

Identification of the Heavy Metal Lead in the Industrial Area River in Buduran, Sidoarjo Regency using the Pollution Index Method

Listin Fitriannah^{1✉}, Ahmad Sholahudin Fawaid²

^{1,2} Environmental Engineering, Engineering Faculty, Universitas Nahdlatul Ulama Sidoarjo, Indonesia

Article Information

Article History

Received : July 03, 2024

Revised : July 14, 2024

Accepted : July 18, 2024

Keywords:

*Industrial area; Lead;
Pollution Index; River*

Kata Kunci:

Area industri; Indeks.
Pencemaran; Sungai;
Timbal.

ABSTRACT

A river is an open channel that has the function of holding and flowing water from upstream to downstream and to the estuary. The Banjarkemantren River in Buduran District is located close to industrial areas. Pollution index and water quality status refers to the Decree of the Minister of Environment No. 115 of 2003. The highest pH at sampling points AI 3 and AI 4 was 7.9. The Pb content has the same results, namely 0.038 mg/L. This value does not exceed the quality standard limit based on Government Regulation No. 82 of 2001 concerning Water Quality Standards. Determined water quality status. using the Pollution Index method. The quality status of each sample is in "Good" condition ($1.0 < PI_j \leq 5.0$). The water quality status of the Banjarkemantren river is in the good category.

ABSTRAK

Sungai merupakan saluran terbuka yang berfungsi menampung dan mengalirkan air dari hulu ke hilir hingga ke muara. Sungai Banjarkemantren di Kecamatan Buduran letaknya dekat dengan kawasan industri. Indeks pencemaran dan status mutu air mengacu pada Keputusan Menteri Lingkungan Hidup Nomor 115 Tahun 2003. pH tertinggi pada titik pengambilan sampel AI 3 dan AI 4 adalah 7,9. Kandungan Pbnya pun memberikan hasil yang sama yaitu 0,038 mg/L. Nilai tersebut tidak melebihi batas baku mutu berdasarkan Peraturan Pemerintah Nomor 82 Tahun 2001 tentang Baku Mutu Air. Status kualitas air menggunakan metode Indeks Pencemaran (IP). Status mutu setiap sampel berada pada kondisi "Baik" ($1,0 < PI_j \leq 5,0$). Status kualitas air sungai Banjarkemantren termasuk dalam kategori baik.

Corresponding Author :

Listin Fitriannah

Environmental Engineering, Engineering Faculty, Universitas Nahdlatul Ulama Sidoarjo, Indonesia
Lingkar Luar street KM 5,5 Rangkah Kidul, Sidoarjo Regency, East Java, Indonesia.

E-mail: listin_fitri.tkl@unusida.ac.id

INTRODUCTION

A river is an open channel that has the function of holding and flowing water from upstream to downstream and to the estuary (Junaidi, 2014). Over time, the valley's slope, longitudinal profile, and latitude will change based on the cliffs, bed material, discharge, and also the type and amount of sediment carried by the river. The Banjarkemantren River in Buduran District is located close to industrial areas. Human and industrial activities are a source of environmental pollution, especially river pollution. This river pollution causes the presence of bacteria and heavy metals which disrupt the health of the river. One of the causes of river pollution

is the influence of metalneric pollution, namely lead. These parameters have many impacts on living creatures, especially humans, if they exceed the specified quality standard limits.

Excessive surface water pollution by various heavy metals is a global public health problem, because heavy metals have the potential to cause adverse effects on human health through the food chain. Metals that have a density greater than 5 g/cm³ are called heavy metals. These metals include lead (Pb). The level of heavy metal pollution in waters is increasing rapidly due to unplanned urbanization, industrialization, and uncontrolled use of agricultural chemicals. Poorly treated waste discharged from various industries into river water causes serious problems for aquatic flora and fauna. Trace elements concentration in the watershed is to the level that can pose a risk to downstream users (Higemengist Astatkie, et. Al, 2021)

Examination of water structure, chemistry and biology. Relevant quality and testing metrics are of the utmost importance when figuring out where a water body stands in terms of its water quality. Determination of environmental quality in water parameters using the Pollution Index (IP) method. When using the IP approach, two indices are calculated: the first index and the second index. The average index (IR) displays typical pollution levels for all factors measured in a single study. In one measurement, the maximum index (IM) can identify the most significant water quality degradation parameters. This Pollutant Index is determined and calculated based on Minister of Environment Decree No. 115 of 2003. If water has been given a Pollution Index value, its quality can be assessed.

The title of the introductory section is written in all capital letters, as are the method, results and discussion, conclusions and suggestions, thanks and references. The presentation of the introductory section is carried out narratively, and there is no need to separate from one subsection to another. Separation is done simply by changing paragraphs. The introductory content includes background, a summary of the literature review, and ends with the research objectives. The introductory section contains a description of the background, research problem, main research objectives, and expectations regarding the benefits of the research results. The introduction is written briefly and clearly. The author is expected to be able to convey the results of research that has been carried out by other people. The last sentence in the introduction is expected to be a statement of the main aim of the research. Authors are not allowed to include any tables or figures in the Introduction.

RESEARCH METHODS

Types of Research

The survey method was used for this quantitative research. The sampling method is required as a surface water sampling technique according to SNI 6989-57:2008, which regulates water and waste water. The content of the heavy metal Lead (Pb) in the water in the Banjarkematren River in the Buduran industrial area by analyzing samples using the AAS (Atomic Absorption Spectrophotometry) tool at the Mojokerto Regency Environmental Service Laboratory.

Location

The research was carried out on the Banjarkemantren River, the river is located around the Buduran industrial area, Banjarkemantren Village, Buduran District, Sidoarjo Regency. The river water sampling point is determined based on the river water discharge which is regulated by the provisions of rivers with a discharge of less than 5 m³/sec. Water samples are taken at one point in the middle of the river at a depth of 0.5 times the depth of the surface so that water samples are obtained from the surface to the bottom evenly (Rahmi and. Dewi, 2020). There are 5 locations for taking research samples. Location at coordinates in Table 1.

Table 1. Location of Each Sample

Location Poin	Latitude	Longitude
1	-7,412570	112, 725530
2	-7, 412600	112, 725272
3	-7, 412653	112 , 725264
4	-7, 412630	112, 725192
5	-7, 412563	112, 725182

Information :

Quality standards pH 6-9

AP samples taken from residential areas

AI samples taken from industrial areas

* Government Regulation No. 82 of 2001 concerning Water Quality Standards

Research variables and samples

Research variables include lead (Pb) and temperature (pH). Each parameter. The number of samples consists of 5 with two repetitions. So the total is 10 samples.

Research analysis

This research analysis uses Lead (Pb) and Total Suspended Solid (TSS) parameters to determine the pollution in the Banjarkeamtren river. Point sampling was carried out at 5 location points. Laboratory results were averaged in Banjarkemantren village by taking 3 air samples and compared with Government Regulation Number 82 of 2001 concerning Water Quality Management. And Air Pollution Control. Identification of the water quality of the Banjarkemantren river was carried out to determine the quality of the river water. Using pH and Lead (Pb) parameters. using the Pollutant Index (IP) method according to Minister of Environment Decree No. 115/2003 Appendix II concerning Determining Water Quality Status to determine the level of river pollution.

Pollution Index Method

The initial step in calculating IP (Effendi, 2015) is to compare the concentration of each pollutant parameter (C_i) with the quality standard (L_i), so that the value (C/L) of the measurement results for each parameter in question is obtained. If the (C/L) value is more than 1, then a new (C/L) value is determined using the following equation (1):

$$\text{New } C/L = 1 - 5 \log C/L \text{ measurements (1)}$$

Where C = Measurement Data

L = Quality Standard by Class

If a decreasing parameter concentration value indicates an increasing pollution level (such as DO), it is necessary to first calculate the theoretical value or maximum value of the parameter.

Next, the IP for the DO parameter is determined using the following equation (2):

$C/L = C_{im} - C_i \text{ (measurement results)} / C_{im} - L_i$ (2) Where C_{im} = theoretical value or maximum value of the parameter in question. For example, for Pb the theoretical value is the saturated Pb value.

Meanwhile, for quality standard parameters that have a range (such as pH), the IP determination uses equation (3) or (4) as follows:

For average $C_i \leq L_i$:

$$C/L = C_t - L_t \text{ average} / L_i \text{ min} - L_i \text{ average} \quad (3)$$

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

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

RESULTS AND DISCUSSION

The results and discussion sections contain the results of data analysis (not raw data). Presentation can be assisted with tables or graphs and must be accompanied by an explanation or giving meaning to the analysis results. Then the discussion contains a discussion of research results regarding previous research, theory, or established knowledge, accompanied by references. Research results can be supported, unsupported, or even contradictory.

Table 2. pH Content of Banjarkemantren River Sidoarjo Regency

Sampel (AI)	pH
AI1	7,6
AI2	7,7
AI3	7,9
AI4	7,9
AI5	7,8

Information :

Quality standards *pH 6-9

AP samples taken from residential areas

AI samples taken from industrial areas

* Government Regulation No. 82 of 2001 concerning Water Quality Standards

The pH value along the Banjarkemantren River is in good condition. The measurement results are still within the limits of class III water quality standards with values ranging from 6 - 9. The pH value of the river is still included in the category that is suitable for the life of aquatic organisms, where the optimum conditions for living creatures in the waters are in the range of 6.5 – 8.2 (Rahayu, et al. 2009).

Based on the table above, the average pH value in residential areas is 7,58 and the average in industrial areas is 7,78. A temperature Rivers can be influenced by seasons or weather, the interaction process between air and water, cloud conditions, wind gusts, and the geographical location of a river (Awalliyah and Suryana, 2019).

The average pH is above 7.5 due to the photosynthesis process by aquatic plants such as phytoplankton which utilize sunlight as energy and CO₂ which is absorbed to continue photosynthesis, such as breaking down water molecules and forming oxygen gas. So the CO₂ levels in the water decrease while the O₂ levels in the water increase. This is in accordance with Sa'adah's statement (2018), the pH of the water will increase if the CO₂ in the water decreases and the pH will decrease as the CO₂ content increases. The existence of places to eat and settlements around rivers also supports the process of photosynthesis by phytoplankton, where the source of nutrients used in the photosynthesis process mostly comes from food waste, urea and feces. This is in accordance with research by Latuconsina (2019).

Pb Content of Banjarkemantren River Sidoarjo Regency

Lead (Pb) is a metal compound in wastewater. The Pb test refers to SNI 06-6989.8-2009 using the Atomic Absorption Spectrophotometry (SSA) method. Water sampling was carried out in 2 areas, namely residential areas and industrial areas. Each area took 5 sampling points. Results of Pb Measurement of the Banjarkemantren River in Residential and Industrial Areas in Tabel 3.

Tabel 3. Pb Content of Banjarkemantren

Sampel (AI)	Pb (mg/L)
AI1	0,038
AI2	0,039
AI3	0,038
AI4	0,037
AI5	0,038

Quality standards *0,5 mg/L

AI samples taken from industrial areas

* Government Regulation No. 82 of 2001 concerning Water Quality Standards

Table 3 shows the Pb parameters at all points in industrial areas showing values that are less than 0.5 mg/L of the quality standard implemented by PP No. 82 of 2001. This shows that the quality of Pb contained in the Banjarkemantren river does not pollute the water environment conditions. safe. Lead belongs to a group of metals that are toxic to living creatures. Lead waste can enter water bodies naturally by crystallizing lead in the air with the help of rain. Lead metal entering water bodies is a result of human activities in the form of waste or waste water which will then settle to the bottom of the river as sediment (Budiastuti et al., 2016). If this lead pollution affects fish in the waters. The bioaccumulation process of metals in fish tissue through the food chain as well as the high process of extracting Pb metal from waters causes high concentrations of Pb and other heavy metals in the bodies of gambusia fish (Yuliana et al., 2020)

Pollution Indeks

Water quality management based on the Pollution Index (IP) helps decision making so that designation can determine the water quality of a water body and also helps cities improve water quality when water quality is reduced. This method refers to the Decree of the Minister of Environment No. 115 of 2003 concerning determining water quality status which functions to make it easier to determine the level of pollution by whether or not rivers can be used for certain uses and with a certain number of parameters.

Table 4. Pollution index and water quality status

Sampel (AP)	Pollution Indeks	Value Range	Water quality status
AI1	0,12	$1,0 < PI_j \leq 5,0$	Good
AI2	0,12	$1,0 < PI_j \leq 5,0$	Good
AI3	0,21	$1,0 < PI_j \leq 5,0$	Good
AI4	0,21	$1,0 < PI_j \leq 5,0$	Good
AI5	0,16	$1,0 < PI_j \leq 5,0$	Good

Based on the Decree of the Minister of Environment Number 115 of 2001 concerning guidelines for determining Water Quality Status, a Pollution Index value that is at $1.0 < PI_j \leq 5.0$ is categorized as "Good". So the Banjarkemantren River is categorized as a river with Good Condition quality status. According to Mahyudin (2015), states the status of river water quality. Shows the level of pollution. A water source in a certain period is then compared against predetermined quality standards. High and low concentrations of metal content in sediment can be caused by various factors, fluctuating water conditions. The heavy metal content in sediment is caused by deposition and stirring that occurs in the sediment according to its conditions (Jessika et al., 2022). Heavy metals that have been dissolved in water will move into the sediment and are associated with free organic matter or organic matter that coats the surface of the sedimen (Listin, 2022). Plant ecosystems along rivers bind and accumulate heavy metals and are able to reduce the concentration levels of toxic substances in the water (Alisa, et.al, 2020). This is because the water

flow continues to flow throughout the day causing minimal contaminants to settle (Yonanda, 2024).

CONCLUSION

The highest pH at sampling points AI 3 and AI 4 was 7.9. The Pb content has the same results, namely 0.038 mg/L. This value does not exceed the quality standard limit based on Government Regulation No. 82 of 2001 concerning Water Quality Standards. Determined water quality status. using the Pollution Index method. The quality status of each sample is in "Good" condition ($1.0 < PI_j \leq 5.0$). The water quality status of the Banjarkemantren river is in the good category.

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