DISTRIBUTION OF DISSOLVED HEAVY METAL Hg AND Pb IN LAMONGAN COASTAL WATERS, INDONESIA

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ABSTRACT

Lamongan Regency has a fairly progressive fisheries sector with high fishing activity, such as the fishing industry and ports, especially in the Paciran and Brondong subdistricts. On the other hand, rapid fishing activities can also cause the gate of pollutants such as heavy metals and have the potential to reduce water quality in the area. The aim of this research is to analyze water conditions based on physical and chemical parameters as well as the distribution of dissolved heavy metal Hg and Pb in the fisheries industrial area and port of Lamongan Regency. The research was carried out using a purposive sampling method at seven stations along the waters of both Brondong and Paciran Districts. The data used in this research includes water quality parameters and dissolved heavy metal Hg and Pb. Analysis of heavy metal content was carried out in the laboratory using an Atomic Absorption Spectroscopy (AAS) instrument. The results showed that the Hg concentration at all stations was not detected by AAS because its concentration was very low. Meanwhile, the heavy metal Pb shows varying values at all stations with a range of 0.08 mg/L – 1.88 mg/L. The concentration of the heavy metal Pb at most location points has exceeded the limits set by Indonesian Government Regulations. The results of statistical analysis show that there is a relationship between temperature and pH and the concentration of the heavy metal Pb in water.

Keywords: *Water quality, Pollutant, Pb, Hg, Lamongan*

1. INTRODUCTION

Lamongan Regency is one of the northern coastal regions of East Java Province which has quite progressive growth in the fisheries sector compared to other regions. Lamongan is a competitive and specialized area in the fisheries sector (Syamsuddin *et al.*, 2022). Fisheries economic activities in Lamongan has been proven to be able to endure the pandemic period. Based on data in 2020, the results of capture fisheries in this region increased by 3.7% and aquaculture increased by 4.1% (Trihusodo, 2021; Lamongan in figures, 2022). In East Java, Lamongan Regency is the largest producer, contributing 18.6% of the capture fisheries sector. Brondong and Paciran subdistricts play an important role in fisheries activities in Lamongan Regency (Pramudyanto, 2014). With a coastline of 46 km, this region promises to become an investment destination in the fishing industry sector.

Various fishing activities in this area, such as capture fisheries, ports, shipping, aquaculture and residential areas, can have the potential for pollutant substances entering the waters. Pollution in a body of water is a common condition that has occurred a lot (Huda *et al.*, 2014). Pollution in coastal areas can occur due to fishing activities and fish processing activities. In addition to supporting economic conditions in an area, fishing industry activities can also be a factor for contaminants entering the waters. One type of pollutant that is often found in the area is heavy metal contamination.

Non-essential heavy metals are one type of pollutant that can come from fishing activities. Sources of heavy metal input in these waters can

come from shipping activities, industrial waste, aquaculture waste or household waste within the nearby area (Trihusodo, 2021). Types of non-essential heavy metals include Hg, Pb, Cd, Cr These types of heavy metals can be considered as toxic if their presence exceeds a predetermined threshold value. The presence of heavy metal contamination in waters can affect various aspects, both biologically and ecologically (Azizah and Maslahat, 2021). Its non-biodegradable nature, will cause an accumulation effect in the environment, causing a toxic effect on the biota that live in it (Maddusa *et al.*, 2017), which can affect the quality and quantity of fishery production directly or indirectly. The high level of fishing activity in Lamongan Regency is one of the possible causes of the entry of pollutants into the waters. Therefore, it is necessary to determine the distribution of heavy metal content in the waters of Lamongan Regency, East Java. This research aims to analyze the quality of waters in the area, especially regarding to dissolved heavy metal Hg and Pb contaminations originating from fishing activities, as well as a preventive measure to prevent excessive environmental damage due to uncontrolled exploitation activities.

2. METHOD

2.1 Study Area

The research location was carried out in the waters of Brondong and Paciran Districts, Lamongan Regency, East Java in May 2023 (Fig. 1). Most anthropogenic activities such as industry, fisheries, and tourism take place in these two areas.

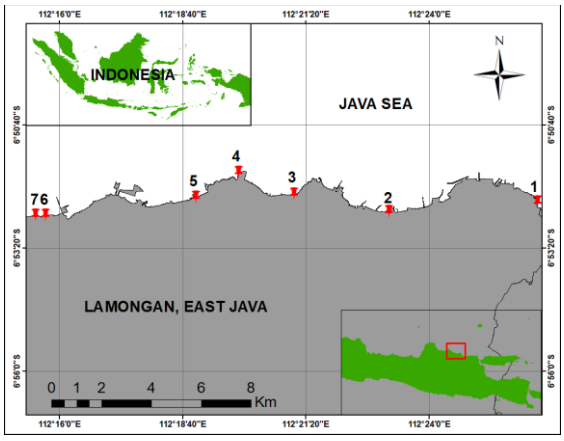

Figure 1. Research site at Lamongan Regency

There are seven research stations located along the coastal areas of Paciran and Brondong Districts. Determination of sampling points is carried out taking into consideration the existence of activities that have the potential to bring heavy metal contamination into waters, such as fishing industry activities, tourism and residential areas or ports.

2.2 Sampling procedure and laboratory analysis

The data used are physical and chemical parameters of water quality which include temperature, pH and salinity as well as the heavy metal content Hg and Pb in water samples. Measurement of water quality parameters is carried out in-situ in the field using a Water Quality Meter instrument, while analysis of heavy metal concentrations is carried out ex-situ in the laboratory using an Atomic Absorption Spectrophotometer (AAQ).

Water samples were taken directly using a 500 ml polyethylene bottle. Next, add five to ten drops (0.5 mL) of 60% HNO_3 solution to the water sample until the pH value is less than 2. This aims to bind the heavy metal content contained in the water sample.

Water samples obtained from each station will be analyzed using AAS in the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Brawijaya. Preparation of the test solution was carried out by homogenizing 100 mL of water sample into an Erlenmeyer. Next, the digestion process was carried out by adding 5 mL of concentrated HNO_3 and closing with a glass funnel. Heat slowly until the volume is around 10 – 20 mL. Transfer the test solution into a 100 mL measuring flask and add distilled water until the test mark is then homogenized (Indonesian National Standards, 2019). The test solution was then measured for absorption using AAS.

2.3 Data Analysis

The results obtained will be presented descriptively and statistically in the form of graphs or tables. The results of measuring water quality and heavy metal concentration values will be compared with the quality standards set by the Government Regulation of the Republic of Indonesia Number 22 of 2021. Statistical analysis was carried out using *Principal Component Analysis* (PCA) with Past3 software (Hammer & Harper, 2006).

3. RESULT AND DISCUSSION

3.1. Water Quality Parameters

The results of measuring water parameters, which includes temperature, salinity and pH, are shown in Table 1.

Table 1. Water Quality Parameters

Station	Temp (°C)	Salinity (‰)	pH
1	30.1	29.4	8.1
2	31.3	29.6	8.2
3	30.8	31.2	8.3
4	30.3	31.1	8.0
5	28.8	29.1	8.0
6	28.5	32.0	8.1
7	28.6	32.0	7.9
*Standards	28 - 32	33 - 34	7 - 8.5

*****Republic of Indonesia's Governemntal Law No. 22, 2021.

Temperature

Temperature is a physical parameter that shows the degree of hot or cold water. Temperature values can be an indicator of the quality of water because of its influence on the organisms that live in it. The results of temperature measurements (Table 1) obtained at all stations ranged from 28.53 °C – 31.27 °C. This shows that the water temperature is still relatively normal and within the quality standard range set by PP RI No. 22 of 2021, namely 28 °C – 32 °C.

Temperature is a crucial water parameter that can significantly impact both the living (biotic) and non-living (abiotic) elements present in the water. The toxicity of heavy metals to organisms can be influenced by temperature. Elevating the temperature will facilitate the absorption of heavy metals into the bodily tissues of aquatic species due to the heightened metabolic rate. This also accelerates the reaction of the bonding between absorbed heavy metals and proteins within the body (Budiastuti *et al.*, 2016).

Salinity

Salinity is a water quality parameter that can affect the growth and chemical composition of an organism. The results of the salinity measurements obtained were in the range of 29.10 ‰ – 32.03 ‰. This shows that the salinity value at all stations is below the value set by PP RI No. 22 of 2021, namely 33 ‰ - 34 ‰. Nonetheless, these results are still relatively normal because the average salinity value in Indonesia ranges from 28‰ - 33‰ (Patty & Akbar, 2018).

Salinity can be a factor that influences the presence of heavy metals in waters. High salinity values can cause increased formation of chloride ions. This causes metal ions to bind with chloride ions so that the concentration of heavy metals in the waters decreases (Mance, 1987 in Hidayatullah *et al.*, 2023).

pH

The pH value which indicates the acidity or base of a body of water will affect the quality of that water (Anzori *et al.*, 2019). Measurements show that the pH of all stations is in the range of 7.91 – 8.34. This value is still within the range set by PP RI No. 22 of 2021, namely 6.5 – 8.5. A pH value below 6 indicates that the waters are acidic, while a pH above 9 indicates that the waters are alkaline. Water conditions that are too acidic or alkaline are not good for the life of aquatic organisms. Most pH in natural waters ranges from 6 – 9.

The pH value can affect the solubility of heavy metal compounds in waters. Water with a pH value that is close to normal in the range of 7 – 8 will have a solubility of compounds that tends to be stable. The high pH value of a body of water will cause a decrease in the solubility of metal compounds in the water so that these compounds will settle to the bottom of the water (Palar, 1994 in Sukoasih *et al.*, 2017).

3.2. Heavy Metal Concentrations of Hg and Pb

The results of the analysis of heavy metal concentrations of Hg and Pb at the research location are shown in Table 2.

Table 2. Concentration Hg and Pb

Station	**Hg (mg/L)**	**Pb (mg/L)**
1	*Ud	0.69
2	Ud	1.12
3	Ud	1.88
4	Ud	Ud
5	Ud	0.23
6	Ud	0.08
7	Ud	0.15
*Standards	0.001	0.005

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* Republic of Indonesia's Governemntal Law No. 22, 2021
*Undetected (Ud)

Mercury (Hg) is a type of non-essential heavy metal whose presence is very dangerous for aquatic organisms if its concentration exceeds predetermined limits. Sources of Hg in the environment can come from nature or as a result of human activities. Most of the massive Hg pollution is caused by quite high levels of anthropogenic activities. Utilization of Hg in various fields such as the manufacturing industry, mining industry, Small Scale Gold Mining (PESK), health facilities and other industries (Minister of Health of the Republic of Indonesia, 2016).

The concentration of mercury at all stations shows a very low value so that it cannot be detected by the AAS instrument. This can happen because the instrument used has a certain detection limit so that the instrument cannot read very small concentrations of heavy metals. This value indicates that the concentration of Hg at all stations is still below the quality standard of PP RI No. 22 of 2021, which is 0.001 mg/L.

The relatively low concentration of Hg in water can be caused by several factors. The heavy metal Hg is a type of metal that is volatile but insoluble in water (Zhang *et al.*, 2018). Most of the Hg that enters the waters as a pollutant will precipitate in sediments or bind to other compounds to form inorganic mercury which can be consumed by microorganisms. This can potentially lead to the accumulation of heavy metals in aquatic biota. Other factors that can affect the low concentration of Hg in water bodies are climatic conditions and the ability of waters to be diluted by tidal currents (Rasul & Musafira, 2022).

The heavy metal lead (Pb) is a type of non-essential heavy metal which is also known as a heavy metal which is very toxic and harmful to organisms. Pb has occurred in several water areas. Sources of entry of heavy metals into waters can come from industrial waste, household waste, and the results of boat or ship traffic. Increased Pb can come from human activities such as gas emissions from motorized vehicles and industrial waste (Nurfadhilla *et al.*, 2020).

The concentration of Pb at all stations except station four showed a fairly high value ranging from 0.08 mg/L – 1.88 mg/L, while at station four heavy metal Pb could not be detected because the concentration was very low. Pb values at most stations are known to have exceeded the quality standards set by PP RI No. 22 of 2021, which is 0.005 mg/L.

The largest concentrations of dissolved Pb were found at stations 2 and 3, with values of 1.12 mg/L and 1.88 mg/L, respectively. The sample site's proximity to the port area and the location of the fish auction could be the reason for station 2 high value. It is believed that local fishing operations have added Pb-containing pollutants to the waters. Station 3 has the highest Pb content measurements. This area is a popular tourist destination that is close to local events and the main highway along the north coast. The community's domestic trash, which has the potential to carry contaminants containing the heavy metal Pb, may have contributed to the region's high Pb level (Elfidasari *et al.*, 2020). Additionally, because of the high number of passing vehicles on the main pantura route, which passes by the sampling location, it is possible that the heavy metal Pb created by motorized vehicles could be present there. The heavy metal Pb can enter waterways through waste from auto repairs that use lubricating oil or gasoline (Azizah *et al.*, 2018). Rainfall will enable the heavy metal Pb pollution prevalent in the atmosphere reach the saltwater.

3.3 Analysis of Relation between Heavy Metal Hg and Pb with the Parameters of Water Quality

The relation between dissolved Hg and Pb with water quality parameters can be shown in the biplot diagram obtained from the *Principal Component Analysis* (PCA) (Figure 2).

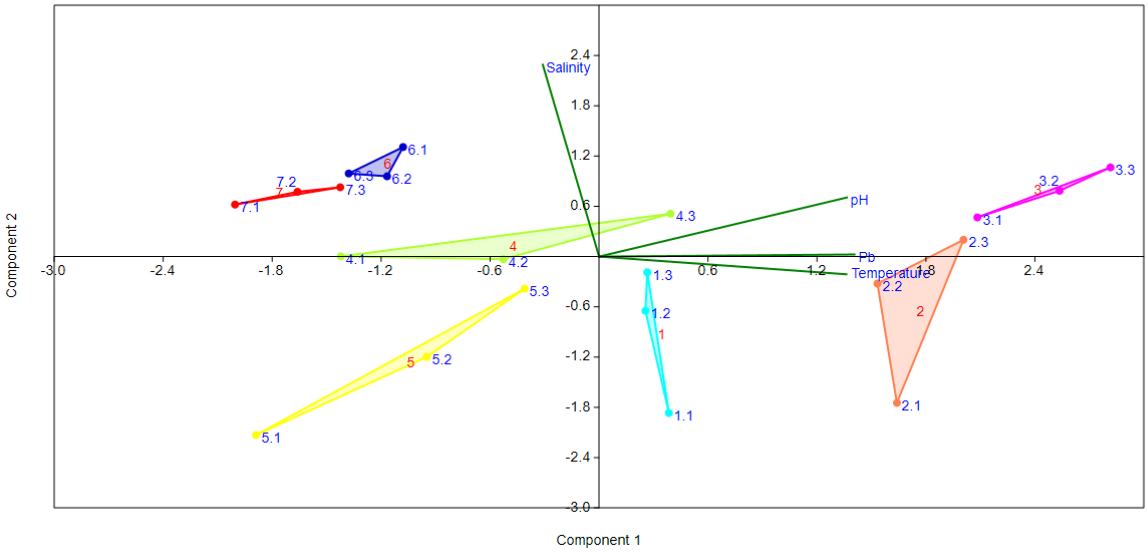

Figure 2. Result of Principal Component Analysis (PCA)

Based on the biplot diagram, it is known that the Pb concentration in water is influenced by the pH value and water temperature. The pH value at all stations shows a stable value in the range of 7 – 8. Heavy metals found in waters generally dissolve more easily at low pH (Elfidasari *et al.*, 2020). However, the results obtained show the opposite. This condition can be caused by other factors at the sampling location, such as the level of pollution in the area. The concentration of the heavy metal Pb is also influenced by water temperature values. Rising water temperatures can cause the concentration of dissolved heavy metals to increase. High temperature values will make it easier for heavy metal compounds to dissolve in water (Sukoasih *et al.*, 2017).

The factorial axis formed from the salinity axis shows no relationship with Pb concentration in water. It is also known that there is a relationship between pH and water temperature which shows a positive correlation. This indicates that an increase in water temperature will be followed by an increase in the pH of these waters. In general, high temperatures can increase the rate of chemical reactions, including acid-base, so that when the temperature rises, the pH value will also tend to increase (Yolanda, 2023).

4. CONCLUSION

The result findings demonstrate that temperature, pH, and salinity values for water quality indicators are still within the limitations established by Government Regulation of the Republic of Indonesia Number 22 of 2021 (PP RI No.22 Tahun 2021). According to the analysis of heavy metal content, Hg concentration is so low that it cannot be identified by the AAS equipment. At most sites, the concentration of the heavy metal Pb, which ranges from 0.08 to 1.88 mg/L, is excessive and exceeds the government's quality standard threshold (0.005 mg/L). The results of a correlation study using PCA indicate a positive correlation between the concentration of the heavy metal Pb in the water and its temperature and pH levels.

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