Analysis of heavy metal of copper (Cu) and lead (Pb) at Siombak Lake North Sumatera Province

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Abstract. This research to knew heavy metal concentrate of copper (Cu) and lead (Pb) in the water and sediment. From this results showed indicated physics chemical parameter of Siombak Lake stilled in the normal range. The concentrations heavy metal copper (Cu) in the water column all the stations in sequence 0.525 mg/l, 0.54 mg/l, 0.51 mg/l and then the concentration heavy metal lead (Pb) in the water column 0.00165 mg/l, 0.0156 mg/l, 0.0148 mg/l. While heavy metal concentration of copper (Cu) in the sediment all the stations in sequence 2.68 mg/kg, 2.47 mg/kg and 21.54 mg/kg and then concentration of heavy metal lead (Pb) of 6.045 mg/kg, 7.17 mg/kg and 4.77 mg/kg. This result indicated the concentration of heavy metal copper and lead in the water column had exceeded the quality standard and concentration of copper and lead in sediment had not exceeded the quality standard.

1. Introduction
Siombak Lake is a tidal lake located on the coast of Medan city, Sumatera Utara. This lake was formed from the sand dredging construction of Belmera (Belawan-Medan- Tanjung Morawa) toll road in the late 1980s. Area of Siombak Lake reaches 28 ha with an average depth of 4.38 m at low tide and 6.25 m at high tide [1]. Siombak lake is very unique because of the flow of the river that enters the lake through the river.

In this research, it is suspected that the waters around Siombak Lake have experienced pollution due to the industry around the lake that discharges waste into water bodies so that it disrupts the life of the biota in these waters. In the area around the lake there are various community activities such as tourism, agriculture, animal husbandry, fisheries ponds and human settlements.

The research objective is to determine the concentration of copper and lead heavy metals in the water column and sediments in Siombak Lake and then to know the relationship of copper and lead heavy metal concentrations in the water and sediment columns.

2. Materials and methods

2.1. Study site
This research was conducted in June - July 2019 which included water of Siombak Lake. Sampling was carried out in 3 stations, sampling was repeated 2 times. The method used was purposive random sampling. The location map of the study can be seen in Figure 1.
2.2. Tools and materials
The tools used in this study are Secchi disk, global positioning system (GPS), vandorn water sampling, stationery, knife, water sample bottle, callipers, refractometer, pH meter, DO meter, thermometer, cool box, porcelain cup, hot plate, furnace, test tubes, measuring cups, analytical scales, Erlenmeyer, beaker glass, pipet volumetric, measuring flask, glass funnel, filter paper, stirrer and Atomic Absorption Spectrophotometer (AAS).

The materials used are water and substrate samples, hydrochloric acid (HCl) solution, choric acid (HCLO₄) concentrated Nitric acid (HNO₃), distilled water (used in the dilution process), standard Cu and Pb solutions, label paper and tissue.

2.3. Data analysis
Determination of heavy metal concentrations by direct methods for water samples and dry / gray methods for sediment samples. Measurement of heavy metals using AAS (Atomic Absorption Spectrophotometer), then calculated:

Concentration on water according to [2]

\[ C_{\text{real}} = \frac{K_{\text{AAS}} \times V_p}{V_s} \]  

Where:
- Actual C : Actual concentration (mg / l)
- K.AAS : Atomic Absorption Spectrophotometer Concentration (mg / l)
- Vp : Solvent volume (l)
- Vs : Sample Volume (L)

Concentrations in sediments according to [3]

\[ C_{\text{real}} = \frac{K_{\text{AAS}} \times V_p \times 10^6}{W_s} \]  

Where :
- Actual C : Actual concentration (mg / kg)
C.AAS : Atomic Absorption Spectrophotometer Concentration (mg / l)
Vp : Solvent volume (l)
WS : Sample Weight (mg)

3. Results and discussion
Parameters of the water observed in this study include the parameters of temperature, salinity, water of transparency, acidity (pH), dissolved oxygen (DO) waters. The results of observations of the physical and chemical conditions of the waters conducted during the study provide an overview of the condition of Siombak Lake Waters as shown in Table 1.

### Table 1. Average values of water physics and chemical parameters in Siombak Lake waters

| Parameter         | Unit          | Station I | Station II | Station III | Quality standard |
|-------------------|--------------|-----------|------------|-------------|------------------|
| Physics           |              |           |            |             |                  |
| Temperature       | °C           | 31.3      | 31.5       | 30.3        | 28 – 32 (c) *    |
| Salinity          | (%)          | 7         | 8          | 8           | 6 s/d 34 (e) *   |
| Water of Transparency | Cm   | 60        | 50         | 80          |                  |
| Chemistry         |              |           |            |             |                  |
| pH                | -            | 7.33      | 7.15       | 7.43        | 7 – 8.5 (d) *    |
| DO                | Mg/L         | 1.13      | 1.85       | 2.13        | > 5 *            |
| Pb                | Mg/L         | 0.0165    | 0.0156     | 0.0148      | 0.008 *          |
| Cu                | Mg/L         | 0.525     | 0.54       | 0.51        | 0.008 *          |

Source: Primary Data
Information: *) [4]

3.1. Concentrations of Copper (Cu) and Lead (Pb) in water
The highest average concentration of heavy metal copper (Cu) at station II is 0.54 mg / l and the lowest concentration at station III is 0.51 mg / l. Whereas the highest concentration of lead metal (Pb) at station I was 0.0165 mg / l and the lowest concentration at station III was 0.0148 mg / l (Figure 2).

![Figure 2. Average values of Cu and Pb in water](image)

3.2. Concentrations of Copper (Cu) and Lead (Pb) in sediment
The highest average concentration of heavy metal copper (Cu) at station III is 21.54 mg/kg and the lowest concentration at station II is 2.47 mg / kg. While the highest concentration of heavy metal lead (Pb) at station II is 7.17 mg / kg and lowest concentration at station III it is 4.77 mg / kg (Figure 3).
Figure 3. The average value of Cu and Pb in sediments

The temperature range is still in the normal category. This is in accordance with [5], the normal temperature for Indonesian waters is 28-30 °C. The temperature values obtained at each observation station in Siombak lake waters are still within tolerance for the life of aquatic biota in general. Temperature also affects the solubility of heavy metals that enter the waters. The higher the temperature of a heavy metal solubility waters will be higher. This is in accordance with [6], high temperatures in water will cause the rate of biodegradation carried out by aerobic decomposing bacteria to rise and can evaporate chemicals into the air. Which affects the high turbidity at station III because by high rainfall. High rainfall can cause erosion. The erosion comes from residential areas and agriculture that carry particles in the form of organic and inorganic materials. Siombak lake have salinity because of the tidal lake which gets a direct influence from the sea.

The degree of acidity (pH) is a measure of the concentration of hydrogen ions and indicates water conditions. Station III has a higher pH value than the other observation stations. The high pH value at station III can because by abundant algal growth. According to [7], to carry out photosynthesis, algae require carbon dioxide. The use of carbon dioxide by aquatic plants causes the equilibrium of the reaction to shift from bicarbonate to carbonate and from carbonate to hydroxide. This hydroxide ion will increase the pH value of water.

The high Water of transparency value can also because by the watershed of Siombak Lake as an outlet with strong currents. Strong movements of water can cause an increase in turbidity in the waters, namely the process of stirring the bottom sediments of the water which causes the removal of organic and inorganic materials.

Dissolved oxygen is oxygen gas dissolved in water. The results of DO measurements during observations show the highest DO concentration values are at station III. This can because by extreme environmental conditions such as large waves causing diffusion of oxygen from the air to the water column. In addition, because at the station II there are many aquatic plants. Photosynthesis by these aquatic plants can also produce dissolved oxygen.

3.3. Concentrations of Copper (Cu) and Lead (Pb) in Water

Within a certain time, the content of Cu metal in the waters will fluctuate, depending on natural conditions and the discharge from human activities containing Cu metal that enters the waters. The concentration of Cu metal in station II is higher than other observation stations. The location of this station is as an outlet of Siombak lake which is likely to accommodate the flow of waste due to erosion or pollution from along the lake edge where there is manufacturing activity or factory waste disposal. [8] even though the current is very slow or does not even exist at every other station, but because of the floating water will still be able to flow the material dissolved in it. The concentration of Cu metal in
station III is lower, this can be due to heavy metals having undergone sedimentation. The heavy metals will precipitate at pH above 6.

Pb metal is a metal that has very little presence on earth. Pb found in the earth’s crust amounts to 12.5 mg/kg [6] Cu metal, Pb metal also in water can occur naturally and also as a result of human activities.

The Pb metal concentration at Station I is higher than that of other observation stations. The high Pb metal concentration can be derived from activities on the lake, one of which is the waste disposal of motor boat fuel, boat paint, and community activities. Motorboats also use anti-corrosion paint which generally contains Pb [9]. At station III the Pb heavy metal is lower, it is also suspected that the heavy metal has sedimentation. In general, the measured Pb metal concentration at each station is relatively small, this is in accordance with [7], the solubility of lead in water is quite low resulting in levels relatively few.

3.4. Concentrations of Copper (Cu) and Lead (Pb) in sediment

The presence of dissolved heavy metals in sediments is very dependent on the good and bad conditions of the waters. Siombak Lake is an area that is prone to pollution. this is allegedly due to the rate of deposition or sedimentation experienced by heavy metals.

The high concentration of copper metal (Cu) at station III can because by pH and dissolved oxygen. At station III the pH value is higher than other observation stations so the heavy metal will settle. The temperature value at station III is lower than other observation stations which can also precipitate heavy metals. In addition, there are activities such as fishing boat vehicles and fishponds. [10], the increase in the solubility of Cu in waters can also originate from shipping lane activities. Station III has a copper metal concentration value (Cu) which is quite high compared to Station I, this is not only due to community activities such as fishery activities (ponds) and fishing vessel lines containing Cu, it can also be caused at the station higher rainfall which can carrying organic and inorganic particles (metals) due to erosion so that the sediment increases.

When compared with the [11] standard, the concentration of Cu in sediment at each station is classified as a target level which is <35 mg/kg and is not too dangerous for the environment and aquatic biota. However, these heavy metals can accumulate in sediment bodies of water so that the concentration will continue to increase [12].

The high concentration of lead metal (Pb) at Station II is due to the area around the disposal of factory and transportation waste. Burchet referred to by [13], states the source of metal contamination tends to be related to water transportation activities, household and agricultural waste disposal as well as on station I has a relatively high Pb concentration value compared to station III, this is due to the fact that the area is also close to population settlements. The lowest Pb heavy metal concentration measurements are at station III, although there are public transport routes and residential activities, heavy metals will be difficult to settle in sediments, this is because in these areas have stronger current movements. The high concentration of Pb metal in sediments at station III can also because by water pH and temperature. High pH water can precipitate heavy metals and low water temperatures also precipitate heavy metals.

4. Conclusion

From the results obtained chemical physics parameters in the Siombak Lake in the normal category. The concentration of heavy metal copper (Cu) in the water column at each station is 0.525 mg/l, 0.54 mg/l, 0.51 mg/l and concentration heavy metal of lead (Pb) at each station is 0.00165mg/l, 0.0156 mg/l, 0.0148 mg/L. The Concentration of Heavy metal copper (Cu) in sediment 2.68 mg/kg, 2.47 mg/kg, and 21.54 mg/kg and then concentration of heavy metal lead (Pb) at each station is 6.045 mg/kg, 7.17 mg/kg and 4.77 mg/kg. This result indicated the concentration of heavy metal copper (Cu) and lead (Pb) in the water column had not exceeded the quality standard and the concentration heavy metal copper (Cu) and lead (Pb) in the water column had exceeded the quality standard.

References
[1] Rangkuti A M 2017 Indonesian Coastal and Marine Ecosystems Jakarta Bumi Angkasa publisher
[2] SNI 01-3554-2006 How to Test Bottled Drinking Water  
[3] SNI 01-3751-2006 Determination of Iron (Fe) Metal Content by Wet and Dry Destruction by Atomic Absorption Spectrophotometry  
[4] Keputusan Menteri Lingkungan Hidup [Decree of the Minister of Environment] Number 51 of 2004 concerning Sea Water Quality Standards Deputy Minister of Environment, Policy and Institutional Affairs Environment Jakarta 11 page  
[5] Nontji A 2007 The Archipelago Sea Jakarta Publishers Djambatan  
[6] Darmono 2001 Environment and Pollution Jakarta Universitas Indonesia press  
[7] Effendi H 2003 Water Quality Study: For Water Resources and Environmental Management Yogyakarta Canisius Publisher  
[8] Setyowati S, Heru N, Erry W 2004 Kandungan Tembaga (Cu) dalam Enceng Gondok (Eichhornia crassipes, Solms) Perairan dan Sedimen Berdasarkan Tata Guna Lahan di Sekitar Sungai Banger Pekalongan [Copper (Cu) content in Eceng gondok (Eichhornia crassipes Solms), Water and Sediment Based on Land Use around the Banger Pekalongan River] Thesis Universitas Diponegoro  
[9] Siaka I M 2008 Correlation Between Sediment Depth at Benoa Harbor and Pb and Cu Heavy Metal Concentrations Journal of Chemistry 2 pp 61-70  
[10] Palar H 2004 Pollution and Toxicology of Heavy Metals Jakarta PT. Rineka Cipta publisher  
[11] CEDA 1997 Standards and guidelines for classifying the level of chemical contamination of dredged materials for disposal (mg/kg dry weight) Non Technical Summary for Berth Environmental Statement for Port of Southampton Further Information  
[12] Begum A, Krishna H, Irfanulla K 2009 Analysis of Heavy Metals in Water, Sediments and Fish Samples of Madivala Lakes of Bangalore, Karnataka Chemical Technical Research 1 2 pp 245-49  
[13] Makmur R, Emiryati, Ode L 2013 Kandungan Logam Berat Timbal (Pb) pada Sedimen di Wilayah Mangrove Teluk Kendari [Lead Heavy Metal (Pb) Content in Sediments in the Mangrove Region of Kendari Bay Waters] Sea Mina 2 6