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HEAVY METAL CONTAMINATION IN SEDIMENTARY MATERIALS AFTER NICKEL MINING IN RIVER LAMBULUO MOTUI, NORTH KONAWE, SOUTHEAST SULAWESI PROVINCE

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ABSTRACT

The research is aimed to determine the amount of heavy metal contamination contained in sedimentary materials in River Lambuluo. The types of heavy metal that would be investigated in this research were As^{3+}, Cd^{2+}, Cr^{6+}, Ni^{2+}, and Fe^{3+}. Observation stations were determined purposefully or purposive sampling based on locations or areas with various activities allegedly contributing to the source of the contamination. Observation stations were divided into 3 stations with 3 different days. The research result on the lowest As^{3+} at Station 1 on day 1 is 0.0005 mg/ L and the highest on Station 3 on day 2, i.e. 0.75 mg/ L, the lowest Cd^{2+} at Station 1 on day 1, i.e. 0.005 mg/ L, and the highest at Station 3 days on day 2, i.e. 0.011 mg/ L, the lowest Cr^{6+} at Station 3 on day 2, i.e. 0.0033 mg/ L, and the highest at Station 2 on day 2, i.e. 0.003 mg/ L, the lowest Ni^{2+} at Station on day 1 is 0.0008 mg/ L, and the highest in Station 2 on day 3, i.e. 0653 m / L, the lowest Fe^{3+} ion at Station 3 on day 1 is 0.36 mg/ L, and the highest at Station 1 on day, i.e. 1.52 mg/ L.

INTRODUCTION

Nickel mining activities result in heavy metal contamination in waters, rivers and seas, and at a high level, it may lead to pollution, which will give rise to negative impacts on aquatic biota. Nickel mining activities in the area of Motui in streams and other water bodies carry a huge amount of waste containing various contaminants that are toxic to Lambuluo. The contaminants include heavy metals As, Cd, Cr, Fe and Ni. The influx of heavy metals into these waters may result in contamination. The analysis result of the Environmental Agency of Kendari City in April 2012 finds that metal concentration contained in water samples and sediments in residents' pounds, located around nickel mining in Motui District, have been contaminated by metals Ni, Pb, and Cd. The concentration of these metals has exceeded the threshold stipulated by the government, namely according to the Government Regulation No. 82 of 2001 on water quality management and water pollution control. In addition to the production of nickel minerals, nickel mining also generates other heavy metals associated with other molecules, forming complex compounds. According to Ahmad (2009), nickel mining produces other heavy metals such as As, Cu, Fe and so on. Furthermore, Fardiaz (1992) states that dangerous heavy metals and commonly pollute the environment are including mercury (Hg), lead (Pb), arsenic (As), cadmium (Cd), chromium (Cr^{6+}) and nickel (Ni). The presence of arsenic, cadmium, chromium, nickel and iron in aquatic environments is allegedly to have been in a certain concentration within the sediments and biota.

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Research Objectives

This is aimed to determine the amount of heavy metal contamination contained in sedimentary materials in River Lambuluo. The types of heavy metal that would be investigated in this research were As^{3+}, Cd^{2+}, Cr^{6+}, Ni^{2+}, and Fe^{3+}.

Theories in Brief

Paquin *et al*. (2003) states industrial waste may lead to heavy metals contamination in coastal waters or rivers. Meng *et al*. (2008) and report the presence of heavy metal contamination in coastal waters and estuaries in Bohai Tianjin Bay, China, due to various activities on land and in the seas. Heavy metals may also originate from activities of industry, agriculture, urban areas and mining (Srinivasa *et al*., 2007). Heavy metal accumulated in the waters can infect humans through the

consumption of water or fish. Besides, metal content exceeding the threshold value can be toxic (Malik, 2004). The higher level of metal content in waters will affect the ecological balance by changing various organisms living underwater (Kamarulzaman *et al*., 2011). Basically, metals at low level are needed by organisms, but in high levels, it can be toxic and detrimental to health (Rainbow, 2007). Metals can be carcinogens through oxidative mechanisms generating free radicals and reactive oxygen species, attacking and damaging DNA as well as other important enzymes. The toxicology and carcinogenicity of heavy metals are a field drawing much attention from scientists (Bal, 2002).

MATERIALS AND METHODS

Observation stations were selected purposefully or purposive sampling based on locations or areas with various activities that allegedly contributing to the sources of the contamination. The determination of sampling stations was based on the characteristics of the surrounding environment of River Lambuluo, divided into three research stations (Figure 1) with the following characteristics: Station (St. I): control area (upstream area); Station (St. II): river flow around the mining area. Station (St.III): the river flow after the mining area (estuary). Sediments were retrieved using Ekman grab, taken on the river banks and in the middle of the river. The samples retrieved were taken on untouched parts of Ekman surface to avoid metal contamination coming from sampling tool. The samples retrieved were later mixed together and put into a clean sample bottle to be brought to the laboratory for analysis. Repetitions as many as 3 (three) times were conducted on each samples for three days with one day-time intervals in the first, second and third days. The analysis found that each day, each station was averaged and included in the map tables of research sites, as presented in Figure 1.

RESULTS

The laboratory analysis result finds the analysis data of sediment samples derived from research sites in River Lambuluo, Motui District, North Konawe Regency. The ion concentrations of As^{3+}, Cd^{2+}, Cr^{5+}, Ni^{2+} and Fe^{3+} in River Lambuluo's sediments contained in the research station are presented in Table 1.

Table 1. Ion concentrations of As^{3+}, Cd^{2+}, Cr^{5+}, Ni^{2+} dan Fe^{3+} in river's sediments

No	Metal Ion	Station	Level (mg/L)		
			Day 1	Day 2	Day 3
1	Arsenic (As^{3+})	Station I	0.0005	0.0007	0.0006
		Station II	0.02	0.04	0.015
		Station III	0.67	0.75	0.58
2	Cadmium (Cd^{2+})	Station I	0.005	0.008	0.008
		Station II	0.005	0.006	0.006
		Station III	0.008	0.011	0.009
3	Chromium (Cr^{6+})	Station I	0.003	0.002	0.002
		Station II	0.0026	0.003	0.0021
		Station III	0.0025	0.0033	0.0026
4	Nickel (Ni^{2+})	Station I	0.0008	0.001	0.0005
		Station II	0.28	0.302	0.653
		Station III	0.31	0.503	0.582
5	Iron (Fe^{3+})	Station I	1.52	1.35	1.44
		Station II	1.35	1.42	1.26
		Station III	0.36	0.48	0.52

DISCUSSIONS

Heavy metals have properties that easily bind to organic materials and precipitate in the river beds and unite with sediments so as to the heavy metals concentration in the sediment is higher than in the water (Harahap, 1991). It is resulted from several factors, namely the metal element which tends to be bound by particles and gravity, thus the particles precipitate in the river beds and experience deposition in sediments (Fachruddin and Musbir, 2011).

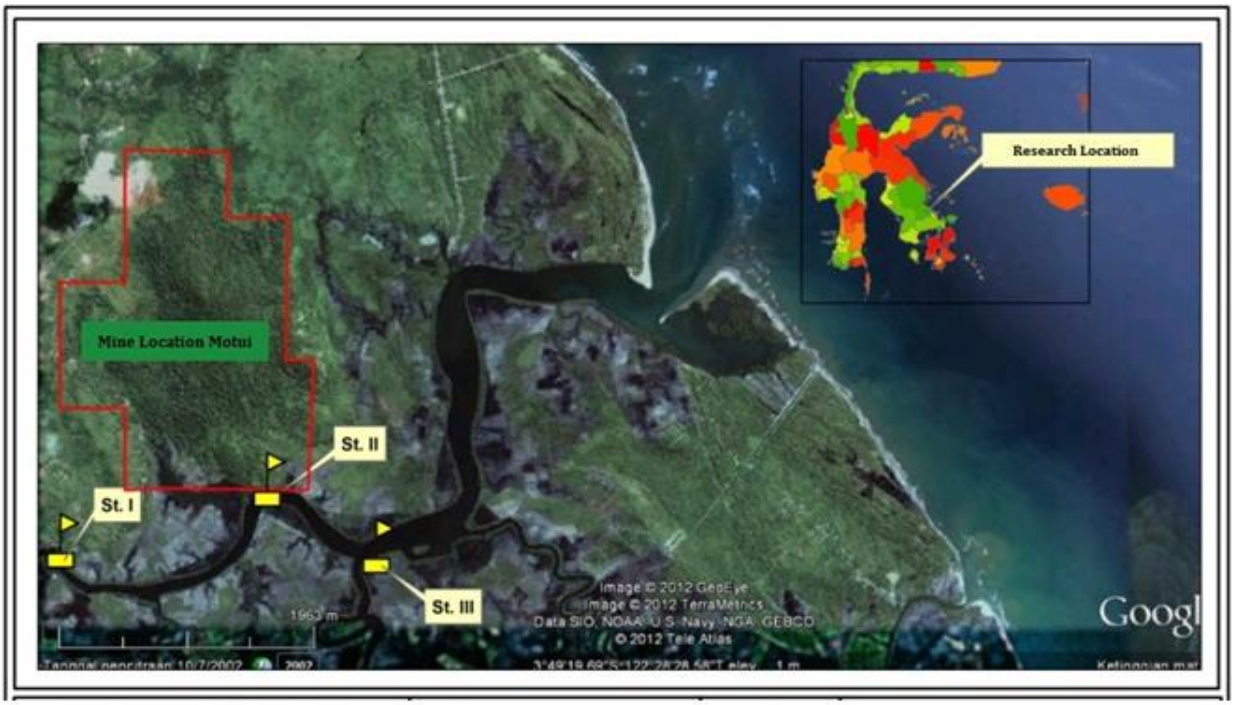

Fig.1. Location Map and Points of Water Sampling Station

A. Metal Ion AS^{3+}

Ion concentration AS^{3+} in sediment tends to be high at station III compared to stations I and II. Ion concentration AS^{3+} can be seen in Figure 2. The increasing ion concentration may be resulted from pollution sources existing around the mining area. The difference in ion concentration in sediments and river water indicates the presence of arsenic accumulation in the sediments, affected by environmental factors, among others the pH and salinity. The relatively high pH causes the precipitation of metal ions, thus its concentrations in sediments is relatively high. High salinity indicates that Cl^- ions are high in the water, so as to these ions capable of forming precipitation with metal ions present in the water. This result is supported by the low concentration of metal ions in water.

B. Metal Ion Cd^{2+}

According to Afiati (2005), the concentration of ion Cd^{2+}in the sediments is higher as the sediment is capable of binding organic and inorganic compounds in a high concentration. Heavy metals dissolved in water will transfer into the sediment in case binding with free organic materials or organic materials coating the sediment surface, and the absorption of heavy metals in the sediments is contained more in the form of precipitation, thereby it is hard to escape back into the waters. The factors causing the high concentration of ion Cd^{2+} on the sediment are affected by environmental factors, i.e. the relatively high pH (Figure 3).

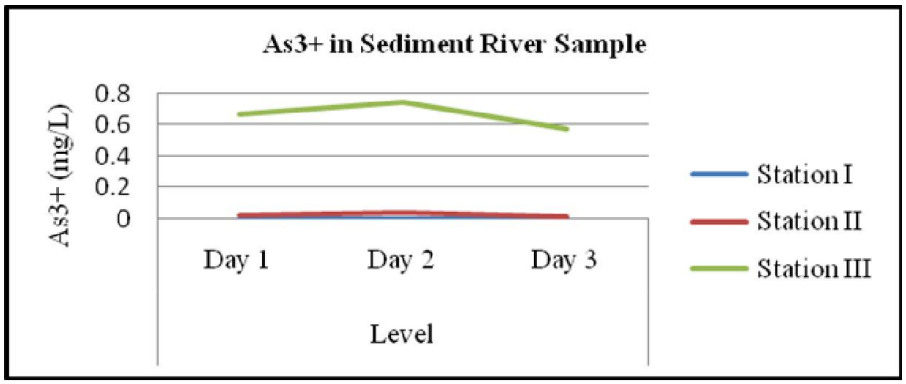

Fig.2. the level of ion As^{3+} in the sediments of River Lambuluo

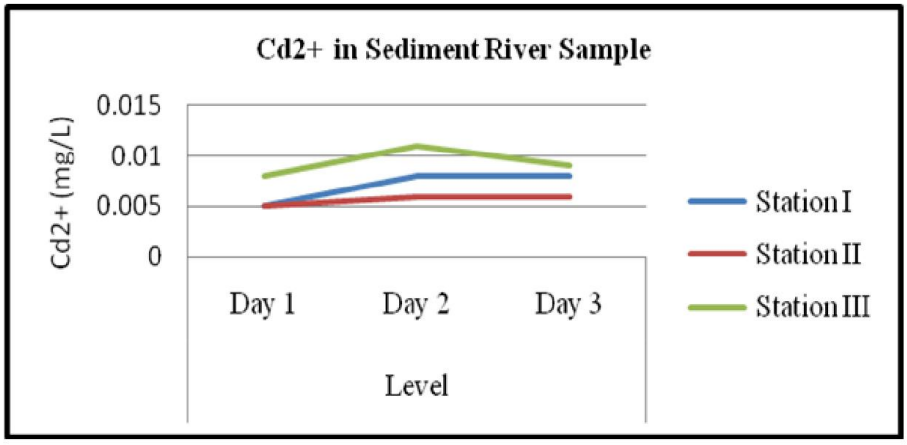

Fig.3. the level of ion Cd^{2+} in sediments of River Lambuluo

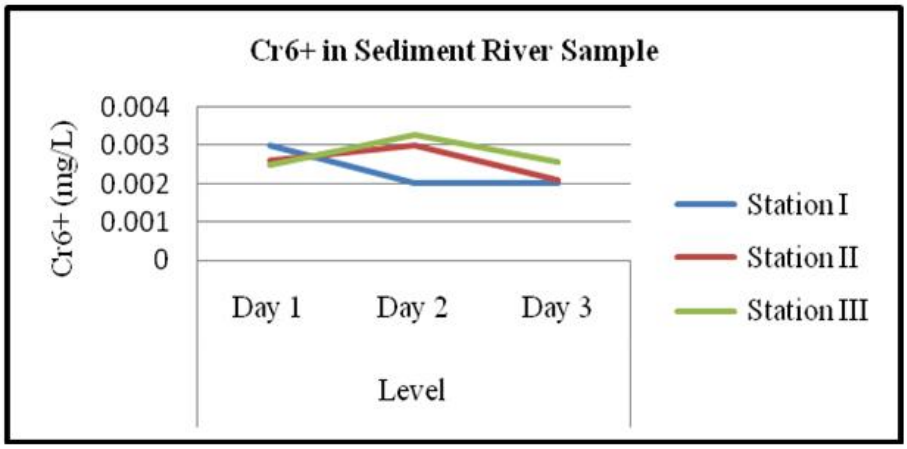

Fig.4. the level of ion Cr^{6+} in sediments of River Lambuluo

C. Metal Ion Cr^{6+}

Ion concentration Cr^{6+} tends to be equal at each station, i.e. from 0.002 to 0.003 mg/ L (Figure 4). The concentration of metal ion Cr^{6+} is yet accumulated in the sediment, as its value is relatively similar to the metal concentrations in the river water.

E. Metal Ion Fe^{3+}

At each station, the concentration of ion Fe^{3+} in the sediment tends to be higher than the concentration in the river water. The concentration of ion Fe^{3+} in sampling on the first day ranged between 0.36-1.52 mg/ L. On the second day ranged between 0.48-1.44 mg/ L, and the on third day ranged between 0.52-1.44 mg/ L (Figure 6).

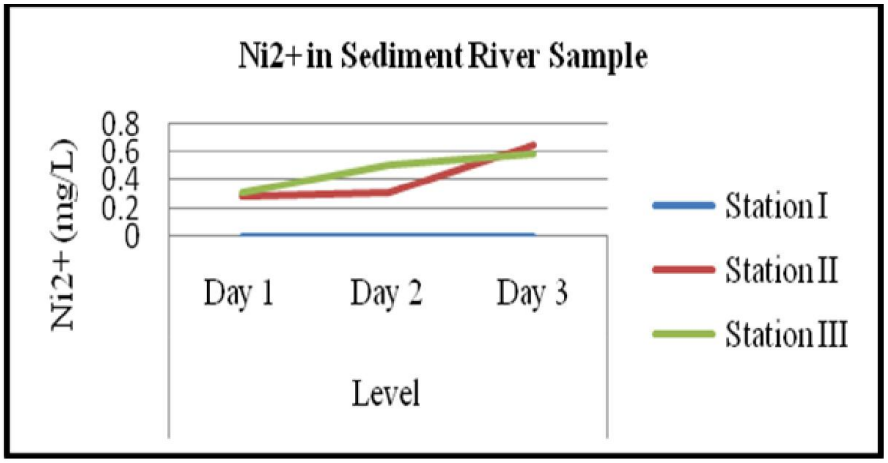

Fig.5. the level of ion Ni^{2+} in sediments of River Lambuluo

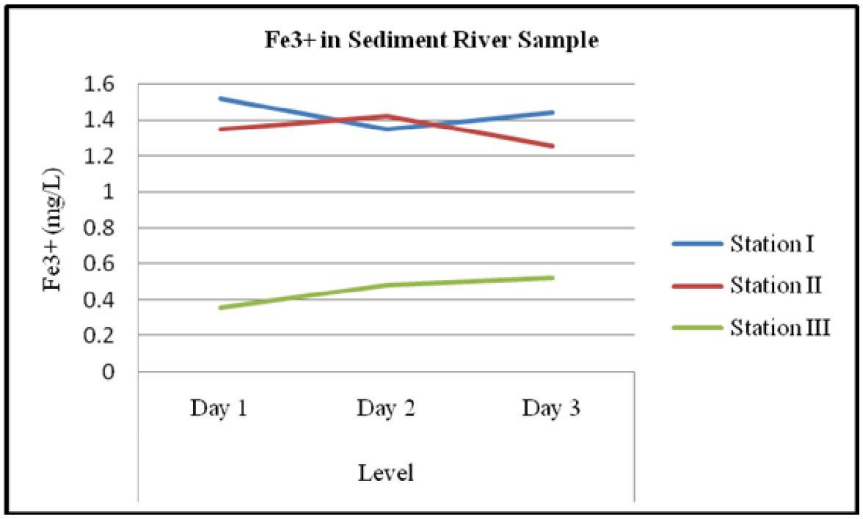

Figure 6. the level of ion Fe^{3+} in sedimens of River Lambuluo

D. Metal Ion Ni^{2+}

The accumulation of ion Ni^{2+}occurs in sediments of River Lambuluo. It will br especially harmful to organisms living in the sediment. Table 1 shows the concentration of ion Ni^{2+} in the sediment at stations II and III which is extremely high compared to the station l, with each concentration value of 0.28 mg/ L and 0.31 mg/ L. Similarly to the sediment samples on the second and third days. The increasing concentration of ion Ni^{2+} in the sediment at stations II and III is caused by environmental factors presence in the river, such as pH, turbidity and TSS. The increased pH can accelerate the metal precipitation in the sediment as well as the increasing turbidity of river water. In a certain period, it will precipitate, thus resulting metal ions in the water to precipitate in the sediments. The increasing concentrations of ion Ni^{2+} at the stations II and III can be seen in Figure 5.

Conclusion

The smallest level of heavy metal ion contaminations of As^{3+}, Cd^{2+}, Cr^{6+}, Ni^{2+}, Fe^{3+} in sediment samples contained in River Lambuluo River is at Stations 1 and 3 in each day of sampling. Meanwhile, the largest contamination level is at Station 2 in each day of sampling. It is due to the station is the most proximate region to the mining area.

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