

# Heavy metal (Mercury and Plumbum) accumulation of two fish species in Sipin and Teluk Lake, Jambi Province

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## ABSTRACT

The illegal mining activities by using mercury might cause water pollution, especially heavy metals mercury (Hg) and Lead (Pb). The purpose of this research was to examine the accumulation of Pb and Hg in sediment, water, and fish at Sipin and Teluk Lake, Jambi Province. All of the samples include sediment, water, and fish were preserved using 96% alcohol and were analyzed using Atomic Absorption Spectrophotometer (AAS). The results show that the concentration and accumulation of Pb are higher than Hg. The Pb concentration in water and sediment at Sipin Lake ranges from 0.0041 – 0.0046 ppm and 18.53 – 42.52 ppm, respectively. On the other hand, the Hg concentration in water and sediment at Sipin Lake ranges from 0.00012 – 0.00072 ppm and 0.19 – 2.2 ppm, respectively. While, in Teluk Lake, the concentration of Pb ranges 0.0041-0.02 ppm and 28.98-58.92 ppm, and the Hg concentration ranges from 0.00012-0.00014 and 0.2 – 2.2 ppm. This study reveals that the concentration of Pb and Hg is accumulated by fish. Furthermore, the heavy metals concentration on fish cages are found higher than the non-fish cage.

*Key words* : Heavy metals, Plumbum, Mercury, Fish, Accumulation

## Introduction

In Aquatic ecosystem, sediments are the main sink and source of heavy metals, serving as a significant role in the transportation and storage of potentially noxious metals (Alonso *et al.*, 2013; Duran *et al.*, 2012; Superville *et al.*, 2014). The heavy metal pollution in aquatic environments has attracted widespread attention due to its persistence, accumulation in the food chain and negative effects on the ecological and human health (Lin *et al.*, 2016; Zhang *et al.*, 2016). The metals can also be detached and released into the water column, negatively affecting

water quality (Simpson and Spadaro, 2016). These metals can be strongly accumulated and biomagnified along water, sediment, and aquatic food chains, thus resulting in sub lethal effects or death in local fish populations (Megeer *et al.*, 2000; Jones *et al.*, 2001; Almeida *et al.*, 2002; and Xu *et al.*, 2004). The Heavy metals like copper and zinc are essential for fish metabolism, while others such as mercury, cadmium, and lead have no known role in biological systems (Chanli and Atli, 2003). Even the discharge of heavy metals into river or any aquatic environment can change both aquatic species diversity and ecosystems, due to their toxicity, and accu-

mulative behavior (Weher, 2008), threat to the existence of organisms thriving in the area, to the ecological integrity of the habitat as these heavy metals may enter the food chains, persist in the environment, bio accumulate and bio magnify and increase the exposure to public health risks (Su *et al.*, 2009).

For the normal metabolism of fish, the essential metals must be taken up from water, food, or sediment. However, similarly to the essential metals, non-essential metals are also absorbed by fish (where they ultimately accumulate in the tissues). The studies from field and laboratory experiments have shown that the accumulation of heavy metals in fish tissue is mainly dependent upon concentrations of the metals in surrounding water, in addition to the exposure period (Yi, *et al.*, 2011). The aquatic organisms such as fish and shell fish accumulate metals to concentrations many times higher than present in water (Jayakumar and Paul, 2006; Al-Kahtani, 2009) or sediment (Weher, 2008); they can take up metals concentrated at different levels in their different body organs (Staniskiene *et al.*, 2006; Weher, 2008) and its accumulation was dose, time, and species dependent (Weher, 2008).

According to Kaban (2017) that special heavy metals mercury in the Batanghari River are caused by illegal mining which is along the Batanghari River. For the gold mining generally using mercury material on the mining process and it might cause pollution to the waters and accumulates into sediments and fish. The heavy metals that dissolve in water or that settle in sediments can be accumulated on organisms and could be harmful to the healthy. For that, we want to examine the accumulation of Plumbum and Mercury in sediment, water, and fish in Sipin and Teluk Lake, Jambi Prov-

ince.

## Methodology

Research on the heavy metals in sediments and fish biota was carried out in 2017 on Teluk and Sipin Lake. Taking sample was done by purposive methods sampling and determined 5 sampling sites on both the lakes. Sampling sites solution is points based on the existence of types of activities that can cause pollution especially heavy metals such as mercury and plumbum (Figure 1)

Sampling was conducted in 5 sampling sites based on purposive sampling method, five location was analyzed:

ST I (Reference site) is an area where there are plant crops and quite far from the population activity.

ST II (Domestic site) is an area close to local population and waste activity

ST III (Cages site) is an area close to fish farming activities (net floating cages)

ST IV (Outlet site) is the outflow area of the lake, the area where the water outflows into the lake

ST V (Inlet site) is an inlet water flow area, the area where the water flows into the lake

Samples tested (water, sediment and fish) that have been preserved at 4 °C (in ice boxes). The preserved sample is taken to the laboratory for analysis. The concentrations of heavy metals analyzed were plumbum (Pb) and Mercury (Hg) analyzed by using the AAS spectrophotometer.

## Results and Discussion

The results of the metal concentration on sediment and water can be seen in Table 1.

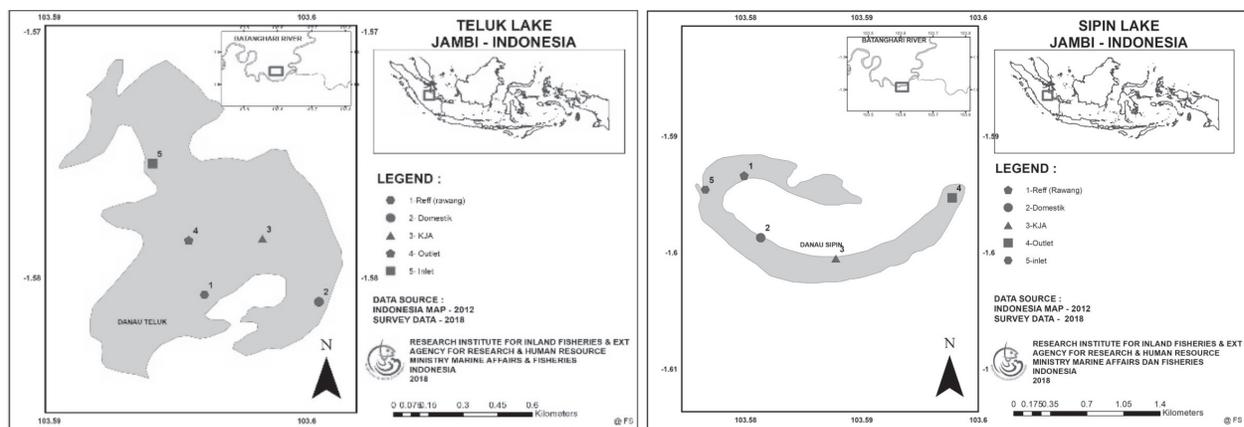


Fig. 1. Sampling Sites (Sipin and Teluk Lake)

The concentration of heavy metal Pb in Teluk Lake in water and sediment ranges from 0.0041 - 0.0235 ppm and 28.98 - 58.92 ppm. The results showed that there was a correlation between the concentration of heavy metals in sediment and water. The high levels of heavy metals in sediments are positively insulated with high levels of heavy metal Pb in water. The concentration of heavy metal Hg in Teluk Lake especially at water and sediment ranges between 0.00012 – 0.00013 ppm and 0.2 – 2.17 ppm. The concentration of this heavy metal in both water and sediment is still below the threshold set by Decree of Ministry of Environment, Indonesia Government No.51 2004.

The concentration of heavy metals and accumulation of heavy metals Hg and Pb can be seen in table 2. The accumulation of heavy metals especially on fish biota in Teluk Lake shown in the table below, this condition shows that heavy metals, it was accumulated in the sample fish, the resulting fish catches and floating cages.

The concentration of heavy metal mercury and plumbum in wild fish ranged from 7.12 - 18.68 mg/kg and 0.022 - 0.064 mg/kg. The concentration of heavy metals heavy metal Hg and Pb in cage fish ranges from 0.0038 - 0.406 mg/kg.

The results of the analysis of the concentration Hg and Pb on water and sediment at Sipin Lake can be seen in Table 3

The concentration of heavy metal Pb in Sipin Lake in water and sediment ranges from 0,0041 - 0,004 mg/L and 18.53– 42.52 mg/L. The results showed that there was a correlation between the concentration of heavy metals in sediment and water. The high levels of heavy metals in sediments are positively insulated with high levels of heavy metal Pb in water. The concentration of heavy metal Hg in Sipin Lake in water and sediment ranges between 0.000123 – 0.000713 mg/L and 0.185– 2.171 mg/L. The concentration of this heavy metal in both water and sediment is still below the threshold set by Decree of Ministry of Environment, Indonesia Govern-

**Table 1.** Concentration of Heavy Metal in Teluk Lake

Location	Water (ppm)		Sediment (ppm)	
	Plumbum	Mercury	Plumbum	Mercury
St 1	0.0036	0.00012	28.98	0.2
St 2	0.0041	0.00012	32.31	0.314
St 3	0.0235	0.000123	46.66	0.313
St 4	0.02095	0.00013	52.09	0.475
St 5	0.0142	0.00012	58.92	2.173

**Table 2.** Concentration of heavy metal on fish in Teluk Lake

Wild fish	Parameter		Cages fish	Parameter	
	Plumbum (Pb) mg/Kg	Mercury (Hg) mg/Kg		Plumbum (Pb) mg/Kg	Mercury (Hg) mg/Kg
i1	10.81	0.022	i1	20.53	0.0038
i2	12.85	0.023	i2	13.13	0.019
i3	18.68	0.049	i3	13.70	0.039
i4	14.12	0.038	i4	22.70	0.406
i5	7.12	0.064	i5	18.39	0.050

**Table 3.** Concentration of Heavy Metal in Sipin Lake

Sampling sites	Water (ppm)		Sediment (ppm)	
	Plumbum	Mercury	Plumbum	Mercury
St 1	0.0046	0.00013	34.35	1.842
St 2	0.00451	0.00013	18.53	0.185
St 3	0.00421	0.000713	23.23	0.198
St 4	0.0045	0.000125	37.32	2.171
St 5	0.0041	0.000123	42.52	1.654

**Table 4.** Heavy metal concentration on fish in Sipin Lake

Wild fish	Parameter		Cages fish	Parameter	
	Plumbum (Pb) mg/Kg	Mercury (Hg) mg/Kg		Plumbum (Pb) mg/Kg	Mercury (Hg) mg/Kg
I1	4.40	0.165	I1	0.20	0.122
I2	0.23	0.146	I2	26.94	0.114
I3	0.21	0.012	I3	8.04	0.091
I4	2.35	0.015	I4	0.21	0.029
I5	12.06	0.046	I5	6.78	0.040

ment No.51 2004.

The concentration of heavy metals Pb and Hg can be seen in Table 4. The accumulation of heavy metals could be seen from the concentration in fish meat, where the concentration of heavy metals in fish is higher compared to concentrations in water and sediment.

The concentration of heavy metals Pb in Sipin Lake especially for wild fish and cages fish range between 0.21-12.12 mg/Kg and 0.2-26.94 mg/Kg. The concentration of heavy metal mercury in wild and cages fish ranged from 0.012 to 0.46 mg/L and 0.029-0.122. It's indicates that some fish in the cage more quickly accumulate heavy metals compared to wild fish, but the concentration of heavy metals plumbum and mercury still below the set threshold by Decree of Ministry of Environment, Indonesia Government No. 51 2004.

## Conclusion

The concentrations of heavy metals Pb and Hg in the Teluk dan Sipin Lakes are still at the threshold of the ministry of environmental decree of Republic Indonesia (No. 51/2004). The heavy metals concentration on fish cages are found higher than the non-fish cage. This founding is become the valuable information especially for the government as the decision maker to set the further regulation. Moreover, the next research is needed on some of the effects of other heavy metals on economically important fish so as to provide information for local communities and the dangers of heavy metals if accumulated in fish.

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