The heavy metal of cuprum (Cu) and lead(Pb) content in *Avicennia marina* and *Rhizophora mucranata*

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**Abstract.** Various types of mangrove plants found in coastal areas have a specific strategy to deal with pollution conditions from heavy metals. One of the several strategies used by mangroves is by accumulating various kinds of heavy metals in various parts of the tree. Most species of mangroves such as *Avicennia marina*, *Rhizophora mucronata*, *Sonneratia caseolaris*, *Bruguiera gymnorrhiza* and others apply this strategy. *Avicennia marina* and *Rhizophora mucronata* are pioneer mangrove species that are able to accumulate heavy metals in the roots, stems and leaves. These species are also act as indicator of the sustainability of mangrove ecosystems. The presence of heavy metals will reduce water quality subsequently will decline the overall condition of the ecosystem. How big is the ability of *Avicennia marina* and *Rhizophora mucronata* mangroves to absorb copper (Cu) and Lead (Pb) metals and how the conditions of the aquatic environment surrounding mangroves during heavy metal stress are need to be studied. Analysis of Cu and Pb heavy metals contents were carried out at the Chemistry Laboratory of the USU Medan Pharmacy Faculty. The mangrove species used for the analysis of Cu and Pb heavy metals were *A.marina* and *R. mucronata* that grew in Muara Sungai coastal areas from April to August 2018. The results showed heavy metal content of Cu was greater than Pb in wire roots, stems and leaves of *A. marina* trees. Analysis of roots, leaves and bark of *R. mucronata* also found greater content of Cu heavy metals than Pb.

**1. Introduction**

The mangrove ecosystem area decreases from year to year as a result of the land conversion into residential, industrial, plantation, road facilities beside pollution by industrial waste. Sustainable industrial development causes a variety of problems. One of several problems due to the existence of industry is waste that comes from various stages of activity. Industrial waste is mostly disposed of through rivers and subsequently empties into the sea. At the mouth of the river there are several ecosystems that will be affected by industrial pollution including mangrove ecosystems consisting of various types of mangrove plants. Pollution level that exceeds the threshold may cause mortality of the mangroves. Reduced mangrove ecosystems will be detrimental to humans, especially people living in the coastal region. Mangrove ecosystems that should act as a deterrent to abrasion, intrusion and reduce the impact of the Tsunami cannot fully play their role due to pollution.
Belawan waters as one of the coastal areas is an area filled with various activities in the form of settlements, agriculture, shipping, fishing, ports, and industry. Industries that are not equipped with waste management systems will produce waste containing mercury (Hg), iron (Fe), manganese (Mn), copper (Cu), lead (Pb), zinc (Zn), chromium (Cr), and nickel (Ni). Previous research in Belawan waters, Directorate General P2SDKP [1], showed the content of heavy metals dissolved in Cu and Zn types that have exceeded the threshold (quality standard) of sea water. The high heavy metal content of Cu and Zn is thought to be due to waste disposal from dozens of industries located around the Belawan River and Deli River watersheds. Based on data from District environmental impact management agency (Bapedalda) of the North Sumatra Province [2] in the 2003, North Sumatra Provincial Environmental Status reported there were 57 industries located along the Deli River and 22 industries along the Belawan River. The industries include cooking oil processing, metal processing, plastic manufacturing, gluing of plywood, textiles, paints, dry batteries, dolomite fertilizers, metal coatings, and others.

Mangrove forests are a type of forests that have special characteristics because of the ability to accumulate heavy metals in the environment that has been affected by toxins. *Avicennia marina* is a mangrove species that can be used to accumulate pollutant metals. According to Mukhtasar [3], *A. marina* can be used as a biological indicator of the environment contaminated with heavy metals, especially Cu, Pb, and Zn through periodic monitoring. Heavy metals Cu and Pb cannot be decomposed by natural processes thus potentially endanger human health. According to Cheng [4] Cu and Pb concentration have been increased in the water. One of the mechanisms that occurs in *A. marina* and *R. mucronata* to reduce heavy metal toxicity is to store a lot of water so that it can dilute the concentration of heavy metals in body tissues. *A. marina* and *R. mucronata* can be developed to control heavy metal pollution in coastal areas.

2. Materials and methods

2.1 Time and place

Determination of heavy metals Cu and Pb were carried out at the USU Pharmaceutical Laboratory in Medan. Samples for the analysis of Cu and Pb heavy metals are *A. marina* and *R. mucronata* plants that grow in Muara Sungai in the coastal area of Belawan. This area is known as Mangrove Forest which is suspected of being contaminated with heavy metals because it is close to the industry. This research was conducted for 8 months (April to August 2018).

2.2 Materials and method

The equipment used in this study consisted of: distilled water bottles, Erlenmeyer flasks, drop pipettes, furnaces, furnaces and filter paper, universal pH, porcelain cups, measuring cups, beaker cups, measuring flasks, thermometers, hand refractometers, hot plates (heaters), sample containers, analytic scales, and atomic absorption spectrophotometers. The materials used for this study were: concentrated HNO₃ solution, distilled water, HClO₄ solution, Cu and Pb standard solution, *A. marina* root samples consisting of breath roots and wire roots, *A. marina* leaves consisting of young and old leaves, sediment samples, and sea water samples.

2.2.1 Research procedure

a. Sampling

Sampling was carried out by following the coastline parallel transect pathway proportionally. The root and leaf samples were taken from *A. marina* and *R. mucronata* trees with stem sizes ranging from 28-35 cm and height ranging from 4-6 m. The root samples were the root of the breath (*pneumatophora*) and of the wire (which buried in the sediment), while young leaves were taken from the shoots and old leaves were from the base of the twigs. Concentration of heavy metals in surface and sedimentary water (± 30 cm depth) and water quality parameters, such as air temperature, water temperature, water pH, and salinity (in situ) were measured on 6 sampling points from the transect line for supporting data.
b. Sample preparation of root, leaf and sediment

Samples of roots, leaves, and sediments were homogenized by composing samples from each six sampling points. For preparation, roots and leaves sample were cut into small pieces before being mashed, while the sediment were mashed directly. After that, they were dried in an oven of 105 °C for 12 hours to remove water content and obtain a constant weight.

The samples of roots, leaves, and sediments was each weighed as much as 5 grams and then put in a furnace at a temperature of 600-650 °C (ignition) for 3-4 hours. After that, the samples were dissolved by 20 ml of concentrated HNO$_3$ and 10 ml of HC1O$_4$. Then distilled water was added to a volume of 50 ml. The solution was heated on a hot plate until boiling and the volume was reduced by 30 ml. If there was no repeat mist, 20 ml of HNO$_3$ and 10 ml of HCLO$_4$ was added to the solution, then reheated until mist was occurred. After fog occurred, the solution was added with distilled water so that the sample volume becomes 50 ml, and then cooled at room temperature. The cooled solution was filtered by the water phase with filter paper. The solution obtained is ready to be analyzed using AAS.

c. Water sample preparation

Seawater was measured 100 ml, and then 10 ml of concentrated HNO$_3$ was added. After that, the solution was preheated in a hot plate until the volume is reduced by 30 ml. Distilled water was added until the volume becomes 100 ml, then cooled at room temperature. The solution was filtered by the water phase with filter paper. The solution obtained was then ready to be analyzed using AAS.

d. Cu and Pb metal standard solutions preparation

Cu and Pb metals were weighed 1 g each, then dissolved with distilled water in a 1000 ml flask to obtain a stock solution of 1000 ppm. A total of 10 ml of the stock was pipetted and then put into a flask and 100 mL distilled water was added to obtain a 100 ppm solution. This solution was then diluted to 10 ppm solution A total of 5 replications of solutions with a concentration of 10 ppm were made to facilitate the preparation of the next standard solution. To get a standard solution with a concentration of 0.2; 0.4; 0.6; 0.8 and 1 ppm, pipetted as much as 2 ml, 4 ml, 6 ml, 8 ml and 10 ml from a solution of 10 ppm then put into respective measuring flask then distilled water was added to each flask to a final volume of 100 ml.

e. Working principle of Atomic Absorption Spectrophotometer (AAS)

AAS tools are arranged in advance according to the instructions in the manual of the tool. Then it was calibrated with a standard curve of each Cu and Pb metal with a concentration of 0; 0.2; 0.4; 0.6; 0.8; and 1 ppm. Each sample absorbance was then measured.

2.3. Data analysis

2.3.1. Concentration of heavy metal. To get the concentration value of the heavy metal analyzed, the formula is used:

$$Actual\ K\ (mg/kg) = \frac{K_{AAS}\ (mg/l) \times Vol.Solvent\ (l)}{Sample\ weight\ (mg)}$$

(1)

2.3.2. Bioconcentration Factor (BCF). After the content of heavy metals in water was known, the data was used to calculate the ability of A. marina to accumulate Cu and Pb through the bioconcentration factor (BCF) level with the formula:

$$BCF\ Cu/Pb = \frac{[Heavy\ metal\ Cu/Pb]_{plant}}{[Heavy\ metal\ Cu/Pb]_{water}}$$

(2)

if BCF value > 1000= high accumulation ability

1000 > BCF > 250= moderate accumulation capability

BCF < 250= low accumulation ability

2.3.3. Descriptive analysis. The data obtained were analyzed descriptively in accordance with the standard quality of Taut water for the link biota contained in the Decree of the State Minister of
Environment (KepMeneg LH) No. 51 of 2004. Since the quality standard for heavy metals in sludge or sediment in Indonesia has not been established, quality standards issued by International Dredging Companies (IADC) / Central Dredging Association (CEDA) Association in 1997 concerning tolerable metal content was used as reference.

2.4. Water quality data
Water quality data was carried out by measuring water quality parameters, such as air temperature, water temperature, water pH, and salinity (insitu) at the six points.

3. Results

3.1. Heavy metals Cu and Pb content in wire roots, stem roots, leaves and bark of A. marina
In average, A. marina contained Cu higher than heavy metal Pb. This was found in all respective sample part of the plant. For example, Cu heavy metal content in the A. marina wire root, was 12.990 mg/kg while Pb was averaged of 7.351 mg / kg. More detailed data on observations are presented in table 1.

Table 1. Average of heavy metals of Cu and Pb in wire roots, pneumatophore, leaves and bark stems of A. marina.

| Samples            | Cu (mg/kg) | Pb (mg/kg) |
|--------------------|------------|------------|
|                    | Station I  | Station II | Station I | Station II |
| Root Wire          | 12.990     | 10.899     | 7.351     | 7.662      |
| Pneumatophore      | 10.016     | 10.756     | 4.668     | 4.256      |
| Leaves             | 6.165      | 8.566      | 3.372     | 4.567      |
| Bark Stems         | 7.536      | 7.427      | 2.230     | 3.568      |

3.2. Heavy metals Cu and Pb content in wire roots, leaves and skin of stems of R. mucronata
Cu accumulation content in the bark, roots and leaves was found higher than that of Pb of R. mucronata. As an example the roots analysis shown the levels of Cu heavy metals were 4.033 and 3.740 g/kg while the levels of Pb heavy metals were 0.884 and 0.799 g/kg. In detail, the results of the analysis of the average heavy metal content in the stem, roots and leaves of R. mucronata are presented in table 2.

Table 2. Average content of Cu and Pb heavy metals in roots, leaves and bark stems of R. mucronata.

| Samples            | Cu (g/kg) | Pb (g/kg) |
|--------------------|-----------|-----------|
|                    | Station I | Station II | Station I | Station II |
| Root               | 4.033     | 3.740     | 0.884     | 0.799      |
| Leaves             | 6.631     | 6.697     | 4.1356    | 1.260      |
| Bark Stems         | 7.357     | 9.213     | 0.115     | 2.380      |

3.3. Heavy metals of Cu and Pb in water and sediment in the growing location of A. marina
According to the analysis, water sample taken from mangrove forest grown with A. marina contains more Cu than Pb. As for the sediment, the average level of Pb tends to be higher than the average level of Cu. In detail the results of the analysis of the average heavy metal content in water and sediment in the two sampling stations are presented in table 3.

3.4. Cu and Pb heavy metal content in water and sediments at R. mucronata growing sites
From two sampling locations, the average of heavy metal content of Cu showed higher yields than that of Pb. The averages of heavy metal Cu in water were 0.0439 mg/l and 0.0496 mg/l while the averages of heavy metals Pb were 0.0137 mg/l and 0.0157 mg/l. Whereas for sediments analysis of heavy metal content in the Fishermen's mangrove forest area showed that the heavy metal content of Pb was higher.
compared to heavy metal Cu. The averages of heavy metal content of Cu were 0.9004 mg/kg and 0.7760 while Pb content levels were 0.0583 mg/kg and 0.0903 mg/kg. In detail the results of the analysis of the average of heavy metal content in water and sediment in the two sampling stations are presented in table 4.

**Table 3. Average of heavy metals of Cu and Pb level in water and sediment A. marina.**

| Samples      | Cu (mg/kg) | Pb (mg/kg) | Quality Standard                                      |
|--------------|------------|------------|-------------------------------------------------------|
| Water (mg/L) | Stasiun I  | Stasiun II | Stasiun I    | Stasiun II   | KEPMEN KLH No. 51 Tahun 2004 (0.008 mg/l)       |
|              | 0.3163     | 0.1365     | 0.2655       | 0.1288       | IADC/CEDA 1997 Cu (600 mg/kg)                     |
| Sediment (mg/kg) | 6.6210  | 5.6938     | 5.1356       | 5.5213       | Pb (1000 mg/kg)                                   |

**Table 4. Average content of Cu and Pb heavy metals in water and sediment of R. mucronata.**

| Samples      | Cu (mg/kg) | Pb (mg/kg) | Quality Standard                                      |
|--------------|------------|------------|-------------------------------------------------------|
| Water (mg/L) | Stasiun I  | Stasiun II | Stasiun I    | Stasiun II   | KEPMEN KLH No. 51 Tahun 2004 (0.008 mg/l)       |
|              | 0.0539     | 0.0496     | 0.0227       | 0.0157       | IADC/CEDA 1997 Cu (600 mg/kg)                     |
| Sediment (mg/kg) | 0.9105 | 0.8760     | 0.0583       | 0.0903       | Pb (1000 mg/kg)                                   |

**3.5. Bioconcentration Factors (BCF) to assess A. marina’s ability in accumulating heavy metals Cu and Pb**

Based on the bioconcentration factor (BCF) value, the highest BCF value was obtained for Cu metal, which was 358.707 ppm and the lowest BCF value was 69.966 ppm for Pb metal. Bioconcentration of Cu and Pb factor values in two observation stations are presented in table 5.

**Table 5. Value of Cu and Pb Bioconcentration Factors (BCF) in Belawan.**

| Station | Cu Concentration | BCF Cu (l/kg) | Pb Concentration | BCF Pb (l/kg) |
|---------|------------------|----------------|------------------|---------------|
|         | Sample = total roots, bark and leaves (mg/kg) | Water (l/kg)   | Sample = total roots, bark and leaves (mg/kg) | Water (l/kg) |
| I       | 41.707           | 0.1163         | 358.707          | 17.621        | 0.255          | 69.966        |
| II      | 42.648           | 0.1265         | 337.138          | 20.165        | 0.168          | 120.029       |

**3.6. Condition of aquatic environment (air temperature, water temperature, water pH and salinity)**

Aquatic environmental data obtained showed the difference between station I (A. marina) and station II (R. mucronata). The result showed that in all parameters taken including air and water temperature, water pH, pH of the highest sediment and salinity, the mangrove forest of fishermen's village where R. mucronata were located were higher than that of the station over grown with A. marina. Final data on air temperature, water temperature, water pH, sediment pH and salinity of the two stations are presented in table 6.
Meanwhile, come the base with a fairly large size, thickness and co.

Cu content at station I was higher than the top of the plant through the transporting tissue (xylem and phloem) to other parts of the plant.

penetrated the root endodermis, surface. Second are usually taken by the roots (rhizosphere) in several ways depending on plant species. Water

metals Cu and Pb in wire roots, stem roots, leaves and bark of A. marina

The measurement at both stations grown with A. marina obtained heavy metal content of Cu was higher than that of heavy metals Pb. The content of Cu and Pb heavy metals in the roots of A. marina tree wire showed higher yields compared to Cu and Pb content in the roots of A. marina tree pegs. At station I the average of Cu content it the root of A. marina tree wire was about 12.990 mg/kg and the average Pb content was around 7.351 mg/kg while station II average of Cu content in the roots of A. marina tree wire was around 10.899 mg/kg and the average Pb content was around 7.662 mg/kg. On the other side, the peg, leaf and bark roots of A. marina also contained higher Cu than the level of heavy metal Pb. A higher Pb heavy metal content at station I was influenced by higher activities in the form of ports, industries, settlement activities which became the source of Pb heavy metals in mangrove roots while at station II these transportation and industrial activities tended to decrease. This causes the wire roots to more dominantly absorb heavy metals directly from sediments at the bottom of the waters. Aksornkoae [5] stated that the texture and size of sediment affect the amount of metal content of waters. The heavy metal content of Pb in the root of the post at station I was lower than that of station II because of the vertical peg root is absorbing heavy metals in the form of vehicle smoke carried by rainwater and non-naturally was due to more frequent transportation activities at station II so that the absorption of heavy metals was directly into the mangrove plant network through the roots. Meanwhile garbage were building up on the flow of the water surface at the station I so that the root of the stake is difficult to absorb heavy metals. Hutabarat and Evans [6] stated that the mangrove area will become a waste accumulation area, especially if pollutants that enter the estuary environment exceed natural purification capabilities.

4.2. Heavy metals Cu and Pb in roots, leaves and skin of stems of R. mucronata

In averages, Cu content was found higher compared to Pb accumulation in the roots, bark and leaves of R. mucronata. Furthermore, the lowest heavy metals level was detected in the roots, with the exception of Pb content in station II. This is because the root does not store the substances that have been absorbed from the soil for a long time and then translocated to the stem, leaves and fruit. Priyanto and Prayitno [7], stated that the absorption and accumulation of heavy metals by plants are divided into three processes, first, absorption by the roots thus plants can absorb metal, then the metal must be circulated around the roots (rhizosphere) in several ways depending on plant species. Water-soluble compounds are usually taken by roots along with water while hydrophobic compounds are absorbed by the root surface. Second process is metal translocation from roots to other parts of plants. After the metal has penetrated the root endodermis, the metal or other foreign compounds follow the transpiration flow to the top of the plant through the transporting tissue (xylem and phloem) to other parts of the plant. Third, the metal is localized inside plant cells and tissues to prevent the metal from inhibiting plant metabolism. Cu content at station I was higher than that of station II due to the comparison between old leaves (at the base with a fairly large size, thickness and color of dark green leaves) and young leaves (on shoots,
small size, not too thick and the color of light green leaves) composted. Leaves on station I tended to be yellowish due to damage of chloroplasts resulted in high accumulation of heavy metals while leaf II station looked green. Singh [8] stated that the metal content of young leaves is less than that of old leaves. Samples of old and young leaves were not differentiated for analysis in order to detect the heavy metal content of the leaves in general. Cu and Pb elements absorption into plant tissues is carried out through xylem to all parts of the plant to the leaves or by attaching Cu and Pb particles to the leaves and into the tissue through stomata [9]. Pb content at station I was higher than that of station II because of leaf size at station I was wider than leaf size in station II so that the metal easily enters the leaf tissue through a passive absorption process when the leaf surface area is wide. Active metal absorption occurs at the root surface which then accumulates in the lower epidermis of the leaf. Dahlan et al. [9] stated that the rough, hairy and wide leaf surface would be easier to capture particles than the smooth, hairless and narrow leaf surface. Moreover, Soemirat [10] stated that younger leaves are more difficult to absorb than older leaves. In addition, generally plants accumulate excess ions in old leaves then followed by falling off. The heavy metal content of Cu in the bark of station I was much less than that of station II. This is due to differences in tree trunk diameter at both stations. The range of tree diameters in station I was 10.2 cm to 13.8 cm while the range of trees in station II was 17.5 cm to 22.6 cm. The difference in tree trunk diameter determines the number of heavy metals and other substances accumulated in the tree. The greater the diameter of the tree trunk, the greater the ability of the tree to accumulate heavy metals and other substances. Lakitan [11] stated that nutrient uptake is affected by, among others; a) water factor to dissolve nutrients or mineral substances so that it is easy to absorb water and b) root absorption, the pressure of each plant is different. The amount of root pressure is affected by the size of the plant. Evidence of the pressure/power of absorption that occurs at this root is on the trunk that is cut so the water looks stagnant on the surface of the stump, c) suction power due to the evaporation (transpiration) of water from the leaves which amount is directly proportional to the area of evaporation (evaporation intensity). The content of heavy metals Cu and Pb was found high in the bark of plants because the stem has a longer time to accumulate heavy metals Cu and Pb stored in the network. Arisandy [12] stated that the stem has a longer time to accumulate heavy metal Lead (Pb) stored in its tissue than in leaves or fruit. In addition, root has a high level of heavy metal because it is directly contacted with the polluted sediment, then translocated to other parts.

4.3. Heavy metals Cu and Pb in water and sediment in the growing location of A. marina

From the measurement results of Cu and Pb level in water at both sampling stations, it can be seen that Cu heavy metal content has a higher concentration than Pb. Measurement of Cu level at station I and II resulted an average of 0.3163 mg/L and 0.1365 mg/L, respectively while Pb content at station I and II obtained an average of 0.2655 mg/L and 0.1288 mg/L, respectively. This is due to industrial are allocated above the sampling location at station I mainly produces Cu as waste while the private and agricultural oil palm plantation area owned by the community at station II. Sea transportation activities also contribute to heavy metals Cu in the environment but in not too large dose. Improper administration of fertilizer dosage in agricultural practices can also cause Cu metal pollution in the environment. Both sampling stations, especially the station I, are area contaminated by industrial activities. At the station I, sea transportation activities were small but industrial activities were very large, namely in the Medan Industrial Area located above the station I sampling site. According to KEPMEN KLH No. 51 of 2004 the content of Cu and Pb heavy metals in both stations has exceeded the limit set for sea water quality standards which is 0.008 L/kg. Pb content at station I was higher than that of station II allegedly because of the different sampling time and the intensive sea transportation activities at station II. Hoshika et al. [13] stated that current patterns affect the presence of heavy metals in water because the water currents can cause heavy metals dissolved in water from the surface in all directions.

The heavy metal content of Cu in the sediment at station I was higher than that of station II because at station I there were many industrial activities then station II it was compared to control. According to IADC / CEDA [14] the level of Cu in the sediment at both stations is still below threshold which is 600 mg/kg thus Cu pollution on both stations can still be tolerated. Pb concentration at station I was averaged of 5.135 mg/kg, while at station II was averaged of 5.121 mg/kg. According to IADC / CEDA [14], tolerance limit for Pb is not exceeded 1000 mg/kg therefore Pb heavy metal content in sediments
at both stations has exceeded the tolerance limit. Heavy metal content in sediment is higher than the heavy metal content in water due to sedimentation of heavy metal content in high water. Heavy metals have properties that are easy to bind organic matter and settle in the bottom of the waters and bind to sedimentary particles causing a higher heavy metal concentration in sediment.

4.4. Cu and Pb heavy metal content in water and sediments at R. mucronata growing sites

The average of Cu content in water at station I was 0.0539 mg/l while at station II, the level detected was an average of 0.0496 mg/l. On the other hand, the average of Pb level in water at station I was 0.0227 mg/l while at station II was an average of 0.0157 mg/l. Cu content at station I was lower than that of station II due to the type of water in the station II research area is semi closed that is protected by islands around the village so that water circulation occurs vertically will distribute heavy metal elements evenly in the waters along with pollution from oil palm plantations around the research location. Pb content in water at station I was higher than that of station II where more input from waste containing Pb comes from vehicles, mining, industry and other activities. Darmono [15] stated that pollutants enter water bodies through various methods such as industrial waste, agriculture, domestic and urban, and others. The analysis of heavy metal content in sediments at station I obtained Cu concentration with an average of 0.9105 mg/kg and Pb with an average of 0.0583 mg/kg, while station II contained Cu with a heavy metal content 0.8760 mg/kg and Pb heavy metal content with an average of 0.0903 mg/kg. The Cu concentration in sediment at station I had a higher concentration than station II. This is influenced by current velocity, depth and width of the river. Current velocity can also affect sedimentary texture, in strong currents, sediment is more dominated by coarse particles so that accumulating low metals such as sand while for slow currents is dominated by finer mud particles which easily absorb metals where the flow will be faster when the waters become narrower and shallow. The current velocity at station I tended to be slower than station II causing heavy metals to be easily absorbed by plants. The measurement results of Pb heavy metals in sediments at station showed lower concentration than station II. This is due to the high rate of erosion on the soil surface at station II carried into the river body subsequently the water inside the river is thought to contain heavy metals because it is carried by the estuary current to the open sea. While there is a suspension of Pb metal ions found in the banks of the river at station I and collected in the stream of small creeks in that location. According to Hutagalung [16], settling heavy metals together with suspended solids will affect the quality of sediment at the bottom of the waters and also the surrounding waters.

4.5. Bioconcentration Factors (BCF) to assess A. Marina's ability in accumulating heavy metals Cu and Pb

Based on the calculation of the bioconcentration factor (BCF) value, Cu metal had the highest BCF value, 358.707 ppm and the lowest BCF value was 69.966 ppm for Pb metal in station I while the bioconcentration value at station II was 337,138 ppm and 120,029 ppm for Cu and Pb, respectively. Levels of bioconcentration factors of a mangrove ecosystem are caused by heavy metal elements stored in the form of organic compounds in plant tissues. The concentration of Cu metal in waters affects the biomagnifications process. This is in accordance with Darmono [15] that if there is an increase in the solubility of Cu in the sea waters, the bio magnification of aquatic biota occurs beyond the specified threshold value. The bio concentration factor for Pb heavy metals at stations I and II were respectively 69.966 ppm and 120.029 ppm are categorized as low. This is due to chemical processes such as complexing and redox reaction systems which can affect the bio concentration factor of Pb at both stations where the precipitation and/or sedimentation of Pb metal at the bottom of the waters occur.

4.6. Condition of aquatic environment (air temperature, water temperature, water pH and salinity)

The results of measurements of the environmental quality of the waters at the time of sampling at Station I obtained an average air temperature of 27.33 °C and Station II at 25.33 °C. The air temperature at station I was higher than station II because the environmental conditions at station I are less rare for mangroves, so the light penetration is more optimal, while station II was shady and tight so the environment has a lower temperature. Based on the Decree of the Minister of Environment No. 51 of
2004 concerning sea water quality standards for biota is ranging from 28-34 °C therefore air temperature at the sampling sites were still below the threshold of the standard set. The temperature of the water at the time of sampling at station I was obtained with an average of 25.5 °C while the water temperature at station II was obtained at an average of 24.3 °C. Water temperature at station I was higher than station II. This is due to differences in the intensity of light entering the water and the amount of mangrove cover vegetation affected the chemical, physical and biological processes of water bodies. Kusmana [17] stated that sea water temperatures range from -2 °C to 30 °C consequently water temperature in both research locations are still in a good range.

Water pH at station I obtained a value of 7 and at station II was 8. The degree of acidity in both stations is categorized as neutral and still within the range of sea water quality standards (Minister of Environment Decree No. 51 of 2004) which is ranged from 7-8.5 that still supports the life of the organisms that are in it. This is because most research stations are estuary areas that have changes in the circulation of water from alkaline (pH> 7) and towards acid (pH <7) occur equally in the waters. This degree of acidity affects the high and low concentrations of heavy metals. Connell and Miller [18] stated that the increase in pH in the waters will be followed by a decrease in the solubility of heavy metals, so that heavy metals concentration will increase.

5. Conclusions
From the research that has been done, some conclusions can be drawn as follows:

1. Heavy metal content of Cu is greater than the level of heavy metals Pb in both A. marina and R. mucronata trees.
2. The quality of Belawan waters where grown with A. marina and R. mucronata is still at the threshold that does not endanger the two vegetations.

6. Recommendations
From the research that has been carried out, it can be suggested that further research is needed to determine the levels of Cu and Pb heavy metals in other environments in Belawan.

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