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Degradation of the Aquatic Environment in Tujuh Muara Lake, Pamulang District, South Tangerang Affected by Urban Liquid Waste

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Abstract. Water is a natural resource requirement needed for every living thing. Water pollution will affect water availability, so fixing it requires effort. The purpose of this study is to determine the quality of the water, analyze the degradation that occurs and provide recommendations for efforts that can be made to improve the ecosystem of Lake Tujuh Muara. The research location was Tujuh Muara Lake, Pamulang District, South Tangerang. The method used in this research is by using storet. Water quality data were collected at two monitoring points: the inlet and outlet areas. Observation of environmental degradation is carried out using field observations. Parameters observed in this study were biological dissolved oxygen (BOD), chemical oxygen demand (COD), detergent, and coliform group. The analysis results show Tujuh Muara Lake's water quality exceeds the class II quality standard based on Government Regulation 22 of 2021. Two parameters exceed the quality standards: BOD and COD at the inlet point of 5.60 mg/L and 27.29 mg /l. The resulting BOD and COD values at the outlet point were 16.80 mg/L and 53.50 mg/L. Degradation of the aquatic environment is known by the abundance of water hyacinth plants that thrive and the turbidity and silting of the bottom of the lake waters. Efforts that can be made to improve the lake environment are by constructing constructed wetlands, building WWTPs, and implementing sustainable ecotourism.

Keywords: environmental degradation; pollution; storet; Tujuh Muara Lake; water; water quality

I. INTRODUCTION

Water resources are essential for the environment and the life of living things on Earth. The quality and availability of water can affect human civilization and urban development [1, 2, 3]. Water quality can change due to interactions with climate variability, environmental changes, and anthropogenic activities [4]. It is a problem that significantly impacts ecosystems and human health [5, 6]. Water problems threaten the world's human population and continue to increase [7, 8, 9, 10]. Some ecosystems experience severe water pollution that causes environmental damage. Pollution in freshwater reservoirs, rivers, and lakes has become a significant concern recently [11, 12, 13, 14]. One of the ecosystems that often experience pollution is the lake. The lake is a reservoir of water above ground level formed naturally or artificially with water sources originating from the ground or surface water [15]. The lake has an essential role in the hydrological cycle because it is a form of a protected area. The existence of a lake in an area has uses and potential in terms of economic value and ecological value, namely to become a water management and irrigation system, water absorption area, water catchment area, recreation area, fish farming area, and other functions related to water management [16]. Tujuh Muara is one example of a lake used by locals in their daily activities. Tujuh Muara (TM) is one of nine lakes located in South Tangerang City. This location has an area of 32 hectares used for various

purposes [17]. This location is also in lakes formed naturally and functions as natural animal habitats [18]. However, increased human activity followed by an increasingly rapid increase in population has caused several problems in this ecosystem. Urban development and population growth have caused the existence of this lake to experience various problems such as sedimentation, water pollution, and area reduction [19]. The conditions can cause more severe damage to the dam, so its function cannot be utilized anymore. Therefore, efforts are needed that can provide a solution to reduce environmental problems that occur. This research needs to be done so that the sustainability of TM can be maintained. This study aims to determine the water quality condition at TM Pamulang, analyze the impact of degradation in the environment, and recommend appropriate measures to preserve TM Pamulang.

II. METHODS

A. Study Area and Data Collection

This research was conducted from September to October 2021 in Pamulang District, South Tangerang City, Banten Province. The research location focuses on Situ Tujuh Muara Pamulang (Figure 1). The water quality research location focuses on two main points: the inlet and outlet sections. The first coordinate point in this study is 6°20'34.7"S 106°43'24.8"E as the inlet point, and the second point is at the coordinates 6°21'04.4"S 106°43'24.7"E as the outlet point.

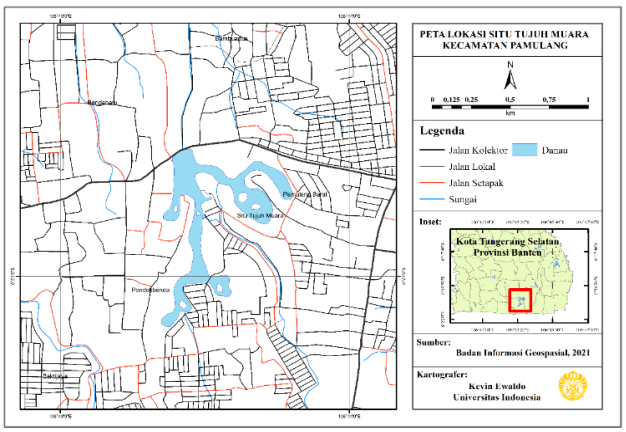

Figure 1. Research Location Map

The data collected in this study are primary data and secondary data. Primary data collection in this study included taking samples of water's chemical, physical and biological parameters at the study site. The chemical parameters considered in this study were the concentrations of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and detergents. The physical parameters considered in this study were the level of water turbidity. Turbidity is water that contains suspended matter that can block light from entering [20]. The turbidity of the water that occurs can affect the sunlight that enters the water's surface and disrupts the process of photosynthesis by aquatic plants as well as the supply of oxygen, which tends to decrease. The biological parameters observed in this study were total coliform contained.

B. Data Analysis

Water quality data were analyzed through laboratory tests on chemical, physical and biological parameters. The laboratory analysis results will then be analyzed using the storet method by comparing the data obtained with the applicable water quality standards. The quality standard used as a reference in this research is Government Regulation (PP) Number 22 in 2021 About the Implementation of Environmental Protection and Management.

The impact of environmental degradation was analyzed descriptively based on field observations of the conditions at the research location. Field observations made focused on shallowing and observing the growth of bioindicators. The bioindicator considered in this study was water hyacinth. Then, efforts to improve water quality are formulated based on a combination of water quality, the impact of degradation, and the results of interviews with key informants in the lake area.

III. RESULT AND DISCUSSION

A. Water Quality of TM Lake

The results of laboratory tests and field verification related to the quality of water in the TM lake show that several parameters exceed the criteria established in Government Regulation (PP) No. 22 of 2021. The BOD concentration obtained from monitoring point 1 (inlet) shows values that exceed the established quality standards. This condition is based on the use of the lake by the community around the research location, which uses TM lake for water tourism and water sports. According to the

water quality standards [21], water used for recreational infrastructure/facilities is classified as class II, with a maximum limit of 3 mg/L. Laboratory test results showed that the BOD value in the inlet area was 5.60 mg/L (Table 1). Therefore, the concentration of BOD at monitoring point 1 (inlet) exceeded the limit value of the class II quality standard with a value of 3 mg/L.

TABLE 1.
LABORATORY TEST RESULTS FOR WATER QUALITY SAMPLES 1 (INLET)

No	Parameters	Analysis Method	Class				Unit	Result
			I	II	III	IV		
1.	BOD (*Biochemical Oxygen Demand*)	SNI 6989.72-2009	2	3	6	12	mg/L	5,60
2.	COD (*Chemical Oxygen Demand*)	SNI 6989.2:2019	10	25	40	80	mg/L	27,29
3.	Detergent-MBAS	SNI 06-6989.51-2005	200	200	200	(-)	µg/L	<11,62
4.	*Coliform Group*	MPN	1000	5000	10000	10000	MPN/100mL	3200

TABLE 2.
LABORATORY TEST RESULTS FOR WATER QUALITY SAMPLES 2 (OUTLET)

No	Parameters	Analysis Method	Class				Unit	Result
			I	II	III	IV		
1.	BOD (*Biochemical Oxygen Demand*)	SNI 6989.72-2009	2	3	6	12	mg/L	16,80
2.	COD (*Chemical Oxygen Demand*)	SNI 6989.2:2019	10	25	50	100	mg/L	53,50
3.	Detergent-MBAS	SNI 06-6989.51-2005	200	200	200	(-)	µg/L	61,83
4.	*Coliform Group*	MPN	1000	5000	10000	10000	MPN/100mL	7500

Similarly, the COD concentration obtained at monitoring point 1 (inlet) also showed results that exceeded the established quality standards. The COD value at the inlet location was 27.29 mg/L, while the quality standard for COD concentration in class II used for water recreation is 25 mg/L. COD concentration can be used to evaluate biodegradation in the environment by analyzing the mass and energy balance of anaerobic processes [22]. COD is the amount of oxygen required to oxidize waste materials in water through chemical reactions, both biodegradable and difficult to degrade [23].

Although the concentrations of BOD and COD exceeded the quality standards, the concentration of detergent at the inlet location was below the quality standard of <11.62 μg/L, with a safe limit of 200 μg/L. The same condition also applies to the coliform parameter. The amount of coliform obtained at the inlet location is within the safe category because it does not exceed the established quality standards. The total coliform value obtained was 3200 MPN/100mL with a standard volume of 5000 MPN/100mL in class II.

Besides being used for recreational activities, the TM lake outlet is used by the community for aquaculture. A few people use the water from this lake to channel it into several private ponds and fish directly. However, the BOD concentration obtained from monitoring point 2 (outlet) shows results that exceed the established quality standards. Laboratory test results showed that the BOD value in the outlet area was 16 mg/L (Table 2). The concentration of BOD in the outlet area is higher than the concentration at the inlet, which can indicate high organic matter in the water [23]. Based on this condition, areas with high concentrations can be called polluted areas. The safe limit of BOD that can be used for fish farming is 6 mg/L in class III, and the concentration of BOD at this outlet location has exceeded the provisions for its utilization for fish farming.

The same condition also occurred in the COD concentration obtained at monitoring point 2 (outlet). The COD value at the outlet location was 53.50 mg/L, which is higher than the quality standard for utilization as fish farming, with a value of 50 mg/L in class III. However, the detergent concentration obtained at the outlet point is lower than the quality standard and the inlet point. The detergent concentration found at the outlet location has a value of 61.83 μg/L with a quality standard of 200 μg/L. In contrast to the conditions at the inlet, the amount of coliform at the outlet location exceeds the quality standard. The total coliform value obtained was 7500 MPN/100m.

However, the detergent concentration obtained at the outlet point has a lower value than the quality standard and the inlet point. The detergent concentration found at the outlet location has a value of 61.83 μg/L with a quality standard of 200 μg/L. In contrast to the conditions at the inlet, the amount of coliform at the outlet location has a value that exceeds the quality standard. The total coliform value obtained was 7500 MPN/100mL with a standard volume of 5000 MPN/100mL in class II. The high coliform value can be caused by much garbage at the outlet point.

Overall, the water quality at the outlet of the TM lake shows worse results compared to the inlet area. In addition, the outlet area has higher turbidity than the inlet area. Worse conditions at the outlet location can be caused by several things, such as a large amount of stagnant waste, the dense water utilization activities around the outlet, and the water flow, which cannot run properly due to being clogged with garbage.

B. Environmental Degradation of TM Lake

Environmental degradation is when an environment experiences a decrease in quality and function, leading to ecosystem damage. Environmental degradation can also be defined as a change or disturbance to the environment that has destructive properties [24]. In aquatic ecosystems, one of the efforts that can be made to determine environmental damage is by looking at the location's water quality indicators [25]. Water quality indicators that can be considered are the concentration of pathogens in the water, the content of heavy metals and toxic wastes in the water, and the level of oxygen contained in the water.

High concentrations of heavy metals will undoubtedly have several negative impacts on the aquatic environment. Apart from conducting laboratory tests, observation of bioindicators can be a way of detecting the presence of heavy metals in an ecosystem. In aquatic ecosystems, one example of a bioindicator that can be used is to look at the presence of water hyacinth. This opinion is reinforced by previous research, which states that water hyacinth can be a natural indicator that the water in the environment is polluted [26]. The presence of water hyacinth is a bioindicator because this plant can absorb heavy metals, so if its presence is abundant and fertile in waters, it can indicate high levels of metals in the waters [27]. That is,

the more heavy metal content there is, the more fertile the growth rate of water hyacinth will be.

The growth of the water hyacinth at the study site looks very high. At the inlet point (Figure 2), the high growth of water hyacinth causes siltation at the bottom of the lake. Silting that occurs can disrupt the sustainability of lake biota, reduce lake discharge, and in the long term can cause a reduction in the area and age of the lake.

Figure 2. Condition of Water Hyacinth in the Inlet Area

The lush growth of water hyacinth does not only occur in the lake inlet area. In the lake outlet area, the growth of water hyacinth has a broader area. The growth of water hyacinth at this outlet location causes a blockage of the drains. In addition, in some parts of the outlet, the presence of water hyacinth causes garbage to become entangled and accumulate even more (Figure 3). The people who come to the location around the outlet ignore this condition and continue fishing activities without worrying about the dangers that can be caused. One member of the local NGO also mentioned that the degradation conditions that occurred had even led to a reduction in the area of the current TM lake. The activity of throwing garbage into the lake is still often carried out by the local community, thus worsening the condition and quality of the TM lake.

The high growth of water hyacinths on the surface of the water can reduce the penetration of sunlight into the water. This condition can cause reduced dissolved oxygen levels in water [28]. A decrease in the dissolved oxygen content in water will reduce the number of water producers in the food chain. In previous studies conducted in this lake, it was also stated that the macrozoobenthic diversity index was included in the low category [29]. Apart from water hyacinth, the presence of macrozoobenthos can also be used as a bioindicator for contamination of an aquatic ecosystem. It confirms that TM lake has experienced environmental degradation and water quality pollution.

Figure 3. Condition of Water Hyacinth in the Outlet Area

C. Recommendations for TM Lake Preservation

The state of the TM lake is in unfavorable condition. Water quality that is not following the provisions of quality standards and environmental degradation that occurs can threaten the sustainability of TM lakes. Based on the conditions and problems that occur, several efforts are needed to overcome this, such as:

1. Construction of the Constructed Wetland

Artificial wetlands or constructed wetlands can effectively and efficiently absorb excess nutrients from water bodies [30]. In addition, constructed wetlands have relatively low costs in construction, operation, and maintenance [31]. The treatment mechanism in constructed wetlands is to precipitate suspended particles; filtration processes and chemical precipitation occur through contact between the wastewater and the substrate (soil, sand, and gravel-supporting plants).

Adsorption and ion exchange processes on the surface layers of plants, substrates, sediments, and litter, can occur in constructed wetlands. The processes that occur in constructed wetlands are the process of decomposition and transformation of pollutants by microorganisms and plants, absorption and transformation of nutrients by plants and

microorganisms, and eating and natural death of pathogenic bacteria.

2. Construction of a Communal Waste Water Disposal Installation (IPAL).

Management of communal domestic wastewater from residential areas directly adjacent to the lake is carried out through the construction of a communal Wastewater Disposal Installation (IPAL). Communal WWTP is a wastewater treatment system that is carried out centrally. Namely, there is a building used to process domestic liquid waste that functions communally (used by a group of households) so that it is safer when discharged into the environment, following environmental quality standards [32, 33].

One of the communal WWTP methods that can be applied is the Centralized Sanitation System. Centralized Sanitation System (off-site sanitation) is a system for disposing of household wastewater (bathing, washing, kitchen, and sewage) which is channeled out of the location of the yard of each house to the wastewater collection channel and then channeled centrally to the water treatment plant. Waste before being discharged into water bodies [34].

3. Implementation of Sustainable Ecotourism in Lake TM

The lake border at the research location is mainly used for motorbike repairs. It becomes a place for illegal waste disposal, causing garbage and liquid waste to flow directly into the lake. The purpose of utilizing this area is to obtain economic benefits for the community. However, the activities carried out harm the state of TM lake. Thus, one form of effort that can be made is to build sustainable ecotourism on the lake border.

Ecotourism that is built can provide income and indirectly reduce pollution originating from workshops and illegal garbage dumps. Economic improvement can occur through fees provided by the community when doing tours in this area. In addition, sustainable ecotourism can be implemented by educating and empowering the surrounding community to build interaction vehicles around TM lake.

The addition of photo rides can also be an attraction for this location. Visitors are more willing to pay for exciting places and are also suitable for taking pictures [35]. Moreover, people prefer tourism with natural nuances because it can calm the mind [36]. The TM Lake Border can also be used as a camping ground area and an outbound area which can make traveling satisfaction while at the same time fostering a sense of concern for nature. This opinion is reinforced by research [37] which states that ecotourism development within the scope of nature can be an educational opportunity as a basis for character education based on the environment and culture to love the environment.

In conclusion, the water quality of TM Lake shows several parameters that exceed the quality standards, as well as environmental degradation occurring in the area. To address these issues, several efforts can be made, such as constructing constructed wetlands, a communal wastewater disposal installation, and implementing sustainable ecotourism.

IV. CONCLUSION

The quality of the waters in Lake TM exceeds the criteria for class II in PP No. 22 of 2021. Environmental degradation in Lake TM is caused by dumping waste directly into the lake, both from household activities, motorbike repair shops, and restaurants. It is also evidenced by the shallowing of the lake and the large number of water hyacinths found in the lake area.

Recommendations for preserving TM lakes that can be carried out include: making artificial wetlands or constructed wetlands, managing communal domestic wastewater from residential areas directly adjacent to the lake through the construction of a communal WWTP, and implementing sustainable ecotourism around TM lakes.

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