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THE RELATIONSHIP OF MACROZOOBENTHOS ABUNDANCE WITH OIL AND METAL CONCENTRATIONS IN SEDIMENTS AROUND COASTAL WATERS INDUSTRIAL AREA OIL CITY OF DUMAI RIAU

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ABSTRACT

Some studies say the pollution level in the waters oil industry in Dumai City, Riau. The level of pollution that occurs will affect the abundance of macrozoobenthos. This research aims to know the concentration of oil and heavy metals in sediments in the waters around the area of the Dumai City oil industry, knowing the effect of oil on the abundance of macrozoobenthos. This research method includes placement of research stations, observation and sampling, TSS sample analysis method, concentration oil in sediment samples, heavy metal concentrations of Pb, Cd, and Cu at sediment samples, macrozoobenthos abundance Analysis, and data analysis. Results research average concentration of oil in sediments in water areas The oil industry of Dumai City, Riau, has passed the threshold that has been set determined by the Department of Water Resources Quality Assurance/Quality Control Program That is > 1000 ppm, so it can be said that station 1 up to 9 are polluted and harmful to organisms that live on the bottom those waters relationship of oil concentration, heavy metals (Pb, Cd, and Cu) moderate to weak.

Keywords: Dumai, Heavy Metal, Macrozoobenthos, Sediment

1. INTRODUCTION

Dumai is a city located on the East Coast of Riau Province. The Rupat Strait is a national and international shipping lane that connects Dumai City, a port city in Riau Province, with other cities in Indonesia and the world. The rapid development, expansion of the area, and industrial growth in the waters of the City of Dumai can increase the pollution load. The increase in the pollution load is caused by the disposal of industrial, domestic, residential, transportation, port, local, and international shipping waste[1].

The development of an area will impact the surrounding environment. If it is not planned correctly, the result will be a decrease in water quality due to increased waste disposal, which harms humans and the biota in the waters. In the industrial waters area of the City of Dumai, especially in the city of Dumai, there are petroleum and palm oil industries. The industry gave rise to water transportation activities, such as ship refuelling, storage, processing, and distribution of oil supplies to various regions using transport ships. This condition can make the Dumai and the Rupat Strait coast vulnerable to oil and heavy metal pollution.

Seawater pollution caused by oil spills in the waters of the city of Dumai often occurs, including spills caused by oil tank leaks from the petroleum industry in the city of Dumai on March 2, 2021, which was reported by Consumer News and Business Channel (CNBC) Indonesia[1]. This incident resulted in an oil spill volume of approximately 8.4 barrels and entered the Dumai Sea's coastal waters. Another

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incident recorded in the city of Dumai on March 26, 2014, was an oil spill of 300 thousand barrels in the coastal waters of Dumai[2].

Ocean currents and waves will accelerate the spread of oil pollution throughout the waters. Oil spills will settle to the bottom of the waters to cover the bottom surface of the water sediments. If the decomposing bacteria cannot decompose the oil, the life of the organisms whose habitat is at the bottom of the water will be disrupted. These organisms will die and cause decay. This condition has the potential to accelerate the decline in water quality and will affect the lives of other organisms in the waters.

Macrozoobenthos live permanently on the bottom of the waters (sediments) and have languid movements, so these animals are more sensitive to environmental disturbances such as water and sediment quality changes. Macrozoobenthos are organisms that live on the bottom of the waters. They are benthic and live on the surface of sediments. These organisms have languid movements, so the accumulation of sediments containing heavy metals will affect their survival; there are only two possibilities for benthos if they face bad environmental changes, trying to adapt or become extinct. Aquatic biota polluted by heavy metals will experience growth disturbances and even death.

Gholizadeh et al.[3] state that changes in macrozoobenthos communities spatially depend on the size of sediment particles, organic matter, and water depth. Therefore, macrozoobenthos are often used as bioindicators for monitoring water pollution because many animals are sedentary and have relatively long life cycles. Long-term, high abundance and diversity can respond continuously to water quality conditions[4].

The method used in this study is a survey method. Samples were obtained from four locations in Belawan waters: the mangrove forest in Belawan, the mouth of the Deli River, residential areas/Gabion Pier, and Pelindo. The research conducted analysed the oil content in the sediments and the structure of the diversity of macrozoobenthos present in these waters.

2. RESEARCH METHOD

Time and Place

The research was carried out in March 2022. The locations for taking the oil, metals, and macrozoobenthos samples were carried around the Coastal Waters of the Oil Industrial Area, Dumai City, Riau.

Method

Determination of the research location using the purposive sampling method by assigning nine observation stations based on the characteristics of activities along the coastal waters of Dumai City: industrial activities, fishing settlement activities, mangrove areas, and urban domestic activities and one control station.

Figure 1. Map of research locations

3. RESULT AND DISCUSSION

The salinity of the oil industry waters in the city of Dumai, Riau, ranges from 10.16 to 10.23%. Salinity was measured to determine the level of salt dissolved in the water; the highest salinity value was at Station 10, with a value (of 10.27 ppm).

TSS ranged from 73 – 137 mg/L. TSS is measured to see suspended solids in water and sediment. Compared to Station 10, the TSS value is 73 mg/L, and Station 10 has a lower TSS value than stations (1-9). The TDS value of the Dumai City oil industry waters in Riau ranges from 5294 to 9858 ppm. TDS measurements are carried out to measure the total solids (minerals, salts, or metals) in the waters. The shallowest depth is at Station 3, which has no current speed, and the most profound at Station 4, which has a current speed value of 0.58 m/s. Current speed is divided into five categories, namely: swift currents (>1m/s), fast (0.5-1m/s), moderate (0.25-0.5m/s), slow (0.10m/s), and very slow (<0.10m/s) (Table 1).

Table 1. Water quality

Station	Salinity (‰)	TSS (mg/L)	TDS	pH	Turbidity (NTU)	Flow Speed (m/s)	Depth (m)
1	10,17	86	6926	7,6	9.48	0,09	16,9
2	10,16	76	5294	6,8	5.93	0,22	10,9
3	10,18	93	5128	7,1	15.95	0	10,7
4	10,22	89	7532	8,3	10.94	0,58	18,9
5	10,22	88	7844	7,5	14.32	0,46	12,1
6	10,23	102	7532	8,3	27.08	0,25	18,9
7	10,21	89	9858	8,1	7.31	0,13	10,9
8	10,20	115	7128	7,7	29.12	0,38	11,2
9	10,19	137	7044	8,1	22.81	0,19	10,8
10*	10,27	73	5893	8,3	4,91	0,55	4

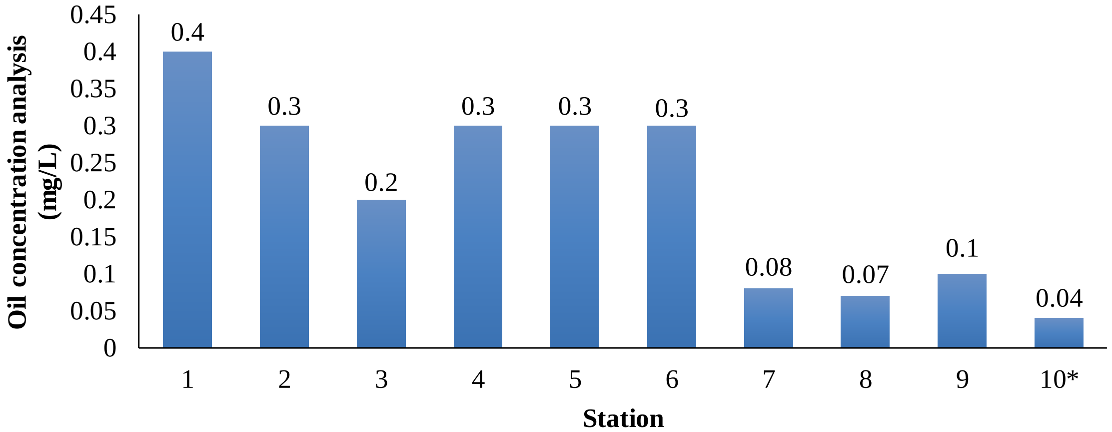

Figure 2. Oil concentration analysis

Oil concentrations in the sediment ranged from 0.07 – 0.35; the highest was found at Station 1, with an oil concentration of 0.35 ppm, while the lowest oil concentration was found at Station 8, with an oil concentration of 0.07 ppm compared to the quality standard. The results of the oil concentration analysis in sediments at Station 1 have a value of 0.35 ppm. This area is in an industrial area. Station 2 is between the river mouth and industrial area, Stations 3 to 7 are in industrial, residential, and urban areas and ports, Station 8 is between tourist and mangroves, and Station 9 is between industrial and mangroves.

The concentration of oil in sediments in the oil industrial waters area of Dumai City, Riau, from Stations 1-9 has crossed the threshold. This can be seen from the comparison at Station 10, which is lower than Stations 1-9, also strengthened by Kep. No.51/MENLH/2004 concerning seawater quality standards. Haryani[5] states that marine pollution occurs due to human activities loading and unloading oil, intentional (air ballast), ship accidents, oil run-off from land, carried by smoke, and oil transportation pipelines, which will endanger organisms and marine biota that live on the bottom of these waters. The results of measuring the concentration of heavy metals Pb, Cd and Cu at each sampling can be seen in Figure 3.

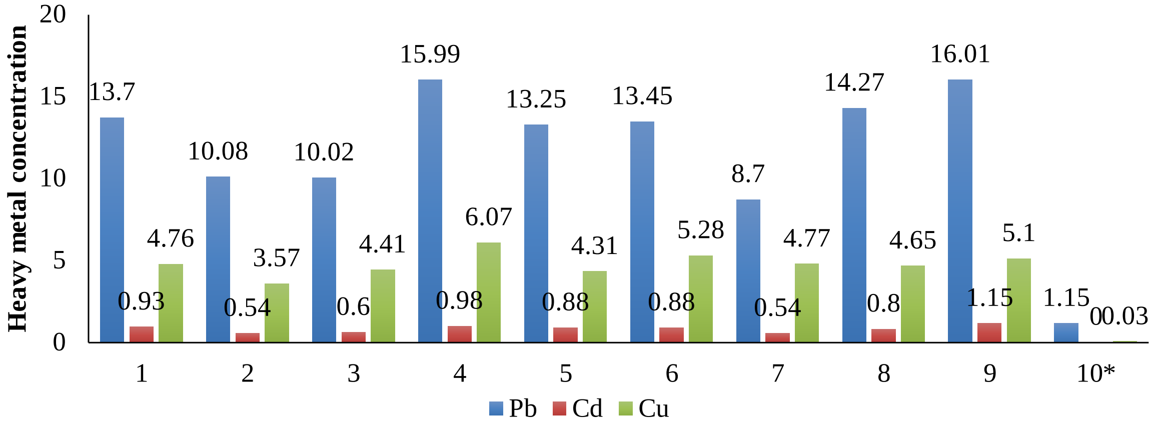

Figure 3. The concentration of Pb, Cd and Cu metals (µg/g)

The concentration of Pb metal in the waters of the oil industry in Dumai Riau ranges from (1.15 to 16.01 µg/g). The lowest concentration of Pb metal is at station 1 (2.91 µg/g), and the highest is at station 9 (16.01 µg/g) with a depth of 5 m. Station 9 is located in the Dumai industrial area. This is thought to be influenced by the tidal currents from the Malacca Strait, the discharge of ballast water from ships falling into the waters that cross the Dumai waters - the Malacca Strait.

The results of the comparison of the concentration of heavy metal Pb with Station 10 where the parameter value is higher than the observation, based on seawater quality standard KEPMENLH No. 51 2004, the parameter of heavy metal Pb has crossed the threshold with a value of (0.008) so that it will affect the abundance of macrozoobenthos.

The concentration of heavy metal Cd in the waters of the oil industry in the city of Dumai Riau ranges from 0 – 0.98 µg/g. The highest concentration is at station 4 (0.98 µg/g) with a depth of 10.8 meters. Sampling point 4 is located in the palm oil mill (PKS) industrial area, ship shipping. The heavy metal concentration value of Station 10 (Control), compared to Stations 1-9, the value of Station 10 is lower. This is because Stations 1-9 (Control) have many industrial, urban, shipping, and port activities in the area.

The concentration of heavy metal Cu in the oil industrial waters area of Dumai City, Riau, ranges from 0.03 – 6.07 (µg/g), the research location and the highest concentration is located at Station 4 (6.07 µg/g) with a depth of 5 m, Station 4 is in the palm oil mill (PKS). This is suspected because of the large amount of waste from the factory, which is directly disposed of into the waters, so the concentration of heavy metals in sediments increases.

Based on observations of species and identification of macrozoobenthos found in the waters of the oil industry, Dumai City, Riau, 22 macrozoobenthos species were found consisting of 5 classes, namely Gastropods, Bivalvia, Clitella, Holothuroidea, and Malacostrata. Macrozoobenthos sampling was carried out two times at each observation station. The total abundance of macrozoobenthos at each observation station can be seen in Figure 4.

In Figure 4, it can be seen that the most abundance of macrozoobenthos was found at Station 8, which is between the tourist area and the mangroves; at this station, there were ten species of macrozoobenthos which had an abundance value of 101 ind/m^2 and a relative abundance value of 100%. The types of species obtained came from several classes, namely the Gastropoda class (*Tympanotonos fuscatus, Aliculastrum cylindricum, Barleeia creutzbergi*), the

Bivalvia class (*Corbicula fluminea, Polymesoda erosa, Anadara granosa, Tellina variegata, Pholas dactylus*) the Clitella class (*Glycera* sp). The high abundance of macrozoobenthos is since most of the area is still overgrown with mangrove vegetation; from visual observations of sediment, which is a living medium for macrozoobenthos, which is more dominated by sand that macrozoobenthos are more commonly found on sandy mud substrates.

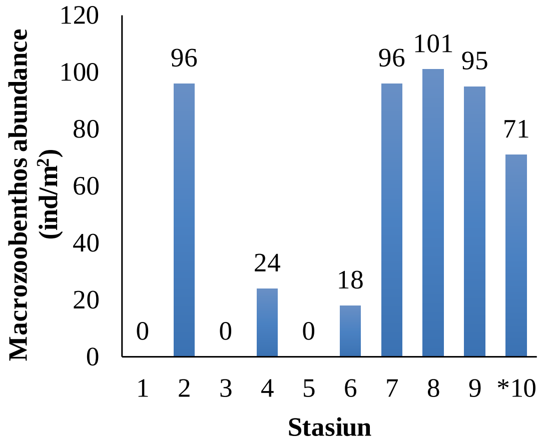

Figure 4. Macrozoobenthos abundance analysis

Macrozoobenthos abundance at Stations 1,3 and 5 (industrial and port areas) was not found (0 ind/m^2), and the relative abundance value was 0% because, at stations 1,3 and 5, no macrozoobenthos species were found. The decrease in the abundance of macrozoobenthos is due to human activities which affect the abundance of macrozoobenthos such as industrial and shipping activities such as disposal of ship ballast water, industrial factory waste, and fishing boat shipping, which results in oil and heavy metal pollution, which will gradually settle to the sediment surface. The deposition of oil and heavy metals into sediments will affect the abundance of macrozoobenthos. The substrate is dominated by mud, but the mud is blackish brown, suspected to be caused by the deposition of oil, heavy metals, and other sources that enter these waters.

Rahayu et al.[6] said that the abundance values for each research station are closely related to differences in the availability of organic matter, substrates, and human activities in each water area.

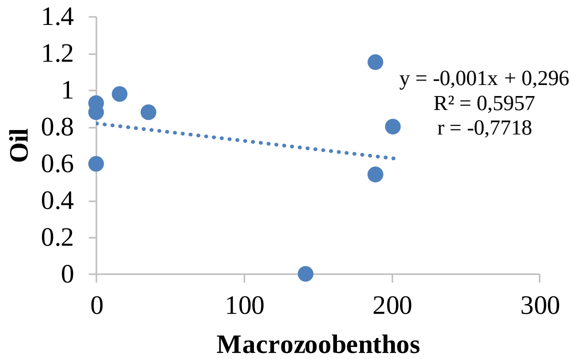

Figure 5. Relationship between oil concentration and macrozoobenthos abundance

The results of a simple linear regression test for oil with macrozoobenthos abundance in Figure 5 show that the equation Y=-0.001x + 0.296 is negative, meaning a negative relationship exists between macrozoobenthos abundance and oil concentration. The higher the oil concentration, the lower the abundance of macrozoobenthos. The coefficient of determination R2=0.5957 means that 59.75% of the abundance of macrozoobenthos is affected by oil concentration, and the rest is influenced by other environmental factors, for example, food reserves and the degree of adaptation of macrozoobenthos. Physical factors (temperature, waves, and type of substrate), chemical factors (dissolved oxygen and salinity), and biological factors (predation, competition, and food) affect the abundance of benthic animals.

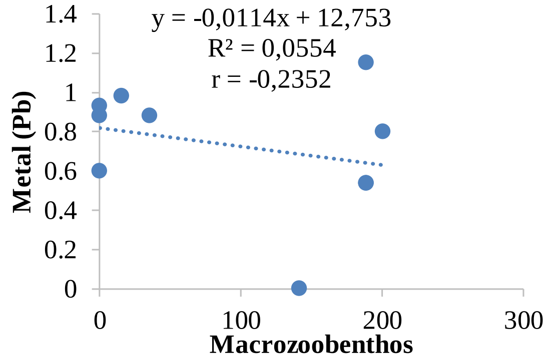

Figure 6. Relationship of Pb metal with macrozoobenthos

The correlation value on the relationship between oil concentration in sediments and its relationship with the abundance of macrozoobenthos around the coastal waters of the oil industrial area of Dumai City, Riau, is r = -0.7718, which means that the relationship is very strong.

The results of the linear regression analysis between heavy metals (Pb) and the abundance of macrozoobenthos in Figure 6 show the regression equation Y = -0.0114x + 12.753. From this equation, it can be seen that the relationship between heavy metals (Pb) is inversely proportional to macrozoobenthos. Based on the regression analysis, it showed a correlation value of -0.2352, indicating a very weak macrozoobenthos relationship. Then, based on the determinant coefficient, R2 shows a value of = -0.0554. This means only 5.53% of the effect of Pb metal on macrozoobenthos. The concentration of the heavy metal Pb and macrozoobenthos has a weak correlation inversely to the abundance of macrozoobenthos. This means that the higher the metal concentration, the more the abundance of macrozoobenthos will decrease.

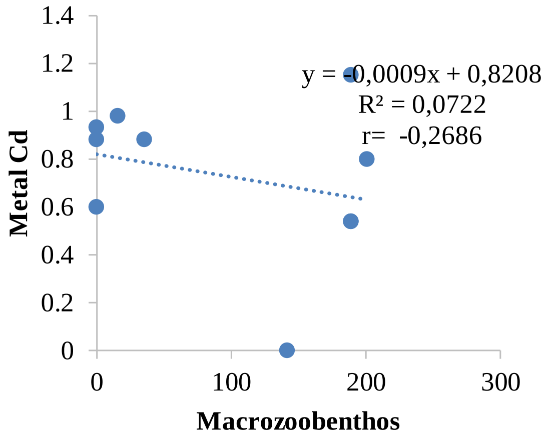

Figure 7. Relationship between Cd and macrozoobenthos

The results of the linear regression analysis between heavy metals (Cd) and the abundance of macrozoobenthos show that the determinant coefficient R2=0.0722 illustrates a negative relationship with the equation Y = -0.0114x + 12.753 (Figure 7). The correlation coefficient (r) obtained in the regression analysis for Pb metal is -0.2352. This shows that only 23.52% of the influence of the heavy metal Cd and the abundance of macrozoobenthos, while 76.48% is explained by other factors not observed in the study. Shows that the relationship between heavy metal concentrations is weak.

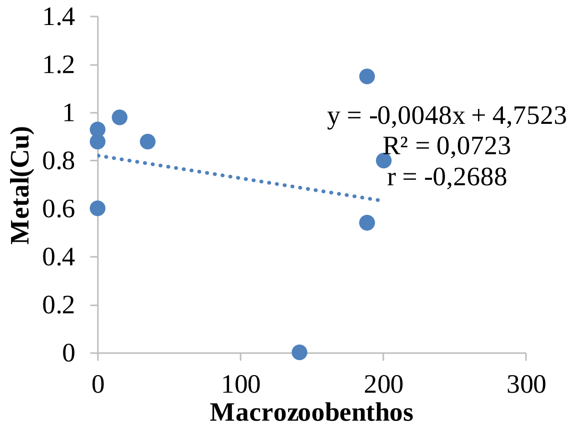

Figure 8. Relationship of Cu Metal with Macrozoobenthos

Based on the results of a simple linear regression of heavy metals (Cu) with the abundance of macrozoobenthos in Figure 8, the Determinant coefficient R2 = 0.0723 illustrates a negative relationship with the equation Y = -0.0048x + 4.7523. The correlation coefficient (r) obtained in the regression analysis for Pb.

4. CONCLUSION

The Oil concentration ranged from 0.07 – 0.35 while for Pb metal concentration 8.7 – 16.01(µg/g), Cu metal concentration 3.57 – 6.07(µg/g), Cd metal concentration 0, 54 - 0.98(µg/g). The abundance of macrozoobenthos around the oil industry waters of Dumai City, Riau, ranges from 200.73 ind/m^2 and a relative abundance value of 20.23%. The effect of oil and metals on macrozoobenthos diversity is negative and inversely, so it has a weak relationship. The increase in oil and metal concentrations will affect the abundance of macrozoobenthos and endanger organisms that live on the bottom of the waters.

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