Heavy Metal Pollution in the Waters of South Konawe Regency, Southeast Sulawesi Province, Indonesia

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Abstract: - The pollution of Plumbum heavy metal in water is an environmental concern. Plumbum (Pb) can be found in water naturally and due to human activities. This study aimed to analyze Plumbum heavy metal's content in the waters of Batu Jaya village in Southeast Sulawesi. The research method employed was descriptive, and the samples were tested for Plumbum heavy metal content using Atomic Absorption Spectrophotometer. The study revealed that several stations (ST) exceeded the threshold, including ST 2 with 0.0217 mg/l, ST 3 with 0.0220 mg/l, ST 5 with 0.0182 mg/l, ST 6 with 0.0141 mg/l, and ST 10 with 0.0312 mg/l. On the other hand, other stations, namely ST 1, 4, 7, 8, and 9, remained within acceptable limits. Consequently, Plumbum heavy metal is present in the waters of Batu Jaya village, South Konawe Regency, Southeast Sulawesi Province, Indonesia. The pollution originates from human activities in the vicinity of the port and from ship traffic passing through the area.

Key-Words: - Heavy metals, Plumbum, Waters, Indonesia

Received: March 9, 2023. Revised: June 15, 2023. Accepted: August 17, 2023. Published: September 11, 2023.

1 Introduction

Indonesia is an archipelagic country with two-thirds of the ocean area more significant than the land area, placing Indonesia in second place after Canada as a country with the longest coastline in the world. Southeast Sulawesi is one of the provinces in eastern Indonesia, which consists of several small islands and coastal regions that dominate the area. This area is very vulnerable to pollution and environmental pressure, which the primary source comes from various kinds of activities and phenomena that occur on land and in the. In addition to biological pollution from solid liquid and gas, chemical pollution from dangerous heavy metals also has a great potential to contaminate marine ecosystems. In fact, at levels exceeding the threshold value, it can threaten human life, [1], [2].

Currently, water quality is lowered due to pollution in various regions worldwide. For example, in several areas of China's sea, a study conducted in 3 seasons finds heavy metal contamination. The accumulation of Plumbum heavy metal is the highest among other heavy metals, ranging between 1.9 to 2222 μg/l, [3]. In the coastal waters of Mokpo, Korea, accumulation of the Plumbum heavy metal in seaweed, sediment, and seawater has also been reported, [4].

In 2017, it was reported that the environmental quality index in some areas of Indonesia had decreased. This was mainly due to a significant drop in the seawater quality index, including in the waters of southeast Sulawesi. This decline in environmental quality highlights the importance of sustainable practices to ensure the preservation of our planet for future generations, [5]. In Southeast Sulawesi, there has been a noticeable decrease in the seawater quality index in various marine water areas. This decline in seawater quality is primarily due to heavy metal pollution. According to a study by Greene et al. (2023), heavy metal accumulation was identified at 12 sampling points in Staring waters (Laonti River Estuary). Iron was the highest

heavy metal accumulation, recorded at 0.01296 ppm. It is essential to take immediate action to address this issue and prevent further deterioration of the marine ecosystem, [6]. It's important to be aware of the amount of iron you're consuming, as too much of this essential element can have toxic effects on the body. It's all about finding the right balance and ensuring you're within the threshold value.

Various human activities, such as shipping, tourism, agriculture, etc., cause heavy metals getting into the waters. When heavy metals enter the waters, they can be bioaccumulated by organisms living in the seas, enter the food chain, and harm predators and humans who consume marine biota. Data from the Southeast Sulawesi Provincial Environmental Service in 2022 report that Plumbum heavy metal pollution in seawater is <0.0033 mg/L.

One of the waters in the Southeast Sulawesi region, which has immense potential for heavy metal contamination, is Batu Jaya Village in South Konawe Regency. From the initial survey, several streams in crowded activity eventually flow into these waters, which are suspected of distributing the Plumbum heavy metal into these waters. This study aims to determine Plumbum heavy metal pollution in the seas of Batu Jaya village in Southeast Sulawesi. Research on lead pollution in the environment provides a better understanding of pollution sources, health impacts, environmental consequences, control technologies, and public awareness efforts. This research is crucial for promoting prevention measures, reducing lead exposure, and safeguarding human health and ecological sustainability. With this knowledge, we can develop policies, regulations, and practices that better protect the environment and human health from the harmful effects of lead.

2 Methods

2.1 Sources and Sampling Data

This study was conducted in December 2022. Seawater sampling was taken using a water sampler on December 18, 2022, in Batu Jaya Village, South Konawe Regency, Southeast Sulawesi Province, Indonesia. Determination of the sampling points used a purposive sampling method accompanied by a GPS (Global Positioning System) tool in determining the coordinates of the location of seawater sampling. This study is a descriptive study to see the levels of Plumbum heavy metal in the waters of Batu Jaya village. The location points of the survey were concentrated at ten stations divided into three ranges. The Range is determined based on the length of the shoreline from South to North, with an altitude of 800 m. Location points of Range I are 240 m long, where the distance of each issue is 80 m. Then, the location points of Range II are 320 m long, with a rarity of 80 m for each topic. Furthermore, the location points of Range III are 240 m long with a point range of 80 m each.

Range 1 consists of stations 1, 2, and 3, where the station locations are close to ports, rivers, and areas where the people take small fish as forage. Range 2 is stations 4, 5, 6, and 7, where points 4 and 7 are in front of cliffs and forests far from settlements, while means 5 and 6 are precise in front of densely populated territories. Then, range 3 is stations 8, 9, and 10. Stations 8 and 9 are detailed in front of the cliffs and forest, while station 10 is taken at the border between Batu Jaya Village and Namu Tourism Village.

Data from the test results were analyzed descriptively based on the variables studied, including the content of Plumbum heavy metal and the ratio of heavy metal at each point based on ranges I, II, and III. The content of Plumbum heavy metal in seawater was compared with the threshold value for the level of Pb heavy metal pollution in seawater for marine biota following the Decree of the Minister of Environment number 51 in 2004.

2.2 Analysis Data

Based on the source national standard Indonesia number 6989.8:2009, the tools and materials used in examining seawater samples were an Atomic Absorption Spectrophotometer (AAS), hollow cathode lamps, 250 ml beakers glass, measured pipettes (1 ml, 5 ml, 25 ml, and 20 ml), 100 ml volumetric flask, glass funnel, electric heater, spray flask, vacuum filter set (filter paper of Whatman 40 with a pore size of ɵ 0.42 µm), Analytical Balance with an accuracy 0.0001 g, Watch Glass, Distilled water, a sample of seawater, nitric acid (HNO_3) and acetylene gas (C_2H_2).

3 Results

3.1 Location of the Study

Sampling was carried out around the waters of Batu Jaya Village, South Konawe Regency, Southeast Sulawesi Province. Sampling points were around the seas of Ferry-Amolenggu Harbor, Settlements, and Borders of Namu Tourism Village by taking 10 points of locations. Map of Sampling Point

Point 1: 4°87'80.3"S 951°20 '91.4"E
Point 2: 4°87'93.02"S 951°25 '98.5"E
Point 3: 4°88 '26.3"S 951°31 '75.5"E
Point 4: 4°88 '52.3"S 951°37 '87.5"E
Point 5: 4°88 '44.5"S 951°42 '31.6"E
Point 6: 4°88 '66.3"S 951°47 '03.8"E
Point 7: 4°88 '88.8"S 951°51 '68.93 "E
Point 8: 4°89' 40.7"S 951°55' 67.6 "E
Point 9: 4°89 '40.7"S 951°51 '59.80 "E
Point 10: 4°89 '41.4"S 951°51 '64.66 "E

The map of the sampling points is presented in Figure 1.

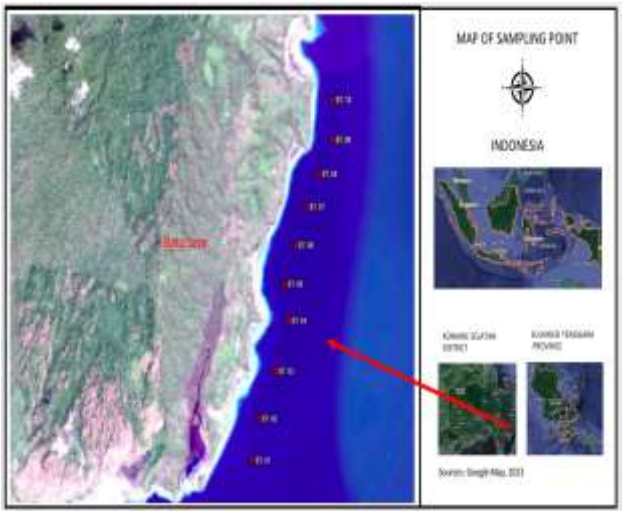

Fig. 1: Map of Sampling Points

3.2 Analysis of Plumbum Heavy Metal

Analysis result of Plumbum heavy metal content in seawater taken at 10 points of location can be seen in the following graph. Figure 2 shows that several areas were not detected from the ten sampling locations, such as at points 1,4, 7, 8, and 9. As for points 2, 3, 5, 6, and 10, there were Plumbum heavy metal contents, most of which passed the Threshold Value according to the Ministry of Environment Republic of Indonesia number 51 in 2004, where the pollution level was high. An overview of seawater quality in the chemical aspects found in the waters of Batu Jaya Village, South Konawe Regency, in 2022 could be seen from the results of tests conducted at the Southeast Sulawesi Provincial Health Laboratory with the inspection indicator for the Plumbum heavy metal.

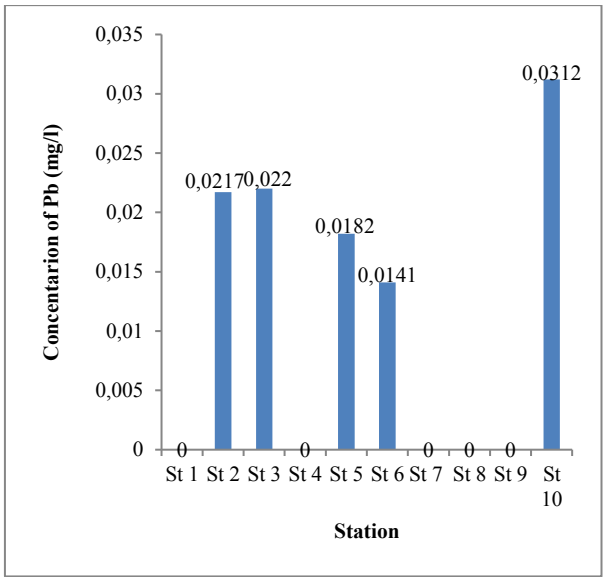

Fig. 2: Concentration value of the Plumbum heavy metal at each point in the location of the study

The test results were as follows:

Table 1. Description of the Chemical Quality of Sea Waters in Batu Jaya Village (Plumbum Content), South Konawe Regency, in 2022

Seawater samples	Pollution Risk	Test results of Plumbum (Pb) content	Quality standards (Mg/l) *	Explanation
ST 1	Low	< 0,0004	0,0008	Qualify
ST 2	High	0,0217	0,0008	Unqualify
ST 3	High	0,0220	0,0008	Unqualify
ST 4	Low	< 0,0004	0,0008	Qualify
ST 5	High	0,0182	0,0008	Unqualify
ST 6	High	0,0141	0,0008	Unqualify
ST 7	Low	< 0,0004	0,0008	Qualify
ST 8	Low	< 0,0004	0,0008	Unqualify
ST 9	Low	< 0,0004	0,0008	Qualify
ST 10	High	0,0312	0,0008	Unqualify

**The quality standard was based on the Decree of the Minister of Environment number 51 of 2004 concerning the Quality Standards of Seawater*

The Plumbum heavy metal in the research location indicated that there was a low and high risk of contamination. The sample points which had a

low or undetectable level of contamination risk are at points 1, 4, 7, 8, and 9. The points which had a high risk of contamination are points 2, 3, 5, 6, and 10. Thus 5 points contain undetected heavy metal content, and 5 points of the location contain the Plumbum heavy metal and exceeding the Threshold Limit Values which had been set based on the quality standards of seawater according to the Decree of the Ministry of Environment number 51 of 2004 (Table 1).

The presence of heavy metal lead (Pb) can cause pollution. Based on the analysis, the risk of lead contamination can be divided into two categories: low and high. The sampling points that indicate low-risk or non-detectable contamination are 1, 4, 7, 8, and 9. This means that the lead levels in these points are relatively low or do not exceed the established Threshold Value. On the other hand, five points in the research location indicate high contamination risk. These points are 2, 3, 5, 6, and 10. This shows that the lead levels in these points exceed the established Threshold Value, indicating a significant level of contamination. There are five points in the research location with undetectable lead levels or low contamination risk. The other five points contain lead levels exceeding the Threshold Value and indicate high contamination risk.

4 Discussion

One of the heavy metals which is a source of pollutants that has the potential to reduce and damage the environment is Plumbum. Plumbum or black Plumbum is a heavy metal generally found naturally in the earth's crust and dispersed in small quantities through natural and artificial processes, [7]. Heavy metals can get into the body through contaminated air, food, and water, [8]. The properties of heavy metals that are difficult to decompose can quickly accumulate in aquatic environments, sediments, and marine biota, [9].

The presence of Plumbum heavy metal in waters can directly endanger the life of marine organisms and indirectly threaten human health through contamination of the food chain. The nature of the Pb heavy metal is toxic if it comes into the human body and, at a level that is not tolerated by the body, will endanger people's health. Lead release into the air originates from industrial activities and vehicle exhaust emissions, leading to environmental pollution. Consequently, lead (Pb) can contaminate the soil and dissolve in water, which plants can then absorb. As a result, humans can be exposed to lead through food or drinking water, [10]. Exposure to lead has negative impacts on the central nervous system, which affects development and function. Lead exposure during prenatal (before birth) and postnatal (after birth) periods plays a crucial role in brain development. Even exposure to low levels of lead can cause a significant decrease in IQ test performance, [11]. There are findings that blood lead levels below 10 μg/dL are associated with decreased IQ and behavioral problems, such as aggression, in proportion to the detected blood lead levels. Within the Range of blood lead levels from 5 to 35 μg/dL, it has been reported that each increase of μg/dL can lead to a 2-4 point decrease in IQ in children, [12], [10]. According to the US Centers for Disease Control and Prevention (CDC), they established the reference level for elevated blood lead levels at 10 μg/dL for adults and 5 μg/dL for children, based on the total tested blood volume, [13].

Laboratory test results for the analysis of the Plumbum heavy metal showed that the concentration of Plumbum in the waters of Batu Jaya Village almost all exceeded the threshold value for seawater quality (Decree of the Minister of Environment number 51 of 2004). At stations 1, 2, and 3, which are the sampling points closest to land, the concentration of Plumbum is high. From these three sampling points, the high concentration of Plumbum is at point 2, 0.0217 mg/L, and point 3, 0.0220 mg/L, both of which are in the high seas area. There are various activities at sea that have the potential to pollute the environment on the coast and sea, including shipping activities, dumping at sea, exploration and exploitation of offshore mining, and marine cultivation/fisheries (Disruptive Chemistry for a Better Life, 2018). In Batu Jaya Village, port activity is very high, such as the shipping of large ships between Regencies and Cities, the activity of fishing boats, and also industrial ship crossing areas. This may be the reason for the high Plumbum pollution in this area. Apart from that, it is suspected that the activity of catching small fish used as forage has also contributed to the high level of heavy metal contamination in this area. This study's results align with the findings of those who conducted research in the waters of the Tanjung Mas port area and Mangunharjo waters, where each obtained figures of 0.253 mg/kg and 0.0697 mg/kg, [14].

At stations 5 and 6, the levels of Plumbum heavy metal also exceeded the specified threshold values (0.0182 mg/L and 0.0141 mg/L). This point is in front of a residential area which is the route for fishing boats, ship assembly, shipbuilding, and fishing boat storage. Activities of Ship painting carried out in the shipbuilding process can also affect heavy metal levels in this area. There is a

Plumbum heavy metal content in the paint, which functions to accelerate the drying process and inhibit rusting on metal or iron surfaces, [15]. The study on the Sampur coast, Central Bangka district, obtained similar results where the Plumbum heavy metal content was high in concentrations in areas where fishermen anchored their boats, [16]. Pollution can come from the process of washing and maintaining ships, as well as the fuel used by ships spilled, [15], [17]. Besides the fuel waste from fishing boats, household waste also contributes to high levels of heavy metals in this area, [18], [19].

At station 10, which is on the border of Batu Jaya Village and Wisata Namu Village, levels of the Plumbum heavy metal are also high. Its location close to the Namu Tourism Village means that this area has experienced an increase in the flow of tourist boats. Ship paint containing Plumbum and human activities around the coastal tourism area may trigger the presence of the Plumbum heavy metal at the border of the two villages, [6], [20]. The same results were also obtained in the study in the Raja Ampat Tourism area of West Papua, where the highest levels of Pb heavy metal were at points located in tourist areas and ports, [21]. Sources of heavy metals can come from ship fuel waste in the form of oil, anti-rust paint materials from ship hulls, and wood preservatives for ships made of wood, [22]. Of the ten stations that were sampling points, four stations, such as stations, 4, 7, 8, and 9, had levels of Plumbum heavy metal below the minimum limit. This is because the location of the four stations is in an area close to the rocks. In addition, there is rarely people activity in this area because it is far from residential areas.

5 Conclusion

In the waters of Batu Jaya Village, South Konawe Regency, Southeast Sulawesi Province, there is a Plumbum heavy metal content that exceeds the threshold. Excessive lead content in water can cause various health problems in humans. Chronic exposure to lead can damage the nervous system, kidneys, and liver. In children, lead exposure can cause developmental disorders and brain damage. Furthermore, the long-term health impacts caused by lead can affect future generations. In addition, aquatic ecosystems also suffer from excessive lead content. Aquatic organisms such as phytoplankton, algae, and invertebrates can be negatively affected by lead. This can lead to population decline, reproductive disorders, and even long-term mortality. Lead can also disrupt the biogeochemical cycle and damage water quality, thus impacting the entire aquatic ecosystem. Addressing the issue of lead content exceeding the threshold in water is crucial for human health and ecosystem preservation. Measures such as strict industrial waste control, environmentally friendly technologies, and enforcement of regulations must be implemented to reduce lead exposure in water. Furthermore, public education about the dangers of lead and the importance of maintaining water cleanliness should also be enhanced.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Concept generation, data collection (P), writing and editing of the manuscript (RT), critically reviewed (NS), writing, and revision (RT, NS).

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of interest:

The authors declare no conflict of interest