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Analysis of Pb Levels as Pollutant in the Waters of the Sentani Lake, Jayapura-Indonesia: Study of Determining Water Quality

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ABSTRACT

We have conducted environment research on the waters and analysis of metal levels of lead (Pb), in the Sentani lake in Jayapura, Papua Province-Indonesia. Sediment characteristics and metal content analysis have been analyzed to determine the levels of Pb in the waters. Metal level analysis using Atomic Absorption Spectrophotometry instrumentation. Waters characteristics that have been analysis are density-porosity, water content, texture, pH, DO, and others. The results showed that at each sampling site and every waters depth showed highly significant influence on the metal content of Pb. Average content of metals, Pb, in sediments at each location were location 1 at 28 mg/kg, location 2 of 4 mg/kg. Concentration of Pb (4 to 28 mg/kg) and in waters is lower than the standard quality of heavy metals in waters is 40 mg/kg for Pb level, therefore concentrations of Pb in sediments at two locations of Sentani lake is still below the quality standard so that the levels of Pb in the waters is not contaminated. The existence of Sentani lake waters act as a reservoir heavy metal and not as a source of pollutants to the water quality in the Sentani lake. A routine check on water at Sentani lake needed to ensure the produced parameters did not exceeded the Ministry of Health Regulation.

Keywords: Contaminant, Metal level of Pb, Sentani lake, Papua-Indonesia

INTRODUCTION

Lake Sentani is located in Jayapura District, Papua Province at position 2°33'-2°41' and 140°23'-140°38'. The lake is located at an altitude of 70-90 m above sea level with an area of 9,360 hectares. Based on the typology, Lake Sentani is a type of Landslide lake that is the stagnant waters that formed due to the shifting of land that forms the basin, forming a steep lake type and surrounded by small hills that are steep and grooved like a bay. In general, lake conditions lead to eutrophic conditions. The brightness of the lake ranges from 100-240 cm, water temperature (29-33 °C), pH (6.6-9), dissolved oxygen concentration (2.75-7.57 mg/L), lake alkalinity ranges from 66, 15-165 mg/L $CaCO_3$, which means classified as a watershed because the lake is surrounded by limestone mountains. Nitrate concentrations between 0.078-0.24 mg/L and phosphate ranged from 0.01-0.29 mg/L. The lake also has potentials in the fisheries, tourism and industry sectors. Some heavy metals are dangerous and often pollute the water environment or water bodies are mainly Hg, Pb, As, Cu, Cd, Cr, Zn and Ni [1-3].

Heavy metal pollution in the Sentani lake, as an example, Pb and other heavy metals, due to the entry of pollutants originating from home industry, urban wastes, agricultural, fishery and from transportation activities [4-7]. In addition, these three elements are interconnected to determine the level of water fertility. The C:N:P ratio affects the food webs in the waters, so the values are different in plants, bacteria, zooplankton and fish. These three elements are available in the form of compounds and have separate processes and are heavily dependent on their presence which is dissolved in water [8,9]. The nutrient concentration in the sediment will affect the biota population in the bottom of the waters. It is also the reverse, that the population may affect the concentration level of the sedimentary nutrients. Heavy metal pollution can come from natural or industrial activities. Water pollution can be salts of heavy metals and heavy metal formed toxic compounds. Heavy metals are often found to water pollution is Hg, Pb, Cd, Cr, Cu, Ni, and Zn in the form of toxic compounds.

Aquatic environmental factors such as pH, TSS, BOD, temperature, and oxygen solubility (DO) also affects the toxicity of heavy metals level [10-12]. The decrease in the pH of the water will cause heavy metal toxicity greater. High hardness can influence the toxicity of heavy metals, because of the heavy metals in the water are hardnesses high will form complex compounds that settles in the bottom waters. Research on the content of heavy metals in the waters and sediments of Sentani lake of Jayapura has never been done. Therefore, aims of this study are to determine the role of the waterfront or waters edge on water quality and the content of heavy metals in in the waters of Sentani lake. This research can be a part or reference for policy makers for the utilization of lake water Sentani forward.

MATERIALS AND METHODS

Locations of research and materials

The study was conducted at two study sites are location 1 and location 2 (near Yahim village). The location of sampling sites used by the GPS device. The material used is a plastic bags, filter paper, label paper, markers, ice cubes, universal pH paper, wathman 42 filter paper, and distilled water. Chemicals used were nitric acid (HNO_3) acid p.a 65%, nitric acid (HNO_3) 1 N, 5% KCl, buffer solution 4.0, 7.0, 10, NH_4CH_3COO 1 M, 2 M HCl, 5% Kalgon, acetylene gas (C_2H_2), Pb $(NO_3)_2$, $ZnSO_4.7H_2O$, $NaPO_3$, Na_2CO_3 and H_2O_2 30%. While the tools used are sediment core, acrylic pipe, Atomic Absorption Spectrophotometer (AAS), Analytical scales, ovens, tape measure, GPS, pH meters, conductometer, DO meter, pycnometer, hot plate, sieve shakers, desiccator, vacuum pump, and thermometer 110°C.

Activities in the laboratory, sediment samples still included in the steel container and remove foreign objects such as pieces of plastic, other material contained in a sample to be analyzed. Dry the sediment in an oven at 110ºC until constant weight was obtained. Carefully weighed 2-3 g of dried sediment and put in erlenmeyer, then added 20 mL of a mixture of HNO_3 and H_2O_2 (1:1) and destructed for 3 h at a temperature of 120°C in a constant state. The result of this destruction was filtered and the filtrate is collected in a 50 mL volumetric flask and diluted with distilled water to mark boundaries. The filtrate is then measured by AAS equipment [13-15].

Total of 3 g of dried sediment or waters and put in erlenmeyer, then added 20 mL of a mixture of HNO_3 and H_2O_2 (1:1) and then destructed for 3 h at a temperature of 120°C in a constant state. The result of this destruction was filtered and the filtrate is collected in a 50 mL volumetric flask and diluted with distilled water to mark boundaries. The filtrate is then measured by AAS [13]. A calibration curve was prepared by measuring the absorbance of a series of concentrations of standard solutions that have been made, then made a graph showing the relationship between the absorbance of the standard solution concentration. Each absorbance was measured at ʎ=283 nm for Pb. After concentration measurement is known, then the actual concentration of Pb in the sample can be determined by calculation [14-18].

RESULTS AND DISCUSSION

Physical and chemical parameters in the waters and sediments of Sentani lake, Jayapura-Papua (location 1 and location 2) measured and the results are shown in Tables 1-3.

Table 1: Data of sediment physical parameters of the Sentani lake

Location/class	Weight (g/cm^3)		Persentage (%)		
	Content	Type	Sand	Dust	Clay
Location 1/Sand and sandy loam	1.3	2.41	84	13	5
Location 2/Silty clay	1.0	2.40	52	43	4

Table 2: Data of sediment chemical parameters of the Sentani lake

Location	Porosity (%)	Water Levels		pH
		g/g	%	
Location 1	46.67	0.51	49.3	8.4
Location 2	59.15	0.91	63.7	7.3

Table 3: Water Sentani lake in Sentani

Year	Month	BOD (mg/L)	COD (mg/L)	TSS (mg/L)
2016	November	2.28	10.52	38.12
	December	2.96	11.61	29.2
2017	January	2.41	9.91	32.7
	February	2.36	10.3	29.5
	March	2.57	11.86	37.85
	April	3.91	14.96	54

The results of the analysis showed that the factor A does not provide a significant difference to the levels of Pb. This means that the depth of the sediment was not significantly different Pb concentrations. Factor B (location) gives a significant difference to the concentration of Pb, it shows at each location were significantly different from the concentrations of Pb, while the interaction of sediment depth and location make a difference. Only locations that significantly influence the concentration or level of Pb. Location 1 had an average concentration of Pb largest (Average=28), while at location 2 had an average concentration of Pb smallest (Average=4). In location 1, with depth of sediment (cm): 0-5 cm=24; 5-10 cm=28; 10-15 cm=32. Meanwhile, in location 2, with depth of sediment (cm): 0-5 cm=3; 5-10 cm=4; 10-15 cm=4.

At location 1, Pb levels at any depth increased metal concentrations slowly, where the existing sediment texture is sandy texture types, and thickness of the sediment layer so as a result of the influence of gravity and tend to result in accumulated metal precipitate. The levels of Pb (28 mg/kg) is higher than other locations. The high concentration of this pollutant in the location 1 also due to the high mobility of home industry and water transportation where transport used many using the motor with the gasoline fuel gases so that the rest of the fuel combustion process produces exhaust gases directly interact with the lake water and the location is also influenced by human activity where that places surrounding locations close to population centers or communities.

At other location, location Pb levels in waters at a depth of 0-5 cm up to a depth of 5-10 cm showed a rise slowly the land, but the depth of 10-15 cm showed a decrease in concentration. While the concentration of Pb in the that place has a lower value than the that location. This is because that location closer to the estuary of the river on a rainy day so as much material into the lake forming sedimentation and dilution occurs so that the smaller the metal concentrations.

On the location 2, Pb levels in sediments at lower depth showed a rise, while on 10-15 cm in depth whereas concentrations showed no increase in concentration. This location has a value of Pb is very small metal content between the three locations, namely 4 mg/kg. This is because, in addition to this is the location where the transport activity and urban activity is also close to the location of the mouth of the river when it rains often flooded so it had a very high dilution that resulted in decreased concentrations of Pb.

Overall levels of Pb in the waters of Sentani lake is in accordance with the quality of heavy metals in sediments are set out in the EPA. Pollutant of Pb in the mean total is 4 to 28 mg/kg. A routine check on water at Sentani lake needed to ensure the produced parameters did not exceeded the Ministry of Health regulation or regulation of Papua governor through the environmental agency. To ensure the produced water meets the standard quality is important to keep the health aspect as source of drinking water. A review on Environmental Impact Assessment (EIA) documents with an environmental audit in every years needed to be focused on technological approach to ensure the produced water meets the standard quality set by Ministry of Health of Republic of Indonesia and Standard of WHO [2,5,16-18].

CONCLUSION

The conclusion that could be drawn from this study are as follows: content of heavy metal level of Pb in waters and sediments at each location that is location 1 at 28 mg/Kg, location 2 of 4 mg/Kg. The levels of Pb (4 to 28 mg/kg) in sediments is lower than the standard quality of heavy metals in sediments that is 40 mg/kg for Pb metal concentration of Pb in sediments at 2 locations Sentani lake is still below the quality standard so that the levels of Pb in the sediment is not contaminated. A routine check on water at Sentani lake needed to ensure the produced parameters did not exceeded the Governor of Papuan regulation and Ministry of Health Regulation of Republic of Indonesia.

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