Analysis of mercury bioaccumulation on bivalve species in Belawan River

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Abstract. Belawan river is an important river in Medan and despite having many activities conducted by the river, the waste produced from such activities are often disposed directly to the water body, causing negative effects to the surrounding environments as well as water biota such as bivalve species. The analysis was done by measuring water quality which was temperature, light penetration, light intensity, flow velocity, river depth, pH, dissolved oxygen (DO), Biological Oxygen Demand (BOD₅), as well as mercury level measurement on water flow, substrate, and bivalve species. The measurement was done in accordance with the Government Regulations Number 82 of 2001 concerning water quality management and water pollution control, as well as the Decision of the Indonesian Minister of Living Environment Number 51 of 2004 about quality standards of water biota. Results showed that the mercury (Hg) level content was 0.00052 while in the river sediment was 0.00088, which was still below the environmental quality standards. The mercury level content in blood clam (Anadara granosa) was 0.00024, while in common geloina (Anadara geloinaerosa) was 0.00026, and in antique ark (Anadara antiquata) was 0.00095 which was still below the quality level and thus can still be consumed.

1. Introduction
Belawan River is an important river in Medan that flows through many places such as industrial sites, human settlement, aquaculture, as well as electric steam and hydroelectric power plant. Despite having that many activities conducted by the river, the waste produced from such activities are often disposed directly to the water body, causing negative effects to the surrounding environments as well as water biota living in it. The water biota which is rare to find in Belawan river flow is fish and bivalve (benthic) species. As a proof of the industrial pollution happened along the Belawan watershed, the local fishermen can no longer catch a fish and bivalves on the estuary site nor Belawan sea, in which they have to move to an unpolluted spot.
Water biotas that are drawing the public attention lately for their ability as a bioindicator of water quality in water ecosystem are bivalve (benthic) species. Bivalves are water organism species that have a very important role in fisheries. The change in water quality is often related to the water potency in terms of its density. The existence of water biota in a water flow can give us information of the water condition as they are very dependant to the tolerance and sensitivity towards environmental change. Water biota can be used as an indication to evaluate the water quality in a water body.

Bioaccumulation of heavy metal inside the water biota, according to Manahan [1], can be affected by many factors, such as: (1) heavy metal content in the water, (2) heavy metal content in the sediment, (3) pH level of the water and sediment, (4) the level of pollution in the form of Chemical Oxygen Demand (COD), (5) the level of sulfur in the water and sediment, (6) type of water organisms, (7) age and body weight, and (8) life phase (egg, larvae). Therefore, analyzing several factors affecting the heavy metal accumulation in the body of the water biota can be important, so that an action to minimize the influence of that factor may be taken in order to prevent the chance of human intoxication for consuming foods from sea water.

In the case of mercury intoxication, it will be accumulated in the tissues and can never be secreted. The high level of mercury in human body can cause several serious negative effects, such as: (1) inhibiting enzyme activities, resulting in disturbance on body metabolism, (2) abnormality in human chromosome (gene), (3) inhibiting infant development, (4) decreases women fertility, (5) inhibiting spermatogenesis, (6) decreases conductivity of peripheral nerves, (7) inhibiting hemoglobin production, (8) causes renal damage, (9) causes anemia, (10) causes head-swelling (encephalopathy), and (11) causes mental and behavior disturbance[2].

The aim of this study was to obtain bivalve species and to know the bioaccumulation level of mercury of bivalve species (according to National Standardization concerning fishery products and their processed products SNI01-3518-1994, as well as in water sediment and water quality of Belawan river according to environmental quality standards (Government Regulations Number 82 of 2001 concerning water quality management and water pollution control) so that the action of Belawan river management can be taken.

2. Materials and Methods
Sample collection was done from August to September 2016. Five sampling locations were picked based on the activities conducted by the local communities with three repetitions each, from upstream to the downstream of Belawan river.

| Table 1. Location of sample collection and local communities activities |
|-------------------------|------------------|
| Station 1 | Salam Tani Village, Kecamatan Pancur Batu, Kabupaten Deli Serdang. | No activities (Upstream) Control |
| Station 2 | Sunggal kanan Village, Kecamatan Sunggal, Kabupaten Deli serdang | Domestic settlements |
| Station 3 | Kelurahan Kampung Lalong, kecamatan Sunggal, Kabupaten Deli Serdang | Market, Hotel |
| Station 4 | Kelambir Village, Kecamatan Hamparan Perak, Kabupaten Deli Serdang. | Soya and paper industries |
| Station 5 | Sicanang Village, Kecamatan Medan Belawan, Kota Medan Belawan. | Downstream |
2.1. Water Quality Sample Collection

Water quality sample is collected using the methods on the table below:

| No | Water Quality Parameter       | Instruments                | Measurement Location |
|----|------------------------------|----------------------------|----------------------|
| 1. | Temperature                  | Thermometer                | In-situ              |
| 2. | Light Penetration            | Secchi disk                | In-situ              |
| 3. | Light Intensity              | Luxmeter                   | In-situ              |
| 4. | Stream velocity (s/m)        | Stopwatch                  | In-situ              |
| 5. | Depth (m)                    | Meter                      | In-situ              |
| 6. | pH                           | pHmeter                    | In-situ              |
| 7. | DO (Dissolved Oxygen)        | Winkler method             | In-situ              |
| 8. | BOD                          | Winkler and incubation method | Laboratory       |

2.2. Clam / Benthic Sample Collection

Clam samples was taken from five (5) determined location based on the local community activities from upstream to downstream. Purposive random sampling method was used in order to collect the clam samples. Subsequently, sample collection was conducted using suber net on each sampling point. The collected clam samples are then put in a plastic bag and preserved using 4% formalin before putting label on the plastic bag. In the laboratory, samples were cleaned from formalin and soaked in clean water for about one day and night, and put in a bottle containing 70 % alcohol afterwards. Identification is then done afterwards using identification book.

2.3. Data Analysis

Data analysis for water quality such as temperature, light penetration and intensity, pH, DO, and BOD, as well as Mercury (Hg) level on several clams such as blood clam, common geloina, and antique ark are done using standard method [3].

3. Results and Discussion

3.1. Water Quality of Belawan River

The result of water quality of Belawan River can be seen on the table 3 below.

| No | Parameter       | Station I | Station II | Station III | Station IV | Station V |
|----|-----------------|-----------|------------|-------------|------------|-----------|
| 1. | Temperature (°C)| 26        | 27         | 27          | 28         | 30        |
| 2. | Light Penetration (m) | 1.3  | 0.88       | 0.56        | 0.60       | 0.58      |
| 3. | Light Intensity (Cd) | 467  | 397        | 524         | 435        | 535       |
| 4. | Flow velocity (s/m) | 0.9  | 1.2        | 1.4         | 1.1        | 0.7       |
| 5. | Depth (m)       | 0.9       | 1.1        | 1.2         | 1.1        | 1.4       |
| 6. | pH              | 7.1       | 6.9        | 6.6         | 7          | 7.6       |
| 7. | DO (mg/L)       | 7.2       | 6.8        | 6.5         | 6.6        | 6.7       |
| 8. | BODs (mg/L)     | 2.1       | 2.9        | 3.4         | 3.2        | 3.2       |
It can be seen on table 3 that the temperature of river belawan ranged from 26-30 °C, with the highest on station V which was the local settlements on downstream. The overall temperature of water from river Belawan is relatively the same. Light penetration was ranged from 0.56 – 1.3 m with the highest light penetration on station I, which was caused by the open area of station I (less plants were grown), which make the light easier to penetrate into water body. Light intensity was ranging from 397 – 535 Candela with the highest on station V. This is caused by the light ability to be absorbed was relatively high. Water pH was ranging from 6.6 – 7.6 with the highest pH on station V (downstream), though the pH was almost the same. Dissolved oxygen (DO) was ranging from 6.5 – 7.2 mg / L with the highest on station I, which was caused by the environmental condition that supports photosynthesis which provides much oxygen in the water body. Likewise, the Biological Oxygen Demand (BOD5) was ranging from 2.1 – 3.4 mg/L.

3.2. Mercury Analysis on Substrate and River Flow
The result of heavy metal measurement on substrate and Belawan river flow can be seen:

| Parameter         | Station  I | Station  II | Station  III | Station  IV | Station  V |
|-------------------|------------|-------------|--------------|-------------|------------|
| River Substrate   | 0.00088 mg/L |             |              |             |            |
| River Water       | 0.00052 mg/L |             |              |             |            |
| Quality Standard  | 0.002 mg/L  |             |              |             |            |

It can be seen above that the heavy metal level on substrate was 0.00088 mg/L while the mercury level on water flow was 0.00052 mg/L, analyzed from the mercury level which was still below the Government Regulations Number 82 of 2001 concerning water quality management and water pollution control, 0.002 g / L.

3.3. Analysis of Mercury Level on Clam Species
The result of the mercury level on clam species can be seen:

| Species            | Parameter | Station  I | Station  II | Station  III | Station  IV | Station  V |
|--------------------|-----------|------------|-------------|--------------|-------------|------------|
| Blood Clam         | 0.00024 mg/L |             |              |              |             |            |
| Common Geloina     | 0.00026 mg/L |             |              |              |             |            |
| Antique Ark        | 0.00095 mg/L |             |              |              |             |            |

It can be seen above that the three clam species showed a different mercury level, which was 0.00024 mg/L on blood clam, 0.00026 mg/L on common geloina, and 0.00095 mg/L on antique ark. The mercury level on these clam species is still below the quality standards set by Minister of Living Environment Number 51 of 2004 which was 0.001 mg/L.

3.4. Determination on Status of Water Quality
The result of determination on status of water quality species can be seen from table 4 below :

| Table 4. Average value of water quality in Belawan River in accordance to quality standard regulation PP No. 82 year of 2001 class III |
| Parameter | Station  I | Station  II | Station  III | Station  IV | Station  V | Quality Standard |
|-----------|------------|-------------|--------------|-------------|------------|------------------|
| 1. Temperature (°C) | 26 | 27 | 27 | 28 | 30 | Natural |
| 2. Light Penetration (cm) | 130 | 88 | 56 | 60 | 58 | - |
| 3. Light Intensity (Cd) | 467 | 397 | 524 | 435 | 535 | - |
| 4. Flow velocity (s/m) | 0.9 | 1.2 | 1.4 | 1.1 | 0.7 | - |
| 5. Depth (m) | 0.9 | 1.1 | 1.2 | 1.1 | 1.4 | - |
| 6. pH | 7.1 | 6.9 | 6.6 | 7 | 7.6 | 6-9 |
| 7. DO (mg/L) | 7.2 | 6.8 | 6.5 | 6.6 | 6.7 | 3 |
| 8. BOD₅ (mg/L) | 2.1 | 2.9 | 3.4 | 3.2 | 3.2 | 6 |
It can be seen from the table above that the water quality on Belawan river was still on a good quality, indicated by the dissolved oxygen level that was affected by the amount of organic and inorganic matters in the water. Oxygen in the water body is going to be used to decompose and oxidize those materials. In addition, the dissolved oxygen level can also be affected by the photosynthetic activity and stream flow [4]. BOD5 was highest on station III, which was the densest human settlements that produce the most domestic waste in the form of organic matter, where the oxygen in this station is mostly used by the microorganism to decompose these materials. According to the measurement done, it can be seen that the environmental condition of Belawan river still met the standard where this water body is still good enough to be lived by water biota.

4. Conclusion
According to the research conducted Bioaccumulation Analysis of Mercury Level on Clam Species in Belawan River, it can be concluded that:
1. The mercury level on Belawan river was 0.00052, which was still below the quality standards
2. The mercury level on the river sediment was 0.00088, which was still below the quality standards
3. The mercury level on blood clam, common geloina, and antique ark was 0.00024, 0.00026, and 0.00095 mg/L respectively. This amount still met the standard and thus is safe to be consumed.

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