Concentration of Heavy Metal Pb and Cu in Reef Fish at the Waters of Miang Besar Island in Kutai Timur Regency

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ABSTRACT

Miang Island is a transportation route for coal ships and a place for loading and unloading coal, then there are also oil palm companies around this island. On this island there are also still islanders who carry out household activities in this area, such as washing activities, thus producing household waste in the waters on this island. Therefore, community activities carried out on this island can contribute to the burden of pollution of waters and reef fish in these waters, therefore it is necessary to conduct research on heavy metal levels that have contaminated organisms in these waters related to the pollution conditions that occur. This research was conducted in February 2023 in the waters of miang island and analyzed water quality and heavy metal content in the water quality laboratory and soil laboratory of mulawarman university. The parameters that will be observed are the analysis of heavy metals lead (Pb) and copper (Cu) found in reef fish meat and statistical analysis using the Chi-Square test by comparing heavy metal content in reef fish against water quality data. In this study, reef fishes that have been analyzed are Lutjanus decassatus, Pentapodus caninus, Ephnephlesu ongus, Lethrinus erythropetrus, Balistapus undulatus, Gymnocranius microdon, Plectropomus leopardus, and Priacanthus meeki. All fish species contain heavy metals lead (Pb) and copper (Cu), this can be caused by activities carried out by local communities that can disturb water conditions and have an impact on fish, In the Chi-square analysis that has been carried out on water quality at each station on Miang Island, the results obtained water quality gives an influence on heavy metals in the bodies of reef fish that have been caught in this study. This can be caused by water quality that is affected by heavy lead (Pb) and copper (Cu) from human activities in these waters, such as ship loading and unloading activities, and ship transportation routes.

INTRODUCTION

The Sangkulirang Subdistrict is a part of the East Kutai Regency with a total area of 2899.32 km^2 (BPS, 2019), consisting of 15 villages, one of which is Miang Island. This island possesses abundant aquatic resources diversity, including coral fish. Miang Island serves as a transportation route for coal ships and a location for coal loading and unloading. Additionally, there are palm oil companies situated around this island. The island is also home to a local community engaged in household activities within its waters, such as washing, consequently leading to household waste being released into the waters surrounding the island. These activities are carried out daily by the nearby residents and have impacts on the aquatic ecosystem of Miang Island.

Waste from palm oil plantations originating from factories situated around the waters also contributes pollutants to the aquatic environment. The primary natural sources of metals such as Pb, Cu, Cr, Cd, Hg, Ni, and Zn are volcanic activities and agricultural or plantation practices. Pollution in these waters is also indicative of contamination from industrial and domestic waste. The activities of maritime vessels entering and exiting the port, which falls under the Loading and Unloading Labor (TKBM), for coal loading and unloading, as well as fuel oil replacement by these ships, can have adverse effects on the waters. The waste from these activities can contain various heavy metals like Fe, Mn, and Cu. Household waste in these waters contains a significant amount of hazardous chemical compounds, including heavy metals. This is primarily due to the washing activities carried out by the island's residents. Commonly discarded waste includes soapy water, urine, feces, and bathing water, all of which are directly released into these waters.

Therefore, the activities carried out by the community, ranging from household tasks to plantation activities, as well as the coal ship routes and coal loading and unloading operations in the waters of Miang Island, are suspected to contribute to the pollution load in the waters and the coral fish present in those waters. Hence, there is a need for research to be conducted on the levels of heavy metals that have contaminated organisms in those waters, in connection with the ongoing pollution situation.

METHODOLOGY

Location and Research Period

This research was conducted in February 2023 in the waters of Miang Island. The analysis of water quality and heavy metal content in Coral Fish was carried out at the Water Quality Laboratory of the Faculty of Fisheries and Marine Sciences and the Soil Laboratory of the Faculty of Forestry, Mulawarman University.

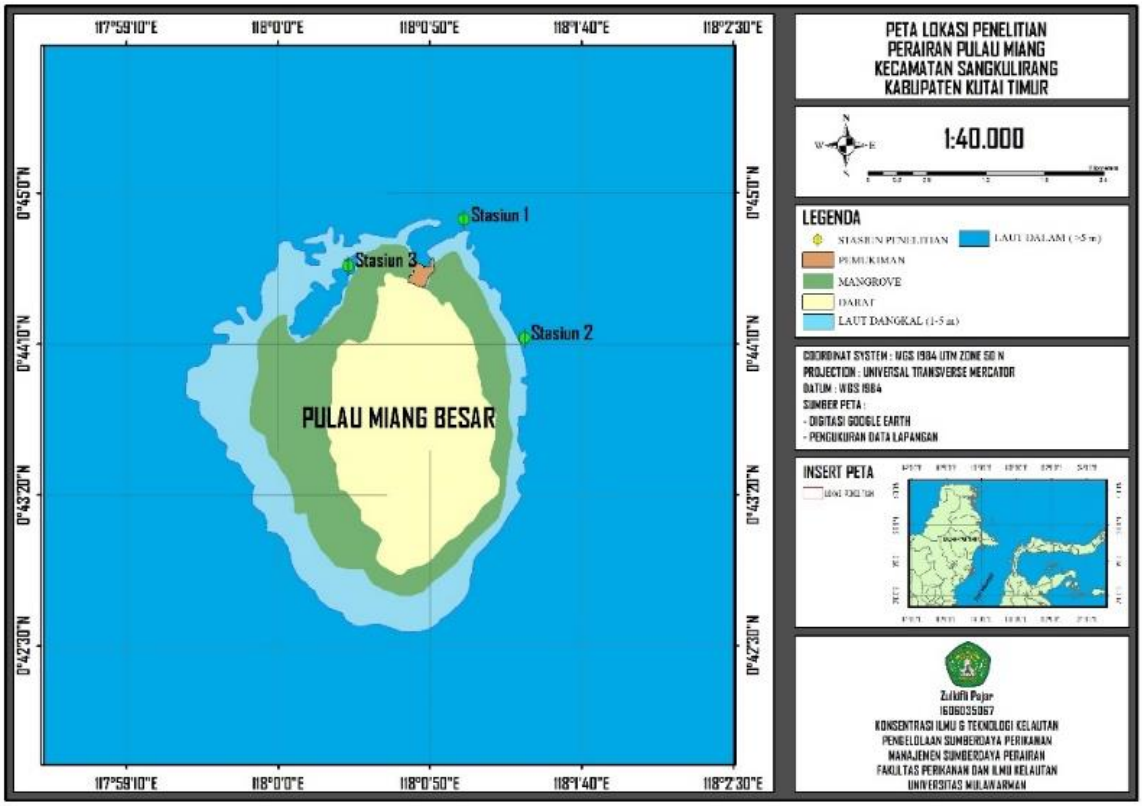

Figure 1. Research Location Map

Research Procedure

The parameters observed in this study are the analysis of heavy metals (Pb and Cu) found in the flesh organs of Coral Fish and the analysis of water quality measured in situ and ex situ, namely: Temperature, Transparency, pH, and DO. Coral Fish samples used in this research were obtained using fishing gear through local fishermen. Three types of coral fish (Herbivores, Carnivores, and Omnivores) were collected, with 3 to 5 individuals captured for each type, repeated for 5 different species. Only the gills, kidneys, and flesh organs of the fish were analyzed after dry destruction.

Data Analysis

The collected data was then subjected to data analysis using the Chi-Square test. The data analysis employed descriptive analysis to observe the distribution of heavy metal characteristics between station points, using the Chi-Square test ($\chi 2$). The Chi-Square test aims to examine the relationship or influence between two nominal variables and measures the strength of the relationship between one variable and another nominal variable (C = Coefficient of contingency).

$$x^2 = \sum_{b=1}^{k} \sum_{j=1}^{b} \frac{(poij - peij)^2}{peij}$$

Explanation:

$\chi 2$ = Chi-Square value

Poij = Observed parameter value

Peij = Expected parameter value

Pi = Sum of row i

Pj = Sum of column j

Σ Pij = Total sum of rows and columns

The result of the Chi-Square calculation is compared with the Chi-Square table. To find the Chi-Square table value, you can use degrees of freedom and expected parameters.

If the calculated $\chi 2$ value is less than the tabulated $\chi 2$ value, then H0 (null hypothesis) is accepted; If the calculated $\chi 2$ value is greater than the tabulated $\chi 2$ value, then H0 is rejected; The coefficient of contingency (C) is used to determine the expected data for the other nominal variable.

$$\text{Peij} = \frac{(\Sigma\, Pi.)(Pj)}{\Sigma\, Pij}$$

Explanation: (Peij = Expected parameter value, Pi. = Sum of row i, Pj. = Sum of column j, Pij = Total sum of rows and columns).

If:

H_0 is accepted, it means there is no significant influence of heavy metal content on the fish organisms at each station.

H_0 is rejected, it means there is a significant influence of heavy metal content on the fish organisms at each station.

RESULT AND DISCUSSION

Research Location Conditions

Miang Island serves as a transportation route for coal ships and a location for coal loading and unloading. Additionally, there are palm oil companies situated around this island. The island is also home to a local community engaged in household activities within its waters, such as washing. For this research, data was collected from 3 station points: Station 1 in the northern part where ship loading and unloading activities take place, Station 2 in the western part where small boat transportation for tourists heading to

water villas and fishing boat transportation occur, and Station 3 in the eastern part where community activities are present, including the construction of water villas for tourists. The details can be seen in the table:

Table 1. Coordinates of Research Station Locations

Number	Station	Coordinate
1	ST 1 (North)	0º44'51.38" LS 118º1'1.19" BT
2	ST 2 (East)	0º44'11.96" LS 118º1'21.03" BT
3	ST 3 (West)	0º44'36.00" LS 118º0'23.00" BT

Water Quality Conditions

The analyzed measurement results of water quality parameters in the waters of Miang Island are as follows:

Table 2. Water Quality Parameters

Parameter	Station 1 (North)	Station 2 (East)	Station 3 (West)
pH	7,60 ppm	7,66 ppm	7,43 ppm
Temperature	28°C	29°C	29°C
Turbidity	3,5 m	2,7 m	7,2 m
Dissolved Oxygen	6,56 mg/l	6,48 mg/l	6,8 mg/l

In Table 4, the values of water quality parameters in the waters of Miang Island, East Kutai, are presented. The water quality conditions at each measured station do not exhibit significant differences. For the chemical parameter pH, the values obtained from the northern, eastern, and western stations range from 7.43 to 7.66 ppm. These values are within the quality standards set by the Ministry of Environment and Forestry Regulation No. 51 of 2004, which stipulates that the acceptable pH range for marine biota is 7 to 8.5 ppm. Therefore, the pH chemical parameter in these waters remains in good condition.

According to Sukoasih et al. (2016), bodies of water with pH levels approaching normal or within the range of 7 to 8 tend to have stable solutions of compounds. Typically, an increase in pH in water will lead to a decrease in the solubility of metal compounds. Suwarsiti and Esti (2014) further explain that when pH conditions are near normal (7-8), the solubility of heavy metals tends to be stable, forming bonds with anions. As a result, heavy metals tend to form organometallic complexes (both organic and inorganic forms) that are likely to accumulate at the bottom of the water body.

The water temperature at Miang Island's northern, western, and eastern stations ranges between 28-29°C. These values are within the acceptable quality standards defined by the Ministry of Environment and Forestry Regulation No. 51 of 2004, indicating that the temperature in these waters remains at a normal level for marine biota. Temperature can also influence the presence of pollutants in water, such as heavy metals. Suryani et al. (2014) state that an increase in temperature will not only raise the metabolism of aquatic organisms but also elevate the toxicity of heavy metals in the water.

The clarity value of the waters around Miang Island at station 3, or the western station, exceeds the threshold quality standard of 7.2 meters. According to the standard set by the Ministry of Environment and Forestry Regulation No. 51 of 2004, the clarity value for waters with marine biota living in coral areas should be > 5 meters. If the clarity value surpasses 5 meters, it indicates good water quality on Miang Island.

The Dissolved Oxygen (DO) value in these waters ranges from 6.48 to 6.80, while a good DO range for marine biota in seawater is > 5 mg/L. The oxygen level in this water remains within normal levels. According to the standard set by the Ministry of Environment and Forestry Regulation No. 51 of 2004, a good DO value is > 5 mg/L. Suryani et al. (2014) state that dissolved oxygen is an environmental factor that affects the concentration of heavy metals in aquatic organisms. Low levels of dissolved oxygen can elevate the respiratory rate of these organisms, thereby increasing the toxicity of heavy metals entering their bodies.

Heavy Metal Content in Sediments

Based on the research results, heavy metal analysis in sediments was conducted using an Atomic Absorption Spectrophotometer (AAS). The results can be observed in the following table:

Table 3. Results of Heavy Metal Analysis in Sediments.

Number	Parameter	Unit	Analysis Result			Quality Standards
			ST 1	ST 2	ST 3	ANZECC (2000)
1	Pb	mg/ Kg	152.25	133.97	132.61	50 mg/Kg
2	Cu	mg/ Kg	7.38	6.24	6.33	65 mg/Kg

The results of heavy metal analysis for Lead (Pb) are as follows: at station 1, there is 152.25 mg/Kg, at station 2, there is 133.97 mg/Kg, and at station 3, there is 132.61 mg/Kg. Among these three stations, the highest concentration of Pb is at station 1, where maritime vessel activities involving coal loading and unloading, as well as fuel oil replacement, take place. The Pb content at stations 2 and 3 is also relatively high due to community activities, including transportation between station 2 and station 3, which has a water villa tourism spot.

Based on the quality standard set by the Australian and New Zealand Environment and Conservation Council (ANZECC, 2000), the heavy metal content of Lead (Pb) in the waters of Miang Island has exceeded the threshold of 50 mg/Kg. This could lead to the presence of heavy metals in sediments becoming pollutants. Generally, the elevated concentration of heavy metals in sediments is due to factors such as rainfall, adsorption, and absorption by aquatic organisms. These heavy metals can accumulate in sediments as they bind to particles and organic matter, which are absorbed by the water and then settle at the bottom, becoming integrated into the sediment (Fajri, 2001).

The analysis results for Copper (Cu) are as follows: at station 1, there is 7.38 mg/Kg, at station 2, there is 6.24 mg/Kg, and at station 3, there is 6.33 mg/Kg. Among these three stations, the highest Cu concentration is found at station 1, followed by station 3. According to the quality standard established by the Australian and New Zealand Environment and Conservation Council (ANZECC, 2000), the heavy metal content of Copper (Cu) in the waters of Miang Island is still below the threshold of 65 mg/Kg. From these results, it is evident that the sediment's heavy metal content in the waters of Miang Island has been contaminated by Lead (Pb)."

Heavy Metal Content in Fish

Based on the research results, heavy metal analysis in fish was conducted using an Atomic Absorption Spectrophotometer (AAS). The results can be observed in the following table:

Table 6. Results of Heavy Metal Analysis in Fish.

No.	Fish Name	Species	Units	Parameter		Quality Standards	
				Lead (Pb)	Copper (Cu)	Lead (Pb)	Copper (Cu)
1	Squaretail Coral Grouper	*Lutjanus decussatus*	mg/ Kg	1.57	1.61	0.3 mg/Kg	0.3 mg/Kg
2	Coral Fish	*Pentapodus caninus*	mg/ Kg	0.87	1.37		
3	Squaretail Grouper (Lencam)	*Gymnocranius microdon*	mg/ Kg	1.18	0.92		
4	Barred Soapfish	*Plectropomus leopardus*	mg/ Kg	1.51	0.88		
5	Giant Grouper	*Ephinephelus ongus*	mg/ Kg	1.36	0.38		
6	Red Snapper	*Priacanthus meeki*	mg/ Kg	1.69	1.14		
7	Badge Grouper	*Lethrinus erythropterus*	mg/ Kg	0.96	0.57		
8	Goatfish	*Balistapus undulatus*	mg/ Kg	1.15	1.10		

All the researched fish, based on the quality standards established by SNI 7387:2009 and SK Dirjen POM No. 03725/B/SK/VII/89, are contaminated with heavy metals Lead (Pb) and Copper (Cu). This contamination can be attributed to the presence of ship transportation activities in the waters of Miang Island. Elevated levels of heavy metals can lead to toxic effects on human health (Handayani, P. 2020). For the species of squaretail coral grouper or Lutjanus decussatus, heavy metals can accumulate in fish due to various activities in the waters of Miang Island, including industrial activities, ship loading and unloading, fishing boat transportation, and local community activities. Heavy metals are difficult to degrade and can dissolve easily in water. This causes them to settle in sediments and accumulate in aquatic organisms through food (diet exposure) and gills (water exposure) (Sarjono, 2009).

The Statistical Analysis of Heavy Metal Content in Coral Fish Based on Research Station Characteristics and Water Quality Data

An analysis of heavy metal content in coral fish, including Lutjanus decussatus, Pentapodus caninus, Epinephelus ongus, Lethrinus erythropterus, Balistapus undulatus, Gymnocranius microdon, Plectropomus leopardus, and Priacanthus meeki as discussed earlier, was conducted in relation to the water quality conditions depicted in point B. A Chi-square test was performed to identify factors influencing the levels of heavy metals in these coral fish. From the analysis, it was revealed that the measured water quality parameters contribute to the variations in the heavy metal content within these coral fish.

The calculated X2 (348.78) was greater than the tabulated X2 (30.14) or H0 was rejected at a significance level of $\alpha = 5\%$. This implies that the water quality characteristics at each station significantly influence the contamination of heavy metals in the coral fish organisms present in the waters of Miang Island.

CONCLUSION

In this study, the analyzed coral fish species include *Lutjanus decussatus, Pentapodus caninus, Epinephelus ongus, Lethrinus erythropterus, Balistapus undulatus, Gymnocranius microdon, Plectropomus leopardus,* and *Priacanthus meeki*. All of these fish species were found to contain heavy metals Lead (Pb) and Copper (Cu). This could be attributed to the local community activities that disrupt the water conditions and subsequently affect the fish.

The Chi-square analysis conducted on the water quality at each station in the waters of Miang Island *revealed* that water quality has an impact on the presence of heavy metals in the bodies of these coral fish caught in this study. This impact may arise from the poor water quality affected by Lead (Pb) and Copper (Cu) due to human activities in these waters, such as ship loading and unloading as well as ship transportation routes.

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