Illegal Gold Mining in Kuantan River: Mercury Contamination Analysis

Rindi Genesa Hatika¹, Indang Dewata², Iswandi U³, Purwo Subekti⁴, & Saiful Anwar⁵

¹Universitas Pasir Pengaraian
Email: rindigenesa@gmail.com
²Universitas Negeri Padang
Email: i_dewata@yahoo.com
³Universitas Negeri Padang
Email: iswandi_u@yahoo.com
⁴Universitas Pasir Pengaraian
Email: purwos73@gmail.com
⁵Universitas Pasir Pengaraian
Email: saifula160@gmail.com

Abstract. The illegal gold mine in kuantan singingi district was a very difficult problem. Raids on illegal gold miners have also been made, but have not been able to cause deterrent effects for the perpetrators. This was due to the lack of public knowledge of the effect caused by illegal gold mining, one of the dangers feared is mercury contamination. This study aims to analyze the mercury contents found in the water in the area of gold mining in the kuantan river, Kuantan singingi district, Riau. Determination of mercury content in the sample was conducted using Atomic Absorption Spectrophotometer (AAS). The results of the analysis found that the mercury content in the sample sites 1 and 4 was 0.0407 mg / L and 0.0117 mg / L, which means that exceeds the limit value of the provisions of 0.002 mg / L (PP No. 82 of 2001).

Keywords: Mercury, Gold Mine, Atomic Absorption Spectrophotometer

1. Introduction

In nature, mining involves the production of waste in large quantities, which can contaminate the soil in large areas, thereby adversely affecting the environment and human health (USEPA, 2009). The type of waste that potentially damages the environment is the waste that is included in Hazardous Toxic Substances (B3) in which there are heavy metals such as mercury (Hg). Mercury is one of the trace elements that have liquid properties at room temperature with specific gravity and high electrical conductivity, and is a toxic element of global concern as it poses a signifying hazard to humans, animals and ecosystems [1].
Kuantan River is one of the existing rivers in Kuantan Singin Regency, Riau, along this river flow there is illegal gold mining activity. The traditional gold processing process applied by Kuantan River, Kuantan Singin Regency, Riau uses simple technology through amalgamation process with mercury as a gold catcher. This process has a negative impact on the surrounding environment because at each stage of the process allows the occurrence of heavy metal element distribution, so it is feared to pollute the environment. The environment contaminated by mercury can harm human life because of the food chain. Mercury accumulates in micro-organisms that live in water (rivers, lakes, seas) through metabolic processes.

Research on the mercury content in the water around the river flow that has gold mining has also been done by Reference [2] who found that mercury content in the river flow of Kuantan Rod, Sijunjung regency West Sumatra where there is illegal gold mining that exceeds the limit that has been determined by PP. 82 of 2001 which is more than 0.002 mg/L. Therefore, research on Mercury Analysis on The Area Around The Illegal Gold Mine in Kuantan River needs to be done to find out the mercury contamination found around Kuantan river flow which has the gold mining of wild.

2. Theory

Hg metal can be absorbed into the body through the digestive tract and skin. Due to its toxic and volatile nature, mercury vapors are extremely dangerous if exposed, albeit in very small quantities. Mercury is a cumulative toxin, in the sense that small amounts of mercury absorbed in the body in the long term will cause harm. The dangers of diseases caused by mercury compounds include hair and tooth damage, loss of memory and disruption of the nervous system [3][11].

Mercury is a toxic metal that can cause a variety of adverse health effects depending on the form of mercury (element, inorganic, or organic) and pathway, quantity, and duration of exposure. Chronic exposure to small amounts of inorganic mercury or mercury occurs mainly through inhalation of mercury vapor and may cause tremor, renal dysfunction, and various neurocognitive and behavioral disorders. Acute exposure to inorganic elements or mercury may occur in certain occupational settings or during acute poisoning events and may result in severe lung injury or death. Chronic exposure to methymercury, a common type of organic mercury, occurs mainly through eating contaminated fish. It can damage the central nervous system, leading to impaired vision and hearing [4]. Mercury (Hg) has a negative impact on health when consumed. The impact of mercury (Hg) on health is characterized by a feeling of nausea in the stomach and vomiting, feeling trembling in limbs such as arms and legs, and sensitive to uncovered skin. And over long periods of time, mercury (Hg) can lead to gingivitis, nervous system disorders, mild tremor and parkinsonism, accompanied by tremor in conscious muscle function [5].

During the amalgamation process, mercury is often discharged into the environment. When it enters the water, it can transform into organic mercury compounds, such as methylmercury, and bioaccumulation in fish. This process presents three main potential routes of mercury exposure: (1) miners can have skin exposure when they mix mercury elements with gold ores; (2) elemental and inorganic mercury vapments may be inhaled when the amalgam is heated; and (3) methylmercury may be consumed from contaminated fish [6].

Mercury can be released into the environment in the washing and repeating steps in the gold amalgamation process. In this process, the waste that is generally still contain mercury is discharged directly into the body of water. This is due to the mercury is mixed / split into fine grains that are difficult to separate in the milling process that is done simultaneously with the amalgamation process, so that in the process of washing mercury in the waste into the river [7].
3. Research Methods

The research was conducted around the Kuantan river in Kuantan Singingi regency, Riau. In this river flow, there are many illegal gold mining activities using mercury. There are 4 locations of specified sampling points using the Global Positioning tool (GPS) tool. Four sample sites are within a 5-10 m radius of gold mining. Water samples were collected in 4 different sample locations separately and put into a 1000 ml plastic container then preserved with concentrated nitric acid. Geochemical studies have been done by determining the pH and concentration of mercury (Hg) metals in water samples using Atomic Absorption Spectrophotometer (AAS). In determining the pH of the water sample is used SNI 06-6989.11.2004 test method, while in determining the mercury concentration used test method SNI 6989.78: 2011.

4. Result and Discussion:

4.1 The pH Level

The results of research on pH level on water samples around Kuantan river, Kuantan Singingi regency, Riau are shown in table 1 below.

| No | Sample Code | pH  |
|----|-------------|-----|
| 1  | A1          | 7.31|
| 2  | A2          | 7.28|
| 3  | A3          | 7.29|
| 4  | A4          | 7.36|

Mean 7.31

Based on the results of the laboratory measurements (Table 1) found that the water samples at the four research sites are located in the standard set by PP. 82 Year 2001 is between 6-9. On average the pH value around the Kuantan river flow, Kuantan Singingi regency, Riau is 7.31 which is still within the established standard. The degree of acidity (pH) of water is preferably neutral to be consumed should not be acidic or alkaline. Water is said to be neutral when it has a pH value of 7, whereas it is said to be acid when pH <7 and is said to be base (bitter taste) when pH> 7. The pH value can affect the toxicity of a chemical compound, the higher the pH value the higher the alkalinity value and the lower carbon dioxide levels. If the pH is low, then the waters are acidic and corrosive, the metal toxicity increases, and the nitrification process will be inhibited [8].

4.2 Mercury (Hg)

The analysis of mercury concentration around Kuantan river flow, Kuantan Singingi Regency, Riau using Atomic Absorption Spectrophotometer (AAS) is shown in table 2 below.

| No | Sample Code | Hg (mg/L) |
|----|-------------|-----------|
| 1  | A1          | 0.0407    |
| 2  | A2          | <0.0003*  |
| 3  | A3          | <0.0003*  |
| 4  | A4          | 0.0117    |

* LoD= Limit of Detection
The results of mercury (Hg) concentration in water samples (Table 2) showed that at sites 2 and 3 mercury concentrations in water samples were still below the limit of detection, whereas at sites 1 and 4 showed 0.0407 mg / L and 0.0117 mg / L. This research area is divided into 4 locations along Kuantan river that there are gold mining activities. Locations 1 and 4 are the closest point to a wild gold mine in the Kuantan river. This indicates that the distance from the sampling site to the illegal gold mining determines the level of mercury concentrations contained in river water, where it can be concluded that the further the location of the sampling with the location of illegal gold mining will be the lower the mercury concentration contained in the river water.

Water quality criteria set by the government in PP no. 82 of 2001 for mercury is 0.001 mg / L (grade 1), 0.002 mg / L (grade 2 and 3) and 0.005 mg / L (grade 4). Class 1 is water that can be used for drinking water, Class 2 is water which can be used for water recreation facilities, freshwater fish farming, farming, water to irrigate crops, while Class 3 is water that can be used for the cultivation of freshwater fish, livestock, water to irrigate crops and Class four is water that the designation can be used to irrigate cultivation. Concentration of mercury in water samples along quantan river, Kuantan Singingi regency, Riau found in this study at sites 1 and 4 exceeded the limits established by PP no. 82 Year 2001. The high concentration of mercury at location 1 and 4 is because the location is adjacent to a wild gold mine in the river flow kuantan. Concentration of mercury in water samples around Kuantan river, Kuantan Singingi, Riau regency found in this study, when compared with WHO limit of mercury content, also exceeds the predetermined limit of 0.001 mg / L.

Previous research also found the presence of mercury in the river stream of quantan, Sijunjung, West Sumatra. Concentrations of mercury found in quantan river stems were 0.009 mg / L and 0.0078 mg / L. The readings of mercury concentrations found also exceed the limits established by PP. 82 Year 2001 [2]. This mercury concentration can be caused by the fine particles carried along with the waste due to the amalgamation and dissolution process of mercury-containing river sediments. In a long period of time mercury metal can be oxidized and dissolved in surface water. The use of mercury (Hg) especially gold mining to separate gold from sand grains through the amalgamation process and the combustion process (alloy). Hg-containing tailings are discharged around the settlement making it potentially contaminating soil and groundwater.

The presence of Hg in the river can occur due to the processing of gold / mining which is the process of amalgamation and bleaching, where Hg can enter groundwater / surface water through seepage and rainwater that drops along with Hg in atmosphere [9]. In the process of traditional gold amalgamation by the community, mercury can be released into the environment at the time of washing and perching. In the washing process, generally mercury-containing waste is discharged directly into the body of water. This is due to mercury mixed / broken down into fine grains that are difficult to separate in the grinding process is done simultaneously with the amalgamation process, so that in the process of washing mercury in the waste brought to the river [10].

5. Conclusion
Concentration of mercury in water samples along Kuantan river, Kuantan Singingi regency, Riau found in this study at sites 1 and 4 exceeded the limits established by PP no. 82 of 2001 and WHO.

6. Acknowledgement
Thank you to DRPM RistekDikti who has provided assistance during this research.
7. References

[1] Mirdat, Patadungan, Yosep. S., Isrun. (2013). Status Logam Berat Merkuri (Hg) Dalam Tanah Pada Kawasan Pengolahan Tambang Emas Di Kelurahan Poboya, Kota Palu. e-J. Agrotekbis 1 (2) : 127-134.

[2] Hatika, R. G., Dewata, I., Alizar., Subekti, P., Anwar, S. Determination of Mercury (Hg) on Water Sampel in Batang Kuantan River. (2017). International Conference of Applied Science on Engineering, Business, Linguistics and Information Technology.

[3] Setiabudi, B. T., (2005). Penyebaran Merkuri Akibat Usaha Pertambangan Emas Di Daerah Sangon, Kabupaten Kulon Progo, D.I. Yogyakarta. Kolokium Kementrian Energi dan Sumber Daya Mineral Badan Geologi.

[4] Centers for Disease Control and Prevention. (2009) Fourth National Report on Human Exposure to Environmental Chemicals. Available at: http://www.cdc.gov/exposurerereport/

[5] Palar, H. (2008). Pencemuran dan Toksikologi Logam Berat. Jakarta. Rineka. Cipta.

[6] Yard, Ellen E., Horton, Jane.,Schier, Joshua G. (2012). Mercury Exposure Among Artisanal Gold Miners in Madre de Dios, Peru: A Cross-sectional Study. J. Med. Toxicol. 8:441–448.

[7] Widowati. (2008). Efek Toksik Logam Pencegahan dan Penanggulangan. Penerbit. Andi Yogyakarta.

[8] Effendi, Hefni. (2003). Telaah Kualitas Air. Penerbit Kanisius. Yogyakarta

[9] WHO, (2008), Guidance For Identifying Populations At Risk From Mercury Exposure, August 2008, Geneva, Switzerland : Department of Food Safety, Zoonoses and Foodborne Diseases Cluster on Health Security and Environment , 20 Avenue Appia 1211.

[10] Widhiyatna, Denni., (2005). Pendataan Penyebaran Merkuri akibat Usaha Pertambangan Emas Di Daerah Tasikmalaya, Propinsi Jawa Barat, Kolokium Hasil Lapang. DIM.

[11] Prihandoko, L.A., Tembang, Y., Marpaung, D.N. and Rahman, F., 2019, October. English language competence for tourism sector in supporting socio-economic development in Merauke: A Survey Study. In IOP Conference Series: Earth and Environmental Science (Vol. 343, No. 1, p. 012170). IOP Publishing.