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MERCURY CONTENT IN WELL WATER AND PUBLIC HEALTH COMPLAINTS (Study Around Small-Scale Gold Mining in Jember Regency)

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ABSTRACT

Mercury Content in Well Water and Public Health Complaints (Study Around Small-Scale Gold Mining in Jember Regency). Small-Scale Gold Mining is a community activity that is generally without permits. This activity contributes to negative impacts on the environment and society due to the use of mercury in gold processing. Waste containing mercury is not processed and is immediately disposed of in the environment. This research aims to determine the mercury content in community well water around Small-Scale Gold Mining and public health complaints. This research is a descriptive study with the research variables being the mercury content of healthy water, the distance of the well to the source of pollution, the condition of the sound construction, the use of the well, and public health complaints. This research involved 13 wells and 46 communities as respondents. Based on the measurements, interviews, and observations that have been carried out, it was obtained that the mercury content in 13 community wells water showed where these results are below environmental quality standards according to Minister of Health Regulation No. 32 of 2017. Three community wells do not meet the requirements for good sanitation and healthy spacing, and several community wells need to meet the requirements, such as walls and floors that are not watertight. Health complaints people feel include itching, redness of the skin, and itching and burning in the eyes. A few respondents around Small-Scale Gold Mining only felt these health complaints. Research shows that Small Scale Gold Mining activities have not polluted community water sources, namely well water, and have not caused significant public health complaints.

INTRODUCTION

Human activities can have an influence on environmental conditions, one of which is decreasing environmental quality. Small-scale gold mining, or what is commonly called ASGM, is one of the human activities that can cause environmental pollution through water. ASGM, also known as community mining without permits for gold processing, typically occurs in the midst of community settlements. ASGM's gold mining activities use a lot of mercury. Data that has been recorded in the UNDP (United National Development Program) shows that around 195 tons of mercury globally have been released into the environment as a waste product

from ASGM processing activities. This heavy metal mercury pollution is persistent and settles in the environment, meaning it cannot decompose.

ASGM activities exist in almost all provinces in Indonesia. National gold production from ASGM activities is estimated to reach 20% per year of formal production, namely 21.84 metric tons of gold. ASGM activities without permits are said to damage the environment. This is because ASGM typically uses mercury (Hg) in its processing. Mercury emissions from ASGM in Indonesia can reach more than 10 tons per year. In East Java, the use of mercury in ASGM activities without permits is estimated at 10.2 tons per year, with mercury emissions of 2 tons per year. [1]. Mercury serves as the primary chemical used in global gold mining, leading to the annual discharge of approximately 410 to 1440 tons of mercury into the environment worldwide. Mercury accounts for 37% of environmental pollution worldwide [2].

ASGM activities are generally located around the community, so over a continuous period of time, they can result in contamination of the community's well water from the liquid waste produced. The amalgamation process used in gold processing has the potential to release mercury into the environment surrounding the gold mining area. The process of emptying the spindle will cause some of the mercury to be released into the ground along with the wastewater. The remaining skeins will flow into the waste pond in ASGM, but they can also overflow and spill and then flow into the surrounding environment. Uncontrolled use of mercury can cause environmental pollution. People who consume water in illegal gold mining areas may face the risk of mercury poisoning [3].

In 2013, there was a lot of news regarding the potential for gold originating from Mount Manggar, Kesilir Village, Wuluhan District, and Jember Regency. This news tells the truth: there is indeed gold potential on Mount Manggar. The local government does not have permission for Mount Manggar gold mining, which is why it is referred to as an illegal mine. Despite this, researchers have observed that people continue to engage in ASGM activities without permission due to their search for natural rocks on the mountain. Preliminary studies conducted in two villages in Wuluhan District, Tanjung Rejo Village and Kesilir Village, which are the closest to the Mount Manggar location, revealed nine ASGM locations in the middle of settlements, with a range of processing spindles or drums from 1 to 15.

The frequency of gold processing carried out in ASGM activities based on the results of researchers' interviews in one week can reach three to four times. The average use of mercury as a gold processing mixture is around 20 to 40 ml per spindle in a week. According to miners' observations, mercury wasted in the environment as residue from gold processing can reach 50%–100% of the mercury that has been used, depending on the quality of the rock obtained. Waste from the amalgamation process, which uses mercury as a mixture, is immediately disposed of without prior processing. We conducted this research using a descriptive approach to determine the mercury content in community wells. We also aimed to describe the mercury content of these wells based on factors such as the well's proximity to ASGM waste, the construction conditions of the well, the use of well water, and the health complaints of the community in the Wuluhan District.

MATERIALS AND RESEARCH METHODS

This study employs descriptive research methodology, incorporating variables such as the mercury content in well water, the well's distance from pollution sources, the construction conditions of the well, its usage, and public health complaints. The sample was determined using a total sampling technique, in which the sample is the entire population. This research sample was divided into two groups, namely community well water from 13 wells and 46 respondents who used or accessed all the well water sampled. The research samples came from two different locations. The first is in Karangsono Hamlet, Tanjung Rejo Village, and the second is in Demangan Hamlet, Kesilir Village, both of which have close access to Mount Manggar. The wells sampled in this study are 0 to 95 meters from the ASGM location.

Data collection for this research was carried out in several ways, including measuring the water content of community wells, measuring the distance of the well to the ASGM location (source of pollution or waste pond), observing the condition of the well construction, and interviewing all respondents. Measurement of mercury content is carried out by taking water samples in accordance with SNI 6989.58:2008, which is a method for taking ground water samples. The well water samples are then sent for examination at the Laboratory of Perum Jasa Tirta 1 Mojokerto. The distance from the well to the source of pollution was measured using GPS coordinates and Google Earth. (Explain the total sampling technique in greater detail.) Please provide arguments for the use of this technique and explain how it ensures the representativeness of the sample within the research context. The observation of well construction conditions examines three aspects: the well wall, the well floor, and whether the well building is sturdy or not. Public health complaint interviews were conducted using a questionnaire with 11 questions that were based on theories of health complaints due to mercury exposure.

This research employs observation sheets and interview sheets as research instruments, incorporating primary data sources such as observation and interview results, as well as secondary data sources such as Jember Regency BPS data and village profiles. This research employs a descriptive data analysis technique to characterize and distribute the results of the conducted research. The research results are presented in table form with an explanatory narrative.

RESEARCH RESULTS AND DISCUSSION

Mercury (Hg) Content in Well Water of Communities Around ASGM

Mercury, which is discarded as waste from gold processing in ASGM activities, is influenced by whether the rock obtained is good or not. The better the rock obtained by the miners, the more mercury used in the processing process will be wasted as waste, and vice versa.

Table 1. Results of examination of mercury content (Hg) in well water in communities around ASGM

Well Water Mercury Content	Number (n)	Percentage (%)
Meets BML	13	100
Does not meet BML	0	0
Total	**13**	**100**

The table above indicates that the mercury content in 13 well water samples was below the quality standard set by Minister of Health Regulation No. 32 of 2017, which is 0.001 mg/L. A laboratory examination of mercury in well water revealed a content of mg/L.

Distance from Community Well to ASGM Location (Waste Pond)

The distance between the pollutant source and the well can affect well water contaminant levels.

Table 2. Frequency Distribution of Community Wells' Distance from ASGM Locations (Waste Ponds)

Distance of Well to ASGM Location	Number (n)	Percentage (%)
Qualify	10	76.9
Not eligible	3	23.1
Total	**13**	**100**

The results of the observations and measurements conducted by the researchers align with the table above, indicating that out of the 13 well samples observed, 3 wells did not meet the required distances. The minimum distance between a well and a pollutant source is 15 meters. There is one well near the ASGM 1 location that is only 5 metres away from the source of pollution or the gold processing waste pond, and there are two wells near the ASK 2

location that are less than 15 metres away, namely a well with a distance of 14 metres and a well with a distance of 5 meters.

Construction Conditions of Community Wells Around ASGM Locations

This research focuses on well construction, specifically the materials used for the well wall, the well floor, and the condition of the well building. Well construction is one of the factors causing pollution of well water.

Table 3 shows the frequency distribution of well construction conditions around ASGM locations.

Well Construction Conditions Around ASGM Locations	Qualify		Not eligible		Total	
	n	%	n	%	N	%
Well Wall	10	76.9	3	23.1	13	100
Well Floor	13	100	0	100	13	100
Building Condition	11	84.6	2	15.4	13	100

Observation results show that there are two types of wells used by the community, namely drilled wells and dug wells. The table above reveals that nearly every well sampled had sound construction. Some of the dug wells used by the community have concrete walls, and some only use bricks without plaster. The well's floor is generally watertight. Likewise with a sturdy well building.

Use of Community Well Water Around ASGM Locations

To meet their daily water needs, people use well water both for consumption and as a toilet. The following table presents the results derived from the interview.

Table 4. Frequency Distribution of Community Well Water Use

Use of Community Wells	Number (n)	Percentage (%)
MCK	8	61.5
MCK & Consumption	5	38.5
Total	**13**	**100**

Respondents in this study used well water as the main water source to meet their daily needs for consumption, toilets, or both.

Public Health Complaints Around ASGM Locations

Several people who live around ASGM locations and were respondents in this study experienced health complaints. Measurements were carried out using health complaint interviews with 11 questions, and the following results were obtained:

Table 5. Frequency Distribution of Public Health Complaints

Public Health Complaints	Number (n)	Percentage (%)
There is	4	91.3
There isn't any	42	8.7
Total	**46**	**100**

According to the table above, of the 46 people who were research respondents, four experienced public health complaints. The distribution of health complaints experienced by the community is presented in the following table:

Table 6. Frequency Distribution of Public Health Complaints

No	Health Complaints	Category				Total	
		Yes		No			
		n	%	n	%	N	%
1	Tremors	0	0	46	100	46	100
2	Cramps	0	0	46	100	46	100
3	Tired Quickly	0	0	46	100	46	100
4	Itching on the Skin	4	8.7	42	91.3	46	100
5	Reddish Skin	4	8.7	42	91.3	46	100
6	Nauseous vomit	0	0	46	100	46	100
7	Diarrhea	0	0	46	100	46	100
8	Dizzy	0	0	46	100	46	100
9	Itchy Eyes	1	2,2	45	97.8	46	100
10	Reddish Eyes	0	0	46	100	46	100
11	Hot Eyes	1	2,2	45	97.8	46	100

The mercury content in community well water around ASGM locations is a significant concern.

According to the results of laboratory examinations, the mercury content in 13 samples of well water near the gold processing location from ASGM activities in two villages in Wuluhan District was found to be very small, falling below the clean water quality standards set by Minister of Health Regulation No. 32 of 2017. This research, in line with what Sofia & Husodo did [4], shows that community well water located around ASGM locations contains mercury, even though its value is below environmental quality standards. The research stated that waste from ASGM activities had contributed to the presence of mercury in groundwater, which then flowed into community wells.

Mercury, as the main chemical used in gold processing, can have a negative impact on the environment. Mercury, a heavy metal, can be found in soil, water, and air via various pathways. One of the causes of mercury in the environment is that liquid or solid waste containing mercury is thrown into the ground, water, or air. [5]. Microorganisms will convert waste containing mercury in the aquatic environment into methyl mercury, which has more toxic properties, a strong binding capacity, and high solubility. The accumulation of mercury will cause mercury levels to increase and reach dangerous levels [6].

Mercury contained in soil can seep or flow through several media, namely rock pores, weak areas in the form of joints, layers, and faults. Mercury, a heavy metal, has properties that are difficult to describe using scientific processes. The presence of mercury in groundwater can last for decades. This is supported by groundwater properties, which can remain in the aquifer for tens or hundreds of years because groundwater movement is very slow. [7]. The continuous accumulation of mercury can result in environmental pollution. One study showed that the mercury content in the river water studied increased within 10 years after the last river water mercury examination. [8].

High rainfall can affect the level of water pollution. This rainfall will describe how much water falls on the ground surface and then seeps into the ground to reach the ground water level. High levels of rainfall can impact groundwater pollution due to the dilution effect of rainwater. This causes contaminants to easily dissolve and move towards free groundwater [9]. Heavy metals are easier to accumulate in sediment, resulting in higher concentrations compared to surface water. Over longer periods of time, sediment can become a potential source of pollution [10].

Description of Well Distance to ASGM Location (Pollution Source)

Well water samples taken at a distance of 0 to 95 metres from the ASGM waste location did not show differences in mercury content. Well locations that do not meet the requirements or are less than 15 meters from the ASGM location (waste pond) have not been contaminated by mercury-containing gold processing waste. Several factors can influence the mercury content in well water based on the distance to the source of pollution.

According to Muryani's research, several groundwater samples were examined for mercury content, and the results showed that groundwater located near gold processing had a

mercury content that exceeded quality standards. Along with being close to the source of pollution, places in the same direction as the ground flow and with lower conditions have a higher degree of pollution. [9]. In line with Handriyani's research, which states that groundwater flows due to differences in pressure and altitude, If the well is located below the source of pollution, the water flow will carry pollutant materials or contaminants to a lower location, specifically the well. [11].

An activity that produces liquid waste and contains contaminants can affect changes in the chemical composition of the soil, which can disturb living organisms in and on the surface of the soil. If the ground water aquifer or rocks contain toxic chemicals, then the ground water is also toxic. The high level of contaminants in waste will determine the high concentration of contaminants that pollute the environment, one of which is water [6]. ASGM waste that enters river water can, in some cases, be carried by river flows a distance of up to hundreds of meters from the ASGM location [12]. There are several factors that influence differences in heavy metal content in well water, including water flow, soil conditions, and water level (13). According to Hertisa's research, the type of soil can influence groundwater pollution. The water-carrying capacity is also different depending on the type of soil. The texture and structure of the soil will influence how the pores are distributed and the permeability of the soil, which in turn will influence the rate of infiltration as well as the soil's ability to hold water. [14].

This section provides a description of the mercury (Hg) content of well water based on well construction.

The wells used by the community around the ASGM location in this study were divided into two types of wells according to observations and interviews that had been conducted, namely drilled wells and dug wells. The drilled well owned by the community has a depth of more than 10 meters. Drilled wells are taken from deep groundwater, where the water is considered to be quite clean and free from contaminants. Unlike dug wells, the water source is shallow groundwater, which is considered not clean enough, so it must first go through a cooking process before being consumed. ([15]. Research conducted by 16 When comparing the quality of clean water between drilled wells and dug wells, it shows that the physical and chemical parameters of drilled wells are better than those of dug wells, but the same results show that both wells are suitable for use because the examination values for these parameters are below environmental quality standards.

Good well construction can be a barrier to mercury contaminants entering well water. According to the research findings, a well closest to the source of pollution, with the bottom walls still made of brick without plaster, was declared suitable for water use because the mercury content was below the quality standard. However, communities around ASGM locations should be concerned, as their wells may not meet the requirements for good wells due to the long-term accumulation of mercury. According to a study, if the well floor develops cracks, there is a higher risk of water pollution from the dug well, which is exacerbated by rainwater seeping directly into the soil layer. [17].

The article provides a description of the use of community well water around ASGM locations.

According to the research findings, there are two types of wells used by the community: drilled wells and dug wells. People who use well water for consumption all use water from dug wells. Even if well water is treated before use, it can still pose a health risk if continuously used. Ariyanti and Raharjo's research on the contaminant content in dug well water reveals that boiling the water before community use does not guarantee the elimination of contaminants, and if consumed by humans, it can lead to poisoning. [18].

The document provides a description of public health complaints around ASGM locations.

Because ASGM uses mercury, a dangerous chemical, its gold processing activities can have a positive impact on the environment and society. Azizah & Maslahat's research states that the content of heavy metals, one of which is mercury, in water and other species, such as fish in gold processing areas, needs to be continuously monitored. This is because of the nature of heavy metals that accumulate in the human body if people consume water or fish contaminated with mercury. [19]. Other research also states that mercury accumulation in the environment can have negative impacts on humans because mercury is toxic. [20]. Fahruddin stated that mercury easily dissolves in water, and if it accumulates in water, it can harm people [21]. Based on this, even though the concentration of mercury in community well water is currently still below environmental quality standards, it does not rule out the possibility that the concentration will increase along with the length of ASGM activities that use mercury as the main chemical.

According to Halid and Aini's research, continuous exposure to mercury can cause skin damage such as itching, redness, and thickened skin. [22]. Another factor that influences whether a person may experience health complaints due to mercury is the level and duration of exposure to the heavy metal. The level and duration of exposure can influence heavy metal toxicity (23). One study shows that the higher the concentration of mercury in a body of water and the contamination of organisms in the water, such as fish, which are then consumed by humans, will be associated with health complaints (skin diseases and neurological diseases) experienced by the community. [24]. ASGM continues to use mercury in its processing and disposes of its waste without proper treatment, potentially contaminating community well water. This is consistent with Situmorang, who stated that there have been several cases of mutations in various aquatic living creatures, allegedly due to the presence of mercury in the water. Avoid making too many generalizations without supporting evidence. For example, "This is in line with Situmorang For instance, a statement such as "This is in line with Situmorang, who stated that there are several cases of mutations in several aquatic living creatures, allegedly due to the presence of mercury in the water" [25] should be accompanied this suggests that mercury in water affects human exposure.

CONCLUSIONS AND RECOMMENDATIONS

Based on the presented research findings, the mercury (Hg) content in community well water around the Artisanal and Small-Scale Gold Mining (ASGM) location generally falls below the environmental quality standard for clean water (0.001 mg/L), as per Minister of Health Regulation No. 32 of 2017. However, three wells were found to be located less than 15 meters from the ASGM waste pond, failing to meet recommended safe distances. The construction of the well buildings was generally good and met standards, potentially reducing the ingress of contaminants from external sources. Usage patterns of the well water are divided into two categories: some use it for consumption despite concerns about clarity, while others restrict its use to non-consumptive purposes like toilet flushing. Reported health complaints include skin itching, redness, and eye irritation, predominantly among users of wells closest to the ASGM waste pond, particularly miners. Interestingly, one ordinary citizen reported more health complaints than miners, despite not being directly involved in ASGM activities.

Increase communication and education among ASGM owners and the surrounding community about the dangers of mercury accumulation over long periods of time. Because illegal ASGM locations can be detrimental to both the environment and society, it is necessary to control them. Miners can avoid using mercury by using alternative, environmentally friendly chemicals. This step is also part of a plan to reduce mercury in ASGM.

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