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Original Research Article

Examining the Water Quality Situation in Klampok River, Semarang through the Application of the NSF-WQI (National Sanitation Foundation – Water Quality Index) Model

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Abstract

The Klampok River is one of the rivers that crosses the Bandungan, Bawen, Bergas and Pringapus Districts. The increase in the number of residents in the river basin which is not matched by the availability of land encourages the conversion of land functions that are not in accordance with their designation. The existence of the Klampok River as a water body receiving wastewater resulting from anthropogenic activities has caused the Klampok River to become polluted. Thus, it is important to study the water quality and water quality status of the Klampok River for nature conservation. This study aims to determine the water quality status of the Klampok River using the water quality index method, namely the National Sanitation Foundation – Water Quality Index (NSF-WQI) with reference to class II river water quality standards. NSF-WQI is a method that uses several specific parameters to determine river water quality.DO, fecal coliform, pH, BOD, nitrate, phosphate, temperature, turbidity, and total solids.The 2018 water quality index using the NSF-WQI method is in the range54.13 – 65.38with medium-good quality status. Meanwhile, the water quality index for 2019 using the NSF-WQI method is within the range35.47 – 66.60with moderate status, except for sampling point 6 which has bad status.

Keywords: Klampok river; pollution index; water quality; NSF-WQI

1. Introduction

Indonesia is an archipelagic country which is rich in potential water resources which must be preserved. Utilization of water resources by humans such as domestic activities, irrigation needs, urban, industrial, agricultural and others will produce by-products in the form of wastewater. The resulting waste if it is not treated will potentially pollute the environment. Domestic waste from residential and office buildings can contain organic carbon, phosphate and nitrogen (Weiner & Matthews, 2003). If the

compound content in waste exceeds the carrying capacity and capacity of the environment, it will result in a decrease in the carrying capacity of the environment. In Indonesia, rivers serve several important functions that contribute to the country's social, economic, and ecological well-being. The key functions of rivers in Indonesia is water supply, transportation, hydroelectric power generation, irrigation and agriculture, biodiversity and ecosystem services, and recreation and tourism (Ginting, 2015). One of the major rivers in Semarang Regency is the Klampok River, which is the receiving body for domestic, agricultural, industrial and other wastewater in the Bandungan, Bawen, Bergas and Pringapus Districts. (Cassandra et al., 2019). There are many activities that depend on the Klampok River, so it is necessary to study the status of water quality to determine the status of water quality in the Klampok River.

Water quality generally refers to the physical, chemical and biological characteristics of water that determine its suitability for various uses. The use of water on a daily basis is generally for drinking water, agriculture, industry, and ecosystem health. This is an important aspect of environmental health and human well-being, as access to clean and safe water is essential for sustaining life and promoting sustainable development. According to the World Health Organization (WHO), more than 2 billion people worldwide suffer from a lack of access to safe drinking water and inadequate water quality, which poses significant health risks. Contaminants such as pollutants, pathogens, and chemicals can enter water sources through various sources, including industrial activities, agricultural runoff, sewage discharge, and natural processes. Monitoring and maintaining water quality are crucial for ensuring public health and safeguarding ecosystems. By assessing parameters such as pH, temperature, dissolved oxygen, turbidity, nutrient levels, heavy metals, and microbial contamination, scientists and environmental agencies can evaluate the suitability of water for specific purposes and identify potential risks and sources of pollution.

Furthermore, understanding water quality is essential for sustainable water management and conservation efforts. By implementing effective water treatment technologies and developing a strong regulatory framework, communities and governments can work towards improving water quality and protecting water resources for future generations. The water quality index is an approach used in determining the status of water quality by minimizing the volume of data. Calculation of the water quality index is based on 3 (three) parameters which include physical, chemical and biological parameters. The advantage gained from developing a water quality index is that it can represent the status of water quality efficiently in certain areas. The National Sanitation Foundation Water Quality Index (NSFWQI) is one example of a water quality index that has been developed worldwide (Tirkey et al., 2013).

This study aims to determine the status of water quality in the Klampok River, Semarang Regency. The study was conducted at 6 sampling points with 9 test parameters, namely DO, fecal coliform, pH, BOD, nitrate, phosphate, temperature, turbidity, and total solids. This is important to do to find out how far the condition of the water quality in the Klampok River is.

2. Methods

The research location is on the Klampok River, Semarang Regency and is one of the rivers that make up the Jragung Watershed. The Klampok River is one of the major rivers in Semarang Regency with coordinates located at 110° 20'45.5" to 110° 27'57.1" East Longitude and 7° 8'12.5" to 7° 11'27.4" South Latitude (Hardyanti, 2020). Administratively, the Klampok River is in Semarang Regency, in the area of Bandungan District, Bergas District, Bawen District, and Pringapus District. The division of the research area was carried out based on considerations of the location of the sampling points, river morphology, topography, and administrative boundaries of the Klampok River. Thus, in this study sampling was carried out at 6 points representing each river segment.

Tabel 1. Coordinates of Klampok Sub Watershed sampling location, DAS Jragung

No	Coordinate point	Region
1	7^0 11' 31" LS 100^0 22' 19" BT	Desa Sidomukti, Kec. Bandungan
2	7^0 12' 48" LS 100^0 23' 04" BT	Jembatan Selarik, Desa Jimbaran, Kec. Bandungan
3	7^0 13' 7" LS 100^0 24' 28" BT	Desa Samban, Kec. Bawen

No	Coordinate point	Region
4	7^0 12' 26" LS 100^0 22' 19" BT	Jembatan sebelah Cimory on The Valley, Kec. Bergas
5	7^0 11' 32" LS 100^0 26' 46.78" BT	Desa Klepu, Kec. Pringapus
6	7^0 11' 38" LS 100^0 27' 54.72" BT	Desa Pringapus, Kec. Pringapus

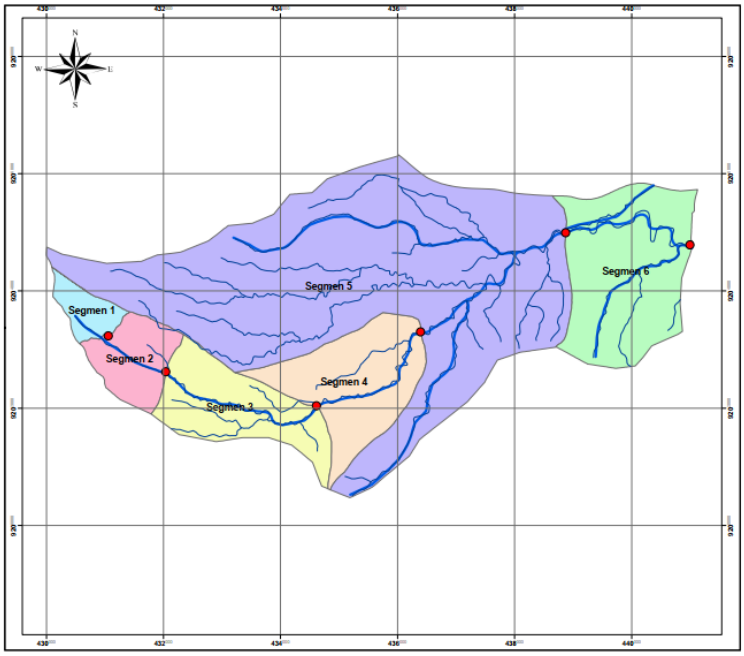

Figure 1. Map of sampling location of Klampok sub watershed, Jragung watershed

Data collection was carried out by means of a literature study so that the data used was secondary data from previous studies that had been conducted in the Klampok Sub-watershed, then data analysis was carried out using the NSFWQI Water Quality Index (National Sanitation Foundation Water Quality Index).

NSFWQI was developed by Brown with various complicated efforts in parameter selection, scale development and weighting assessment. NSFWQI produces 9 parameters that affect water quality, namely DO, fecal coliform, pH, BOD, nitrate, phosphate, temperature, turbidity, and TDS with different weighting values (Dewi et al., 2016). Then the weight of each parameter will be multiplied by the score obtained from the curve sub-index (Li). To obtain a sub-index score, you can use a graph or online with the WQI calculator. In this research, the researcher uses the WQI calculator online, namely on the websiteWater Quality Index Calculator for Surface Water (knowyourh2o.com). Furthermore, the score of each parameter is summed up with the following formula:

$$\text{NSF-WQI} = \sum_{i=0}^{n} Wi \; x \; Li$$

Keterangan :

NSF WQI : Water Quality Indeks

Wi : Weight

Li : Score from sub-index curve

Tabel 2. Criteria of index of water quality (NSF -WQI)

NSF – WQI Score	Criteria
0 -25	Very Bad
26 – 50	Bad
51 – 70	Medium
71 – 90	Good
91 - 100	Excellent

3. Result and Discussion

Based on the results of a literature study, water quality data has been obtained by (Cassandra et al., 2019) and Muhtadin, 2019 at 6 sampling points on the Klampok River.

Tabel 3. Water Quality at the 2018 and 2019 Sampling Points

Parameter	Unit	Point 1		Point 2		Point 3		Point 4		Point 5		Point 6	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Temperature	(⁰C)	23	24.1	24	25	24.6	25	24.4	25	26.2	25	31.1	25
pH		8.04	7.6	7.87	7.57	8.05	7.85	7.82	7.71	7.87	7.58	8.15	8.01
Turbidity	(NTU)	7.47	5.96	4.7	5.2	27.3	38.2	48.1	56.8	32.8	45.1	16.72	30.9
Total Solids	(mg/L)	143	80.7	176	153	598	437	837	782	636	421	388	297
Fosfat	(mg/L)	0.06	0.12	0.1	0.2	0.13	0.23	0.36	0.5	0.33	0.17	0.16	0.16
DO	(mg/L)	6.3	7.5	4.9	6.9	5.7	6.9	4.8	7.2	5.7	7.2	5.4	7.2
BOD	(mg/L)	2	2.1	2	4.6	2	2	2.4	3.3	2	2	2	2
Nitrit	(mg/L)	0.336	0.01	0.178	0.031	0.042	0.021	0.007	0.104	0.002	0.011	0.004	0,013
Nitrat	(mg/L)	2.3	1.3	1.8	1.7	2.8	1.5	1.7	1.7	1	0.9	0.8	1
Fecal Coliform	(number/100mL)	400	1400	17900	8800	13800	11900	10300	13000	16700	7300	15500	14500

Source: Muhtadin, 2018 (Cassandra et al., 2019)

1. Temperature

The water temperature in the Klampok River in 2018 and 2019 is in the range of 23.55 – 29.5. If the average air temperature is 26 °C, then the temperature conditions in the Klampok Watershed are classified as good according to the class II water designation quality standard PP No. 22 of 2021. According to Spellman and Darian, one of the things that affects the oxygen content in water is temperature (oxygen levels tend to be lower when the temperature increases). Biological and chemical processes in water also depend on temperature. Several things that affect temperature changes include weather changes, waste disposal, clearing of vegetation around the river°C (Bhateria & Jain, 2016).

2. pH

The pH level is indeed a measure of the acid content, or more precisely, the acidity or alkalinity of a water-based solution. It indicates the concentration of hydrogen ions (H+) in the solution. The pH scale ranges from 0 to 14, where pH 7 is considered neutral. Most aquatic life is very sensitive to pH. The range of pH values in the Klampok River is in the range 7.72 – 9.35. Based on the pH value at 6 sampling points, the Klampok River is classified as having good quality, except for at point 6 sampling in 2019 the pH value of 9.35 is classified as alkaline. The increase in pH is affected by the presence of organic and inorganic waste that is discharged into the river (Naillah et al., 2021).

3. Turbidity

Turbidity is a measure of the relative clarity of water caused by the presence of suspended particles or solids that scatter or absorb light, thus making the water appear cloudy or opaque. Turbidity is measured in nephelometric turbidity units (NTU) or formazine turbidity units (FTU) (Standar Methods, 2017). The turbidity value in the Klampok River is in the range of 4.9-41.3 NTU. This value is classified as good to moderate. Turbidity affects the ecosystem in the water, if the water is too turbid then the water will lose its ability to support plants and organisms in the water.

4. TDS

The total solid value in the Klampok River ranged from 111.88-471 mg/l. Based on class II water quality standard PP NO. 22 of 2021, the water quality in the Klampok River with the TDS parameter is still relatively good. Based on the APHA (American Public Health Association) the concentration of TDS in water is influenced by various factors (Bhateria & Jain, 2016). Domestic waste is very influential on the high increase in TDS and also affects other parameters such as phosphate and nitrate.

5. Phosphate

The total phosphate value in the Klampok River ranges from 0.09-0.405 mg/l. The total phosphate content in the Klampok River is good, except at point 6 for sampling in 2019. The total phosphate value at point 6 is 0.405 which exceeds the class II water quality standard PP No. 22 of 2021 of 0.2 mg/l. Mustofa explained, the phosphate content in the waters is in the form of orthophosphate, where the orthophosphate content in the waters indicates the fertility of the waters. However, according to Green, phosphate content that is too high can have a harmful impact on the environment. Phosphate content in water can come from the disposal of agricultural and domestic waste, soap, detergents, and the pulp and paper industry into water bodies (Patricia et al., 2018). Phosphates can have negative impacts on various ecosystems when they enter water bodies (algal blooms, oxygen depletion, harm to aquatic life, disruption of food chains, hu,an health risk) (Dodds, et al. 2009).

6. DO

Dissolved oxygen is the concentration of molecular oxygen (O2) that is dissolved in water, expressed in units of milligrams per liter (mg/L) or parts per million (ppm). It represents the amount of oxygen available for aquatic organisms to respire and is a crucial indicator of water quality and ecosystem health (Wetzel, 2000). DO values in the Klampok River ranged from 4.995-6.925 mg/l. The DO content in the Klampok River is quite good. Based on PP No. 22 of 2021 the DO class II quality standard is 4 mg/l. The greater the DO content in water, the better the water quality (Naillah et al., 2021).

7. BOD

BOD values in the Klampok River ranged from 0.925-3.425 mg/l. The BOD content in the Klampok River is quite good, except at point 6 of the 2019 sampling the BOD value at that point was 3.425 mg/l. Based on PP No. 22 of 2021 the class II BOD quality standard is 3 mg/l. High levels of BOD in water indicate high levels of microorganisms in these water bodies (Naillah et al., 2021).

8. Nitrate

Nitrate values in the Klampok River ranged from 0.415 mg/l – 3.54 mg/l. Phosphate content in the Klampok River is quite good. Based on PP No. 22 of 2021 the class II nitrate quality standard is 10 mg/l. According to Irwan et al, nitrate is an important nutrient for plants, but if the nitrate content is excessive in water, it will cause water quality problems. High nitrate content in water can lead to eutrophication and increase the height of plant growth, thus affecting dissolved oxygen levels, temperature, and other chemical parameters (Patricia et al., 2018).

9. Fecal Coliform

Fecal coliform values in the Klampok River ranged from 600-98000 MPN/100 mL. When compared with class II water quality standards PP No. 22 of 2021, the water quality in the Klampok River, seen from the parameters of the fecal coliform, is classified as bad. Fecal coliforms, which include bacteria such as Escherichia coli (E. coli), are indicators of fecal contamination in water bodies. Fecal coliform contamination in water bodies can lead to the following negative impacts (waterbone diseases, recreational hazards, contamination of drinking water, and ecological imbalance) (Barton, et al., 2004).

Table 4. 2018 water quality status results

No	Sampling Point	Mark	Criteria
1	Point 1	65.38	Medium
2	Point 2	57.63	Medium
3	Point 3	57.67	Medium
4	Point 4	54.13	Medium
5	Point 5	58.55	Medium
6	Point 6	57.72	Medium

Based on the results of water quality data analysis using the NSF-WQI (National Sanitation Foundation - Water Quality Index), the water status in the Klampok DAS Jratun Sub-watershed in 2018 was in the moderate category both in the upstream and downstream. The WQI value range is 54.13 – 65.38.

Table 5. 2019 water quality status results

No	Sampling Point	Mark	Criteria
1	Point 1	59.12	Medium
2	Point 2	61.60	Medium
3	Point 3	57.18	Medium
4	Point 4	59.69	Medium
5	Point 5	66.60	Medium
6	Point 6	35.47	Bad

Different from 2018, the status of water quality in 2019 has a value range of 35.47 – 66.60. The quality status of the water quality in the Klampok River in 2019 is moderate except at point 6. This can happen because the water quality results show that the further downstream the turbidity, TDS, and fecal coliform values in the river.

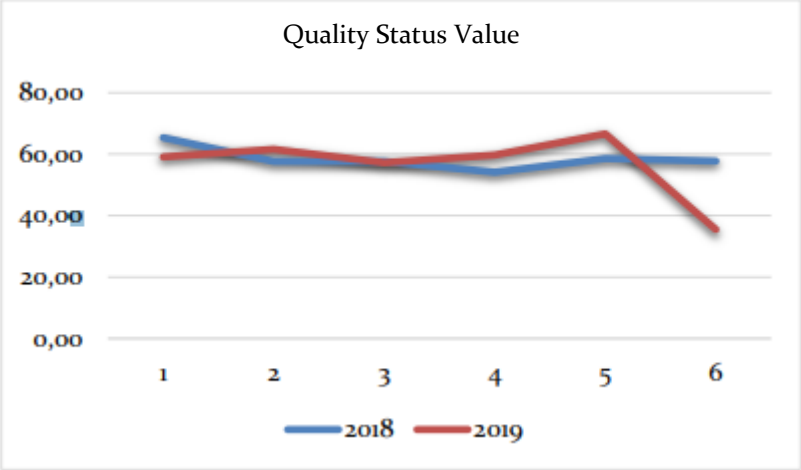

Figure 2. Comparison of water quality status in 2018 and 2019

4. Conclusion

Based on the results of research that has been carried out on 9 parameters using the NSF-WQI (National Sanitation Foundation - Water Quality Index), it can be concluded that most of the water quality status of the Klampok Sub-watershed is in the moderate category, except in 2019, item 6 is the status of deep water quality bad category. Therefore, it is necessary to make efforts to reduce pollution in the Klampok River through various efforts, such as processing domestic waste before disposing of it into river bodies and prohibiting the indiscriminate disposal of waste into rivers. Maintaining the condition of polluted rivers is an effort that should be done at this time. But efforts also need to be made to neutralize the condition of the river that has been polluted.

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