P-ISSN : 2598-1277
E-ISSN : 2621-3966

JOURNAL OF GREEN SCIENCE AND TECHNOLOGY

DETERMINATION OF WATER QUALITY INDEX (WQI) CENTRAL JAVA PROVINCE WATER BODY BASED ON TOTAL COLIFORM

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ABSTRACT

In recent years, the Central Java Province municipal river's water quality in the area is classified as heavily polluted. Therefore, research on water quality and its pollution level needs to be carried out in the Surakarta municipal river, especially in the Central Java Province. This study aimed to determine water quality and the pollution conditions in the Surakarta municipal river and analyze the conditions of the pollution load in the river at a predetermined observation point. This research was conducted using a survey method field with secondary data. The analysis was carried out using the method water quality index (WQI). The results showed The WQI change from heavily polluted to lightly polluted was measured at several observation locations from 2016 to 2018. The changes in the measured pollution index from 2016 to 2018 by coliform.

Keyword: *Coliform, WQI, Central Java, river*

I. INTRODUCTION

The management of water resources in Central Java faces considerable challenges. The need for water supply, which includes carrying capacity and water demand development, is increasingly being felt, both for water supply for domestic needs, agriculture, industry, housing, and other sectors. In Central Java, the average requirement for irrigation water per year is 19,636,378,014 m3/year (Pemerintah Jawa Tengah, 2018). Increasing water demand must also pay attention to the quality of water used by the community. Domestic and industrial wastewater must be monitored and controlled before discharge to streams (Sofiyah & Suryawan, 2021; Afifah et al., 2020). Management of water resources is essential because most of them also used as raw water supply source (Fadhilah et al., 2020). Various parameters that must be met in stream water quality are physical, organic and inorganic chemistry and bacteriology (Septiariva et al., 2021).

One of the microorganisms in domestic waste that acts as an indicator for contamination is the coliform bacteria. According to Wahyuni (2015), the abundance of coliform bacteria cannot be used as a basis for concluding the environmental conditions of polluted waters or not. Instead, it is an early indicator indicating that environmental conditions have decreased biologically, one of which is discovering pathogenic bacteria, including coliform.

People close to pollutant sources from tofu, septic tank, and animal waste still use water from clean water sources to fulfil their daily needs. However, the handling of waste is still effortless, namely, disposed of directly into the environment. From this alone, the potential for contamination from bacteria is there (Sekarrini et al, 2016). One of the monitoring efforts being undertaken in developing a water quality index (WQI). WQI can reference whether a water body is polluted or not, besides knowing that the index can be used as a policy determinant and prevention of environmental pollution that all stakeholders can carry out.

This research was conducted to determine the quality of coliform in Central Java Province with the study locations in the sub-districts of Jebres, Bulakan, Napel, Kajangan, Cepu, Bojonegoro, Beran, Lebak Kayu, Pingir Sari, Mangunharjo, Cengklik, Demangan, Semanggi, Bacem, Sukoharjo, Embanmati, and Peren. In addition, WQI is also seen for each region to determine the contamination status by coliform bacteria.

II. LITERATURE REVIEW

Open Defecation Free (ODF) is one of the conditions in which a community has carried out total sanitation, namely by not defecating. Poor sanitation causes various infectious diseases such as diarrhea, soil-borne worms, schistosomiasis, and trachoma infection. Sanitation management is closely related to public health. Because feces have an impact on public health. Some diseases that can be spread by human feces include typhoid, dysentery, cholera, intestinal worms, skin diseases and so on. Several studies mention the relationship and influence between poor sanitation by lack of land, lack of involvement, and lack of promotion (Abebe et al., 2020).

Coliforms are included in pathogenic bacteria that can cause disease (McGinnis et al., 2018). Coliform is an indicator of bacteria that is considered important in biological quality. Coliform bacteria are used to monitor the level of water safety from the possible presence of pathogenic bacteria. Coliform bacteria can be used as an indicator because their density is directly proportional to the level of water pollution. These bacteria can detect waterborne pathogens such as viruses, protozoa, and parasites. In addition, these bacteria also have a higher resistance than pathogens and are easier to isolate and grow.

Identification of bacteria in water can serve as an evaluation of the effectiveness of water disinfection methods (Fatemeh et al., 2014). Coliform bacteria require a temperature of 35°C as the optimal temperature for breeding (Pratiwi, 2007). Factors that affect the presence of Coliform bacteria are pollution in raw water, types of equipment used, treatment of processed water, transportation systems to transport water from raw water sources (Adriyani and Suprihatin, 2008). The higher the level of contamination with coliform bacteria, the higher the presence of other pathogenic bacteria. Usually, the processing of pathogenic bacteria can be carried out by means of physical, chemical, or physico-chemical disinfection (Hasnaningrum et al., 2021; Pangestu et al., 2021).

III. METHODOLOGY

The data used in this study are secondary data from local governments. The location of the sampling points consists of 16 points. Sample testing is carried out in the Surakarta municipal government

laboratory. Data used from 2015 to 2018. This study uses a cross-sectional study design using secondary data analysis. The data source was taken from the raw data of the Surakarta municipal river area government publication. The publication was carried out at 16 sampling points. Sampling points are located in Jebres, Bulakan, Napel, Kajangan, Cepu, Bojonegoro, Beran, Lebak Kayu, Pingir Sari, Mangunharjo, Cengklik, Demangan, Semanggi, Bacem, Sukoharjo, Embanmati, and Peren in Central Java Provinces.

The total coliform content measurement method used is the Most Probable Number (MPN) Coliform. MPN is intended to show the number of microbes in the water sample by counting bacterial colonies grown in the test tube and based on the number of positive tubes. Examination of coliform bacteria is carried out in 4 stages: the presumptive test, confirmative test, and complete test. The density of coliform bacteria was calculated according to SNI 06-4158-1996 equation (1).

$$\text{Total Coliform (JPT/100 mL)} = (A \times 100)/\sqrt{(B \times C)} \quad (1)$$

Information: A = Number of positive tubes, B = Volume (mL) of the test specimen in a negative tube, C = Volume (mL) of the test specimen in all tubes. Quality standards used for water body quality standards based on Indonesian Government Regulation No. 82 of 2001 for class I water quality and USPA National Recommended Water Quality Criteria 2004 (only for Ni parameters). The water quality index used to determine the level of pollution relative to permitted water quality parameters. Evaluation of pollution index values is:

$0 \leq IP \leq 1{,}0$ = Meet quality standard

$1{,}0 < IP \leq 5{,}0$ = Slightly polluted

$5{,}0 < IP \leq 10$ = Medium polluted

$PI > 10$ = Heavy polluted

IV. RESULT AND DISCUSSION

The Coliform bacteria are indicators of the presence of other pathogenic bacteria. More precisely, the faecal Coliform bacteria is an indicator bacterium that pollutes pathogens. Examples of coliform bacteria are *Escherichia coli* and *Enterobacter aerogenes*, and the less coliform content means the better water quality. The results of this study were conducted from January 2016 to December 2018. The study results from January 2016 to December 2018 showed total coliform at 16 sampling points in the Central Java Province (Figure 4.1).

The influence of community habits to dispose of household waste such as feces or other food scraps still dominates as a factor causing environmental water pollution (Adicita et al., 2021). Locations of densely populated settlements with high population density, very close distance from one house to another, the distance between household waste disposal and septic tanks with tended air sources and the habit of residents on the riverbanks of dumping urine and feces directly into the river causing coliform bacteria contamination events (Adrianto, 2018).

Based on Figure 4.1, the average total coliform at each sampling point is calculated. The results of calculating the average total coliform can be seen in Table 4.1.

It can be determined that the average total coliform for each year is different for each location. This is primarily determined by the hydrological conditions of each observation location. Khotimah (2013) states that faecal coliform bacteria's content is higher at low tide than at high tide. This is consistent with the results of this study which show the same pattern. The volume of water also influences the content of bacteria. When the water volume is high, the bacteria content is not as big as when it decreases.

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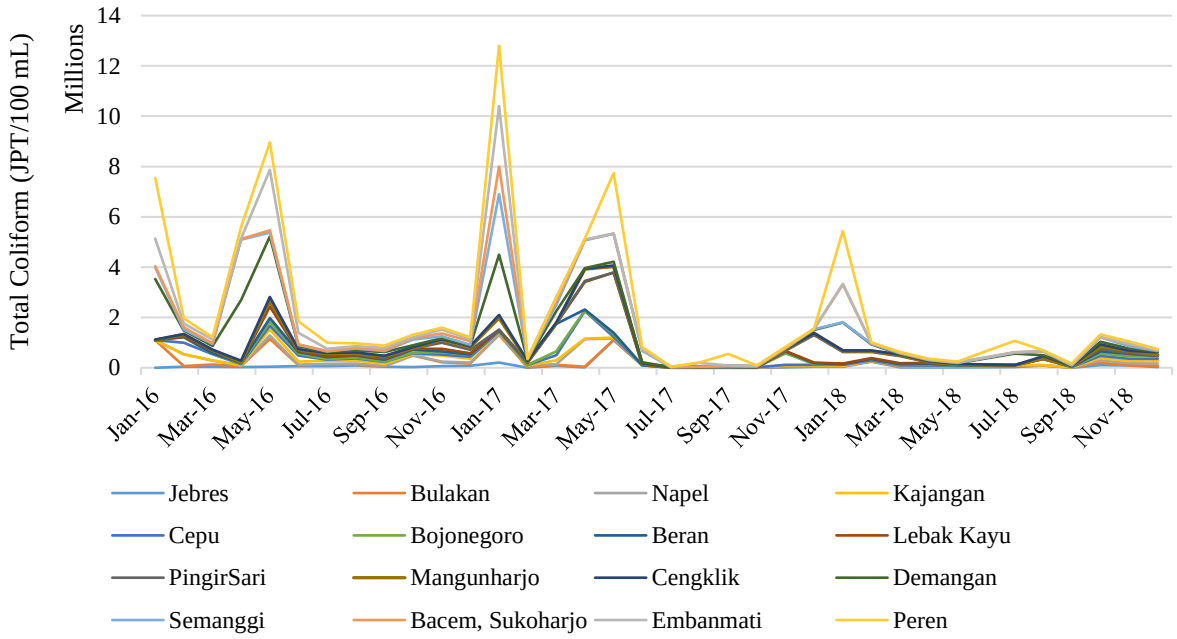

Figure 4.1. Total Coliform Water Body Fluctuation in Central Java

Table 4.1. Average coliform water body in Surakarta City area

Observation Points	Total Coliform (JPT/100 mL)		
	2016	2017	2018
Jebres	53091	195375	27946
Bulakan	193545	153375	8923
Napel	85364	185429	5228
Kajangan	104182	36542	10429
Cepu	136455	201714	9851
Bojonegoro	67000	113857	15930
Beran	62636	200714	5201
Lebak Kayu	77273	304917	15013
PingirSari	82091	117364	101505
Mangunharjo	38909	188143	15519
Cengklik	43091	405375	8775
Demangan	510091	32375	117729
Semanggi	289545	671875	9790
Bacem, Sukoharjo	60182	172125	130179
Embanmati	334545	281500	7722
Peren	274455	458250	183229

The calculation of WQI in this study is based on 16 points with the total coliform parameter. WQI from 2016 to 2018 has decreased in the sense that class II air quality standards have been completed. All sampling points show a change in the quality index to be lower (Figure 4.2). However, Pengir Sari, Bacem, and Peren are still in the weight index. From the calculation of the water quality status in Surakarta City for class II, WQI in 2016 and 2017 was heavily polluted at 14 points and lightly contaminated at 2 points. Meanwhile, in 2018 the heavily polluted category decreased to 4 points (Table 4.1). The WQI value is lightly contaminated at 11 points, while in the medium polluted category at 1 point.

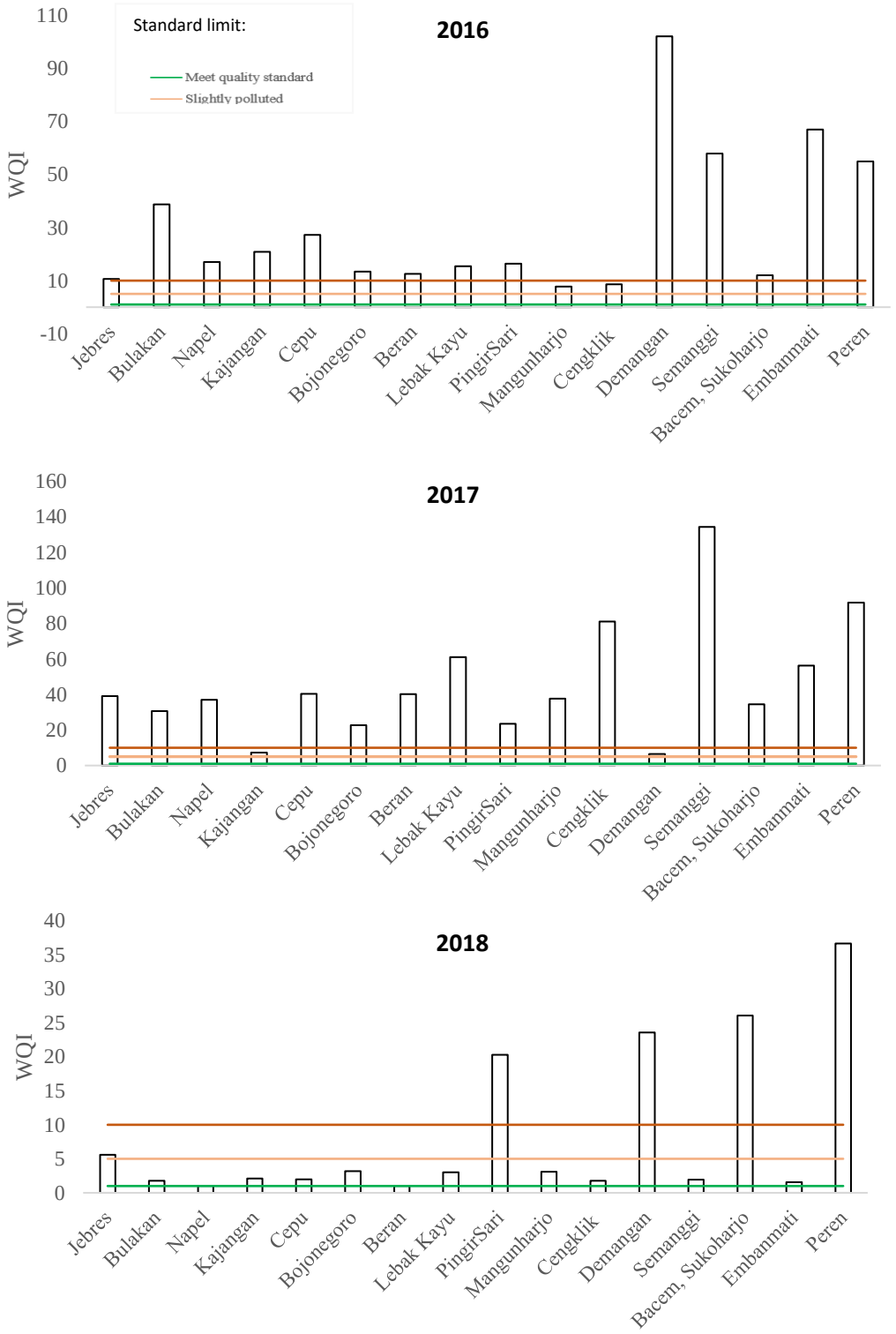

Figure 4.2. WQI 2016-2018 based on the Total Coliform Water Body parameters in Central Java Province

Changes in the measured pollution index from 2016 to 2018 by coliform. At maximum discharge, bacteria will further increase their velocity rate. Hence, at maximum discharge, the number of bacteria is greater than the number of bacteria at the minimum discharge (Sa'diyah et al., 2013). Table 4.2 shows the recapitulation of the quantification results of the air quality index due to bacteriological pollution. The water quality index change from heavily polluted to lightly polluted was measured at several observation locations in 2016 to 2018.

Tabel 4.2. Water Quality Index Based on Total Coliform Parameters

Observation Points	Quantification		
	2016	**2017**	**2018**
Jebres	Heavy polluted	Heavy polluted	Medium polluted
Bulakan	Heavy polluted	Heavy polluted	Slightly polluted
Napel	Heavy polluted	Heavy polluted	Slightly polluted
Kajangan	Heavy polluted	Medium polluted	Slightly polluted
Cepu	Heavy polluted	Heavy polluted	Slightly polluted
Bojonegoro	Heavy polluted	Heavy polluted	Slightly polluted
Beran	Heavy polluted	Heavy polluted	Slightly polluted
Lebak Kayu	Heavy polluted	Heavy polluted	Slightly polluted
PingirSari	Heavy polluted	Heavy polluted	Heavy polluted
Mangunharjo	Medium polluted	Heavy polluted	Slightly polluted
Cengklik	Medium polluted	Heavy polluted	Slightly polluted
Demangan	Heavy polluted	Medium polluted	Heavy polluted
Semanggi	Heavy polluted	Heavy polluted	Slightly polluted
Bacem, Sukoharjo	Heavy polluted	Heavy polluted	Heavy polluted
Embanmati	Heavy polluted	Heavy polluted	Slightly polluted
Peren	Heavy polluted	Heavy polluted	Heavy polluted

Community basic sanitation programs and wastewater treatment are essential sources of waste. The program that supports stream management in the Central Java Provincial Government's development plan is the Irrigation Network and Raw Water Management program. The program is directed at rehabilitation and construction of irrigation facilities with a priority of 7 Irrigation Areas (DI Banjaran, DI Kedunglimus Arca, DI Padurekso, DI Kalisapi, DI Krenceng, DI Sinongko, DI Jetis), rehabilitation and construction of raw water infrastructure (embung) with priority 6 embungs (Kamal, Karanganyar, Saradan, Sokoagung, Bakal and Sempu embungs), as well as support for the construction of the Randugunting, Jragung, Dolok, Ngemplak, Jatinegara and Bodri dams. This program is carried out to measure performance indicators, namely the proportion of good condition of irrigation network facilities and infrastructure, the proportion of fulfilment of raw water needs; the proportion of irrigated area maintained, and the ratio of raw water infrastructure supported.

V. CONCLUSION

In general, the pollution value of the water quality status is based on the pollution index method for each dynamic moving observation point from 2016 to 2018 WQI from 2016 to 2018 has decreased in the sense that class II air quality standards have been completed The condition of the pollution load in the Central Java streams is calculated based on the number of pollutant elements contained in the river water flow and is influenced by the river water discharge. The calculation of the pollution load using the total coliform parameter. From the calculation of the water quality status in Surakarta City for class II, WQI in 2016 and 2017 was heavily polluted at 14 points and lightly contaminated at 2 points. Meanwhile, in 2018 the heavily polluted category decreased to 4 points.

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