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Assessment of Sail River Water Quality in Pekanbaru City Using the STORET and Pollution Index (IP) Methods

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Abstract

The Sail River acts as the main drainage in Pekanbaru City. Several community activities around the Sail River, such as residential areas, plantations, livestock, shops, markets, and schools, cause decreasing in water quality in the Sail River. For this reason, it is necessary to analyze the water quality of the Sail River using the STORET method and the Pollution Index. The physical (temperature, TSS, TDS), chemical (pH, COD, DO, Pb), and biological (total coliform) parameters were analyzed. The results of the water quality analysis obtained were compared with Class II Water Quality Standards based on PP No. 22 of 2021. The results of the analysis of the quality status of the Sail River downstream based on the STORET method over the last five years show a "heavily polluted" condition, while the results of the IP method analysis show a "moderately polluted" condition. Based on the STORET and Pollution Index methods results, sail river needs a pollution control policy and management to overcome the pollution.

Keywords: Sail river, STORET, pollution index, quality status, river inventory, scoring of WWTP locations

1. Introduction

The Sail River is a tributary of the Siak River in Pekanbaru. The Sail River Basin is ± 29 km long, with a depth of ± 5 m and width of ± 10 m. It is characterized by turbid water with a base of sand, mud, and gravel (Wu et al., 2018). The Sail River passes through 4 (four) sub-districts in Pekanbaru City, namely Sail, Bukit Raya, Limapuluh, and Tenayan Raya Districts, with various kinds of community activities. The Sail River is divided into three regions: the Sail I River, which is in Limapuluh District and Sail District; the Sail II River in the Bukit Raya District; and the Sail III River, which is in the Tenayan Raya District.
Local communities use the Sail River as a means of transportation, bathing, washing, toilets (MCK), and animal husbandry. From the survey that has been carried out, the Sail River is a dumping place for various waste from various community activities including domestic waste originating from residential areas, shophouses, schools, restaurants, and shops. Waste from small industries such as workshops and woodworking, waste originating from the manure of residents' livestock and waste originating from drainage which flows directly into the river body. The high level of domestic activity around the Sail River has resulted to reduce river water quality which will directly affect the status of the river's water quality (Wu et al, 2022).

Water quality status is defined as the level of water quality that indicates whether the polluted condition or good condition of a water source at a certain time by comparing it with the water quality standards set (Government Regulation Number 22 of 2021). The STORET method and Pollution Index (PI) are the methods most often used in Indonesia to determine water quality. This was in accordance with the Decree of the State Minister for Environment No. 115 of 2003 concerning the Guidelines for Determining Water Quality Status. In principle, the STORET method and Pollution Index (IP) are used to compare water quality data with quality standards adapted to its intended use to determine water quality status.

To determine water quality status using the STORET method is by using a value or score system by classifying water quality into four classes (Hermawan, 2017):

a) Class A: very good, score = 0 (meets quality standards)
b) Class B: good, score = -1 to -10 (lightly contaminated)

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c) Class C: moderate, score = -11 to -30 (moderately polluted)
d) Class D: poor, score = ≤ -31 (severely contaminated)

Initially, STORET was developed to assess water quality for "specific use", for example drinking water. However, recently this method can also be used to assess the "overall use" of water. Determination of water quality status using the STORET method using time series data. Wei (2006) said that a time series is a series of observations of a variable taken from time to time and recorded sequentially according to the time sequence of events at fixed time intervals.

Meanwhile, the Pollution Index (IP) method is determined from the resultant maximum value and average value of the concentration ratio per parameter to the quality standard value (Suriadikusumah, et al., 2020). According to Minister of Environment Decree Number 115 of 2003, the water quality assessment categories based on the Pollution Index (IP) value are as follows (Hermawan, 2017):

a) IP ≤ 1, meets quality standards
b) 1 < IP ≤ 5, lightly polluted
c) 5 < IP ≤ 10, moderately polluted
d) IP > 10, heavily polluted.

Using the Pollution Index (IP) method has the following advantages and disadvantages:

a) Advantage: The advantage of the Pollutant Index method is that it can be used to determine water quality status with just one water quality sampling, requiring relatively little cost and time. Apart from that, the advantage of the Pollutant Index Method is that the results obtained are determined based on data units and the water quality status at each point can be determined.
b) Disadvantage: Single data is not enough to represent the actual quality of the river so that results differences in interpretation of river water quality status and creates confusion. Apart from that, the disadvantage of the Pollutant Index Method is also that the results obtained are less sensitive because they depend on the number of parameters studied.

2.Methodology

2.1.Materials

The tools used in this research were a pH meter, thermometer, DO meter, global positioning system (GPS), bucket, 500 ml polypropylene bottle, 100 ml glass bottle, ice box, small rope, label paper, evaporator cup, oven, desiccator, tongs, 20 ml measuring cup and analytical balance. Meanwhile, the materials used in this research were Sail River water, distilled water and Whatman No. filter paper 42.

2.2. Research Area and Water Sampling

The study area for this research was the Sail River in Pekanbaru City, Indonesia. Water samples were collected from the Sail River (Figure 1). River water sampling was conducted using the grab sampling method, in accordance with SNI 6989.57:2008. Sampling locations were determined based on the monitoring activities of the Environment and Forestry Service of Riau Province, ensuring representative points for assessing the water quality of the Sail River (Figure 2). At each sampling point, 5 liters of river water were collected during the morning between 13:00–13:45 WIB.

The collected samples were placed into 500 mL plastic bottles, labeled, wrapped in aluminum foil to prevent light exposure, and transported to the laboratory for further analysis. In-situ measurements of physical and chemical parameters, including temperature, dissolved oxygen (DO), and pH, were conducted immediately at the sampling site.

Laboratory analyses were conducted to measure physical parameters Total Dissolved Solids (TDS), and Total Suspended Solids (TSS). Chemical parameters Chemical Oxygen Demand (COD), Lead (Pb), and biological parameters (total coliforms).

The assessment of water quality status for the Sail River was based on the Minister of Environment Decree No. 115 of 2003, utilizing the STORET method and Pollution Index (IP). Additionally, water quality standards referenced Government Regulation No. 22 of 2021, Attachment VI, which outlines criteria for surface water quality.

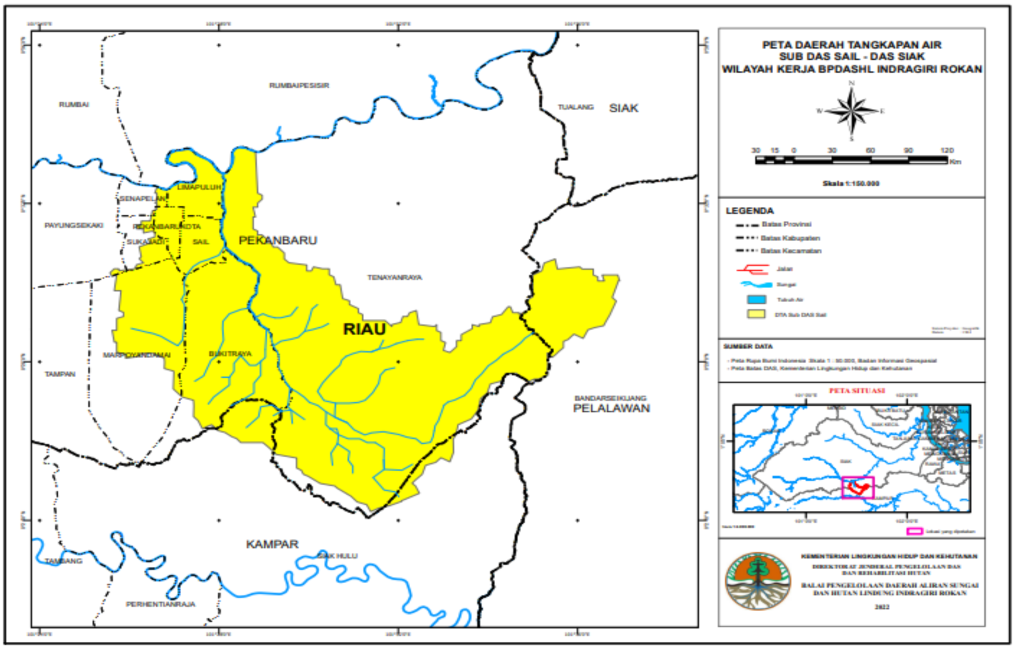

Figure 1. Sail watershed

Figure 2. Sampling point

2.3. Measurement of Water Quality

Some of parameters are collected in situ, that is, carried out directly in the field and taken simultaneously with water sampling. Environmental parameters taken in situ including temperature, current speed, DO and pH. The aim is to describe the water conditions at the time the research was carried out.

Water sample examinations were carried out at the Riau Provincial Health Service Laboratory and the Environmental Pollution Control Laboratory, Faculty of Engineering, Riau University. The parameters tested are physical, chemical and biological parameters to determine the quality status of river water, including TDS, TSS, COD, Pb and total coliforms.

2.4. Data Analysis

Data analysis in this research uses several methods, the first of which is determining water quality status using the STORET method and the pollution index (IP) method. Second, determining the best water quality status by analyzing standard deviation, standard error, and correlation between methods and linear regression equations.

2.4.1. STORET Method

Determination of water quality status using the STORET method is carried out with the following steps:

1) Collect water quality and water discharge data periodically so as to form data from time to time (time series data) with a minimum of 2 data series.
2) Compare the measurement data for each water parameter with the quality standard value that corresponds to the water classification. In this research, class II water quality standards were used in accordance with PP No.22 of 2021.
3) If the measurement results meet the water quality standard value (measurement result <quality standard), then a score of 0 is given.
4) If the measurement results do not meet the water quality standard (measurementresults>quality standards), then a score is given(Table 1).

5) The negative number of all parameters is calculated and the quality status is determined from the total scores obtained using a value system classified into 4 classes as mentioned previously.

Table 1. STORET method assessment score (Canter, 1997)

Number of Parameters	Value	Parameters Phys	Chem	Bio
< 10	Max	-1	-2	-3
	Min	-1	-2	-3
	Averagre	-3	-6	-9
≥ 10	Max	-3	-6	-9
	Min	-2	-4	-6
	Average	-6	-12	-18

2.4.2. Pollution Index (PI) Method

Determining the River Water Quality Index. The following actions are carried out as part of the Pollution Index (IP) Calculation Procedure: For each water quality measurement, data from the sampling point is entered first. Second, the sample concentration value is divided by the standard concentration value of each measured water quality parameter (Ci/Lij and Ci/Lij New) using the Excel formula. The pollution index value is then determined for each sampling point. Decision makers can be influenced to take action to improve water quality if there is a decline due to the presence of pollutants by using the Pollution Index (IP) in water quality management (Marselina et al, 2025).

PP No. 27 of 2021 concerning the Environmental Quality Index, Attachment I concerning the Procedure for Selecting Monitoring Locations, Data Collection Methods, and Calculation of the Water Quality Index using the following formula (Equation (1)) is the basis for analysis using the IP method.

$$PI_j = \sqrt{\frac{\left(\frac{Ci}{Lij}\right)^2 M + \left(\frac{Ci}{Lij}\right)^2 R}{2}} \quad (1)$$

The Ci/Li calculation procedure is based on several parameter conditions:

$$\left(C_i/L_{ij}\right)_{new} = \frac{C_{im}-C_i(\text{measurement results})}{C_{im}-L_{ij}} \quad (2)$$

$$\left(C_i/L_{ij}\right)_{new} = \frac{\left[C_i-(L_{ij})_{average}\right]}{\left\{(L_{ij})_{minimum}-(L_{ij})_{average}\right\}} \quad (3)$$

$$\left(C_i/L_{ij}\right)_{new} = \frac{\left[C_i-(L_{ij})_{average}\right]}{\left\{(L_{ij})_{minimum}-(L_{ij})_{average}\right\}} \quad (4)$$

If the Ci/Lij value from sampling results is ≥ 1, then Equation (5) is used.

$$\left(C_i/L_{ij}\right)_{new} = 1{,}0 + P.\text{Log}\left(C_i/L_{ij}\right)_{\text{measurement results}} \quad (5)$$

Determine the IPj value using Equation (6).

$$IP_j \qquad IP_j = \sqrt{\frac{\left(C_i/L_{ij}\right)_M^2 + \left(C_i/L_{ij}\right)_R^2}{2}} \quad (6)$$

3. Results and Discussion

3.1. Quality of the Sail River

In this study, eight water quality parameters were analyzed, namely temperature, TDS, TSS, pH, DO, COD, Pb and total coliforms. Meanwhile, the quality standard used to compare the water quality of the Sail River is class II water quality standard in accordance with Appendix VI of Government Regulation Number 22 of 2021. The following is data on the water quality of the Sail River which is compared with the class II water quality standard of PP Number 22 of 2021 which is presented in Table 2.

Tabel 2. Sail river water quality analysis

No	Parameter	Unit	Quality standard Class II	Analysis Results (Year)				
				2018	2019	2020	2021	2022
Physics								
1	Temperature	ºC	Dev 3	29	29	30	30	31
2	TDS	mg/L	1000	160	182	320	311	337
3	TSS	mg/L	50	86	105	183	216	273
Chemistry								
4	pH	mg/L	6 – 9	6,2	6,0	6,2	6,2	6,2
5	DO	mg/L	4	5	3	3	2	2
6	COD	mg/L	25	67	72	77	82	89
7	Lead (Pb)	mg/L	0,03	0,011	0,011	0,011	0,016	0,017
Biology								
8	Total E-coli	MPN	5000	57000	52500	125000	172500	240000

First, the water temperature is measured using a thermometer, by placing the tool in a container filled with water and leaving it for a few minutes until the temperature stable. In class II water quality standards, the water temperature has a standard deviation of 3 from the ambient air temperature. Figure 3 presents a diagram of the Sail River temperature measurement results.

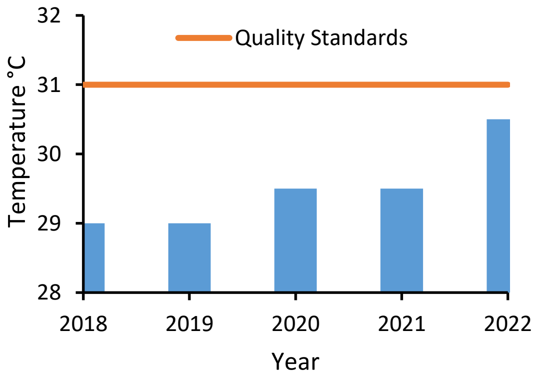

Figure 3. Sail river water temperature

Based on the results of measuring river water temperature parameters over the last 5 years, it shows that there are no big differences or are relatively stable, ranging between 29°C - 31°C. When compared with class II water quality standards based on PP Number 22 of 2021, namely a deviation of 3 from natural conditions, then the water quality conditions of the Sail River in terms of temperature parameters are still within the water quality standard limits according to its intended use. The high and low temperature of river water is influenced by the surrounding air temperature and the intensity of exposure to sunlight entering the water body. The intensity of sunlight is influenced by cloud cover, season and time of day. The greater the intensity of sunlight that hits a body of water, the higher is the river water temperature (Khatri et al, 2021).

TDS refers to the amount of inorganic and organic materials dissolved in water. The typical components of TDS are the main cation such as sodium, potassium, calcium, and magnesium and the main anions such as chloride, sulfate, and alkalinity, mainly bicarbonate (Ndou and Nontongana, 2025). *Second*, the results of TDS parameter measurements show that the water downstream of the river is still within the threshold for quality standards of PP RI Number 22 of 2021, namely 1000 mg/L. A small TDS value indicates that the solid substances dissolved in water are not very large but are quite risky because they can limit growth in water and also the death of living creatures in the water. The Sail River, which flows as the main drainage channel in Pekanbaru City, of course receives liquid waste from activities in the watershed.

Domestic waste from households can be kitchen leftovers such as meat, fish, washing water containing food scraps and detergent and soap residue (Giri, 2021). The following is a diagram of thes Sail River TDS measurement results presented in Figure 4.

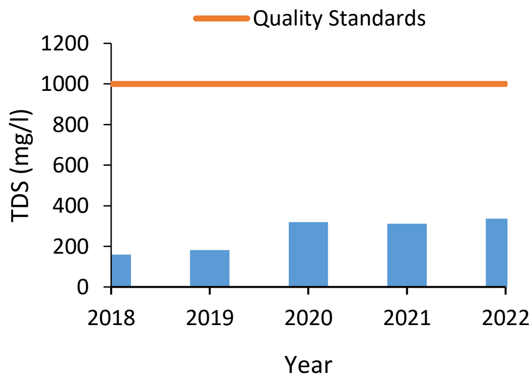

Figure 4. Sail river water TDS

In Fig. 4, the results of TDS measurements in the Sail River from 2018 to 2022 have increased quite significantly. This is due to differences in activity and the increase in population every year. However, in 2019 the TDS concentration in the Sail River decreased from the previous year and increased again in 2020, this was caused by runoff from plantations and housing. According to Shampa et al (2024), TDS levels in water are affected by a variety of natural and human-related factors. Natural sources like mineral springs, salt deposits, and soil erosion contribute to TDS. Human activities like agricultural runoff (fertilizers, pesticides), industrial discharges, and urban runoff (road salts, pollutants) also increase TDS levels.

Furthermore, Soeprobowati et al (2021) stated that TDS is caused by river basins which are dominated by agricultural land and plantations where the source of TDS comes from fertilizer.

Third, in class II water quality standards, the maximum concentration of TSS in water is 50 mg/l. TSS is generally known as the element of total solids featured in a given water sample that is usually floated on the surface in most peculiar conditions (Adjovu et al., 2023). TSS are particles that exceed 2 microns in size (Uwidia et al., 2017). The Sail River TSS concentration during the study showed an increase every year. When compared with class II water quality standards, the TSS concentration in the Sail River does not meet the standards because it is in the range of 30 mg/l – 229 mg/l. In research, Delpia et al (2023) said that TSS levels are influenced by soil erosion which can occur when it rains.

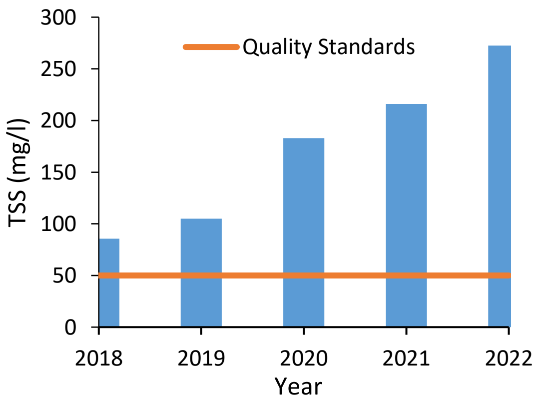

Figure 5. Sail river water TSS

According to Linayage and Yamada (2019), residential activities allow suspension-sized soil erosion to occur which then enters the Sail River. According to Sulthonuddin et al (2018), the high TSS is caused by the many activities in the area around the river, ranging from residential, agricultural to plantation activities, which will cause several factors such as runoff and erosion which will increase the particles in the water, resulting in high levels of TSS in the water. The following is a diagram of the Sail River TSS measurement results presented in Figure 5.

Fourth, pH measurements are carried out directly in the field using a pH meter. The pH measurement results are then compared with class II quality standards in accordance with Government Regulation Number 22 of 2021. The pH value in water according to class II quality standards is 6 - 9. Normal pH for irrigation activities ranges from 6.5 - 8.4, the pH range for domestic activities 6.5 – 8.5 (Suriadikusumah et al, 2020). The degree of acidity of waters is one of the chemical parameters that is quite important in monitoring the stability of waters. The following is a diagram of the results of Sail River pH measurements presented in Figure 6. Sail River pH measurement results ranged from 6.1 – 6.4. These results indicate that the pH of the Sail River meets class II water quality standards.

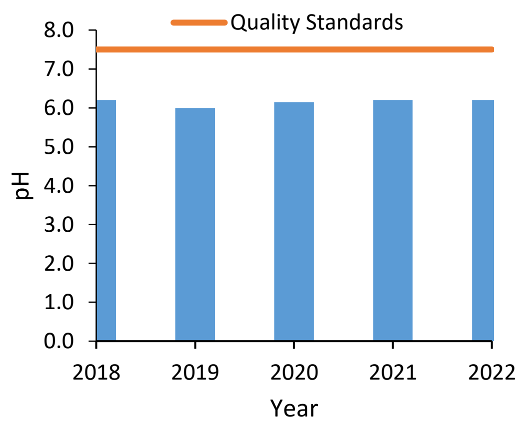

Figure 6. Sail river water pH

Fifth, Chemical Oxygen Demand (COD) is the amount of oxygen needed to chemically oxidize organic materials, both those that can be degraded biologically and those that cannot be degraded biologically, into CO_2 and H_2O (Manna et al, 2019). The following is a diagram of the Sail River COD measurement results presented in Figure 7.

High and low levels of COD in waters indicate a large amount of organic substance consisting of hydrocarbon, oxygen, nitrogen, phosphorus and sulfur components (Indrasari et al, 2023). The increase in Chemical Oxygen Demand (COD) in water bodies is primarily attributed to the discharge of various pollutants, especially organic matter from sources like household, agricultural, industrial, and fish farming activities. Salinity also plays a role, affecting the amount of COD measured, especially in coastal areas (Wang et al, 2025).

Figure 7. Sail river water COD measurement results

Sixth, the results of testing the concentration of Pb parameters in the Sail River have relatively the same values as the data for the last 5 years, namely ranging from 0.011 – 0.017 mg/L. Meanwhile, the water quality standard for Pb parameters according to the second class designation in PP RI No.22 of 2021 for rivers is 0.03 mg/L. The Pb concentration in the Sail River has a little impact on the river's water quality. The presence of waste and runoff from workshop activities and roads entering water bodies causes an increase in lead concentrations in the water. Figure 8 present the Sail River Pb measurement results.

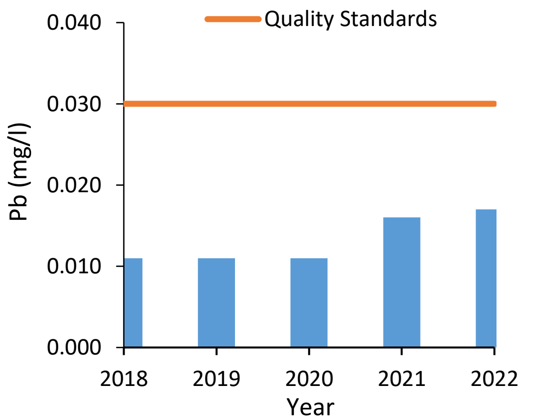

Figure 8. Sail river water Pb measurement results

Seventh, apart from testing physical and chemical parameters, this research also tested biological parameters. The biological parameters tested in this study were total coliforms. This was done to determine the effect of domestic waste on water quality status. The total coliform content is related to organic waste originating from human and animal waste (Chen et al, 2020). The total coliform measurement results for the Sail River are presented in Fig. 9.

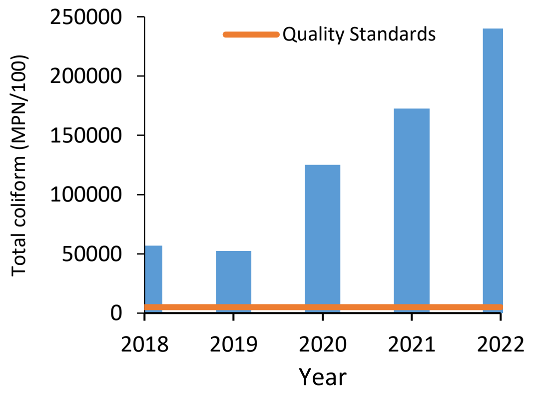

Figure 9. Sail river water total coliform measurement results

The increase in population along the Sail River in the last 5 years is the main factor in increasing the total coliform concentration. This is because many residential developments on the banks of the Sail River are indicated to dispose of their household waste directly into the river body. Other domestic waste that influences the total coliform concentration in the Sail River is the presence of markets and livestock (Wu et al, 2018).

3.3. Sail River Water Quality Status

The data obtained was processed using the STORET and IP methods to determine the Sail River Quality Status, the results is presented in Table 3 and Table 4.

The difference in the water quality status of the Sail River based on the results of STORET and IP calculations is due to different data requirements and different calculation methods. So these two methods cannot be compared directly. Based on the results of STORET and IP calculations, there is the same trend for determining river quality status. As the water flow from upstream to downstream, the level of pollution decreases. This is due to changes in river dimensions due to branching of tributaries. Apart from that, water flow is always changing all the time so that it cause changes in the concentration of pollutant parameters. The presence of waste in water is evidenced by the increase in the concentration of TDS, TSS, COD and total coliform parameters.

Table 3. Sail river STORET method calculation results

No	Parameter	Quality Standard	Unit	Measurement Result			Score			Amount
				Max	Min	Avg	Max	Min	Avg	
1	Temperature	Dev 3	°C	31	28	30	0	0	0	0
2	TDS	1000	Mg/L	312	63	158	0	0	0	0
3	TSS	50	Mg/L	240	28	99	-1	0	-3	-4
4	pH	6 - 9		7	6	6	0	0	0	0
5	DO	4	Mg/L	4	3	3,7	-2	-2	-6	-10
6	COD	25	Mg/L	89	25	61	-2	-2	-6	-10
7	Pb	0,03	Mg/L	0,017	0,011	0,013	0	0	0	0
8	Total coli	5000	MPN/100	240000	12000	104700	-3	-3	-9	-15
				Total						-39

Table 4. Sail river IP method calculation results

No	Parameter	Unit	Sample (Ci)	Quality Standard (Lij)		Ci/Lij
1	Temperature	°C	30	31	0,97	0,97
2	TDS	Mg/L	158	1000	0,16	0,16
3	TSS	Mg/L	99	50	1,98	2,48
4	pH		6	6 - 9	1,00	1,00
5	DO	Mg/L	3,7	4	1,08	1,16
6	COD	Mg/L	61	25	2,44	2,94
7	Pb	Mg/L	0,013	0,03	0,43	0,43
8	Total coli	MPN/100	104700	5000	20,94	7,60
(Ci/Lij)R						2,09
(Ci/Lij)M						7,60
Pij						6

Determination of Water quality status of Sail River by using the STORET method from year 2018 to 2020 says that the condition of the Sail River was moderately polluted. While in the last two years, namely 2021 and 2022, the condition of the Sail River was categorized as heavily polluted. This is caused by the high concentration of domestic pollution entering water bodies and the high level of community activity along the Sail River.

Determination of water quality status using the Pollution Index Method are that from 2018 to 2020 the condition of the Sail River was lightly polluted, while in the last two years, namely 2021 and 2022, the condition of the Sail River was categorized as moderately polluted. It can be seen that there are quite significant differences from the analysis results of the STORET method and the Pollution Index.

4. Conclusion

Based on the STORET method, the water quality status of the Sail River is categorized as heavily polluted with a score of -39, while the IP method provides a moderately polluted category with a score of 6. These results show that the Sail River has been polluted and requires pollution control policy and management.

Author contribution statement

F.D.: Conceptualization, methodology, supervision, writing, and editing. S.N.R.: Data collection, data analysis, and writing. D.L.: Conceptual, methodology, supervisison.

Data availability statement

The data presented in this work are included in the article.

Declaration of Competing Interest

The authors declare no conflict of interest.

References

Canter W. L. (1997). *Environmental Impact Assessment*. Mc. Graw-Hill Company.

Chen K., Chen H., Zhou C., Huang Y., Qi X., Shen R., Liu F., Zuo M., Zou X., Wang J., Zhang Y., Chen D., Chen X., Deng Y., Ren H. (2020). Comparative analysis of surface water quality prediction performance and identification of key water parameters using different machine learning models based on big data. *Water Research*, 171, 115454. https://doi.org/10.1016/j.watres.2019.115454

Delpla I., Bouchard C., Dorea C. & Rodriguez M.J. (2023). Assessment of rain event effects on source water quality degradation and subsequent water treatment operations. *Science of The Total Environment*, 866,161085. https://doi.org/10.1016/j.scitotenv.2022.161085

Giri S. (2021). Water quality prospective in Twenty First Century: Status of water quality in major river basins, contemporary strategies and impediments: *A review, Environmental Pollution, Volume* 271, 116332. https://doi.org/10.1016/j.envpol.2020.116332

Hermawan C. (2017). Penentuan Status Pencemaran Kualitas Air dengan Metode STORET dan Indeks Pencemaran (Studi Kasus: Sungai Indragiri Ruas Kuantan Tengah). *Jurnal Rekayasa, 7*.

Indrasari W., Nabilla Z. & Sunaryo, S. (2023). Water quality status analysis based on a parameter of Physics and Chemistry using the STORET method in Bekasi river. *Journal of Physics: Conference Series* 2596 012055. https://doi.org/10.1088/1742-6596/2596/1/012055

Jubaedah, D. (2015). Water Quality Index of Floodplain River Lubuk Lampam South Sumatra Indonesia. *Journal of Environmental Science and Development*, 6(4). https://doi.org/10.7763/JESD.2015.V6.379

Khatri, P., Gupta, K.K. & Gupta, R.K. (2021). A review of partial least squares modeling (PLSM) for water quality analysis. *Modeling Earth System and Environment.* 7,703–714.

Kementerian Negara Lingkungan Hidup. (2003). *Keputusan Menteri Negara Lingkungan Hidup Nomor 115 Tahun 2003 Tentang Penetapan Status Mutu Air*. Jakarta : Kementerian Negara Lingkungan Hidup.

Liyanage C.P. & Yamada K. (2017). Impact of Population Growth on the Water Quality of Natural Water Bodies. *Sustainability*, 9(8),1405. https://doi.org/10.3390/su9081405

Manna, A. & Biswas, D. (2023). Assessment of Drinking Water Quality Using Water Quality Index: A Review. *Water Conservation Science Engineering* 8, 6

Marselina, M., Rahmi, N. A., & Nurhayati, S. A. (2025). The water quality of the Upper Citarum: Applying the overall index of pollution, Said-WQI, and pollution index methods. *Heliyon*, *11*(2).

Ndou, N., & Nontongana, N. (2025). Bias evaluation and minimization for estuarine total dissolved solids (TDS) patterns constructed using spatial interpolation techniques. *Marine Pollution Bulletin*, *210*, 117353. https://doi.org/10.1016/j.marpolbul.2024.117353

Pemerintah Republik Indonesia. (2021). *Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup.*

Shampa, M. T. A., Ahmed, M. K., Chowdhury, K. A., Islam, M. A., Hasan, M., Rahman, M. S., & Islam, M. S. (2024). Spatial and seasonal variability of chlorophyll-a, total suspended matter, and colored dissolved organic matter in the Sundarban mangrove forest using earth observation and field data. *Heliyon*, *10*(19).https://doi.org/10.1016/j.heliyon.2024.e38789

Soeprobowati T.R., Addadiyah N.L., Hariyati R., & Jumari. (2021). Physico-chemical and biological water quality of Warna and Pengilon Lakes, Dieng, Central Java. *Journal of Water and Land Development*, 51, 38-49. https://doi.org/10.24425/jwld.2021.139013

Sulthonuddin, I., Hartono, D. M., dan Utomo, S. W. (2018). Water Quality Assessment of Cimanuk River in West Java Using Pollution Index. *E3S Web of Conferences. Jakarta: EDP Sciences.* https://doi.org/10.1051/e3sconf/20187301058

Suriadikusumah A., Mulyani O., Sudirja R., Sofyan E.T., Maulana M.H.R., & Mulyono A. (2020). Analysis of Water Quality in the Cipeusing River, Indonesia Using the

Pollution Index Method. *Acta Ecologica Sinica, CHNAES-00710*

Uwidia, I. E. (2017). Analysis of total suspended solids, total dissolved solids, electrical conductivity of domestic sewage. *The Experiment*, *44*(2), 2538-2545. https://doi.org/10.1016/j.rsase.2024.101381

Wang, Y., Liu, R., Wang, J., & Hao, F. (2025). Optimization and application of acid-modified coal gasification fine slag for effective removal of chemical oxygen demand and volatile phenols in semi-coking wastewater. *Results in Engineering*, *26*, 104697. https://doi.org/10.1016/j.rineng.2025.104697

Wu Z., Wang X., Chen Y., Cai Y. & Jiancai Deng. (2018).Assessing river water quality using water quality index in Lake Taihu Basin, China. *Science of The Total Environment*, 612, 914-922. https://doi.org/10.1016/j.scitotenv.2018.05.393

Yogafanny, E. (2015). Pengaruh Aktivitas Warga di Sempadan Sungai Terhadap Kualitas Air Sungai Winongo. *Jurnal Sains dan TeknologiLingkungan, 7*, 41-50.https://doi.org/10.20885/jstl.vol7.iss1.art3