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MERCURY CONTAMINATION LEVELS IN RIVERS AND RESIDENT WELLS IN PADESA AND SEPUKUR VILLAGES, LANTUNG DISTRICT, SUMBAWA REGENCY, INDONESIA

Nurlaila Agustikawati* and Anak Agung Ngurah Ketut Riyadi
Public Health Study Program, STIKES Griya Husada Sumbawa, Sumbawa Besar, Indonesia
*Email: Agustikawatighs@gmail.com

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Abstract: Traditional mining business activities for processing gold ore in Lantung District are amalgamated using mercury (Hg) from 2015 to 2021 and are still ongoing. On average, there are ten to fifteen logs in each village, the waste being discharged only through ditches or small streams leading to rivers. Mercury that enters the aquatic environment will experience precipitation, dilution, and dispersion, absorbed by organisms living in these waters. Mercury water will be converted into methyl mercury by certain bacteria called biomethylation. In methyl-mercury (MeHg), mercury has toxic properties, firm binding, and high solubility. If consumed by biota, it will experience bioaccumulation in the body, and if consumed by humans for a long time, it can cause various types of diseases up to death. This study aims to determine mercury levels in the rivers and wells of residents in Sepukur Village and Lantung District. The research method is a survey with a sampling technique that is purposive sampling based on the distance from the logs to the residents' wells and rivers. The results showed that mercury levels in the Padesa Village river and springs were 0.002 mg/L. The average mercury level in the Sepukur Village River is 0.0004 mg/L, dug wells are 0.0014 mg/L, and drilled wells are 0.0024 mg/L. It can be concluded that the mercury levels in the springs in the village of Sepukur exceed the standard, and the river is classified in class 3. Mercury levels in the drilled wells of the residents of Sepukur Village exceed the standard, and the dug wells are still within the safe limits of the standard. Meanwhile, the river level in the Village of Sepukur is still relatively safe.

Keywords: *Mercury; Drilling wells, Dug wells, Rivers, ASGM, Environmental Pollution*

INTRODUCTION

Industrial progress can improve the community's economy and cause environmental pollution. Industrial progress is not supported by good technology and knowledge, such as small-scale gold mining ASGM activities. Identified 800 ASGM points spread across the country from Papua to Sumatra involving 300,000 workers with gold production of 192 – 384 tons per year [1]. Gold processing in ASGM uses mercury in amalgam and produces mercury emissions. ASGM is the most extensive activity that releases 580 tons of mercury in water [2].

Mercury has toxic properties and strong affinity, and high solubility. The mercury will be converted into methyl-mercury in water, called biomethylation [3]. The United Nations Environment Program states that most of the leachate of mercury into aquatic systems comes from sewage treatment (42%), mining and ore processing (42%), and the energy sector (16%) [4]. Mercury that enters the aquatic environment will experience precipitation, dilution, and dispersion and then be absorbed by aquatic organisms. Methyl mercury will accumulate in the body of biota, and if consumed by humans in the long term, it will cause various diseases and death [5].

In 2015 in Lantung District, the land was cleared for small-scale mining (PESK). The villages of Sepukur and Padesa are centers of gold processing using logs. On average, logs in each village are ten to fifteen logs whose waste disposal is only flowed through ditches or small streams that lead to rivers. Considering that residents use river water for washing and bathing activities, it needs great attention. Mercury intake from bathing activities is on average 1.27×10^{-9} mg/kg per day, while mercury intake from washing activities is 1.1x10-9mg/kg per day on average [6].

In addition, the existence of logs located in the middle of the village and located close to dug wells and community borewells needs special attention considering the negative impact of mercury. The ASGM activities have contributed to waste disposal, which is absorbed by groundwater, which eventually flows into people's wells. If it continues to be consumed for a long time, it will endanger the population [7]. Therefore, this study aims to determine mercury levels in the rivers and wells of residents in Sepukur and Padesa, Lantung District, Sumbawa Regency.

The findings can be used to 1) determine the characteristics of water quality in Padesa and Sepukur Villages, Lantung District, 2). It can be considered primary data in collecting data on the distribution of mercury concentrations due to gold log processing activities in Padesa Village and Sepukur Village, Lantung District, 3). It can be used as a basis for managing and monitoring the evaluation of mercury distribution due to the processing of gold logs in Padesa and Sepukur Villages, Lantung District, and the development of science and technology, 4). The results are expected to be understood by the community and consider environmental management efforts in the mining area, and 5). For local governments, it can be used as reference material for decision-making handling

Traditional Gold Mining activities in Padesa Village and Sepukur Village, Lantung District.

RESEARCH METHODS

The method used in this research is laboratory analysis with a sampling technique that is purposive sampling based on the researcher's considerations, namely based on the people who have gold logs in Padesa village. In contrast, the good samples of Sepukur village were taken based on the distance between the wells and the logs. The sample of the river in the village of Sepukur has points, namely upstream, middle and downstream of the river (the river passes through the middle of the village of Sepukur. Sample determination in the village of Padesa is determined based on the distance of the logs to the river (SG = 10 m from the settlement, G2 = 15 meters from the territory), G3= 50 m from the territory, G4= 10 m from the river, G5= 10 m from the second reservoir. A sampling of community bore wells is based on the distance from the waste dump dumpsite (Bore Well 1= 5 m from the pool and the borehole). 2 = 1 m from the pool). In comparison, the determination of the sampling of dug wells (5 m from the pool) and based on pa and located in the village of Sepukur, namely the top dug well is in the upper reaches of the village, the middle dug well is in the middle of the village. The bottom dug well is downstream of the village.

Laboratory analysis was carried out at the construction material testing center of the Mataram city public works department using an automatic mercury analyzer. This type of research is a Quasi Experiment with a survey method. The independent variable in this study is the activity of gold processing spools, and the dependent variable is mercury levels in the residents' rivers and wells.
Preservation of water samples is done by adding 1 mL of HNO_3 to ensure that the sample is not damaged and meets the requirements to be tested. The sample is then stored in a refrigerated container, and the sample bottle is equipped with a label that informs the location and time of sampling.

RESULTS AND DISCUSSION

The type of data used in this study is primary data. Primary data was obtained by sampling in the field, in river water, springs, bore healthy water, and dug well water. The samples were tested with an automatic mercury analyzer to determine the mercury concentration. The results of the analysis of the measurement of mercury levels in the water environment of Padesa Village can be seen in Table 1.

Based on Table 1, it can be seen that the mercury level in the Padesa Village River is 2×10^{-4} mg/L. It can be said that the mercury level in the Padesa Village river does not exceed the standard Permenkes Number 32 of 2017, namely in class 1 (1×10^{-3} mg/L), class 2, class 3 (2×10^{-3} mg/L), and class 4 (1×10^{-3} mg/L). Meanwhile, springs located on the banks of rivers contain mercury levels of 2×10^{-3} mg/L, which exceeds the standard set by the Minister of Health Regulation Number 32 of 2017 (1×10^{-3} mg/L). Differences in mercury levels in the river and springs of Padesa Village, even though they are next to each other, can be caused by several factors, including the soil layer zone, technical properties of the soil, evaporation of groundwater, and absorption of water by plant roots. The zoning of water catchment and groundwater flow is influenced by the parameters of land use, rainfall, slope, and soil type [7]. The ongoing season was the dry season with dry water conditions in Padesa Village at the sampling time.

Table 1. Measurement of Mercury Levels in Rivers and Springs in Padesa Village

Samples	(mg/L)
River	2×10^{-4}
Springs	2×10^{-3}

[8]

Mercury levels in the Padesa Village River, apart from gold processing activities in Padesa Village, are also more or less influenced by the flow from Sepukur Village, so it is vital to analyze it. In the village of Sepukur, there are 26 logs where the waste is thrown into the river. In fact, according to the Regulation of the State Minister of the Environment Number 23 of 2008 concerning Technical Guidelines for the Prevention of Pollution and Environmental Damage Due to People's Gold Mining, gold mining activities are not carried out on riverbanks as a form of preventing pollution or environmental damage [9]. The data for measuring mercury levels in the Sepukur Village River can be seen in Table 2.

Table 2. Mercury Level Measurement Data in the Sepukur Village River

Samples	(mg/L)
Downstream River	6×10^{-4}
Bag River. Middle	4×10^{-4}
River Bag. Upstream	3×10^{-4}

[8]

Table 2 shows that mercury levels in the river in Sepukur Village are still within the safe limits of the standard, with an average of 4.3×10^{-4} mg/L. It is still within the safe limits of the standard set by the Minister of Health Regulation No. 32 of 2017. The river in the village of Sepukur is not included in any class clusters set by the Minister of Health Regulation No. 32 of 2017. The concentration of Hg content in the district. Kuantan Mudik (upstream) of 9 x 10^{-3} mg/L and 7.8 x 10^{-5} mg/L. This value is still below the average mercury concentration in the Cimadur River, Lebak Banten, 2.21 x 10^{-3} mg/L [10], and the average mercury concentration in rivers in Gunung Mas Regency,

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Central Kalimantan, which is 0.00284 mg/L [11]. This research has similarities with this study, namely analyzing the mercury concentration in the river, which is used as a waste disposal site from the gold amalgamation process. However, this does not mean it can be left to small-scale gold processing activities without thinking of solutions to prevent pollution. This mercury contamination level could increase in the next 10-20 years.

The logs of Sepukur Village are located in the middle, and the river also passes through the center. The activity of the residents' logs can last for 24 hours. It is a big concern where the people's wells that are consumed are very close to the location of the logs. Therefore, measuring mercury levels in drilled and community dug wells is necessary. Data on the results of measuring mercury levels in the drilled wells and dug wells of the residents of Sepukur Village can be seen in Table 3.

Table 3. Measurement of Mercury Levels in the wells of the residents of Sepukur Village

Sample	(mg/L)
Upper Dig Well	13×10^{-4}
Middle well dug	14×10^{-4}
Bottom Dig Well	16×10^{-4}
Drilling Well 1	14×10^{-4}
Drilling Well 2	34×10^{-4}

[8]

Table 3 shows that the average data of mercury levels in the Sepukur Village well is 18.2×10-4 mg/L. The residents' wells had been affected by Hg waste disposal as indicated by the average Hg concentration value of 0.24 ± 0.25 g/L [12]. The highest mercury level exceeding the Standard Permenkes No. 32 2017 is found in Drilling Well 2, which is in the middle of the village and just below the location of the logs with a value of 34×10^{-4} mg/L. Meanwhile, dug wells and drilled wells are still at the standard limits but need attention to reduce their activities. The results of laboratory tests that have been carried out by researchers on five samples of the Singingi River, Kuantan Singingi Regency, found 1 sample of healthy water 10 m from the river water with a Hg concentration of 1.3 x 10-3 mg/l, which is used by the community for daily drinking needs. It is not feasible because it passed the predetermined quality standard value. At the same time, four samples of healthy water with a distance of 12, 14, 15, and 17 meters from polluted river water did not show any mercury content [13]. It indicates that gold processing activities by residents have contributed to waste disposal, which is absorbed by groundwater which eventually flows into residents' wells. The research was conducted by the presence of mercury in citizen wells. It can be caused by the location of dug wells and drilled wells that are very close to the reservoir area and the area of the gold processing logs, which causes seepage to be directly absorbed into the soil layer and enters the springs. It is confirmed by a study conducted by Boky et al., who stated that there was a difference in the average concentration of Hg between 0 meters and 500 meters from the gold processing site [14]. It is supported by data on the Hg content in the Kuantan River water at the upstream, middle, and downstream locations as follows in Table 1. The average Hg content in the Kuantan River is 0.0325 mg/l. The upstream area had the lowest moderate Hg content of 0.0230 mg/l, while the downstream location had the highest average Hg content of 0.0444 mg/l. The results of the calculation of analysis of variance from the three areas of the Kuantan River showed a significant difference between the Hg content at each location. Duncan's test was carried out to see the difference in the value of the Hg content at each river location. We obtained that each area had a significant Hg content value from the results. The average concentration of Hg significantly increased in value from upstream to downstream, 0.007 mg/l to 0.014 mg/l of the river [15].

The high level of mercury in drilled well two used for cooking, drinking, bathing, and washing activities will negatively impact the health of the residents. The average mercury intake from bathing activities is 1.27×10^{-9} mg/Kg/day. The average mercury intake from washing activities is 1.10×10^{-9} mg/Kg/day. The average mercury intake from water is 9.64×10^{-4} mg/Kg/day [10]. Based on this, the residents of Sepukur and Padesa can have a considerable risk of health problems, namely acute poisoning, which includes the throat (pharyngitis), dysphagia, pain in the stomach, nausea, and vomiting, accompanied by blood and shock. If these early symptoms are not treated immediately, the patient will then experience swelling of the salivary glands, inflammation of the kidneys (nephritis), and inflammation of the liver (hepatitis) [16]. It is in line with research conducted by Soprima et al., which stated that the average level of health risk (*risk quotient*/ RQ) from the ingestion pathway was 18.57×10^{-5} mg/L and the skin absorption pathway was 2.63×10^{-5} mg/L [9]. Mercury has a cumulative nature, so the length of stay can affect mercury levels in the body. The longer a person lives in a mercury-contaminated area, the higher the mercury content in his body, which means that prolonged exposure to mercury in workers will increase mercury levels in the body and impact decreasing workers' health problems [17].

The high level of mercury in the residents' wells can be explained by the high level of mercury in the dumping logs, which can be seen in Table 4.

Table 4 indicates that mercury levels from waste community gold processing logs are 3.782×10^{-2} mg/L. This data explains the mercury levels in residents' wells exceeding the Minister of Health Number 32 of 2017. It is similar to the Mercury Content (Hg) in the Traditional Gold Mining Wastewater Disposal Center in Saba Padang Village,

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Huta Bargot District, Mandailing Regency, which is $1.74\times10.^{-2}$ mg/L.

Table 4. Data on the Measurement of Mercury Levels in the Shelter of the residents of Padesa Village

Sample	Measurement Results (mg/L)
SG	9×10^{-3}
G2	7.11×10^{-2}
G3	4.58×10^{-2}
G4	1.76×10^{-2}
G5	4.56×10^{-2}

[8]

The proximity of the logs and gold processing waste storage sites is the main factor causing the high levels of mercury in the residents' wells. The distance from the traditional gold mining processing location determines the concentration (Hg) from the healthy water. The closer the space and the mining processing location, the higher the concentration compared to areas far from traditional gold mining processing sites[18]. Water seeps underground through the pore spaces between soil grains which is influenced by the technical properties of the soil. Soil with more pore spaces will store more water because the soil pore spaces will be filled with water.

The soil layer has three zones: the saturated zone, the capillary zone, and the unsaturated zone. The unsaturated zone is located at the soil surface with a depth of 0.91 m–9.1 m, where the water in this zone is strongly influenced by evaporation of sunlight and absorption of plant roots [19]. It is in line with the condition of the gold processing logs waste dump having a depth of 1 meter with an area of 2-3 m^2. Heavy metal contamination usually accumulates at a depth of 75 cm above the ground [20-21]. So it can be concluded that the mercury level in the river is low even though the mercury level in the discharge is very high. The distance of the logs influences the speed of seepage and water flow in the soil of storage and evaporation of ground surface water, and the absorption of water by plant roots. Soil dominated by sand will have a lot of macropores (large), soil dominated by dust (silt) will have a lot of mesopores (medium), and dominated by clay will have a lot of micropores (small).

The quality of natural groundwater is strongly influenced by the interaction between groundwater (a solvent of chemical elements present in groundwater storage rocks), the type of soil or rock through which groundwater passes, and the water from groundwater. This quality will change when there are actions by humans on groundwater, such as excessive groundwater extraction and waste disposal. The decline in groundwater quality in community wells, which are ± 3 to 5 meters from river water, is proven to contain Hg that exceeds the threshold value. It is because PETI activities are still rampant in that location. In addition, decreasing groundwater quality can also occur because of the type of soil in the well.

CONCLUSION

In conclusion, mercury levels in the Padesa village river are 2×10-4 mg/L. Mercury levels in Padesa village springs are 2×10-3 mg /L, and this level exceeds the standard Permenkes Number 32 of 2017. The average mercury level in the Sepukur Village River is an average of 4.3×10-4 mg/L. The average mercury level in the wells of the residents of Sepukur Village is 18.2×10-4 mg/L. The highest level of mercury and exceeds the standard limit of the Health Regulation Number 32 of 2017 is at Drill Well 2.

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