Analysis of water pollution in Kaliotik River, Lamongan-West Java

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Abstract. Kaliotik River is the one of important rivers in Lamongan District. In the middle of the center of the city and crosses the settlements of residents, markets and, restaurants by the river. The river is a source of water in agricultural activities, fish cultivation, and vannamei shrimp around the watershed. This study uses a quantitative descriptive method with purposive sampling. Sampling was conducted at as many as 7 stations, conducted in March-September 2020. Data taken in this study include physics parameters (temperature, total suspended solid /TSS), and chemical parameters (BOD, DO, pH, phosphate, ammonia). Determination of Kaliotik River water pollution status using STORET method (KEPMEN No.115/MENLH/2003), by comparing water quality data with standard water quality criteria according to its provisions / based on its Class (PP No. 82 of 2001). Based on the results of the study shows that the water quality of Kaliotik River is below the standard limit of water quality. Kaliotik River based on STORET method belongs to the category of heavily polluted.

Keywords: Kaliotik River; Lamongan; pollution; STORET method

1. Introduction

Lamongan Regency is one of the districts where people's lives are very dependent on rivers. Kaliotik River is one of the important rivers in Lamongan Regency, which flows in the middle of the city crowd and crosses residential areas, markets and restaurants along the river. This river is a source of water for agricultural activities, fish, and vannamei shrimp cultivation around the watershed. Rivers are the most important water resources for industrial, domestic water supply, irrigation, and other purposes in a watershed, thereby tending to stimulate serious hygienic and ecological problems [1]. Activities in the city will produce different pollutants. The various roles of rivers along with the development of human activities around the river will have an impact on decreasing water quality [2].

Pollutants that enter the river body continuously without any control over the source of pollution will change and reduce the quality of the Kaliotik River waters. The Kaliotik River started to smell bad and the color of the waters turned black. Changes in water quality in the Kaliotik River will have a serious impact on pond fisheries in Lamongan, including a decrease in fishery product production and frequent diseases of milkfish and vannamei shrimp around the Kaliotik river basin that have passed through the city. Therefore it is necessary to study water quality and water pollution of the Kaliotik River for the basis of planning for sustainable water resource management so that fishery production in Lamongan Regency remains optimal. The purpose of this study was to determine the status of water
quality and water pollution of the Kaliotik River, to know the parameters of the quality of water that was polluted and to know the source of pollution in the waters of the Kaliotik River.

2. Material and methods

2.1. Time and location
Samples were collected monthly using purposive sampling methods from March 2020 to September 2020. Sampling was carried out as many as 7 stations (figure 1), spanning once a month. Samples that have been taken will be tested in the Laboratory of Water Resources Management of the Islamic University of Lamongan, the Laboratory of the Fisheries Service of Lamongan Regency, and the Laboratory of Water Resources Management of Diponegoro University.

2.2. Water quality analysis
Data taken in this study include physical parameters (temperature, current velocity, water discharge, total suspended solid / TSS) and chemical parameters (BOD, DO, pH, phosphate, ammonia, oil and grease). Determination of the water quality status of the Kaliotik River using the STORET method (KEPMEN No.115 / MENLH / 2003), which is by comparing water quality data with standard water quality criteria according to its class (PP No. 82 of 2001 concerning Water Quality Management and Pollution Control). The PP No. 82/2001 serves as the national guideline to refer in managing of water quality especially for the water managers and operators who work at the national, provincial, and river basin level institutions [3]. STORET method use the value system of the “US-EPA on water quality status by classifying water quality into four classes (table 1) [4]. The results of the measurement of each water quality parameter if it meets the water quality standard, it will be given a score of 0 and if the measurement results do not meet the water quality standard then it will be given a score according to table 2.

![Figure 1. Research area in Lamongan Regency, Indonesia.](image)

| Class | Score | Criteria               |
|-------|-------|------------------------|
| A     | 0     | Very good              |
| B     | -1 s/d-10 | Low Polluted         |
| C     | -11 s/d-30 | Moderately Polluted    |
| D     | ≥ -31 | Heavily Polluted       |
### Table 2. Water quality assessment system.

| Parameter | Physic | Chemistry | Biology |
|-----------|--------|-----------|---------|
| Number of examples | Score | | |
| < 10 | Maximum | -1 | -2 | -3 |
| Minimum | -1 | -2 | -3 |
| Average | -3 | -6 | -9 |

### 3. Result and discussion

#### 3.1. Characteristics of Kaliotik river water quality

The characteristics of the Kaliotik River water quality during observations in March-September 2020 varied greatly, as shown in the following table 3. The pH value at several points in the Kaliotik River is above the water quality standard for Class 3. The pH value in wastewater increases due to excess aeration and due to algae blooms [5]. The phosphate value in the Kaliotik River has exceeded water quality standards. This is because, residents in Lamongan are used to throw household waste such as detergents and garbage into the river. One of the contributing factors to the high value of phosphates is the value of domestic waste containing detergents. In wastewater, phosphates can come from resident waste such as detergent residues, industrial waste, and agricultural waste [6]. The high value of phosphate in the waters is thought to be due to the influence of plantations near the location, the increase in phosphate is also thought to come from river flows originating from residential (domestic) housing [7].

### Table 3. Characteristics of water quality during the study.

| No | Parameters | St 1 | St 2 | St 3 | St 4 | St 5 | St 6 | St 7 | Water Quality Standard Class 3 |
|----|------------|-----|-----|-----|-----|-----|-----|-----|--------------------------------|
| Physical |
| 1 Temperature (°C) | 27-29.2 | 24.5-26.3 | 25.6-26.5 | 25-26.6 | 26-28 | 23-26 | 23.9-26.5 | Deviation 3 |
| 2 Sechi depth (m) | 0.2 | 0.26 | 0.24 | 0.13 | 0.34 | 0.25 | 0.35 | - |
| 3 Depth | 0.2-1.1 | 0.4-1.5 | 0.1-1.2 | 0.1-1.08 | 0.2-1.3 | 0.12-1.1 | 0.2-1.5 | - |
| 4 TSS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Chemical |
| 1 pH | 9.25 | 8.92 | 9.1 | 8.92 | 8.8 | 9.08 | 8.72 | 6-9 |
| 2 Dissolved Oxygen (mg/l) | 0.98 | 1.12 | 1.25 | 0.95 | 1.19 | 1.51 | 1.37 | >4 |
| 3 Phosphate (mg/l) | 1.52 | 1.53 | 1.02 | 1.65 | 1.20 | 172 | 1.09 | 1 |
| 4 Nitrate (mg/l) | 1.9 | 2.1 | 1.52 | 2.825 | 2.1 | 2.75 | 1.38 | 10 |
| 5 Nitrite (mg/l) | 0.066 | 0.061 | 0.064 | 0.081 | 0.119 | 0.067 | 0.071 | 0.06 |
| 6 Ammonia (mg/l) | 0.96 | 0.95 | 0.79 | 1.05 | 0.23 | 0.86 | 0.81 | 0.02 |
| 7 BOD (mg/l) | 40.1 | 36.3 | 23.2 | 54.8 | 22 | 34.4 | 35.2 | 12.5 |
Dissolved oxygen (DO) levels in Kaliotic rivers have low values. This can be seen in the diagram above that the DO value is below the quality standard value, namely 4, causing low species diversity. There are six fish tolerant species found in Kaliotik rivers: *Trichogaster trichopterus*, *Anabas testudineus*, *Hyposarcus pardalis*, *Mystus sp*, *Channa striata*, and *Oreochromis Mossambicus* [8]. DO is very influential on fish life, especially growth, tissue repair, and reproduction. Most fish in some polluted waters die, not because of the direct toxicity of waste materials, but because of a lack of oxygen in the waters as a result of being used by degradation process of organic matter by microorganisms [9]. The low DO value in the Kaliotic River is due to a process of decomposition and overhaul of organic matter that requires a lot of oxygen coupled with the respiration of water biota in the waters, so that the remaining dissolved oxygen levels in the waters are very low [10]. This is indicated by the BOD value that has exceeded the water quality standard.

![Diagram of dissolved oxygen levels in Kaliotic rivers](image)

**Figure 2.** Fluctuations in nitrate, nitrite, and ammonia content in March, April, May and, September in the Kaliotic River.

In March-April, the discharge and volume of water in the Kaliotic river is still high so the nutrients are relatively low. However, in September, the discharge and low volume of water caused the nutrient content in these waters to increase significantly. The condition of the Kaliotic River waters shows that the water quality is still below the water quality standard value. Nitrate levels in water fluctuate according to the season, and higher nitrate levels occur after heavy rains. The main source of nitrate on freshwater bodies is the fertilization of plants and weeds which can cause dissolved oxygen levels to be low [11]. Nitrite and ammonia in the Kaliotic River also increased significantly in September. Phosphate content in Kaliotic River has exceeded the water quality standard. Phosphorus stimulates algae growth, so when algae growth is excessive other aquatic forms of life are endangered [12]. This
is due to the high amount of organic material that comes from incoming domestic waste and the absence of flushing due to low water discharge. Concentration nitrate and phosphate will pollute surface water as it has negative impacts on the ecosystem and water supply [13]. BOD also has exceeded water quality standards. Ganga River, India, and Pasig River, Manila also have high BOD content due to high domestic waste entering the river [14][15].

3.2. Kaliotik river pollution status

The pollution status of the Kaliotik River based on STORET compared to the 2001 PP No. 82 concerning Water Pollution Control is shown in the following table.

Table 4. STORET calculation results in the Kaliotik river.

| No | Station                   | STORET score | Pollution Status  |
|----|---------------------------|--------------|-------------------|
| 1  | Sidoharjo Market Input    | -36          | Heavily Polluted  |
| 2  | Sidoharjo Market Output   | -36          | Heavily Polluted  |
| 3  | Fish Market Input         | -34          | Heavily Polluted  |
| 4  | Fish Market Output        | -39          | Heavily Polluted  |
| 5  | Lamongan Market place     | -33          | Heavily Polluted  |
| 6  | Sidokumpul Village        | -39          | Heavily Polluted  |
| 7  | Glugu Village             | -33          | Heavily Polluted  |

The table 4 shows that the waters of the Kaliotik River in Lamongan Regency are in the heavily polluted category. This reveals that urban waste that enters the river directly causes a decrease in water quality, both market waste and residential and agricultural waste. Waste load can interfere with the sustainability of function of the river ecosystem even in the long term give bad implications for the survival of aquatic biota, and will bring losses to local communities who use these aquatic resources [16]. This is consistent with the statement from [17], on rivers in the Jakarta area, domestic wastewater contributes to water pollution of around 75%, office and commercial area wastewater 15%, and industrial wastewater 10%, thus household wastewater. or domestic is the biggest contributor to water pollution in the Jakarta area. Human activity in the upper reach watershed potentially brings high organic materials to the lower reach, inducing the aquatic circumstance [18]. The STORET number value at Pasar Ikan station is the highest, this proves that at that station the waste has a direct impact on water pollution. This case same as like Citarum River, has resulted in growing quantities of untreated domestic sewage, solid waste, and industrial effluents being dumped in the river because of rapid urbanization and industrial growth in the past 20 years [17].

4. Conclusion

The water quality of Kaliotik River, Lamongan, East Java, is below the standard limit of water quality and belongs to the category of heavily polluted based on STORET method

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