

Effect of Heavy Metal Spread on River Flows from Gold Mining Toward Water Biota in Batang Gadis Mandailing Natal River

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Abstract : The purpose of this study is to find out the river water quality in terms of the spread of heavy metals found from the gold mining in Batang Gadis Mandailing Natal River and to determine the effect of heavy metal distribution on river flow from the gold mining of aquatic biota on the Batang Gadis Mandailing Natal River. This research uses descriptive exploratory method by conducting a survey first. Determination of sampling sites using purposive sampling method at the two stations that are determined. Sampling of water and sediments from each location. Water samples were taken as much as 500 mL, samples of sediment were taken at a depth of 10-15 cm from the base surface as much as 100-200 g (Mann, 1978). Examples of water biota are randomly taken at each station as much as 50-100 g, then put together into a composite sample for further analysis in the laboratory. Water quality is measured insitu include temperature, brightness, turbidity, depth, current speed, pH, DO, CO₂. While the COD sample, BOD was taken to the laboratory to be analyzed by preservation using ice at a temperature of around 4 oC before observing in the UMTS biology laboratory. Data obtained, then analyzed descriptively. The results of this study are the levels of heavy metals found in the two Batang Gadis River observation stations that are equally good in water, sediment and those found in fish, namely Hg <0,0008, Cd <0,003 and Pb <0,005. Metal levels found are still below the threshold value, but need to be aware of the accumulation of these metals. The histological observations of crisp fish gills at the Bustak mine station are found to experience edema and necrosis which are strongly suspected to be caused by pollution of heavy metals found in the Batang Gadis River. The histological observations of crisp fish liver at the Bustak mine station are found to experience necrosis which is allegedly caused by heavy metal pollution found on the Batang Gadis River

Keywords : pollution; heavy metal; biota water; Batang Gadis river

I. Introduction

Water as a component of the environment will affect and be influenced by other components. Bad quality water will cause the environment to be bad so that it will affect the health and safety of humans and other living things. One of the bodies of water which is a wealth of water resources is a river. The river is also an easy and practical place for the disposal of waste, both solid and liquid, as a result of household activities, home industries, garments, animal husbandry, workshops, and other business ventures. With the disposal of various types of waste and waste containing various types of pollutants to water bodies, both biodegradable and non-biodegradable substances will cause more weight to be borne by the river.

Batang Gadis River is the estuary of several tributaries, the Lahantan River and the Batang Pungkut River, which originates from Gunung Kulabu, Mandailing Natal District. This river is the longest and largest river along the Kotanopan area, as for the characteristics of the Batang Gadis River which is an attraction is the clear water and large rocks neatly arranged. The results of the Atifah and Lubis (2017) study show that two observation stations

observed showed low water quality at the Bustak Mine Station and Dalan Lidang. The low pH found in the station is due to the large number of activities of the population and gold mining activities that dispose of mining waste directly into the river in large quantities every day. The more widespread gold mining activities are worrying about the life of biota on the Batang Gadis River, especially fish. The most worrying pollution at the moment is mining activities that are increasingly prevalent in the Batang Gadis river that use engines and diesel fuel which are directly disposed of into the River (Abdullah, 2013).

Activities on the Batang Gadis River that are mostly carried out are gold mining around the river. In gold mining activities, the amalgamation process requires a process of mixing gold and mercury. According to Widodo (2011) the amalgamation process is the process of binding gold from the ore by using mercury in a tube called a bubble. The waste produced in gold mining usually contains toxic chemicals. In the mining process, mercury is used to bind gold. Ginting (1995) states that in addition to dangerous heavy metal elements, the main element that must be considered and very dangerous that is found in gold mining waste is mercury.

The entry of heavy metals mercury (Hg) and other heavy metals that have not been identified in the Batang Gadis River which can accumulate in the body of aquatic organisms living in the Batang Gadis River, especially in fish tissue. Fish absorb heavy metals through their food and directly from water by passing gills. Heavy metals can also bind to proteins throughout fish tissue, if consumed by humans for a long time they can be accumulative poisons if they cannot be decomposed by organs so that they will endanger health (Diliyana, 2008). Therefore, it is necessary to do further research on "The Effect of Heavy Metal Distribution on River Flow from Gold Mining Products to Water Biota on the Batang River Mandailing Natal Girl".

II. Materials and Methods

This research used descriptive exploratory method by conducting a survey first. Determination of sampling sites using purposive sampling method at the two stations that were determined. Sampling of water and sediments from each location. Water samples were taken as much as 500 mL, samples of sediment were taken at a depth of 10-15 cm from the base surface as much as 100-200 g (Mann, 1978). Examples of water biota were randomly taken at each station as much as 50-100 g, then put together into a composite sample for further analysis in the laboratory. Water quality was measured with *insitu* included temperature, brightness, turbidity, depth, current speed, pH, DO, CO₂. While the COD sample and BOD were taken to the laboratory to be analyzed by preservation using ice at a temperature of around 4°C before observing in the UMTS biology laboratory. Data obtained, then analyzed descriptively.

III. Result and Discussion

3.1 Heavy Metal Spread on the Batang Gadis Mandailing Natal River

The results of analysis of heavy metals found in the waters of Batang Gadis Mandailing Natal river can be seen in the table below.

Table 1. Water Test Results of Batang Gadis Mandailing Natal River Against Metals

No	Station	Heavy Metal (mg / l)			Note
		Hg	Cd	Pb	
1	Sitamiang	< 0,0008	< 0,003	< 0,005	
2	Bustak Mine	< 0,0008	< 0,003	< 0,005	
Metal Maximum Limit		0,05	0,01	0,03	

The results of metal content on water in Batang Gadis river were found to contain the same levels of Hg, Cd and Pb which were < 0,0008 mg / l, < 0,003 mg / l, < 0,005 mg / l in two different observation stations, namely in Sitamiang and at the Bustak Mine. The levels of metals Hg, Cd and Pb found are still below the threshold value. The maximum threshold value for Hg metals was 0.05 mg / l, Cd 0.01 mg / l and Pb 0.03 Mg / l. Metals that have the highest levels of the three metals tested were Pb metal or lead which is 0.005 mg / l but still below the threshold value of 0.03 mg / l.

Table 2. Soil Test Results of Batang Gadis Mandailing Natal River Against Metals

No	Station	Heavy Metal (mg / l)			Note
		Hg	Cd	Pb	
1	Sitamiang	< 0,0008	< 0,003	< 0,005	
2	Bustak Mine	< 0,0008	< 0,003	< 0,005	

Based on results of soil analysis on Batang Gadis Mandailing Natal River at Sitamiang Station and the Bustak Mine it was obtained in the form of sandy mud with the same heavy metal content value at the two stations. The content of mercury (Hg) <0,0008, Cadmium <0,003 and Lead <0,005. Metals with the highest metal content are found in Lead metal, which is <0.005. The metal content found is still at the maximum limit of metals in the waters. Levels of Hg metal still <0,0008 still meet the Quality Standards for Quality Materials in accordance with Government Regulation No. 82 of 2001 class I. 0.001 mg / L class II. 0.002 mg / L class III. 0.002 mg / L class IV 0.005 mg / L.

According to Dahuri. Et al. (2001) that waters that are high in sediment can endanger life in the aquatic environment, including sediments which cause an increase in turbidity of water by blocking the penetration of light entering the water so that it can disrupt the life of organisms in it. Sediment is the place for the accumulation of heavy metals around the ocean waters.

Table 3. FishTest Results of Batang Gadis Mandailing Natal River Against Metals

No	Station	Heavy Metal (mg / l)			Note
		Hg	Cd	Pb	
1	Sitamiang	< 0,0008	< 0,003	< 0,005	

2	Bustak Mine	< 0,0008	< 0,003	< 0,005	
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The results of fish analysis of metal content in Batang Gadis river were found to contain the same levels of Hg, Cd and Pb which were <0,0008 mg / l, <0,003 mg / l, <0,005 mg / l in two different observation stations, namely in Sitamiang and at the Bustak Mine. The levels of metals Hg, Cd and Pb found are still below the threshold value. The maximum threshold value for Hg metals is 0.05 mg / l, Cd 0.01 mg / l and Pb 0.03 Mg / l. Metals that have the highest levels of the three metals tested are Pb metal or lead which is 0.005 mg / l and still below the threshold value of 0.03 mg / l.

3.2 Microscopic Observation of Garing Fish Gills

Fish gills are the main respiration organ that works by the mechanism of surface diffusion of respiration gases (oxygen and carbon dioxide) between blood and water. Oxygen dissolved in water will be absorbed into the gill capillaries and fixed by hemoglobin to then be distributed throughout the body. While carbon dioxide is released from cells and tissues to be released into the water around the gills (Brown, 1962; Rastogi, 2007). Therefore, any changes that occur in the aquatic environment will directly and indirectly affect the structure and function of the gills.

The basic structure of the gills consists of the primary lamella as the main body in each gill filament and secondary lamella as a small part of the gill filaments found around the primary lamella body. In the middle part of the primary lamella there is a large duct along the primary lamella called the venous sinus filled with erythrocytes (Pinontoan, 2015).

The primary lamella is composed of chloride cells surrounded by flattened pavement cells and can be observed at the intersection between the primary lamella and the secondary lamella. Chloride cells are often located at the base of the secondary lamella. Mucus cells are a prominent feature of the gill epithelium. (Genten et al., 2009).

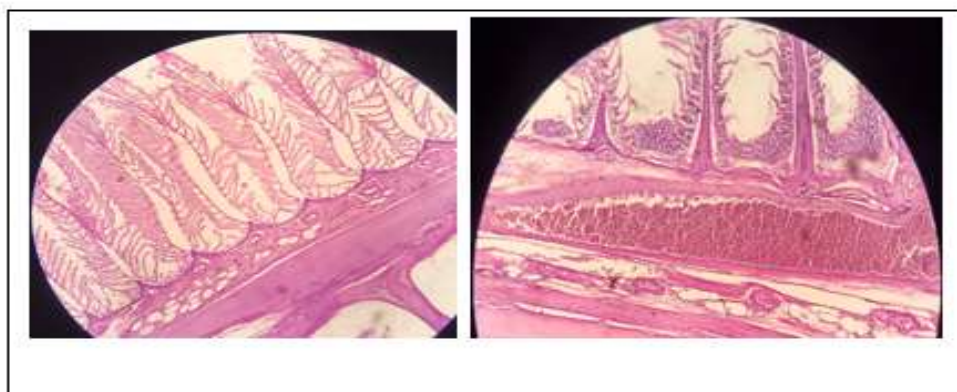


Figure 1. Histology of Garing Fish Gills at Sitamiang Station

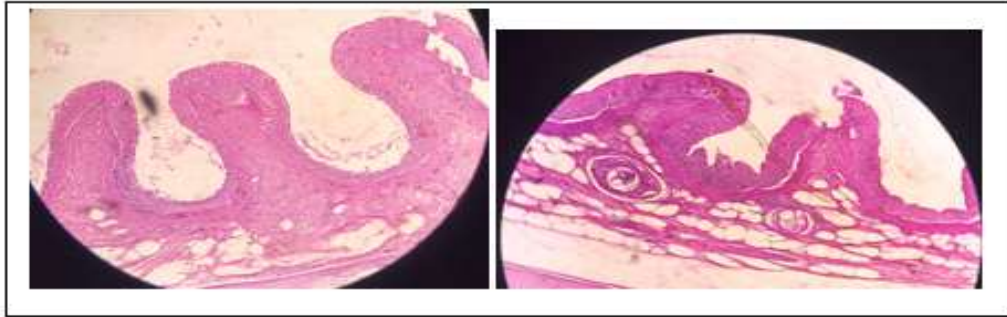


Figure 2. Histology of Garing Fish Gills at Sitamiang Station Bustak Mine

3.3 Microscopic Observation of Garing Fish Gills

Hydropic degeneration is an advanced stage swelling of the liver cells where visible spaces in the cytoplasm can be seen from cells with vacuoles appearing to enlarge to push the nucleus to the edge of the cell (Triadayani et al, 2010). In addition to this picture there are also more hepatocyte cells that experience necrosis.

Hepatopankreas in fish is one of the vital organs that is very important in detoxifying substances that enter the body. Fat celling is a process of fat degeneration which is a disturbance in fat cells or excessive fat accumulation in the cytoplasm (Ramadhani et al, 2013). Characterized by the presence of vacuoles (the state between the liver cells with each other becomes stretched). Based on the study of El-Naggar (2009) who reported that the liver of Tilapia (*Oreochromis niloticus*) which experienced pathological changes in the form of cell fatty tissue and necrosis is the result of the liver accumulating by heavy metals (Fe, Cu, Zn, Mn, Pb, and Cd). Fat degeneration occurs because of the accumulation of fat (neutral fat) with damage to the cell nucleus and shrinking liver cell tissue (Panigoro et al., 2007). According to research by Alifia and Djawad (2000), mentioning that milkfish (*Chanos chanos* Forskall) exposed to lead metal results in liver degeneration.

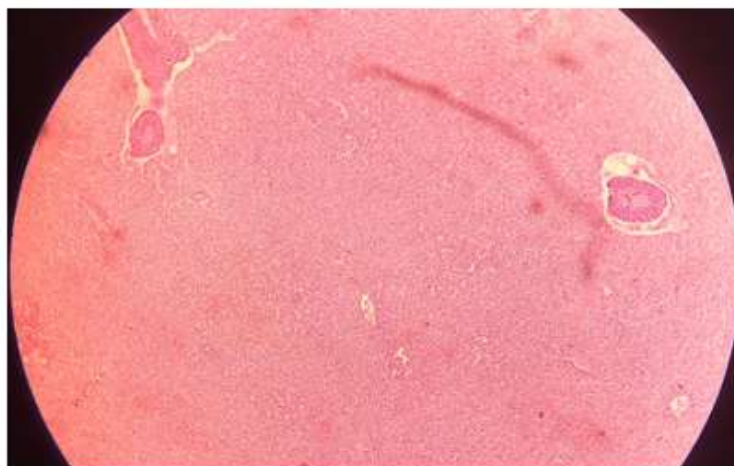


Figure 3. Histology of Liver Garing Fish at Tamiang Station

In three pictures above, it appears that there are empty cavities outside the liver cells that look like white dots. The empty cavity is caused by an enlarged vacuole. Hydropic degeneration is the swelling of advanced liver cells where there are visible spaces in the

cytoplasm of cells with vacuoles appearing to enlarge so that it pushes the nucleus to the edge of the cell.

In addition, in this picture there are also necrotic hepatocytes (Triadayani et al, 2010). Supported by the research conducted by Triadayani et al regarding the effect of lead metal (pb) on liver tissue of duck grouper (*Cromileptes altivelis*) it was found that lead metal caused hydrophic degeneration characterized by an enlarged vacuole that pushed the nucleus towards the edge.

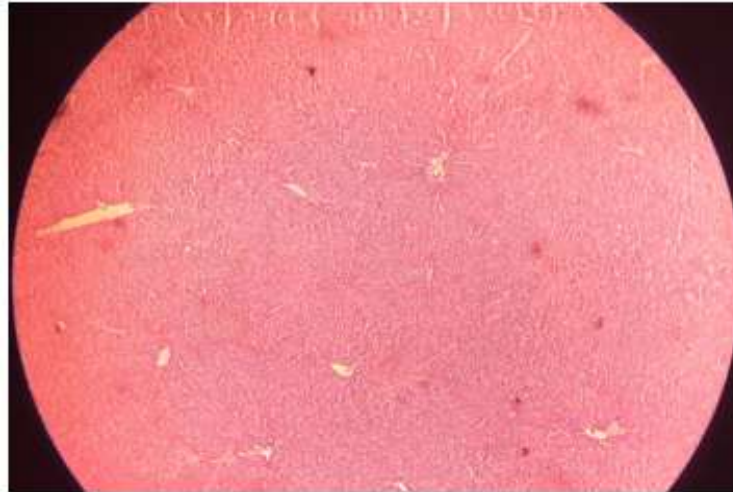


Figure 4. Histology of Liver Garing Fish at Bustak Mine

IV. Conclusion

The conclusion of this study is that the heavy metal levels found in the two Batang Gadis river observation stations are of equal value both in water, sediment and those found in fish, namely Hg of $< 0,0008$, Cd of $< 0,003$ and Pb of $< 0,005$. Metal levels found are still below the threshold value, but need to be aware of the accumulation of these metals. The histological observations of crisp fish gills at the Bustak mine station were found to experience edema and necrosis which were strongly suspected to be caused by pollution of heavy metals found in the Batang Gadis river. The histological observations of crisp fish liver at the bustak mine station were found to experience necrosis which was strongly suspected to be caused by pollution of heavy metals found in the Batang Gadis river.

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