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Research Article

Effect of traditional gold mining to surface water quality in Murung Raya District, Central Kalimantan Province

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Abstract : There are many locations for traditional gold mining in Indonesia. One of these is in Murung Raya District, Central Kalimantan Province. Mining activities involving the application of traditional gold processing technology have a high potential to pollute the environment, especially surface water. Therefore, this study aims to determine the impact of gold mining and processing on surface water quality around the mine site. Based on the results of field surveys and laboratory analysis, our data shows that the concentration of mercury (Hg) and Cyanide (CN) has reached 0.3 mg/L and 1.9 mg/L, respectively, in surface water. These values exceed the drinking water quality standards of Indonesia and WHO. Many people who live in the mining area use surface water for daily purposes including drinking, cooking, bathing and washing. This scenario is very dangerous because the effect of surface water contamination on human health cannot be immediately recognized or diagnosed. In our opinion the dissemination of knowledge regarding the treatment of gold mining wastewater is urgently required so that the quality of wastewater can be improved before it is discharged into the environment.

***Keywords**: heavy metals , surface water contamination, traditional gold mining*

Introduction

Natural resources in Indonesia is very abundant both energy resources and mining resources. One of considerable mineral potential is a gold mine. The potential gold resources are distributed almost in every island. Gold mining has also been carried out both large and small scales, one of them in the Central Kalimantan Province. The number of gold companies in this area is 49, which 3 companies located in the District of Murung Raya (Regional Development Planning Agency Murung Raya District, 2010). Despite the big gold deposits there are many smaller deposits that are not interesting enough for big mining companies. Therefore those deposits are still undeveloped. This condition has attracted to the local communities to operate small scale gold mines. However, almost of them do not concern to the environment and mining safeties. The situation like this is common in the developing countries such as Indonesia.

Contamination of the traditional gold-mining areas of Transbaikalia (Russia, Siberia) is investigated by Laperdina (2002). The concentration of mercury in the water reaches 27,800 mg/L. The most severe cases of mercury contamination were observed in areas with direct use of the mercury amalgamation technique. The extent of mercury contamination depended on the duration and intensity of mining activities. The arsenic contamination in soil and stream sediment at traditional gold mining Wonogiri area, Central Java reaches up to 385 mg/kg, even though the arsenic mineral is rare (Harijoko et al., 2010). The heavy metals contamination in the water is not all from anthropogenic process but some of them controlled by natural condition such as arsenic contamination in Bangladesh and West Bengal (Nickson et al., 2000) and Buyat Indonesia (Wilopo et al., 2006)

In order to understand the effect of traditional gold mine and processing in Murung Raya District, Central Kalimantan to the environment especially for surface water, some water samples were taken from the field to analysis. In addition, analysis of sediment samples was also conducted to understand the source of water contaminant from human activities or natural process.

Materials and Methods

A research site is located in the Murung Raya District, Central Kalimantan Province as shown in

Figure 1. River water and river sediment samples were taken from four rivers namely Muramatoi River, Karamulung River, Potung River and Punin River. Each river was taken 3 water samples and 3 river sediment samples that located in the upper, middle (after the gold processing sites) and downstream. Samples were filtered through 0.45 µm pore size membrane filters, acidified to a final concentration of 1% nitric acid, stored in a polyethylene recipient, and refrigerated until analysis. Non-acidified samples were measured in situ for pH, temperature and total dissolved solute (TDS). Portable HANNA meters, calibrated with standard buffers, have been used for in-situ measurements of temperature, pH and TDS. Acidified samples were analyzed for trace elements by inductively coupled plasma – atomic emission spectrometry (ICP-AES) and mass spectrometry (ICP-MS) at PT. Sucofindo. The river sediments were analyzed for their mineral composition by X-ray Diffractometer (XRD) Rigaku in Geological Engineering Department, Gadjah Mada University.

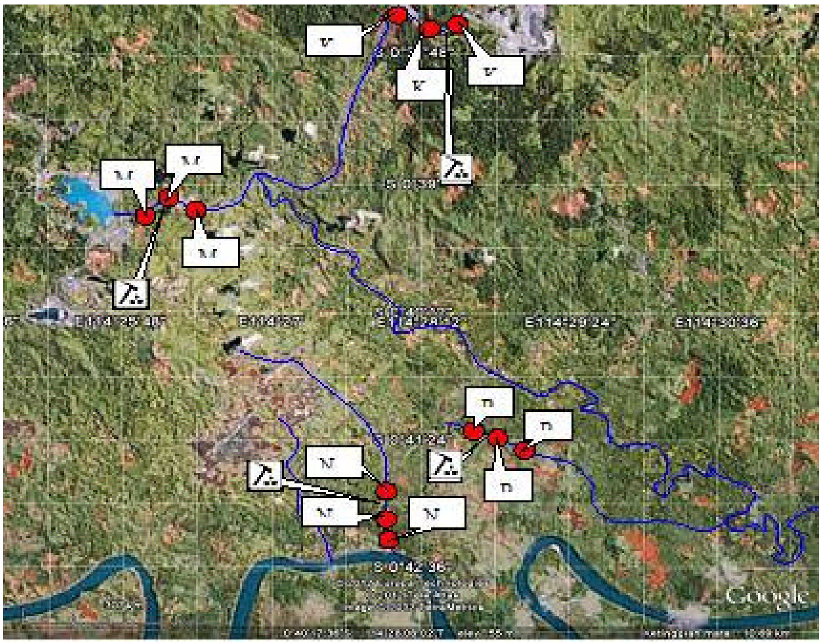

Figure 1. Location of water and sediment river sampling

Results and Discussion

Clean water is a basic requirement that should be consumed of people regularly to maintain their health. Good or poor water services will greatly depend on the availability of raw water for further processing. Mostly of raw water for water supply is taken from the river. The water supply agency (PDAM) in Murung Raya also uses the river water as a source for drinking water after treatment. This agency only can provided small resident that stay close to the processing plant. In addition, the production of clean water relative small and distribution cannot reach all resident (Regional Development Planning Agency Murung Raya District, 2010). Some resident cannot buy it because their income is low. Although the depth of groundwater is relative shallow around 1- 8 meters from the surface but the resident prefer to use river water, especially for the people who live in the river banks. They use river water for daily purposes such as drinking, cocking and washing which is not guarantee the healthiness. In other side many gold mining and processing are located near the river in the upstream area. This processing is operated by local people with traditional method such as amalgamation and cyanidation. Mostly of them discharge a liquid waste to the river without any treatment. The river water is very vulnerable to contaminate by heavy metals that contains in the liquid waste from gold processing.

The analysis of water samples from 5 rivers indicate that the river water already contaminated by some heavy metals as shown in Table 1. In the river Muramatoi shows increasing of mercury (Hg), arsenic (As) and copper (Cu) concentration are quite significant in water samples taken at downstream after the location of gold processing (M3) (Table 1).

Table 1. Result of river water and river sediment analysis

Sample Code	Coor	dinate	River Name	Sub District Name	Water	Qua	lity								Sediment Composition
	Longitude	Latitude			Temp	Turbidity	pH	TDS	TSS	Hg	As	Pb	Cu	Cn	
					°C	NTU		mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
M1	114° 24' 22.31"	00° 38' 21.57"	Muramatoi	Sei Babuat	28.5	6	6.2	17	02.0	1.1	24.5	nd	nd	15.9	Quartz, Laumontite
M2	114° 24' 19.10"	00° 38' 17.56"	Muramatoi	Sei Babuat	29.2	133	6.1	42	11.0	72.6	19.2	9.9	8	16.9	Quartz, illite, hematite
M3	114° 24' 18.39"	00° 38' 13.89"	Muramatoi	Sei Babuat	28.8	73	4.3	105	19.0	86.1	62.6	nd	113	18.1	Quartz, illite,
K1	114° 28' 42.20"	00° 37' 21.20"	Karamulung	Tanah Siang	27.3	29	5.0	360	11.0	1.5	nd	nd	Nd	15.7	Illite, Hematite, Diopside, Holloysite
K2	114° 28' 36.59"	00° 37' 21.20"	Karamulung	Tanah Siang	27.5	32	6.3	101	14.0	29.8	43.9	nd	8.2	22.8	Quartz, Hematite
K3	114° 28' 12.69"	00° 37' 09.19"	Karamulung	Tanah Siang	28.3	99	6.3	345	98.0	1.2	Nd	nd	nd	11.4	Quartz, calcite, hematite
P1	114° 27' 15.90"	00° 40' 42.60"	Potung	Tanah Siang Selatan	27.2	3	5.9	10	1.0	nd	15.4	9.9	10.7	12.8	Quartz, calcite, hematite
P2	114° 27' 21.42"	00° 40' 41.54"	Potung	Tanah Siang Selatan	27.2	16	6.0	12	4.0	nd	19.2	nd	Nd	24.1	Quartz, calcite
P3	114° 27' 49.29"	00° 40' 42.20"	Potung	Tanah Siang Selatan	27.3	80	7.6	38	71.0	1.1	19.8	nd	438.8	1863.3	Quartz, Alunite
N1	114° 27' 57.60"	00° 42' 18.20"	Punin	Murung	27.0	23	6.5	82	36.0	nd	nd	nd	Nd	54.9	Illite, Quartz, Diaspote, Hematite
N2	114° 27' 59.79"	00° 42' 18.60"	Punin	Murung	27.2	237	8.3	109	236.0	4.8	nd	nd	32.9	1479.8	Quartz, hematite
N3	114° 27' 58.60"	00° 42' 27.10"	Punin	Murung	27.0	1036	9.1	74	477.0	346.3	nd	9.9	551.6	1965.4	Quartz, hematite, kaolinite, illite

Note : nd = not detected; 1= sample from upstream; 2=sampel from close to gold processing and 3 sample from downstream.

Increasing of Hg concentration was recognized in the middle (M2) closely related to the disposal of liquid waste from gold processing. Almost of gold processing in this area uses amalgamation and cyanidation methods. In addition, analysis of mineral composition from the river sediment also indicate dominant minerals are quarts, illite and hematite that do not contain metals Hg, As and Cu. Decrease in pH in the sample from downstream (M3) also affects to the increasing in concentration of metals, especially Cu. Copper (Cu) is easily to dissolve in acidic conditions (Deutsch, 1997).

Increasing of Hg, As, Cu and Cyanide (Cn) in river water were recognized in Karamulung river, especially in sample K2 which taken close to the gold processing (Table 1). However, this concentrations decrease again in the downstream area (sample K3). It might be due to increasing of pH causes precipitation of heavy metals and immobilization by mineral. Increase of pH is triggered by the presence of calcite in the river sediment according to XRD data. Hematite is also detected from XRD analysis in all samples. This mineral has capability of immobilize Cu and As (Benjamin et al., 1996). In addition, the result from XRD also shows all minerals not contain of Hg, As, Cu and Cn elements. The miners use amalgamation and cyanidation methods for gold processing which produce high concentration for Hg and Cn in wastewater. Therefore, it can be concluded that high concentration of heavy metals in water is due to discharge of liquid waste water from gold processing. Water samples from Potung river show a trend increasing of Cn and Cu metals in downstream areas (Table 1).

Although the pH conditions from upstream to downstream increase to be relative alkaline because the presence of calcite in the sediment, however this pH still cannot make Cu precipitated. A high Cn concentration in river water is caused by using of cyanide in gold processing with the cyanidation method which located close to Sample P2.

High concentration of cyanide is recognized in the Punin river, especially sample N3 (Table 1). It reaches 1965.4 μg/L, the highest if compare with other rivers. In addition from sample N3 also shows increasing of Hg and Cu in the river water if compare with other samples. Anlaysis of XRD from sediment river show the presence of quartz, illite and hematite which are not content of cyanide. Almost of miners in this area using cyanidation method for gold processing. Only small miners use amalgatmation method. Therefore, high cyanide concentration in the river water is caused by contamination from liquid waster from gold processing.

Conclussions

According to the chemical analysis of river water shows that in Muramataoi river, Karangmulung river, Potung river and Punin river already contaminated by heavy metals especially Hg and Cn. Thus elements are not come from geologic process because according to XRD of river sediment dot not contains Hg and Cn minerals. Therefore, it can be concluded that river water contamination is caused by gold mining and processing in upstream area. Therefore, it is urgently required to make some socialization to the miners for liquid waste water treatment before discharging to the river. Because the river water in downstream area is used by people for their daily purposes.

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