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Abstract

Title	Environmental Impacts of Mercury Released from Small-Scale Gold Mining in Central Kalimantan, Indonesia

(800 words)

The aims of this study are to evaluate the environmental impacts of mercury released from small scale gold mining; to identify the bioaccumulation process of mercury in the environment; the determine the amount of mercury released into the river systems and its distribution into different environmental compartments; to asses the human health risk; and to find better solutions in reducing mercury emission from gold mining activities in Central Kalimantan

To achieve those purposes, field samplings were conducted in high gold mining activities areas. Study areas were divided into three groups (Eastern, Center and Western parts of Central Kalimantan). Field samplings were carried out between January 2007 and January 2011 in Eastern part, between January 2004 and December 2009 in Center part, and in Western part, the sampling was only carried out in January 2009. Water, sediment and atmospheric samples were collected from all the study areas. However, for soil and human hair samples were collected only from Eastern part. Fish samples were obtained from Eastern and Center parts.

This study revealed that small-scale gold mining was a main source of mercury contamination in Central Kalimantan. Mercury concentrations in water samples collected from Eastern part reached a value of 46700 ng/L. This concentration exceeded mercury concentrations allowable in drinking water of Indonesia (1000 ng/L). Even for mercury content in wastewater, the value was still high. For example, The Ministry of the Environment of Japan has set up the mercury concentrations that can be discharged into the environment. The value is set up at 5000 ng/L. While, the limitation of mercury content in wastewater set up by US EPA is 10000 ng/L. In other parts, the mercury concentrations did not exceeded the value of 2200 ng/L. In sediments, mercury concentrations were also higher in Eastern part (reached a value of 58 mg/kg DW). Whereas, mercury concentrations from other parts were less than 0.67 mg/kg DW.

Fish species collected from Eastern part (tributaries of Barito River) have mercury concentration exceeded US EPA guideline for human consumption (0.3 mg/kg). Accumulation of mercury in an environment was investigated in Lake Tilap. Average mercury concentration increased 2.5 times from the lower to the higher level of organisms on food chain position. Fish, in the highest position of food chain, accumulates more mercury in its tissue through dietary process.

Eastern part had the highest atmospheric mercury concentrations compared to the others in which mercury concentrations reached a value of 6250 ng/m^3. While in Center part, the concentrations were less than 1800 ng/m^3. Atmospheric values in Western part were the lowest, but still higher than normal value (1 to 2 ng/m^3).

Mercury entered into the environment distributed into different compartments. The distribution of mercury in the environment was investigated in Lake Tilap by using Fugacity Model Level I. The results obtained by the model were compared to the observation results. The percentages of mercury distribution were influenced by the depth of the sediment and the height of the atmospheric area applied in the both calculations. The percentage was higher in the sediment than in air when the depth of sediment applied in the calculations was 3 cm. Whereas, if 1 cm of sediment depth was applied, the distribution of mercury in the air was higher than in sediment.

Hazard Index (HI) was used to evaluate the human health effect by consuming mercury contaminated fish obtained from study areas. HI values were more than one in which mean adverse effects on health occurs if consuming the fish investigated in this study. Fish from Eastern part are not recommended to be consumed due to the HI values were more than one. Human health assessment was also examined by measuring mercury levels in human hair were still under the normal concentration (10 mg/kg). Only 16% of the donors had mercury concentrations exceeded the normal value, but the values were still below the level which caused Minamata disease (50 mg/kg). Most donors who had mercury concentrations in their hair were donors living within gold mining areas. Gold mining activities have influenced mercury concentrations in human hair.

Efforts in reducing mercury emissions from the gold mining activities are being conducted by miners. Home made retorts are used to reduce mercury released in to the atmosphere when heating an amalgam form. Local government has issued two regulations related on mercury distribution in markets and how to handle mercury properly during amalgamation process by miners. In addition, combinations between hard and soft actions could be applied in order to minimize the mercury released into the environment in Central Kalimantan.