water cloudiness caused by suspended solids such as silt, plankton, or pollutants. High turbidity reduces light penetration, inhibits photosynthesis in aquatic plants, and can clog the gills of aquatic organisms. The main sources of turbidity include soil erosion and suspended solids carried by river flow. In this study, turbidity was measured using a turbidity meter. Based on the test results, the turbidity value in segment 1 was 5,92 NTU, in segment 2 it was 3,00 NTU, and in segment 3 it was 16,39 NTU.

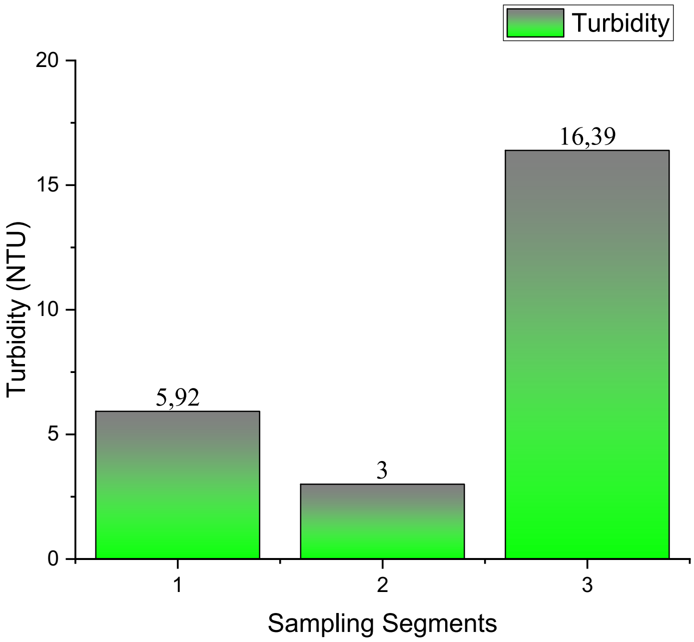

Fig. 6 Turbidity Test Results Chart

3.2.5 Total Dissolved Solid (TDS)

Total Dissolved Solids (TDS) measures the concentration of dissolved organic and inorganic substances in water, such as salts, metals, or chemical compounds. Excessive TDS levels can alter the taste of water, damaging fish ecosystem, and indicate contamination from industrial effluents. TDS measurement is important for assessing the impact of pollution on the chemical balance of water. In this study, TDS values were measured using a TDS meter. Based on the test results, the TDS value in segment 1 was 520 mg/L, in segment 2 was 551 mg/L, and in segment 3 was 465 mg/L.

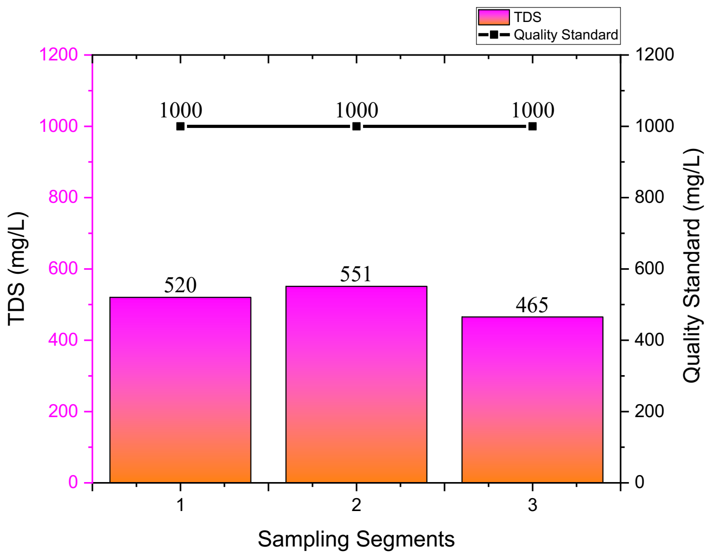

Fig. 7 Comparison Chart of TDS Test Results with Quality Standards

3.2.6 Quality Standard

The test results for each parameter were compared against the water quality standards to assess compliance. This study refers to the Indonesian Government Regulation No. 22 of 2021, Appendix VI, concerning the Implementation of Environmental Protection and Management, using the Class III Water Quality Standards for rivers and similar water bodies.

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Table 2
Sumo River Chemical Parameter Test Results

Parameters	Unit	Sampling Point			Quality Standard
		Segment 1	Segment 2	Segment 3	Class 3
BOD	mg/L	20,1	13,4	33,23	6
COD	mg/L	50,6	34,6	76,26	40
pH	-	7,6	7,76	7,63	6 – 9
Temperature	°C	29,5	29,6	29,6	Dev 3
Turbidity	NTU	5,92	3	16,39	-
TDS	mg/L	520	551	465	1.000

3.3 Analysis of Biological Parameters

Macrozoobenthos are aquatic animal organisms larger than 0.5 mm that inhabit the bottom substrate of rivers, including insect larvae *(e.g., Ephemeroptera, Trichoptera)*, worms *(Oligochaeta)*, snails *(Gastropoda)*, and clams *(Bivalvia)*. *Macrozoobenthos*, such as bottom-dwelling insect larvae, worms, and snails, serve as natural *bioindicators* for assessing water quality. Diversity indices, such as the Shannon-Wiener index, are used to measure the variation in *macrozoobenthos* species at a site. High diversity typically indicates the presence of sensitive species *(e.g., Ephemerellidae)*, which is characteristic of clean water, whereas low diversity suggests a dominance of tolerant species *(e.g., Tubificidae)*, indicating heavy pollution.

Table 3 Number of *Macrozoobenthos* in Sumo River, Surabaya City

Family	Photo	Number of *Macrozoobenthos*		
		Segment 1	Segment 2	Segment 3
Tubificidae		11	6	4
Parathelphusidae		3	3	1
Thiaridae		3	2	-
Viviparidae		1	-	-
Total		18	11	5

3.4 Shannon-Wiener Diversity Index (H')

The Shannon-Wiener Diversity Index (H') is a quantitative metric used to assess species diversity within a community by accounting for both species richness and evenness. In this study, the index was applied to evaluate the response of *macrozoobenthos* to variations in river water quality.

Table 4 Shannon-Wiener Diversity Index

Family	ni	ni/N (Pi)	Ln(Pi)	Pi.Ln(Pi)	H'
Segment 1 Sumo River					
Tubificidae	11	0,6111	-0,4925	-0,3010	
Parathelphusidae	3	0,1667	-1,7918	-0,2986	
Thiaridae	3	0,1667	-1,7918	-0,2986	
Viviparidae	1	0,0556	-2,8904	-0,1606	
Total	**18**	**1**	**-6,9664**	**-1,0588**	**1,0588**
Segment 2 Sumo River					
Tubificidae	6	0,5455	-0,6061	-0,3306	
Parathelphusidae	3	0,2727	-1,2993	-0,3543	
Thiaridae	2	0,1818	-1,7047	-0,3100	
Total	**11**	**1**	**-3,6102**	**-0,9949**	**0,9949**
Segment 3 Sumo River					
Tubificidae	4	0,8000	-0,2231	-0,1785	
Parathelphusidae	1	0,2000	-1,6094	-0,3219	
Total	**5**	**1**	**-1,8326**	**-0,5004**	**0,5004**

In the diversity index, a high H' value indicates a healthy environment with high biota diversity, while low values reflect the dominance of pollution-tolerant species and ecosystem degradation. Based on the calculation results in the Shannon-Wiener diversity index table, the value of H' in segment 1 of Sumo River is 1,0588. The result of H' shows that the condition in segment 1 of Sumo River is semi-polluted with moderate diversity, the ecosystem condition is quite balanced, the productivity is sufficient, and the ecological pressure is moderate.

Segment 1 of the Sumo River still exhibits moderate biotic diversity, indicating a relatively balanced ecosystem with low to moderate ecological pressure. This condition is supported by several environmental factors observed in the area. Despite being densely populated and the presence of hospitality facilities, the water flow remains relatively swift, the riverbed is still visible, and riparian vegetation is present. The water in this segment also appears relatively clear, although early signs of domestic wastewater pollution have been detected. Consequently, anthropogenic pressure in segment 1 is not yet severe, allowing the ecosystem to maintain its self-purification capacity and sustain an adequate level of biotic diversity.

In segment 2 of the Sumo River, the Shannon-Wiener diversity index (H') was 0,9949. This low value indicates that segment 2 is heavily polluted, characterized by low species diversity, unstable ecosystem conditions, very low biological productivity, and high ecological pressure. Human activities in this segment are intense, including food and beverage industries, educational institutions, and a higher density of residential areas compared to segment 1.

Interestingly, the BOD, COD, and turbidity levels in this segment are lower than those observed in segments 1 and 3. This condition may be attributed to the relatively fast water flow and the presence of a rocky riverbed, which enhance aeration and accelerate the decomposition of organic matter. Additionally, the presence of aquatic vegetation such as mosses and water hyacinths contributes to pollutant absorption, further improving water quality parameters despite the high anthropogenic load.

In segment 3 of the Sumo River, the Shannon-Wiener diversity index (H') was 0,5004. This very low value indicates that the segment is heavily polluted, with minimal species diversity, unstable ecosystem conditions, extremely low biological productivity, and severe ecological pressure. Segment 3 exhibits the most degraded environmental conditions among all segments, marked by very low biotic diversity and ecosystem instability.

The segment is characterized by dense residential areas, the presence of bar screen garbage traps, and a calmer, more turbid water flow. The accumulation of domestic, industrial, and solid waste contributes to elevated BOD, COD, and turbidity levels that significantly exceed environmental quality standards. The slow flow of water further intensifies pollutant accumulation, allowing only highly pollution-tolerant species to survive. Consequently, biotic diversity and ecosystem productivity in this segment have declined sharply.

4. Conclusion

Based on the results of the biomonitoring study on the water quality of the Sumo River in Surabaya City, it can be concluded that the river ecosystem has undergone significant degradation from segment 1 to segment 3. This is evidenced by elevated BOD (13,4–33,23 mg/L) and COD (34,6–76,26 mg/L) levels across all segments, which exceed the Class III water quality standards as stipulated in Appendix VI of Government Regulation No. 22 of 2021. Although physical parameters such as temperature (29,5–29,6°C), pH (7,6–7,76), and TDS (465–551 mg/L) remain within permissible limits, the high turbidity observed

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in segment 3 (16,39 NTU), along with the dominance of pollution-tolerant species such as *Tubificidae*, strongly indicates severe contamination. The analysis of the Shannon-Wiener Diversity Index (H') revealed a marked decline in biodiversity from segment 1 (H' = 1,0588) to segment 3 (H' = 0,5004), reflecting increased ecological stress due to pollutant accumulation and low water flow. The predominance of tolerant macrozoobenthos and the low overall biotic diversity confirm substantial anthropogenic impacts, particularly from dense residential settlements, food and beverage industries, and poor waste management practices. These findings highlight the urgent need for integrated waste management systems, enhanced environmental education for the public, and routine biomonitoring to support the ecological restoration and sustainable management of the Sumo River.

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