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Assessing bioaccumulation of Pb and Cu of Mangroves in Sarinah Island, Indonesia

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ABSTRACT

The species mangroves are consisted of *Sonneratia alba*, *Avicennia marina* and *Avicennia alba* which the dominate mangroves in Sarinah Island, Indonesia. The concentration of Pb and Cu were analyzed of roots, leaves, and sediments. This study aims on the bioaccumulation and translocation of heavy metal (Pb and Cu) in mangroves in the Sarinah Island. the ability of bioaccumulation of heavy metals in each mangrove species is provided.

Key words : *Mangroves, Bioaccumulation, Pb and Cu*

Introduction

Mangroves area is one of the coastal component ecosystems that have a function in the coastal environment protection. Mangroves are communities on tropical beaches that are dominated by a variety of distinctive tree species and shrubs that have the ability to grow in salty waters (MacFarlane, 2001). Mangroves can grow on sediments with high levels of heavy metals exclude and regulate uptake of metals in the root (MacFarlane and Burchett, 2002; Patty *et al.*, 2013). The heavy metal contamination is a major environmental problem that is accumulated in the various organisms of the estuarine ecosystem and ultimately enter the food chain, thereby affecting the human well-being (Yoon *et al.*, 2006).

Generally, the pollutant of heavy metal entering the estuary comes from industrial activities, among others Cu, Pb, and Zn. Pollutants from industrial waste can pollute the river and have a negative impact on ecosystems and impact on ecosystems such as temperature, pH, BOD, COD and heavy metal content which greatly affects the life of aquatic flora and fauna (Heriyanto and Endro, 2011; Murtini *et al.*, 2006).

Materials and Methods

Study area

This research was conducted in Sarinah Island located in Jabon District, Sidoarjo, East Java, Indonesia (112º42’19.87"E, 7º31’30.33"S). This island is formed from the Lapindo mudflow deposition at the mouth of the Porong River is a marine tourism object which is located in Tlocor village.

Sampling procedures

Mangroves root and leaf tissue were sampled in

three species mangrove that consisted of *Sonneratia alba*, *Avicennia marina*, and *Avicennia alba*. The concentration of Cu and Pb were measured by using an Atomic Absorption Spectroscopy Shimadzu AA-6800. The water quality analysis was measured by water quality checker WQC-22A (Kammaruzzaman *et al.*, 2008)

Data analysis

Data analysis were performed by calculating the bioconcentration factor. BCF is a comparative analysis of metal concentrations in organs with metal concentrations in sediments, with high accumulation category (> 1mg.kg^{-1}) and a low accumulation (< 1mg.kg^{-1}). Bioconcentration factors are used to calculate the ability of roots and mangrove leaves to accumulate heavy metals (MacFarlane *et al.*, 2002).

$$\text{Bioconcentration Factor} = \frac{\text{Metal concentration in leaf}}{\text{Metal concentration in root}}$$

The Bioconcentration factor value is divided into 3 (three) categories, winning a BCF value (>1) is considered an accumulator. BCF = 1 value can be categorized as an indicator, while BCF value <1 is categorized as an exluder (Mastaller, 1996).

Furthermore, heavy metal translocation factors are used to calculate the process of translocation of heavy metals from roots to leaves (Nugrahanto *et al.*, 2014). TF is the ratio of metal concentrations between organs to analyze the effectiveness of interorgan metallic translocation, TF (>1) values showed high effectiveness (Mastaller, 1996).

$$\textit{Translocation Factor} = \frac{\textit{Metal concentration in leaf}}{\textit{Metal concentration in root}}$$

Mangroves that have the value of bioconcentration and translocation factors (>1) can be used as bio-accumulators, which indicates that plants can accumulate heavy metals from their environment. Bioconcentration (>2) is considered a high value. Mangroves can be used as phytostabilizers that have a translocation factor (<1) and as phytoextraction in a bioconcentration value (<1) and translocation factors (>1) (McFerlane, 2007).

Results and Discussion

Heavy metal content (Pb and Cu)

Mangrove Roots Tissue

The average concentration Pb in root Sonneratia alba was 0.040±0.007, *Avicennia marina* was 0.040±0.000, *Avicennia alba* was 0.098±0.000. Meanwhile, the average concentration of Cu in root *Sonneratia alba* was 0.301±0.060, *Avicennia marina* was 0.208±0.039, *Avicennia alba* was 0.339±0.142 (Table 1). The result shows that *Avicennia alba* root is the highest of concentration content of heavy metal Cu and Pb. The result found that *Avicennia alba* is the greatest to accumulate Cu and Pb in the root. The genus Avicennia is proven to accumulate a large number of heavy metals including Pb, Cu, and Zn. Whereas accumulation of Pb and Cu also are also high to be accumulated in *Soneratia alba*. Genus Sonneratia readily translocates Pb and Zn to the upper parts such as the leaves.

Table 1. Heavy metal concentration in roots tissue in each species mangroves

Sampling Points	Heavy metals Cu and Pb in root (ppm)	
	Cu± Std. Deviation	Pb± Std. Deviation
1*	0.301 ± 0.060	0.040 ± 0.007
2*	0.208 ± 0.039	0.040 ± 0.000
3*	0.339 ± 0.142	0.098 ± 0.000
Min	0.18	0.004
Max	0.344	0.098
Average	0.282 ± 0.080	0.049 ± 0.002

Mangrove Leaves Tissue

The average concentration Pb in leaves *Sonneratia alba* was 0.031±0.000, *Avicennia marina* was 0.024±0.002, *Avicennia alba* was 0.039±0.016. Meanwhile, the average concentration of Cu in leaves *Sonneratia alba* was 0.101±0.009, *Avicennia marina* was 0.040±0.000, *Avicennia alba* was 0.149±0.032 (Table 2). The result shows that the highest accumulation of Cu and Pb is species mangrove *Avicennia alba*. Moreover, the accumulation of Cu was higher than Pb in each mangrove species. *A. alba* accumu-

Table 2. Heavy metal concentration in leaves tissue in each species mangroves

Sampling Points	Heavy metals Cu and Pb in leaves (ppm)	
	Cu± Std. Deviation	Pb± Std. Deviation
1*	0.101 ± 0.009	0.031 ± 0.000
2*	0.040 ± 0.000	0.024 ± 0.002
3*	0.149 ± 0.032	0.039 ± 0.016
Min	0.04	0.004
Max	0.172	0.051
Average	0.096 ± 0.013	0.031 ± 0.012

lated significantly higher levels of heavy metal in its leaves compared with the other mangrove species. The presence of Cu in leaves is influenced by the metabolic need for essential micronutrients such as Cu (McFerlane, 2003: Rohyatun *et al*., 2006).

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