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Environmental Monitoring of Water Quality in the Jangkok River, Mataram City

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Abstract: The increase in population and domestic activities of the community along the banks of the Jangkok River contribute to the decline in river water quality. This study aims to analyze the water quality of the Jangkok River based on physical and biological parameters by comparing the measurement results to class III water quality standards according to PP No. 22 of 2021 and evaluate the water quality status using the Pollution Index according to the Decree of the Minister of Environment No. 115 of 2003. This type of research is Descriptive Quantitative. Sampling was conducted at three points upstream, downstream, and midstream and the samples were tested in the laboratory using Indonesian National Standard methods. The results show that the temperature in the upstream, middle and downstream sections is 26.3°C, the highest TSS value is in the upstream section, namely TSS 0.119 mg/L, the highest pH value is in the downstream section, namely 6.07, the highest DO value is in the upstream section, namely 19.78 mg/L, the highest BOD value is in the middle section, namely 4.48 mg/L, the highest COD value is in the downstream section, namely 84 mg/L and the lowest total coliform is in the upstream section, namely 91 MPN/ml. Several parameters, such as pH, DO, and COD, do not meet the class III quality standards under PP No. 22 of 2021, while temperature, TSS, BOD, and total coliform remain below these standards. The Pollution Index at all points is in the "lightly polluted" category, with IP values of 3.69 upstream, 3.68 in the middle, and 3.30 downstream. Domestic waste activities along the Jangkok River significantly impact water quality, although overall pollution levels remain relatively low. Waste management and public education are needed to maintain the river's sustainable function.

Keywords: Environmental Monitoring; Jangkok River; Pollution Index; Water Quality.

Introduction

Population growth and urban development have also led to significant year-to-year changes in consumption patterns, while the remaining land area has placed increasing pressure on the environment. Human activities, including agriculture, industry, and households, generate waste that contributes to the decline in river water quality [1].

Water pollution in Indonesia is largely caused by human activities that generate residential, agricultural, and industrial waste, as well as mining waste. Residential waste is defined as any pollutant produced by residential areas or households. This waste can include organic waste (wood, leaves, etc.) and non-organic waste (plastic, metal, and detergent). Agricultural waste is defined as any pollutant produced by agricultural activities, such as the use of pesticides and fertilizers. Meanwhile, industrial waste is defined as any pollutant produced by industrial activities, which often produce hazardous and toxic materials (B3) [2].

Rivers are one of the most crucial ecosystems for human life. Many cities in Indonesia, including Jakarta, Surabaya, and Bekasi, utilize the rivers flowing through their territories as a source of clean water, making river water quality a crucial resource. Several other cities utilize rivers to support fish farming (raising cages) and also to supply water to rice fields through irrigation systems. Given the importance of rivers to human life, maintaining river quality is a key priority [3].

Research on river water quality was also conducted on the Citarum River, revealing that the water is lightly polluted. The pollution is primarily driven by inadequately treated domestic wastewater discharges and runoff from human activities along the river [4].

Another study regarding water quality status was conducted on the Bangosari River. Analysis using the Pollution Index method revealed that the upstream section of the Bangosari River had an index value of 1.84, while the downstream section had 1.76; both fall into the "lightly polluted" category [5].

The Pollution Index is used to assess the pollution level of a water body based on existing water quality parameters. Its determination is tailored to specific intended uses and can be adapted for various purposes along different sections of a river. Pollution Index (PI)-based water quality management provides decision-makers with information to assess a water body's condition relative to its designated use and to determine remedial measures in the event of pollution-induced water quality degradation [6].

Another study on the Surabaya River found that water quality is influenced by the characteristics of the areas surrounding the sampling points. At the river inlet, pollution loads for temperature, DO, and BOD5 were notably high, largely due to the prevalence of manufacturing industries along the river's course. The middle section is characterized by densely populated residential areas and home-based industries predominantly in the service sector, while the river outlet is dominated by

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dense, low-income settlements and slums situated directly adjacent to the river [7].

Measuring water quality status serves as a database for formulating water pollution control strategies. Data derived from water quality measurements provide objective information that urges the government, the public, and industrial stakeholders to heighten awareness and responsibility regarding pollution control [8]. These measurements determine whether river water conditions remain within safe limits or are polluted (whether mildly, moderately, or severely) based on environmental quality standards. Deterioration in water quality such as low dissolved oxygen levels or high organic waste content can damage aquatic habitats and destroy river ecosystems. Government bodies and relevant authorities require water quality data to formulate mitigation strategies, evaluate the effectiveness of industrial wastewater treatment plants (IPAL), and develop regional spatial planning policies [9].

The Jangkok River is one of the river basins located on Lombok Island. The Jangkok River has an area of 170,298 km2, with a main river length of 47,106 km, stretching from east to west, crossing West Lombok Regency upstream and Mataram City downstream, and emptying into the Lombok Strait. The Jangkok River is located in South Ampenan District, Mataram City, because South Ampenan District is the downstream area of the Jangkok River, which has a high level of pollution. The Jangkok River, located in South Ampenan District, Mataram City, is still used by the community for daily needs, such as toilets and agricultural water. In addition, it is used as a site for the disposal of garbage and domestic wastewater, both directly and indirectly. This community's use of the river can degrade river water quality, potentially disrupting phytoplankton populations.

No research on the water quality of the Jangkok River has been conducted previously; therefore, this study can serve as an up-to-date reference and broaden public understanding, especially given that the river's water is used for daily needs. Based on this background, the aim of this study is to analyze the water quality of the Jangkok River based on physical, chemical, and biological parameters, and to identify the extent to which waste from riverbank residents contributes to the pollution that occurs.

Research Methods

This type of research is Descriptive Quantitative. Sampling was conducted at three points upstream, downstream, and midstream and the samples were tested in the laboratory using Indonesian National Standard methods.

Tools

Sample bottles, Petri dishes, Exchange cups, Funnels, Erlenmeyer flasks, Measuring flasks, Furnaces/hotplates, Tweezers, Beakers, Winkler bottles, Measuring pipettes, Dropper pipettes, Glass funnels, Beaker glasses, Watch glasses, Rubble bulbs, Burettes, Acid cabinets

Materials

Surface Water (River Water), Aquades, Tissue, Litmus Paper, MnSO4 Solution, Alkali Iodide Azide Solution, Concentrated H2SO4 Solution, 0.025 N Na-thiosulfate Solution, Starch Indicator Solution, 2% Brilliant Green Lactase Broth (BGLB) Medium, Cotton

Research Location

This research was conducted in the Jangkok River located in West Lombok Regency and Mataram City, West Nusa Tenggara Province. Sampling was carried out at three points: Upstream at Ranget Spring, Sesaot Village, Narmada District, West Lombok Regency, with coordinates: latitude 8o33’5.42”S and longitude 116o14’8.57”E. Middle section in Bagek Nyake, Monjok Barat Village, Selaparang District, Mataram City, with coordinates: latitude 8o34’25.89”S and longitude 116o6’17.92”E. and finally in the downstream part of Mataram City, empties into the Lombok Strait with coordinates: latitude 8o34’27.10”S and longitude 116o4’16.58”E.

Water Temperature Check

Dip the thermometer directly into the river water and leave it for 2 to 5 minutes until it stabilises. Record the thermometer reading without removing the thermometer from the water.

Total Suspended Solids Procedures

Prepare the filtering apparatus, then wet the filter with a little distilled water. Stir the sample until homogeneous, then transfer 50 mL into a measuring cylinder. Then insert the sample into the filtering apparatus and wait until all the solution has passed through the filter. Collect the filtered results because they will be used for the TDS test. Carefully transfer the filter paper from the filtering apparatus to a petri dish. Dry in a furnace/hot plate for 15-20 minutes at 103°C to 105°C. Then cool and weigh until a constant weight is obtained [5].

pH

Measuring pH using litmus paper is done by inserting a sufficient amount of water sample into a glass container, inserting the litmus paper into the water sample for a few moments until the litmus paper changes color, matching the color change on the litmus paper with the color indicated on the Universal Indicator, and recording the pH of the water obtained [10].

Dissolved oxygen (DO)

Taking river water samples with a 250ml Winkler bottle until there are no air bubbles, Incubating for 5 days in a dark room for DO5 samples and for DO0 samples without incubation, Adding 2ml of 40% manganese sulfate (MnSO4) solution and letting the solution stand for a few minutes and homogenizing it, Adding 2ml of alkali iolide azide (NaOHKI) then letting it stand until a brown precipitate appears, Transferring a 25ml solution containing a lot of precipitate into a 250ml Erlenmeyer flask, Adding 2ml of concentrated sulfuric acid (H2SO4) until the precipitate dissolves, Titrating with 0.025 N sodium thiosulfate (NO2S2O2) solution until a light yellow color forms, Adding starch indicator until a blue color forms and continuing the titration with titration until the blue color disappears then record the titration volume [11].

Biological Oxygen Demand (BOD)

Put the river water sample into a Winkler bottle. Incubate for 3-5 days in the dark. Determine the DO_5 value according to the dissolved oxygen determination. Subtract the DO_0 and DO_5 values [12].

Chemical Oxygen Demand

Take a water sample using an Erlenmeyer flask. Take 10 mL of the sample water and transfer it to another Erlenmeyer. Add 5 ml of $K_2Cr_2O_7$, 0.025 N solution. Then, pipette 10 ml of concentrated H_2SO_4 solution and cover with a watch glass. Let stand for 30 minutes in a fume hood. After 30 minutes, add 7.5 ml of distilled water. Add 3 drops of ferroin indicator solution, then homogenize. Titrate with 0.1 N Ferro Ammonium Sulfate solution from a green solution to orange. Record the volume of the titration used [13].

Total Coliform

Multilevel Dilution

Prepare 9 test tubes and label each tube with a sign 10^{-3}, 10^{-4}, and 10^{-5}. Fill each test tube with 9 mL of sterile distilled water measured with a measuring cup. Add 1 ml of the river water sample to each tube using a dropper, then homogenise. Add 1 ml of the sample from dilution 10^{-3} into diluent tube 10^{-4}, then homogenise by vortexing until mixed. Add 1 ml of the sample from the 10-3 dilution to the 10^{-4} dilution tube, then homogenise by vortexing until mixed. Add 1 ml of the sample from the 10-3 dilution to the 10^{-5} dilution tube, then homogenise by vortexing until mixed.

Estimator Test

Fix the mouth of the LBDS media tube on the Bunsen flame then add 5 ml each from the 10^{-3} dilution tube into 3 LBDS media tubes, and re-fix the test tube and cover it with cotton, Fix the mouth of the LBSS tube then add 1 ml each from the 10^{-4} dilution tube into 3 LBSS media tubes, and re-fix the test tube and cover it with cotton, Fix the mouth of the LBSS tube then add 0.5 ml each from the 10^{-5} dilution tube into 3 LBSS media tubes, and re-fix the test tube and cover it with cotton, Homogenize slowly in all tubes so that the sample spreads evenly throughout the media, Incubate all tubes at 37^{OC} for 24-48 hours, Observe the presence of air bubbles in the Durham tube and record the code of the tube that positively emits gas and observe the color changes that occur, Determine the MPN Coliform value based on the MPN table.

Test of Confirmation

Take water samples from positive LBDS and LBSS tubes, which are marked by bubbles in the Durham tube and a change in the color of the media. Then insert 2 BGLB 2% into the EC media tube, and incubate the BGLB media at 37 °C for 24-48 hours. The presence of gas in the BGLB indicates the presence of total coliform, with the number of tubes that show a positive confirmation test recorded [14].

Take water samples from positive LBDS and LBSS tubes, which are marked by bubbles in the Durham tube and a change in media colour. Then insert 2 BGLB 2% into the EC media tube, and incubate the BGLB media at 37 °C for 24-48 hours. The presence of gas in the BGLB indicates the presence of total coliform, with the number of tubes that show a positive confirmation test recorded [15].

Results and Discussion

The Jangkok River is one of the main rivers that flows through Mataram City and West Lombok Regency in West Nusa Tenggara Province. The river flows into the Lombok Strait. The Jangkok River flows through various areas, from relatively pristine upstream areas to urban areas with dense domestic activity.

Table 1. Comparison of Ancar River Water Quality Test Results with Class III Quality Standards (PP No. 22 of 2021).

No	Parameter	Result			Unit	PP No. 22 of 2021 Class III Quality	Information
		Upstream	Middle	Downstream			
1	Temperature	26.3	26.3	26.3	^{O}C	Dev 3	Qualify
2	TSS	0.119	0.105	0.112	Mg/L	100	Qualify
3	Ph	5.94	6.05	6.07	-	6-9	Qualify
4	COD	26	50	84	mg/L	40	Not Qualify
5	DO	19.78	19.2	14.72	mg/L	3	Not Qualify
6	*BOD*	1.86	4.48	3.84	mg/L	3	Not Qualify
7	Total Coliforms	91	94	94	MPN/ml	10000	Qualify

Based on the table above, it is evident that the COD, BOD, and DO values in the upstream, middle, and downstream sections do not meet the standards set by Government Regulation Number 22 of 2021; specifically, COD values were 26 mg/L (upstream), 50 mg/L (middle), and 84 mg/L (downstream); BOD values were 1.86 mg/L (upstream), 4.48 mg/L (middle), and 3.84 mg/L (downstream); and DO values were 19.78 mg/L (upstream), 19.2 mg/L (middle), and 14.72 mg/L (downstream).

Temperature

The water temperature at all three sampling points was uniform at 26.3°C. This value falls within the normal temperature range for tropical waters and remains suitable for the survival of aquatic organisms. Based on Government Regulation (PP) No. 22 of 2021, the water temperature quality standard for Class III (agricultural, livestock, and industrial raw water) states that temperature should not deviate by more than ±3°C from the natural temperature. This means that the normal temperature of river water depends on the initial or natural conditions of the river, but generally ranges between 25–30°C. An increase of more than 3°C is considered to exceed the quality standard [16].

Total Suspended Solid (TSS)

Based on the results of TSS (Total Suspended Solids) measurements of river water during observations, the TSS concentration was 0.119 mg/L in the upstream, 0.105 mg/L in the middle, and 0.112 mg/L in the downstream. These TSS values remain below the Class III water quality standard (100 mg/L), indicating no significant increase in turbidity due to suspended solids. This indicates that particulate pollution from domestic activities has not had a serious impact on water clarity. In extreme cases, such as tofu waste in the Nguneng River, TSS increased drastically from an average of 220 mg/L to 558 mg/L after the discharge, indicating severe pollution and the need for wastewater treatment before disposal. These suspended solids inhibit light penetration, disrupting photosynthesis and oxygen production. These solids also quickly settle on the riverbed, further triggering siltation, altering the flow, and degrading the habitat of bottom-dwelling organisms [17].

pH

Acidity is an important factor in water treatment processes to improve water quality. The pH measurements in the Jangkok River ranged from 5.94 to 6.07. The lowest pH value was found in the downstream area at 5.94, while the highest pH value was found in the middle of the river at 6.07 and in the upstream area at 5.94. These results indicate that the pH of the Jangkok River still does not meet the quality standards set by Government Regulation No. 22 of 2021. Low (acidic) pH in water is usually caused by increased CO_2 from respiration, organic decay, and domestic waste. According to a study by Fiqi Nurbaya et al. (2024), organic household waste entering rivers in Central Java undergoes microbial decomposition, producing CO_2 and lowering the pH to below 6.5 [18].

Chemical Oxygen Demand (COD)

Based on the COD test results, the COD levels were 26 mg/L upstream, 50 mg/L in the middle, and 84 mg/L downstream. In accordance with Government Regulation No. 22 of 2021, these results do not meet the quality standards and require further testing.

These high levels indicate a high concentration of organic compounds in the river water. This is evident in the numerous drain pipes connecting residents' homes to the river, which discharge large amounts of organic and inorganic waste into it. High Chemical Oxygen Demand (COD) levels in water generally indicate a heavy load of organic and inorganic materials. These materials can come from industrial waste (tofu, palm oil, textiles), domestic waste, and agricultural fertilizers or pesticides. Based on research results, the high COD levels in the Pesanggrahan River are caused by the tofu industry and livestock waste containing complex organic and inorganic substances, as well as dissolved pesticides or fertilizers. Other studies have shown that COD levels in the Babang River are higher than BOD [19].

Dissolved Oxygen (DO)

Dissolved oxygen levels measured were 19.78 mg/L upstream, 19.2 mg/L in the middle, and 14.72 mg/L downstream. All DO values exceeded the minimum threshold of 3 mg/L set for Class III water. High DO levels generally indicate good water conditions, but decreasing values from upstream to downstream indicate oxygen consumption by organic compounds, as the pollutant load from domestic activities increases.

High levels of dissolved oxygen (DO) in water generally indicate healthy water conditions and support the life of aquatic organisms. One of the main causes of high DO is reaeration, the entry of oxygen from the atmosphere into the water, influenced by flow, turbulence, and open water surfaces. Furthermore, photosynthesis by algae and aquatic plants also plays a major role in increasing DO. In clear water with sufficient sunlight, algae can actively photosynthesize and produce oxygen in the water [20].

Biochemical Oxygen Demand (BOD)

BOD values were 1.86 mg/L in the upstream, 4.48 mg/L in the middle, and 3.84 mg/L in the downstream. Higher BOD values reflect the greater amount of organic matter in the water, which requires oxygen to decompose. Values in the middle and downstream increased, indicating a high organic load due to the influx of domestic waste from residential areas along the riverbanks [21]. High values indicate a high organic waste load in the water, with increased BOD due to the discharge of greywater and blackwater into the river. The highest BOD values in the middle strengthen the assumption that densely populated areas (the middle reaches of the Jangkok River) contribute significantly to organic pollution.

Total Coliform

Total coliform is an indicator of faecal contamination (from urine and faeces). Its presence indicates an influx of blackwater or toilet waste. The total coliform content was measured at 91 MPN/100 mL upstream and at 94 MPN/100 mL in the middle and downstream. This value indicates biological contamination from domestic wastewater, although it remains well below the domestic wastewater quality standard set by Government Regulation No. 22 of 2021 (10,000 MPN/100 mL). However, the presence of coliform still indicates that the water is unsuitable for direct consumption without treatment.

Based on research on the Plumbon River in Semarang, the Total Coliform value exceeded 1,200,000 MPN/100 mL, far above the quality standard, indicating severe pollution from domestic and industrial wastewater. This high coliform concentration is an indicator of human or animal fecal contamination, potentially spreading infectious diseases such as diarrhea, typhus, and skin infections [22].

Jangkok River Quality Status

The Pollution Index (IP) calculations in the table indicate that the water quality at three river locations falls within the "Lightly Polluted" category. In the upstream section, the IP value of 3.69 is considered lightly polluted (range >1–5). Meanwhile, in the middle section, the IP value was recorded at 3.68. which also falls into the lightly polluted category. Meanwhile, downstream, the IP value of 3.30 remains in the lightly polluted category. This finding indicates that although all three points belong to the same category, the IP value decreases from upstream to downstream. According to Decree of the Minister of Environment No. 115 of 2003, water quality status is determined by the IP value, where a higher IP value indicates greater water pollution [23]. Jangkok River Quality Status can be seen in the table below.

Table 2. Jangkok River Water Quality Status

Location	Result	Water Quality	PI	Water Quality
Upstream	3.69	Lightly Polluted	0-1	Good
Middle	3.68	Lightly Polluted	>1-5	Lightly Contamined
Down-stream	3.30	Lightly Polluted	>5-10	Heavily Contamined

The Pollution Index (PI) is a widely used water quality evaluation method in Indonesia. This theory is rooted in combining various water quality parameters, such as BOD, COD, DO, pH, and TSS, into a single, easy-to-understand index [24]. PI is very useful for describing overall water quality, especially in areas under pressure from domestic and industrial activities. In the context of the presented table, although the three locations fall into the same category, differences in PI values indicate the influence of local activities at each point along the river [25].

In general, a river classified as "Lightly Polluted" based on the Pollution Index (PI) indicates that water quality has exceeded standards for specific parameters, yet the ecosystem retains the potential for rapid recovery. This classification arises because water quality parameters have exceeded established standards; the water no longer meets quality criteria due to pollutant influx [26]. Light pollution is typically characterized by elevated levels of specific parameters, such as organic indicators. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), alongside a decline in Dissolved Oxygen (DO). Physical and microbiological parameters also play a role, including Total Suspended Solids (TSS), turbidity, and high counts of fecal or total coliform bacteria [27]. Environmental management interventions by stakeholders, such as regular monitoring, public education on domestic waste management, and the construction of communal Wastewater Treatment Plants (WWTPs), are essential to prevent the pollution status from escalating to "Moderately Polluted" or "Severely Polluted" [28].

Conclusion

Jangkok River water at the study sampling points exhibits significant organic matter pollution, characterized by high BOD, COD, and DO levels, as well as *Escherichia coli* contamination. Based on the Pollution Index (PI) calculation, the water in the Jangkok River is classified as polluted. The PI value is 3.69 in the upstream area, decreasing to 3.68 at the midstream sampling point and to 3.30 at the downstream point. This level of pollution is categorized as "lightly polluted." According to the State Minister for the Environment Decree Number 115 of 2003 concerning Water Quality Status, this category is defined by a PI value of>1 to 5. In terms of water quality classification, this condition is considered unsafe, as it falls within the range of light pollution.

Author's Contribution

Muhamad Mardian Rizaldi: Collection of river water samples and analysis laboratory. Tina Melinda: Compiling Laboratory test results and preparing and submitting articles.

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