International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 42 No. 2 January 2024, pp. 247-251

ANALYSIS OF WATER POLLUTION LEVELS USING THE POLLUTION INDEX METHOD (CASE STUDY OF THE SIRAH PULAU PADANG RIVER, OKI DISTRICT)

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Abstract

The Sirah Pulau Padang River (Sp. Padang) is a Komering river that flows through OKI (Ogan Komering Ilir) Regency. With the many activities of village residents on the Sp. Padang river can cause a waste burden on the pollution levels of the Sp.Padang river so the pollution levels decreases. River pollution levels is the level of pollution levels conditions which shows the condition of being polluted or in good condition at the water source by comparing pollution levels standards. Determining the level of river water pollution can use an approach using statistical analysis into a water quality index system. Guidelines for determining water quality status using the method of evaluating the level of water pollution with a water quality index are contained in the Decree of the Menteri Negara Lingkungan Hidup No 115 tahun 2003 and determining water quality can be done using the Pollution Index method.The parameters that will be measured in this research are, $NO^{3-}N$, PO4, pH, temperature, COD, DO, BOD, TSS. The IP method is a quality status that is Analysisd based on the IP formula calculation. Where the IP method compares the value of each parameter with the quality standard. Sp.Padang river pollution levels status, which is calculated using the pollutant index (IP) method, is low pollution with a pollutant index value between $1 < IP \leq 5$, namely with an IP value of 2.831.

Keywords: Pollutant Index, Pollution levels, Sp.Padang River, OKI

Introduction

Raw water sources are very important in a reliable clean water supply system. Raw water sources in the Sirah Pulau Padang sub-district (Sp.Padang) generally come from rivers, but with very rapid development and water catchment areas that are not well maintained, So the raw water source from the existing river is disturbed and the discharge from this river becomes reduced/decreased from time to time. This river can be used as a source of raw water for raw water needs in the Sirah Pulau Padang sub-district considering the importance of knowing the pollution levels of the Sp Padang river, especially in the Sp.Padang sub-district, with the aim of being able to meet the raw water needs in the sub-district. Where the many activities of village residents in the Sp.Padang river can cause a waste load on the pollution levels of the Sp Padang river so that the pollution levels decreases (Reno, 2017). The pollution levels status of the Sp Padang River is known from previous research using the Storet method, namely that it is low pollution due to the activities of sand miners (Yosieguspa, 2021) and heavily polluted due to the activities of floating net cages.(Yosieguspa, 2023).

The analysis that must be carried out on a sample depends on the type of water body being examined, the use of the water body for the local community for providing drinking water and fisheries and the type of pollution that is suspected to occur (Ali Akbar 2012). Analysis of the level of river water pollution can use an approach by means of statistical analysis into a water quality index system. This was chosen because it can provide measurement values for pollutant parameters in an easy and simple way. The use of the pollution levels index can be adjusted to different areas (Bharti, 2011). Based on its designation, it is of course expected that the pollution levels in the river will still be within tolerance limits (Mary Selintung, 2011). Pollution levels criteria are whether they are still suitable for use or not, in the sense that pollution levels is used to Analysis whether the water is safe enough to consume or use for certain activities. From Dahuri (2003) that the source factors for water pollution are urban domestic waste, urban liquid waste, residential liquid waste, mining, industrial waste, agricultural waste, aquaculture waste and shipping waste water. Pollution Index (IP) is used to determine water quality status.

Material and Methods

Pollution Index (IP) Method

As an index-based method, the IP method is built on two quality indices. The first is the average index (IR). This index shows the average pollution level of all parameters in one observation. The second is the maximum index

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(IM). This index shows one type of parameter that dominantly causes a decrease in pollution levels in one observation. Pollution levels assessment categories based on IP values are as follows (KepMen.LH, 2003):

1. Meet quality standards: IP ≤ 1
2. Low pollution: 1 < IP ≤ 5
3. Middle pollution: 5 < IP ≤ 10
4. High pollution: IP > 10

The initial step in calculating IP is to compare the concentration of each pollutant parameter (Ci) with the quality standard (Li), so that a value (C/L) is obtained from the measurement results for each parameter in question. If the (C/L) value is more than 1, then a new (C/L) value is Analysisd using the following equation (1):

$$C/L_{new} = 1\text{-}5\text{Log } C/L_{measurement} \quad (1)$$

Where *C* is measurement data, *L* is quality standard.Based on class if a parameter's concentration value decreases indicating an increased level of pollution (such as DO), it is necessary to first calculate the theoretical value or maximum value of the parameter. The pollution index for the DO parameter is Analysisd by the following equation (2):

$$C/L = C_{im} - C_{i\ (measurement\ result)} / C_{im} - L_i \quad (2)$$

Where C_{im} is the theoretical value or maximum value of the parameter in question. For example, for DO, the theoretical value is the saturated DO value. Meanwhile, for quality standard parameters that have a range (such as pH), the IP determination uses equation (3) or (4) as follows:

For Ci ≤ Li avg :

$$C/L = C_i\text{-}L_{i\ avg} / L_{i\ min} - L_{i\ avg} \quad (3)$$

From the serial index (C/L), the average value is calculated as IR and the maximum value is Analysisd as IM. Next, the IP formulation is formulated using equation (4) as follows:

$$IP = \sqrt{IR\ 2 + IM\ 2} \quad (4)$$

The IM value Analysiss the main type of parameter in reducing pollution levels. By modifying the IM on certain parameters, indications of the main pollutant sources in the river being monitored will be known. Modifications are made by removing parameters that become IM. IM removal is adjusted to the ith parameter whose effect you want to know one by one to detect the source of pollution. The pollution levels standards (BMA) used in this research are class II water designation criteria(PP 82/2001).

The data required consists of primary data including data on the pollution levels of the Sp.Padang river at each station, both physical and chemical parameters. Physical parameters include temperature and suspended solids, chemical parameters namely pH, BOD, COD, DO, total phosphate and nitrate. Primary data was obtained by observing and taking samples directly, then followed by analysis in the laboratory. The data was then analyzed using the IP method. Primary data collection was carried out by taking samples from 5 location points for a week (7 days) in a row starting from August 4 2023 to August 11 2023.

The materials used in this research were a pH meter, plastic bottles for samples, thermometers, stationery, label paper, rope, plastic buckets, measuring instruments, digital cameras and coolboxes. And the materials needed for the research are water samples from the Sp.Padang river, OKI district, where there is a lot of activity from village residents.

Results and Discussion

The Komering river flows from Tanjung Lubuk sub-district, Kayuagung City, Pedamaran sub-district, Sirah Pulau Padang (Sp.Padang) sub-district, Jejawi sub-district and empties into the Musi river in Palembang(BPS OKI, 2016). The Sp Padang River is one of the tributaries of the Musi river which flows along the Sp Padang village. This identification is carried out to ensure the actual situation of the Sp Padang river which will then be reviewed from several physical and chemical parameters. Identification is carried out by taking river water sampling at 5 (five) preAnalysisd point locations divided into two, namely river pollution levels conditions and river hydraulic conditions.

Hydraulic Conditions

The pollution levels of the Sp Padang river was obtained from primary and secondary data. Primary data collection was carried out by taking samples from 5 location points for a week (7 days) in a row starting from August 4 2023 to August 11 2023. Sampling from each point is carried out using average speed and distance functions and based on river discharge. For Sp Padang river hydraulic data covering water discharge, speed and

depth of river water, the data was obtained from direct research in the field then laboratory testing (primary data) and for secondary data obtained from the South Sumatra River Region Center. Sp Padang river hydraulic data is presented in table1.

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Table 1. Sp.Padang river hydraulic data on August 11 2023

No	Parameter	Unit	Point I	Point II	Point III	Point IV	Point V	Quality Standards*
1	Suhu	°C	32	29	28	32	31	Deviasi 3
2	pH	-	8	8	9	9	8	6-9
3	DO	mg/l	3,47	3,18	5,5	4,9	4,3	4
4	TSS	mg/l	512	568	558	672	716	50
5	BOD	mg/l	2,9	2,7	2,8	3	3	3
6	COD	mg/l	53,2	53,4	59,8	59,7	53,3	25
7	Fosfat	mg/l	0,072	0,069	0,089	0,063	0,074	0.2
8	Nitrat	mg/l	0,107	0,134	0,180	0,115	0,118	10

Source. Environmental Laboratory UPTD Lab Results

* Government Regulation No.82 of 2001 class II

Analysis of River Pollution levels Status

River pollution levels status shows the level of pollution of a water source at a certain time, compared to established pollution levels standards. A river is said to be polluted if it cannot be used according to its normal purpose (Azwir, 2006). In this research, the parameters used in analyzing pollution levels status are temperature, pH, TSS, DO, BOD, COD, phosphate and nitrate which are compared with class II pollution levels criteria based on Provincial Regulation No. 2 of 2008. Analysis of pollution levels status is carried out based on the guidelines for determining pollution levels status stipulated by the Ministry of Environment number 115 of 2003 with the Pollution Index.

Calculation of Pollution levels Using the Pollutant Index Method

The pollutant index can be calculated after all pollutant parameters of the Sp Padang river have been analyzed by comparing the value of each parameter with the quality standard and the quality status is Analysisd based on the IP formula calculation.

The IP calculation results are presented as follows

Example of IP calculation

1. **Temperature**
   - Temperature quality standards (Li) = deviation 3
   - Temperatue (Ci) = 32^0C

   Because temperature is a parameter that has a range, the equation is used

   Li (average) $= \frac{(28+32)}{2}$

   $= 30^0$C

   (Ci/Lij)new $= \frac{Ci-Lij\ (average)}{Lij(min)-Lij(avarage)}$

   $= \frac{32-30}{28-30} = 1$

2. **TSS**
   - Quality standards TSS (Li) = 50 mg/l
   - Concentration TSS (Ci) = 605 mg/l
   - Ci/Li = 605/50 mg/l = 12,1 mg/l

   Value Ci/Li > 1 then use it

- Ci/Li new = 1+ P.log (Ci/Li)
  = 1+ 5.log (12,1)
  = 6,47

3. pH

- Quality standards pH (Li) = 6-9
- pH (Ci) = 8,4

because pH is a parameter that has a range, it is used

Li (avg) $= \frac{8+9}{2} = 8{,}5$

Ci/Lij new $= \frac{Ci-Lij(avg)}{Lij(min)-Lij(avg)}$

$= \frac{8{,}4-8{,}5}{8-8{,}5}$

= 0,2

4. BOD

- Quality standars BOD (Li) = 3 mg/l
- Concentration BOD (Ci) = 2,88 mg/l
- Ci/Li = 2,88/3
  = 0,96 mg/l

  Value Ci/Li > 1 then use it
- Ci/Li = 1+ P.Log (Ci/Li)
  =1 + 5. Log (0,96)
  = 1,085

5. COD

- Quality standards COD (Li) = 25 mg/l
- Concentration COD (Ci) = 55,88 mg/l
- Ci/Li = 55,88/25
  = 2,24 mg/l

  Value Ci/Li > 1 then use it
- Ci/Li = 1 + P.Log (Ci/Li)
  = 1 + 5. Log (2,24)
  = 2,75 mg/l

6. DO

- Quality standards DO (Li) = 4 mg/l
- Concentration DO (Ci) = 4,27 mg/l
- DO saturation 28^0C = 5,5 mg/l

Because DO is a parameter which if the parameter value decreases indicates the level of pollution is increasing, it is used

C_2 new $= \frac{C_{im}-C_{i(measurement\ results)}}{C_{im}-C_{ij}}$

$= \frac{5{,}5-4{,}27}{5{,}5-4}$

= 0,82 mg/l

(Ci/Lij)new = 0,82/4 mg/l
= 0,205 mg/l

7. PO_4^{3-}

- Quality standards PO_4^{3-} (Li) = 0,2 mg/l
- Concentration PO_4^{3-} (Ci) = 0,0734 mg/l
- Ci/Li = 0,0734/0,2
  = 0,367 mg/l

8. NO_3^-

- Quality standards NO_3^- (Li) = 10 mg/l
- Concentration $NO3^-$ (Ci) = 0,131 mg/l
- Ci/Li = 0,131/10 mg/l
  = 0,0131 mg/l

After all the Ci/Li values are known, the Pollutant Index (IP) value is calculated.

Ci/Li average = 1,55

Ci/Li max = 6,47

$$= \sqrt{\frac{(6,47)^2+(1,55)^2}{2}}$$

$$= 2,831$$ **(low pollution)**

pollutant index (IP)

The IP method provides flexibility in determining the number and type of parameters used to calculate the index. However, this flexibility can lead someone to choose parameters and have an impact on inferring pollution levels status. Considering that someone with limited knowledge of pollution levels/environment will not really understand the significant parameters that are important to measure in order to describe the variability and problems of existing pollution levels. Some pollution levels parameters are considered more important than other pollution levels parameters. In this study, the parameters that contributed the most scores and influenced the weighting were chemical parameters, including BOD, COD and TSS. And DO also provides a score which makes the total index increasingly negative. The more often these parameters do not meet the threshold, the worse the quality will be (Saraswati, et al 2014). So the more pollution levels parameters that are measured, the more that do not meet the quality standards as seen from the maximum, minimum and average values of the parameters. When using the storet method, you must be careful in selecting parameters because errors in determining parameters can lead to errors in pollution levels status.

Acknowledgements

We would like to thank the Palembang City Environmental Center for helping to use the pollution levels laboratory and the research and community service institute, Universitas Islam Ogan Komering Ilir Kayuagung as a research grant funder

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