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I. INTRODUCTION

Mangrove ecosystem had been known to provide natural function to protect coastal area from the impact of the ocean and land activities. According to Yunus et al. (2011) mangrove sediments have the capability to trap and retain heavy metals from indirectly enters the other ecosystem, such as seagrass and coral ecosystem. Mangrove trees has strong capabilities in heany metals absorption and fixation (Kumar et al., 2010). According to Defew et al. (2005), the capability of mangrove ecosystem in heavy metal retention is caused by its anaerobic and reduced condition which is rich of sulphide and organic matter.

Coastal ecosystem in tropical countries are mostly mangrove abundant. Demak region is one of many regions in Central Java which naturally abundant of mangrove plants. Mangrove ecosystems are mostly found around the estuaries and immersed wetlands. Unfortunately, increasing upland activities lead to the increase of pollutant discharge to aquatic system, such as river runoffs, estuaries and coasts. According to Kathiresan (2003), complexity of mangrove aerial roots play an important rules in sediment trapping. In the other side, Nasr et al. (2006) mentioned that sediment serve as heavy metal reservoir. There were also correlation between sediment grain size and heavy metal concentration. Finer sediment grain size contain more heavy metal concentration than coarse sediment (Maslennikova et al., 2012).

Since mangrove plays important rule in sediment trapping, heavy metal accumulation comes along with sedimentation process. Concentrations of heavy metal in mangrove sediments all over the world are elevated which are caused by long term pollution caused by human activities (Harris and Santos, 2000). According to Chaiyara et al. (2013), heavy metals are taken up directly grom discharges of coastal communities, ships, rivers, atmospheric deposition and land runoffs. Since urban development areas are close to mangrove ecosystem, large input of heavy metal into mangrove ecosystem are generated from industrial and domestic wastes

which contain trace and heavy metal in dissolved particulate form (Preda and Cox, 2002).

Mangrove plants were also known to absorb and accumulate heavy metal in its tissues (Prica et al., 2007). According to Kumar et al. (2008), the uptake of heavy metal by plants is passive and its translocation from roots to other organs is generally low. The concentration of heavy metal within mangrove plants are varied among organs. Some heavy metals such as Pb and Zn are mostly acumulated in mangrove roots, while accumulation in stems and leaves are lower (Kumar et al., 2010).

Heavy metals are bioaccumulative especially to aquatic organisms. Some of them are essential to the life processes of organisms, while some other are toxic, even at low concentration (Jakimska et al., 2011). Heavy metal concentration and accumulation increases as the increase of throphic levels of the organisms. As the rise of heavy metal concentration within organisms, the risk of toxicity would rise eiter. Excessive concentration of heavy metals have varied toxic effects on living organisms via metabolic interverence and mutagenesis (Govind and Madhuri, 2014).

Zinc (Zn) is one kind of heavy metal regarded as serius pollutant in aquatic ecosystem because of its environmental persistence, toxicity and ability to be incorporated into food chains (Kishe and Machiwa, 2003). According to Chaiyara et al. (2013) Zn plays an important role in cellular metabolism and can be regulated by organisms in their body. A research conducted by Kumar et al. (208) showed that mangrove sediments could contain 8.1 mg/kg of Zn while mangrove water could contain 3.89 mg/L of Zn. While the observation on mangrove organs revealed that Zn concentration in mangrove leaves, stems and roots were 2.89 mg/kg, 1.49 mg/kg and 4.0 mg/kg respectively.

Several research had been conducted to observe the concentration of heavy metal on aquatic organisms, especially which lived within the mangrove ecosystem. A research conducted by Chaiyara et al. (2013) detected Zn concentration within mangrove crabs ranged from 0.38 – 3.92 mg/kg. While Kamaruzzaman et al. (2010) observed the concentration of Zn in fish was 19.27 mg/kg. Another research conducted by Hobbelen et al. (2006) showed the concentration of Zn in earthworms *Lumbricus rubellus* and *Aporrectodea caliginosa* ranged from 954 – 1,871 mg/kg dry weight and 676 – 1,958 mg/kg dry weight respectively.

Massive upland development had became the main problem to coastal ecosystem. Marine pollution such as heavy metal accumulation increased over time, and Zn is one of several heavy metal discharge which is resulted from the increasing anthropogenic activities. The accumulation of heavy metal in the mangrove ecosystem had became threats to coastal aquatic organisms. Hence, information concerning the current condition is required to formulate better management strategies. This research aimed to observe current concentration of Zn in sediment and water within mangrove ecosystem in Demak coastal area and its pollution state.

II. MATERIALS AND METHOD

This research was conducted through field observation and literature study. Observation was conducted in mangrove ecosystem within coastal area of Demak region. Four sampling station was occupied for observation, including 3 sampling transects at each station. Sampling stations were defined purposively to achieve proper information of heavy metal concentration from different mangrove structure. Total of 12 sampling transects was occupied to gain appropriate information concerning the distribution of Zinc (Zn) along the mangrove ecosystem in Demak coastal area. Each transect has 10 x 10 m2 of sampling area.

To describe the condition of mangrove ecosystem in Demak coastal area, observation of mangrove structure was conducted. Observation including mangrove specieses, species abundance and species coverage of mangrove tree. Data analysis was including mangrove community structure such as relative abundance, relative dominance and index of importance was conducted. Analysis formula including:

$$RA : \frac{ni}{N} \quad X\ 100\%$$

Notation:

RA = Relative Abundance
ni = Abundance of Species i
N = Total Abundance

$$RD : \frac{BAi}{BA} \quad X\ 100\%$$

Notation:

RA = Relative Dominance
BAi = Basal Area of Species i
BA = Total Basal Area

Importance Value Index: RA + RD

Data of Zn concentration in mangrove ecosystem was observed from mangrove sediment and water. Samples of sediments were collected randomly from each transect with core sampler. The sediment was taken from the soil surface untill the depth of 30 cm. While samples of water were colected from the floods within mangrove ecosystem. The analysis of sediment end water Zn concentration was conducted at Laboratory of Chemical Analythic, Diponegoro University Semarang.

III. RESULT AND DISCUSSION

The observation on the mangrove structure showed there were 3 mangrove specieses found in coastal area of Demak region. Mangrove specieses including *Avicennia marina*, *Rhizophora mucronata* and *Rhizophora stylosa*. Species distribution and abundance were varied among stations. *Avicennia marina* was found at all sampling stations, where in sampling station 1 and 2 *Avicennia marina* was the only mangrove species found. The abundance of *Avicennia marina* was highest in sampling station 1, and decrease at sampling station 2, 3 and lowest at sampling station 4. The abundance of *Avicennia marina* was 4,067 – 5,600 trees/ha at station 1; 3,033 – 3,900 trees/ha at station 2; 2,033 – 3,200 trees/ha at station 3; and 0 – 400 trees/ha at station 4.

Rhizophora mucronata was found in sampling station 3 and 4 and most abundant in sampling station 4. The abundance of *Rhizophora mucronata* at station 3 was 1,800 – 2,300 trees/ha and 4,100 – 5,200 trees/ha at station 4. While *Rhizophora stylosa* was only found in sampling station 4 in low abundance, covering 67 trees/ha. Highest total average abundance was found at station 1 (4,700 trees/ha), followed by station 4 (4,678 trees/ha), station 3 (4,489 trees/ha) and station 2 (3,356 trees/ha). *Avicennia marina* was also observed as the most abundant mangrove species along coastal area of Demak, followed by *Rhizophora mucronata* and *Rhizophora stylosa*.

Analysis on the Importance Value Index of mangrove species resulted an absolute importance of *Avicennia marina* for sampling station 1 and 2, Since *Avicennia marina* was the only mangrove vegetation found in both station. At sampling station 3, *Avicennia marina* had higher Importance Value Index than *Rhizophora mucronata*. Importance Value Index of Avicennia at sampling station 3 was 127.81% including Relative Abundance of 55.94% and Relative Dominance of 71.87%, while *Rhizophora mucronata* had the Importance Value Index of 72.19% including Relative Abundance of 44.06% and Relative Dominance of 28.13%. Exceptional for sampling station 4, *Rhizophora mucronata* had the highest Importance Value Index followed by *Avicennia marina* and *Rhizophora stylosa*. Importance Value Index of *Rhizophora mucronata* was 174.04% including Relative Abundance of 76.36% and Relative Dominance of 97.68%. The Importance Value Index of *Avicennia marina* was 22.05% including Relative Abundance of 20.26% and Relative Dominance of 1.79%. While the Importance Value Index of *Rhizophora stylosa* was 3.91% including Relative Abundance of 3.38% and Relative Dominance 0.53%.

Analysis on the Zn concentration within mangrove ecosystem in Demak coastal area showed its variation both in the sediment and in the water. Concentration of Zn in the sediment at sampling station 1 was lowest among other stations and station 3 has the lowest water Zn concentration, while at sampling station 4 was highest among other stations both for sediment and water. Zn concentration at station 1 was 293.67 – 536.86 mg/kg in the sediment and 0.09 – 0.16 mg/l in the water. At station 2, Zn concentration was 520.18 – 599.95 mg/kg in the sediment and 0.10 – 0.14 mg/l in the water. At station 3, Zn concentration was 403.44 – 582.67 mg/kg in the sediment and 0.06 – 0.14 mg/l in the water. While at station 4, Zn concentration was 11,108.04 – 12,101.44 mg/kg in the sediment and 0.07 – 0.17 mg/l in the water.

The concentration of Zn in mangrove water according to regulation of Indonesian Ministry of Environment had exceeded the allowable limit, but acording to USEPA (1986) the concentration were still under the permissible limit. According to Indonesian Ministry of Environement regulation No: 51 / 2004, concentration limit of Zn in the water is 0.05 mg/l (Wahyuni et al., 2013), while according to USEPA (1986), concentration limit of Zn in the water is 1.00 mg/l (Saeed and Shaker, 2008). Concentration of Zn in mangrove sediments varied among regulations. According to CCME maximum concentration of Zn in sediment is 124 mg/kg (Saeed and Shaker, 2008), while ANZECC/ARMCANZ recommend the concentration range of 200 – 410 mg/kg (Lestari and Budiyanto, 2013), while IADC/CEDA recommend maximum concentration of 150 mg/kg (Wahyuni et al., 2013). According to the regulation mentioned, the contamination of Zn in mangrove sediment had exceed the allowable limit.

The observation of Zn concentration in mangrove ecosystem showed high accumulation rate in mangrove sediment, but not in mangrove water. It is because solubility of heavy metal in water is lower than its capability to attach on the sediment. According to Keshavars et al. (2012), finer sediment has better capability in absorbing heavy metal. Another factor affecting the high accumulation of Zn in mangrove sediment is because the heavy metal uptake by mangrove plant is low. According to Wen-Jiao et al. (1997), annual accumulation rate of Zn in *Rhizophora stylosa* was 0.11 mg/kg. Since Zn is essential material for vegetation, accumulation of Zn in mangrove organs would not harm the growth of mangrove (Shanmugaarasu et al., 2013).

Mangrove structure plays important role in heavy metal accumulaton. Increasing discharge from anthropogenic and industrial lead to the accumulation of heavy metal contamination in mangrove sediment. Another factors affecting the accumulation of heavy metal and mangrove sediment are rock weathering, soil erosion and dissolution of salts. Low grain size as well as silt and clay fractions attributed to high specific area, favour adsorption processes of heavy metal (Goutam and Ramanathan, 2013). This condition suits the sediments of mangrove ecosystem.

IV. CONCLUSION

Mangrove ecosystem of Demak coastal area consist of 3 mangrove species including *Avicennia marina Rhizophora mucronata* and *Rhizophora stylosa*. Among 3 mangrove

species, distribution of *Avicennia marina* was prevalent at all sampling stations, while *Rhizophora mucronata* was only found in station 3 and 4. *Rhizophora stylosa* was rarely found, which was only at station 4. The concentration of Zn in sediment nor in the water had exceeded the maximum allowable concentration, which means that mangrove ecosystem in Demak coastal area was polluted with Zn.

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