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River Water Quality and Management of Water Pollution (Study in Grogol River, South Jakarta)

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Abstract:

The river water is one of the environmental components that have an important function for human life, including to supports economic development. Currently, residents in DKI Jakarta Province still use river water as a source of clean and drinking water, this is due to the limited supply of clean water provided by PDAM Jaya so that river water is an alternative source of water. The river as a body of recipient of domestic waste water becomes one of the natural resources that are vulnerable to pollution. Grogol River is one of the rivers that is used as raw water for clean water and is now polluted due to community activities. This study aims to analyze water quality and determine efforts to control water pollution in the Grogol River. The research method used is a combination of quantitative and qualitative methods. The SWOT (Strength, Weakness, Opportunity, and Threat) method is used to determine water pollution control efforts. The results showed that efforts to control water pollution that can be applied in the Grogol River are: control the people who live and operate in river border areas, organize socialization and training to the community and MSME about the importance of waste management, improve supervision of MSME liquid waste disposal, government assistance in creating systems and implementing integrated WWTP for MSME activities and slums, and implementation of water pollution control programs.

Keywords: *River, water quality, management, water pollution.*

I. INTRODUCTION

River pollution in big cities, especially DKI Jakarta has shown quite serious problems. DKI Jakarta as the center of government and business is an attraction for the people to migrate. Various problems regarding spatial planning, settlements, garbage, poverty and so on have caused the complexity of environmental problems in DKI Jakarta, including river pollution. Pollutant sources in DKI Jakarta are broadly divided into three namely industrial, domestic and waste from shops and cities (commercial areas) [1]. As a result of the lack of municipal wastewater treatment facilities and the inclusion of waste loads from various activities without the support of adequate river capacity, pollution occurs [2]. Pollutant Index (IP) status for 13 rivers flowing in DKI Jakarta in the polluted category at 99.24% while for the category meeting the quality standard only 0.76% [3].

Grogol River is one of the 13 rivers that flows in DKI Jakarta and has decreased water quality. Grogol River has an important function to support the needs and activities of the people in DKI Jakarta. Based on the Governor Regulation (PerGub) DKI Jakarta No. 582 of 1995 concerning Establishment of Designation and Quality Standards for River Water or Water Agency and Liquid Waste Quality Standards in the DKI Jakarta Region, the Grogol River is designated as raw water for drinking water or class B at the upper reaches of the river until the river meets the flood channel [4]. Furthermore, the states that as much as 5% of the total raw water supply in DKI Jakarta is obtained from the Grogol river [5]. Ironically, a variety of community activities around the river flow cause the Grogol River to be polluted due to waste discharged directly into water bodies. That the status of the Grogol River water quality is in

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the category of mild to moderate pollutants [3]. Furthermore, A river is said to be polluted if the water quality is not in accordance with its designation [6].

The Increased human activity contributes to the river to be vulnerable to water pollution, causing the impact of environmental degradation [7]. DKI Jakarta Regional Regulation No. 1 of 2014 concerning Detailed Spatial Planning and Zoning Regulations, the West Jakarta region in the Grogol River flow is dominated by sub-zones of settlements and offices so that waste from domestic activities has a major influence on river water quality. On the other hand, the Grogol river segment in West Jakarta is used as raw water for drinking water by the DKI Jakarta Regional Water Supply Company (PDAM) for community clean water needs so that this becomes a serious problem when there is a failure to meet human needs for access to clean water. Based on the water supply, efforts to control pollution in the Grogol River are needed so that the Grogol River can be in accordance with its designation.

II. RESEARCH METHOD

This research generally uses a quantitative approach. The research method used is a combination method (mix method) between quantitative and qualitative. This research was conducted in July to December 2019. Quantitative methods were used to determine the condition of the Grogol River water quality by comparing the quality standard designation of the Grogol River in accordance with DKI Jakarta Governor Decree No. 582 of 1995 concerning Determination of Designation and Quality Standards for River Water or Water Bodies and Quality Standards for Liquid Waste in the DKI Jakarta Region, calculating river water quality status using the Pollution Index (IP) method as well as evaluating river pollution control efforts using the SWOT method. The qualitative method in this study is data collection through interviews with stakeholders (DKI Jakarta Environment Agency, DKI Jakarta Water Resources Office and the Ministry of Environment and Forestry) to illustrate the efforts that can be made to control Grogol River pollution.

Water sampling was carried out in the Grogol River in the South Jakarta city, on the grounds that the Grogol River had been polluted or was not in accordance with its intended quality standard, but on the other hand the upper Grogol river was used as raw water by PT PAM Lyonnaise Jaya (PALYJA) to treat clean water. Water samples are taken at 5 (five) Monitoring Points (TP). Water sampling in TP 1, 2, 4 and 5 is the point taken based on the Master Plan for the Control of Pollution and Restoration of River Water Quality by the Jakarta Department of Environment (DLH) in 2015.

The TP is the target of water quality recovery (BOD and COD) conducted by DKI Jakarta DLH, but not periodically observed. This TP was chosen to get a picture of the achievement of the Grogol River water quality recovery target in the segment before the water was used as raw water for drinking PDAM or treated at PT PAM Lyonnaise Jaya (PALYJA). Whereas TP 3 is a point taken based on the DKI Jakarta DLH monitoring point on a regular basis so that water quality comparisons can be made in the previous year (2016-2018).

River water sampling is done by the instant sample method (Grab Sample) or water sampling which has water characteristics that do not change and represent the condition of the time and place. The parameters that were tested were: turbidity, TSS, TDS, pH, DO, COD, BOD, Ammonia, Phosphate, Nitrate, Total Coliform and Fecal Coliform. The test results obtained are then compared with water quality standards in accordance with DKI Jakarta Governor Regulation No. 582 of 1995 concerning Determination of Designation and Quality Standards for River Water or Water Bodies and Quality Standards for Liquid Waste in the DKI Jakarta Region and the calculation of water quality status is calculated using the Pollution Index (IP) method. Calculation of Pollution Index using formula 1:

$$IP_j = \sqrt{\frac{(\frac{C_i}{L_{ij}})^2_M + (\frac{C_i}{L_{ij}})^2_R}{2}} \quad \ldots\ldots (1)$$

Information :
Lij = Concentration of water quality parameters stated in the water allotment quality standard (j).
Ci = Concentration of water quality parameters from survey
results.
Ipj =Pollution Index for allotment (j).
(Ci / Lij)M = Max Ci / Lij value.
(Ci / Lij)R = Average Ci / Lij value.

The results of the Pollution Index calculation are

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then analyzed for the level of pollution to determine the status of water quality in accordance with Minister of the Environment Decree No. 115 of 2003 concerning Guidelines for Determination of Water Quality Status, as in Table 1.

Table 1. Relationship between the value of Pollution Index and Water Quality

No.	Pollution Index	Water Quality
1	$0 \leq PIj \leq 1,0$	Good condition
2	$1,0 \leq PIj \leq 5,0$	Light pollution
3	$5,0 \leq PIj \leq 10$	Medium pollution
4	$PIj \geq 10$	Heavy pollution

III. RESULTS AND DISCUSSION

A. River Water Quality

Based on the results of river water quality testing shows that the value of the TSS at the upstream location of the River (TP 1) is not in accordance with the quality standard of group B that is ≤ 100 mg / L. This can be caused by changes in land cover at TP 1, so that it can have an impact on the decline in water quality at these locations. Similar to the statement, that one of the main pollutant sources of road use and construction land use is sediment so as to allow the entry of sediment due to land clearing into waters which results exceeding quality standards [8].

TSS values obtained from substances that can be filtered by millionpore paper measuring 0.45μm consisting of microorganisms, mud, sand suspended in water [9]. Unlike the case with TSS, that the TDS values obtained from solids that can pass in the filter so that the TDS is a continuation of the TSS analysis. The distribution of TDS values is at 86 mg / L - 99 mg / L. It can be concluded that the TDS value at each location of the observation point is at a specified quality standard with a maximum limit of 500 mg / L.

Oxygen plays an important role as an indicator of water quality because dissolved oxygen plays a role in the oxidation and reduction processes of organic and inorganic pollutants naturally and in aerobic treatment aimed at reducing pollutant concentrations in industrial and household wastewater [10]. In contrast to other water parameters that an increase in the value of a parameter expresses the contamination of a waters, in contrast to the DO value that the lower the value of the parameter the more polluted waters.

The observations showed DO values in TP 1-TP 5 were quite low between 2.8 mg / L - 3.3 mg / L. Although some points meet the class B quality standard of ≥ 3mg / L, there is a DO value that exceeds the specified quality standard threshold, namely TP 4 of 2.8 mg / L. the concentration of dissolved oxygen indicates an increase in the burden of pollution from wastewater entering the waters. The states that dissolved oxygen in waters is strongly influenced by the process of decomposition of organic matter and oxidation of inorganic materials [9].

BOD concentration indicates the oxygen demand of microorganisms to break down organic compounds contained in water. The monitoring results show that the BOD value in TP 1- 5 is susceptible 9 mg / L-16 mg / L. There are several locations that do not meet the quality standard with a maximum value of 10mg / L, namely at locations TP 1, 2 and 3. The high BOD value at TP 1 indicates that pollution has occurred before the river enters DKI Jakarta causing the BOD value to exceed the quality standard. Likewise in TP 2, there are tofu processing MSMEs that directly dispose of liquid waste into water bodies before the TP 2 sampling location which also causes high BOD values.

Similar to BPPT research, which states that the waste from tofu and tempeh processing has high BOD and COD levels which is around 5,000 - 10,000 mg / L for BOD values, while COD with values of 7,000 - 12,000 mg / L [11]. This also underlies the high COD value of TP 2 location which consistently exceeds the quality standard of class B. When compared with the quality standard of liquid waste in the food product industry from tofu according to the Jakarta Governor's Regulation No. 582 of 1995, the value of BOD and COD allowed to be discharged into water bodies were 75 and 100 mg / L, respectively, it is clear that MSME liquid waste tofu processing needs to do waste management first before being discharged into water bodies. In addition, high BOD values indicate high levels of organic matter in water, because the BOD value is a value that indicates the need for oxygen by bacteria to oxidize organic matter in water. When connected with the amount of dissolved oxygen (DO) that meets the quality standards in TP 1-3, it reflects that bacteria can oxidize organic matter aerobically at that location.

COD value is a measure for water pollution by organic compounds which naturally can be oxidized through chemical processes and results in reduced

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DO values in water [12]. The measurement results show susceptible COD values ranging from 16 mg / L - 26 mg / L. Similar to the BOD value, based on the results of the measurement of the COD value at TP locations 1, 2 and 3 do not meet the quality standards of group B that is ≥ 20 mg / L. The high value of COD is due to the many activities that contribute to the contribution of chemical pollutants entering the Grogol River water body. In addition, TP 1 and TP3 have high population densities so as to increase the potential value of total COD.

B. Grogol River Water Quality Status

In this study the calculation of water quality is based on the sampling point of the predetermined parameters. The water quality standard used is based on DKI Jakarta Governor Regulation No. 582 of 1995 concerning Stipulation of Designation and Quality Standards of River Water / Water Bodies and Liquid Waste Quality Standards in the DKI Jakarta Region.

The water quality status of the Grogol River in 2019 was analyzed using the Pollution Index method. The results of calculations using the IP method show that the water quality status of the Grogol River is at a vulnerable IPj value (IP value for the designation of the river) of 6.6-7.6 (Table 2). If it is adjusted to the Water Quality Status, it can be concluded that each monitoring point is in the Medium Polluted condition. This is shown by the GPA value greater than 1. Grogol River water pollution generally comes from domestic waste pollution, this can be seen from the high biological parameters such as Fecal Coliform and Total Coliform which greatly affect the calculation of IP.

Table 2. Results of the Grogol River Pollution Index Calculation

Location of Sampling	River type	Status IP			
		Meet Quality Standards	Light pollution	Medium pollution	Heavy pollution
		0 ≤ PIj ≤ 1	1≤ PIj ≤ 5	5≤ PIj ≤ 10	PIj ≥ 10
TP 1 (Sukadamai Village)	B			7.6	
TP 2 (Kencana Village				7.5	
TP 3 (Senayan City)				6.9	
TP 4 (Gelora Bung Karno Main Stadium)				6.6	
TP 5 (Bank Danamon Central Park)				6.7	

Source: Primary Data (2019)

The periodic monitoring of the Grogol River is carried out based on the results of water quality monitoring in 2016-2018 with the calculation of the pollution index based on the location of TP 3 and the parameters determined namely TSS, TDS, pH, COD, BOD, Nitrates, Total Coliform and Fecal Coliform. The results of periodic water quality status calculations for 2016-2018 can be seen in Table 3.

Table 3. Water Quality Status TP 3 of 2016-2018

Location of Sampling	River type	Status IP			
		Meet Quality Standards	Light pollution	Medium pollution	Heavy pollution
		0 ≤ PIj ≤ 1	1 ≤ PIj ≤ 5	5≤PIj ≤ 10	PIj ≥ 10
February 2016	B			5.3	
August 2016				7.1	
May 2017				7.3	
July 2017				7.4	
September 2017			3.8		
March 2017				7.3	
May 2017				7.4	
July 2018				7.2	
September 2018				7.5	

Source: The processed data is based on DKI Jakarta DLH water quality data 2016-2018.

Table 3 shows the periodically the status of the water quality of the Grogol River in 2016-2018 is in light pollution-medium polluted conditions. The medium IPJ value was in the observation period September 2018 which was stated in severe polluted conditions and the IPJ value was 7.5. The increase and decrease in the value of the IPj is strongly influenced by land use and the activities of the surrounding communities [13].

In addition, the IPJ value is also influenced by aeration, namely the addition of oxygen content in the water due to the turbulence that occurs so that the transfer (diffusion) of oxygen from air to water where aeration is very dependent on the depth of flow, flow velocity, slope of the river and river bottom roughness .

It can be concluded that based on the status of water quality, the Grogol River is no longer in accordance with the designation of class B as drinking water raw water. Therefore, river management needs to be done in an integrated manner so that ecological, economic and social water functions can be maintained.

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C. The Efforts to Control River Water Pollution

Based on observations, results of river water quality testing, community questionnaires, stakeholder interviews and water pollution control principles in Minister of Environment Regulation No. 01 of 2010 a description of aspects and indicators of water pollution control in the Grogol River are made as presented in Table 4.

Table 4. Results of Analysis of Water Pollution Control

Aspects of Grogol River Pollution Control	Indicator
1. Physical Condition of the Grogol River	a. The water quality status of the Grogol River is moderately polluted. b. The value of Total Coliform and Fecal Coliform at each monitoring point consistently exceeds the water quality designation of the Golongan B River based on DKI Governor's Regulation No. 582/1995 and had a great influence on the status of water quality status. c. The border area of the river until the river embankment is turned into a residence and business place.
2. Government's Role	a. The routine monitoring point of the Grogol River before the water is used as raw water from the PDAM is only 1 monitoring point. b. There is a policy regarding wastewater quality standards and permits for the disposal of liquid waste based on the Governor's Regulation No. 582/1995. c. There is a study on the Capacity of Pollution Load (DTBP) of Grogol River Water. d. There is a data inventory of rivers and water polluting sources. e. There is a data inventory of rivers and water polluting sources. f. Accessibility of complaints by the public related to pollution and environmental damage has been done through electronic applications and websites. g. Budget support in the implementation of superior programs in controlling environmental pollution. h. Water quality improvement targets in the water pollution control and RPJMD master plan report, but based on the primary results water quality improvement has not been achieved. i. The difficulty of supervising MSMEs is due to the relatively large number of MSMEs with broad distribution. j. Weak law enforcement due to weak supervision. k. Coordination between agencies is weak so the environmental control and management program does not run according to the specified time.
3. The Role of Communities and SMEs	a. Community sanitation facilities for processing wastewater are inadequate and MSMEs that dispose of wastewater from processing have not yet gone through WWTP. b. The community violated government regulations and appeals to dispose of rubbish arbitrarily and in water bodies. c. The existence of environmental NGOs and non-governmental organizations.

Based on the results of the assessment of the matrix of internal and external factors, obtained a score of each factor, namely internal factors with a value of 2.4 and an external factor value of 2.2. The next step is to map the score on the x and y axes. This aims to determine the current position of controlling the Grogol River pollution. Position mapping is determined based on external and internal factor scores visualized through Figure 1.

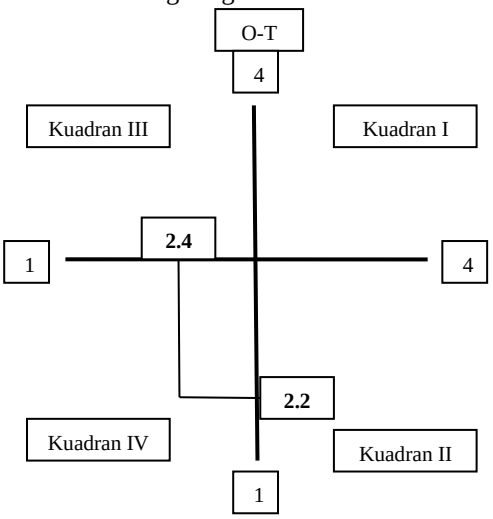

Figure 1. Position of Grogol River Pollution Control

In Figure 5, the mapping of the Grogol River pollution control position is currently in Quadrant IV with the characteristics of S < W and O < T. This means that the existing pollution control policy is not able to prevent water quality pollution with various internal weaknesses and threats external in the Grogol River.

The efforts that can be recommended are defensive strategies. This strategy aims to reduce internal weaknesses by avoiding external threats. Now that pollution control is known, mapping of internal and external factors in the SWOT matrix is currently carried out. Through the SWOT matrix a strategy is expected to control river pollution and optimize river use based on its designation. The strategy used is the WT strategy, as presented in Table 5.

Table 5. WT Strategy on SWOT Matrix

Internal factors	Weaknesses: W1. The status of river water is polluted moderately. W2.The value of Total Coliform and Fecal Coliform at each monitoring point consistently exceeds the quality standard of the Group B river water designation based on DKI Governor's Regulation No. 582/1995. W3. The routine monitoring point of the Grogol River before the water is used as raw water from the PDAM at PT PAM Lyonnaise Jaya (PALYJA) is only one point. W4. Primary water quality results are based on the RPJMD.
External Factors Threatness: T1. The border area of the river until the river embankment is turned into a residence and business place.	1. Control of the people who live and business in river border areas. 2. Hold socialization and training to the community about waste management. 3. Improving environmental

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T2. Weak law enforcement due to weak supervision. T3. Coordination between agencies is weak so the environmental control and management program does not run according to the specified time. T4. Community sanitation facilities for processing wastewater are inadequate and MSMEs that dispose of wastewater from processing have not yet gone through WWTP. T5. The difficulty of supervising MSMEs is due to the relatively large number of MSMEs with broad distribution. T6. Violation of garbage disposal into river water bodies and just about any place.	supervision, especially MSMEs. 4. Government assistance in implementing systems and implementing integrated WWTP for MSMEs and slums. 5. Implementation of water pollution control programs.

Based on the results of the WT strategy on the SWOT Matrix (Table 5), the efforts to control the Grogol River water pollution in order to be in accordance with its designation are as follows:

1) Control the people who live and operate in the border area of the river.
2) Conducting outreach and training to the community and MSMEs on the importance of waste management.
3) Improve supervision of MSME liquid waste disposal.
4) Government assistance in creating systems and implementing integrated WWTPs for MSME activities and slums.
5) Implementation of water pollution control programs.

IV. CONCLUSIONS

1. Water quality status of the Grogol River is polluted moderately at five (5) monitoring points with Pollution Index values namely (7.6), (7.5), (6.9), (6.6) and (6.7).
2. Efforts to control water pollution can be done in several ways, namely: (a) Control the people who live and businesses in the river border area (b) Organize socialization and training to the community and MSMEs about the importance of waste management (c) Improve supervision of waste disposal MSME liquidity (d) Government assistance in creating systems and implementing integrated WWTPs for MSME activities and slums (e) Implementation of water pollution control programs.

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