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Submission date: 19-Jan-2023 12:43PM (UTC+0700)

Submission ID: 1995225878

File name: 42561_Elanda_GFA1_Rev.docx (61.1K)

Word count: 7776

Character count: 45864

Keberadaan Penambangan Emas Skala Kecil di Indonesia, Dampak Kesehatan Masyarakat dan Keberlangsungan Lingkungan : Sebuah Tinjauan Naratif

The Existence of Arisanal Small-Scale Gold Mining in Indonesia, The Impact of Public Health and Environmental Sustainability : A Narrative Review

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ABSTRACT

Introduction: This research is about reviewing the negative impacts caused by artisanal small-scale gold mining. This paper presents an examination of the impact of artisanal small-scale gold mining (ASGM) on health, with a scope of discussion of diseases and disorder in human, toxic substances, public and miners safety, environmental damage, economic and social. The contribution of this study is a mitigation recommendations for ASGM in Indonesia. The subject of the research is important because in Indonesia there has not been an ASGM study that has reviewed these aspects. **Discussion:** Chronic, acute, infectious, and disability diseases can threaten the survival and health of local communities. The use of toxic substance heavy metals is difficult to avoid in ASGM, such as mercury, cadmium, arsenic, and lead which has a high level of use. Other pollutants generated by ASGM are noise and silicia dust. ASGM has caused accidents with a total of 36 minor injuries, an estimated 57 serious injuries, and a total death toll of 11. The existence of ASGM also causes pollution of water, soil, and air, to a threat of the geology of world heritage sites. The existence of ASGM in several parts of Indonesia has been proven to improve the community's economy. **Conclusion:** The existence of ASGM has proven to have a significant impact on public health, environmental sustainability, and the socio-economy of Indonesian society. In general, the lack of legitimization of ASGM in Indonesia is an enabling factor for these impacts to occur.

Keywords: ASGM, environmental damage, health impact, safety miner, toxic substance

INTRODUCTION

Globally, artisanal small-scale gold mining (ASGM) has experienced growth and development. This is in line with the increasing price and scarcity of minerals, on the other hand, there is an increase in miners. In 2017, artisanal small-scale gold mining miners reached 40.5 million, compared to 2014 miners only reached 30 million (1). Meanwhile Indonesia, one of the countries

that have a large amount of metal content and is a recognized gold producer in the world with a total production in December 2020 reaching 130 tons (2,3). Artisanal small-scale gold mining does have a big role in supporting the economy of a country, it's just that on the other hand small-scale artisanal gold is defined as gold mining activities that are owned or carried out by each individual or local community (4,5). In general, artisanal small-scale gold mining miners operate without having a license or certificate that supports environmental health sustainability. For example, mining activities are carried out in protected forest areas, conservation areas, and even some areas where mining activities are carried out near settlements. As a result, these activities can have an impact on the health of the environment and local communities (5).

The gold mining and extraction process requires at least four steps. The first step is the process of extracting gold ore at a predetermined location, the location can be in the form of soil, rock, and surrounding tributaries, the excavation process can be carried out directly or on former industrial mine excavations (6). In the second step, gold ore is processed and concentrated using the gravity method, then added with mercury compounds, so that it will form gold-mercury amalgamation. In the third step, amalgam is burned to remove mercury through the evaporation process and in the last step, the result of the combustion is a gold alloy with a high level of purity and can be continued for the refinement process (7). The mining process produces waste from burning gold ore with the addition of heavy metal (mercury) and liquid (in the form of leachate from the sale of amalgam). In addition to the heavy metal mercury used in artisanal small-scale gold mining, cyanide is still found and used in gold mining activities. The use of cyanide in the cyanidation process, the gold extraction method is also very dangerous for public health and environmental health. In addition to these chemicals, chemicals such as thiocyanate, thiourea, and thiosulfate (7). The type of chemical used in artisanal small-scale gold mining is the responsibility of the mine owner, usually, the mine owner will choose the type of chemical that is cheap but provides the effectiveness and efficiency of gold extraction. It aims to reduce production costs to a minimum and get the maximum possible profit. The mine owner's ignorance of the dangers posed by the type of chemicals chosen is also a driving factor for the emergence of public health problems and environmental damage. Until now, the Indonesian government has not found the limitations of alternative safe use of chemicals for artisanal small-scale gold mining. The use

of mercury and other toxic substances has indeed been banned by the Indonesian government through the regulation of Regulation of the President of the Republic of Indonesia number 21 of 2019 and implementing regulations Regulation of the Minister of Environment of the Republic of Indonesia and Forestry number 81 of 2019.

Such gold refining processes harm public health and the environment. Additions of heavy metals other than mercury are used, lead, cyanide, arsenic, cadmium, and cobalt are also commonly used. The evaporation process of amalgam is a source of contamination of toxic materials that are harmful to public health, such as damage to nerves, kidneys, digestion, and immunology (8). In addition, miners often neglect the use of personal protective equipment during the mining process, as a result, miners can have work accidents, for example falling from a height at the mine site resulting in serious injuries, lacerations, and amputations(6). Globally problems, it is estimated that there are 10-18 million artisanal small-scale gold miners in the world, a third to half of whom are women and children (specifically 5 million child miners) (5,9). This can happen because children have a smaller body size than adults, so it is possible to enter small gold mining pits. These conditions can allow for hazards that can threaten the safety and health of children. Reportedly in 2020, globally, deaths due to artisanal small-scale gold mining reached 592 deaths (10). This research is about reviewing the negative impacts caused by artisanal small-scale gold mining. This paper presents an examination of the impact of artisanal small-scale gold mining on health, with a scope of discussion of diseases and disorder in human, toxic substances, public and miners safety, environmental damage, economic and social. The contribution of this study is a mitigation recommendations for artisanal small-scale gold mining in Indonesia. The subject of the research is important because in Indonesia there has not been an artisanal small-scale gold mining study that has reviewed these aspects.

DISCUSSION

This research is a review with a narrative approach. A narrative review is used to identify the dangers posed by artisanal small-scale gold mining, diseases and disorder in human, toxic substances, public and miners safety, environmental damage, economic and social. In this study, there are no research questions and research hypotheses, so that later the output of the results

of this study will serve as a reference for further research. The data used is sourced from articles published in the SCOPUS and Google Scholar. The selected articles contain the ¹⁵ keywords artisanal small-scale gold mining, environment, health, and safety miners. The criteria for the inclusion of articles that were set were 2018 to 2022 publications year; having related theme artisanal ⁴⁵ small-scale gold mining; hazards to public health and environmental damage; downloaded full article; and the article does not use the review method. Narrative review does not have specific requirements or protocols guide for the article screening process used (11), therefore figure 1 below is the article screening process,

From the results of the article screening process, a total of 36 articles were obtained which were used as review material. The article met the specified inclusion criteria. A total of ⁷ 17 articles were used to review aspects of disease and disorder in humans. A total of ⁷ 4 articles were used to review aspects of toxic substances. A total of ⁷ 4 articles were used to review aspects of public and safety miners. A total of 8 articles were used to review the environmental damage aspect. A total of 5 articles were used to review the economic and social aspects. The findings from the review of articles are presented in table 1 below,

Disease and Disorder in Human

From the results of the article review, artisanal small-scale gold mining locations have poor access to basic sanitation, and lack of availability of health services such as vaccination facilities and disease surveillance. Based on 8 articles, it was stated that malaria was most commonly reported in Venezuela, Brazil, French Guiana, and Sudan (12,13,14,15,16,17,18,19). Studies in Guyana show that ³⁹ 94% of malaria cases occur in major gold mining areas. These areas have small, isolated populations, high malaria densities, and minimal resources. These cases can be detected with active surveillance efforts and diagnosis (12). Studies in Brazil and French Guiana explain that 32.7% (6390 cases) of malaria occurred in rural areas. One of the rural areas is gold miners along the river. The parasites detected in Brazil and French Guiana were *Plasmodium falciparum* (67.8%) and *Plasmodium vivax* (27.8%), *Plasmodium malariae* was also detected but the amount found was not large at 0.2%. Slow diagnosis and treatment was a contributing factor to the spike in cases in Brazil and French Guiana (17). In addition, other diseases reported were hantavirus,

yellow fever, leishmaniasis, and measles (14,15,16,17). Public who live around artisanal small-scale gold mining do not get vaccinated, especially children who are a group susceptible to infectious diseases. Even though children have received basic immunizations, a study says that exposure to mercury and the condition of children who are malnourished can cause a decrease in the body's immune system (18,19). The emergence of malaria, hantavirus, yellow fever, leishmaniasis, and measles in several countries is a warning for Indonesia to be prepared for them, especially for areas of Indonesia used for artisanal small-scale gold mining. For example, there is a need for active disease surveillance and early diagnosis on a regular basis for gold mine workers and communities living in mining areas as a form of disease prevention and control efforts.

The source of noise pollution comes from the use of engines and diesel. The use of machinery such as dredges, excavators for gold mining activities generates a certain level of noise. Noise due to the use of equipment that is not operated properly in artisanal small-scale gold mining often exceeds the permissible quality standards. As a result, miners and the surrounding community will experience hearing, decrease productivity, cognitive, chronic stress, and social problems (20,21). In addition, high levels of noise can cause hypertension, sleep disturbances, and behavioral changes (22).

In Indonesia, illegal artisanal small-scale gold mining in the North Lebong sub-district, Lebong Regency, Bengkulu province has health effects on the surrounding community in the form of impaired lung function, coughing, and tuberculosis (23). The disease can occur due to air pollutants such as silica dust and airborne particles caused by the gold-making process. Artisanal small-scale gold mining in Merangin, Sarolangun, Bungo, and Tebo, Jambi province have health effects on pregnant women and children around the location such as impaired child development and permanent disability (24). The presence of heavy metals as a contributing factor to impaired child development and permanent disability. The threat of chronic and acute disease also lurks in gold miners. Chronic diseases that may occur as a result of artisanal small-scale gold mining are impaired liver function, decreased leukocytes, partial or total paralysis of the limbs, numbness, the impaired balance of the body (Parkinson disorder), depression, emotional fluctuations, memory

decline, and so on. worry. Meanwhile, acute diseases that can occur are acute poisoning, diarrhea, upper respiratory tract infections, eye diseases, vertigo, and multisystem inflammatory syndrome in children (MIS-C) (25,26,27,28).

Toxic Substances

Some of the toxic materials that are often used in artisanal small-scale gold mining processes are mercury. Of the total 15% supply of artisanal small-scale gold mining worldwide in 2018, it produces 40% mercury pollution (28). Indonesia is reported by the United Nations to be the third largest producer of mercury in the world after China and India. The use of mercury for mining processes has been restricted and prohibited based on the Minamata Convention on mercury. The Government of Indonesia through the Ministry of Environment and Forestry has ratified the convention, which is contained in the Republic of Indonesia number 21 of 2019 and implementing regulations Regulation of the Minister of Environment of the Republic of Indonesia and Forestry number 81 of 2019. Mercury is classified as transition metal, the mercury exposure pathway is through amalgam vapor and leachate which empties into rivers, thereby contaminating fish (methylmercury). The highest toxicity of mercury can interfere with the nervous system, on the other hand, mercury toxicity can interfere with the reproductive system. Pregnant women who are exposed to mercury can cause impaired fetal growth and development, spontaneous abortion, premature birth, low birth weight, and congenital malformations anomalies (48,49,50).

Mercury concentrations in the form of gaseous elements were identified around the gold mining area of Central Sulawesi, Indonesia with an average of 9172 ng/m³ per 24 hours. This concentration exceeds the threshold set by the World Health Organization (WHO), which is 1000 ng/m³. In Mangkahui village, Palu City, Mercury is a pollutant that causes indoor and outdoor air pollution, the mercury concentration in the indoor air of Palu City reaches 450 ng/m³, while the mercury concentration in the outdoor air is 2250 ng/m³ (51). Meanwhile, in the village of Mangkahui site A, the mercury concentration in the indoor air is 196 ng/m³ and in the outdoor air is 103 ng/m³. At site B, the mercury concentration in the indoor air was 238 ng/m³ and in the outdoor air, it reached 279 ng/m³. Apart from being a toxic material for humans, mercury is also a toxic material for ecology. As reported in a study, mercury was identified with a concentration

of 1.4 g/g in the leaves of plants growing around the mine. Plants around artisanal ⁵ small-scale gold mining in the Districts of Rarowatu and Rarowatu Utara Bombana were contaminated with mercury with a concentration of ¹² 9.9 ± 14 g/g d.w. (52). This value is categorized in high-level ecotoxicology, ie the value exceeds >3 g/g. These plants are also used as raw materials for animal feed, plants contaminated with mercury and then given as animal feed will cause a process of bioaccumulation and biomagnification of their toxicity.

Other ⁴² toxic metals used in artisanal small-scale gold mining are cadmium, arsenic, and lead. Cadmium, arsenic, and lead help in gold exploration geochemistry so that later it produces gold with a good level of purity (30). The metal has toxic properties, for example, lead can cause anemia, stomach pain, encephalopathy, and even death. Metal arsenic is a carcinogenic substance, which can cause respiratory, skin, and cardiovascular diseases. Meanwhile, cadmium exposure can cause impaired kidney function, immune system, cardiovascular, and bone (53,54,55,56,57).

The presence of silica dust in ⁵ artisanal small-scale gold mining is also found in values above the quality standard. Silica dust is present due to the crushing process of hard rock during artisanal small-scale gold mining. Silica dust in high concentrations will have an impact on respiratory disorders and cause diseases such as silicosis, tuberculosis, to lung cancer (58).

Public and Miners Safety

Reported globally, in 2020 deaths caused by artisanal ¹⁴ small-scale gold mining amounted to 592 cases. Meanwhile in ¹⁷ Indonesia, in 2021 the Ministry of Energy and Mineral Resources reported a total of 36 minor injuries, an estimated 57 serious injuries, and a total death toll of 11 (32). The number of cases is the accumulation of legal and non-illegal ⁴⁰ gold mining, Ministry of Energy and Mineral Resources does not report specifically minor injuries, serious injuries, and deaths from ²² artisanal small-scale gold mining. Work accident data in artisanal small-scale gold mining is reported in 2021, the total number of miners who suffer injuries is 25 and work-related accidents are 25. The data was obtained from a review article, the article basically does not fit into the

inclusion criteria of the reviewed article and the article does not include where the data was obtained from, only stated that the data was obtained from online news (33).

Psychosocial hazards also threaten the safety of the public and miners. Psychosocial threats such as prostitution, criminalization, violence, substance abuse, and the displacement of indigenous peoples (59). These threats certainly affect the quality of life of the public and miners (34). Psychosocial threats also contribute to increased morbidity and mortality among the public and miners. Lack of awareness and application of occupational safety and health regulations in artisanal small-scale gold mining is a contributing factor to psychosocial threats.

The psychosocial threats that occur cannot be separated from the applicable regulations. Currently, the regulations applied to refer to top-down, which means that lower-level gold mining activities in terms of regulations are not monitored or covered by the regulations applied. Top-down regulations lead to a lack of availability, financing, health insurance, and health services (promotive, preventive, and curative). Another thing that is also directly proportional is the absence of financial, social, and formal employment contracts so that the welfare of the owners or workers of small-scale gold mining is threatened (60).

Environmental Damage

Apart from humans, the biotic (animals, plants, and other organisms) and abiotic (soil, water, and air) environments are also affected by artisanal small-scale gold mining. In Indonesia, illegal artisanal small-scale gold mining causes damage to agricultural land, this happens because of clogged irrigation channels for rice fields, so it becomes a breeding place for mosquitoes, pollutes rivers, and aquatic biota, and changes soil structure. In the Sekonyer river basin, Central Kalimantan, the concentration of mercury in water and sediment exceeds the quality standard, this is due to the illegal artisanal small-scale gold mining which has been operating since 1990(36). Besides being found in sediment and water, mercury is also found in some shrimp and fish that exceed the requirements of the Environmental Protection Agency (EPA) (36). In Kayeli Bay, Kaiely Bay sub-district, Buru Regency, Maluku province, mercury concentrations and water in the bay were found to exceed the quality standard, meanwhile, due to the bioaccumulation process,

mercury was also found in the leaves and rhizomes of the seagrass *Enhalus acoroides* (37). In the Batanghari River, Dharmasraya Regency, West Sumatra, the presence of artisanal-small scale gold mining along the river causes ecosystem damage, threatens the survival of aquatic biota, high levels of turbidity cause river water to be no longer consumed (38). In the Cikaniki River, Bogor, West Java, the mercury concentration identified in the water was 0.4-9.4 g/L. The highest concentrations are in watersheds adjacent to artisanal small-scale gold mining. The form of mercury with the highest concentration is in the element Hg(0), while the form of methyl mercury (MeHg) is identified as lower. This shows that artisanal small-scale gold mining does not produce methyl mercury (MeHg) waste, but produces mercury waste in the form of element Hg(0) (61). The existence of artisanal small-scale gold mining has proven to threaten the resilience and sustainability of the environment. Damage to the aquatic environment in Indonesia such as water pollution, irrigation dams, land and agriculture due to artisanal small-scale gold mining. The availability of access to clean water is also disrupted, people living around the mine have difficulty accessing clean water. On the other hand, mining activities are the people's livelihood (62,63).

Soil pollution can also occur due to artisanal small-scale gold mining activities. In Madre de Dios, Peru, artisanal small-scale gold mining resulted in the loss of 3900 hectares of land (39). This happened because of the conversion of land use into mining activities. Deforestation can cause the El Nio Southern Oscillation climate phenomenon (ENSO), in the Amazon, there are fluctuations in rainfall due to these activities. El Niño Southern Oscillation (ENSO) is one of the climate phenomena that can also cause climate change. Fluctuations in the Amazon cause flooding, this is because the Amazon forest is included in the rain forest, besides having an impact on residents around the Amazon forest, flooding can also disrupt mining activities (21). In Indonesia, the geology of world heritage sites along the Marupa and Kahayan rivers, Central Kalimantan, is threatened by artisanal small-scale gold mining activities. Indonesia's unique biodiversity and geology are threatened with damage, such as the presence of forests, watersheds, and mountains (40). This is because small-scale gold mining artisanal owners and miners often disturb protected places such as national parks (41). It is projected that artisanal small-scale gold mining produces mercury pollution in the air by 57.5%, 15.5% in water, and 14% in soil or sediment (64). In addition to mercury residues found in aquatic biota, pesticide residues

are also found in plants and animals around the mine. Mercury residues were identified in forest and paddy fields with concentrations of 0.07-16.7 and 0.4-24.9 g/g respectively. Meanwhile, MeHg was identified in lowland soil with a concentration of 0.07–2 g/kg and 0.07-56.3 g/kg in lowland soil. People who eat plants, animals, or fish contaminated with mercury will undergo a process of bioaccumulation and biomagnification, causing the highest mercury residue to exist in humans and causing health effects.

The emission of mercury in the air which is also the cause of air pollution is classified into three forms, the first is mercury in the form of gaseous elements, secondly mercury in the form of reactive gases, and thirdly mercury in the form of particulates (42). The form of mercury in the gaseous element from artisanal ¹ small-scale gold mining is the highest source of mercury pollution in the air. The form of mercury in the gaseous element has high kinetics so that in the air it can travel very long distances and residues can be found in the tops of trees and forest leaves (65). As reported by the United Nations Environment Program (UNEP) in 2018, globally mercury emissions released into the air reached 838 tons, East and Southeast Asian countries were a group of countries that contributed greatly to the release of mercury emissions in the air, namely 214 tons (28). Of the group of countries, one of them is Indonesia, namely Central Sulawesi (51).

Economic and Social

As reported by the United Nations Development Program (UNDP), as many as 300,000 miners in Indonesia depend on artisanal ²⁰ small-scale gold mining (66). Owners of artisanal small-scale gold mining can produce up to 70% gold at prices above international standards. Therefore, people in rural areas consider ⁴ artisanal small-scale gold mining a way out of poverty (67). Small-scale gold mining artisanal miners mostly consist of people who are farmers and fishermen, they work part-time to supplement their income. Some communities rely on artisanal ³⁸ small-scale gold mining as their ³ main source of livelihood to fulfill their daily lives. ² Artisanal small-scale gold mining in West Nusa Tenggara (Sekotong island, Lombok) and East Nusa Tenggara (Taliwang-Sumbawa), has been proven to contribute to improving the community's economy (43). This is inversely proportional to ² artisanal small-scale gold mining in the North Lebong sub-district, Lebong Regency, Bengkulu province, where the existence of the mine does not have a socio-

economic impact on the community (44). Artisanal small-scale gold mining in Sulawesi does not have a long and large economic impact on the community (45).

The existence of artisanal small-scale gold mining has two impacts, such as in Bakan village, Bolaang Mongondow Regency, North Sulawesi province, the positive impact is increasing economic welfare for miners, while the negative impact is the danger that threatens public health and environmental health (46). Even though the mines in the area have a positive impact, the residents living around the location do not get compensation or benefit, instead, the residents get the negative impact of environmental damage. So that the benefits obtained from artisanal small-scale gold mining are directly proportional to environmental damage, social vulnerability, and injustice (social security disruption and corruption) (45). What can be done to correct the negative impacts that arise is that artisanal small-scale gold mining must have an operating license so that all aspects can later be anticipated, including the provision of profit sharing for residents living around the mine (46). The community's economy in Dharmasraya Regency, West Sumatra has proven to have improved dramatically, especially for mine owners. The existence of mining facilities causes social inequality, the rich will get richer by getting continuous profits, while the poor will get poorer because of the various impacts caused by these activities (38).

Human resource management in illegal artisanal small-scale gold mining varies and has no (subjective) standards. For example, artisanal small-scale gold mining in Pongkor, West Java, does not yet have regulations regarding the labor system (47). Based on ethnographic research conducted in Pongkor, West Java, over the past 25 years all artisanal small-scale gold mining operations have been illegal. Local gold development occurs dynamically and is closely tied to the lives of surrounding communities. Gold production is closely aligned with fluctuating socio-natural factors, local geology, the global financial crisis, and the demands of technological innovation. In addition, the wage system in artisanal small-scale gold mining does not refer to the regulations that should be set by the Indonesian Ministry of Manpower. In Pongkor gold mining, labor in the extractive section is paid using ore wages, while labor in the downstream section will be paid money wages. The division of gold ore and money to labor certainly fluctuates based on the mining results obtained. Miners have the possibility of not being paid if they do not get anything

from the mining process. But if production is in good results, they can get one million rupiah per week or five million rupiah per day if production soars. The absence of a labor system gives workers huge losses, for example not getting health insurance, employment insurance, and workload.

ACKNOWLEDGMENTS

We thank the Politeknik Kementerian Kesehatan Bandung, Universitas Sebelas Maret, and Politeknik Industri Furnitur dan Pengolahan Kayu for assisting in the article plagiarism checking facility

CONCLUSION

The existence of artisanal small-scale gold mining can have a health impact on miners or the surrounding community. Chronic, acute, infectious, and disability diseases can threaten the survival and health of local communities. This can happen due to the absence of health facilities so that promotive, preventive, curative, and rehabilitative efforts cannot be carried out optimally. The use of toxic materials such as metals or heavy metals is difficult to avoid in artisanal small-scale gold mining, especially mercury, which has a high level of use. These toxic materials can have an impact on public health and environmental health around the mine. Depending on the use of heavy metals in the mining process, miners do not use personal protective equipment, and the absence of compensation or profit sharing to the community is the cause. Artisanal small-scale gold mining has caused accidents with a total of 36 minor injuries, an estimated 57 serious injuries, and a total death toll of 11. This is because illegal mining does not have a health safety license or supervision. The existence of artisanal small-scale gold mining also causes environmental damage. Pollution of water, soil, and air, to a threat of the geology of world heritage sites. This can happen because of the absence of environmental maintenance, for example, there is no budget for repairs or maintenance of environmental sustainability. The existence of artisanal small-scale gold mining in several parts of Indonesia has been proven to improve the community's economy, but it is also directly proportional to health risks, environmental damage, and social

vulnerability. This happens because there is no profit sharing between the mine owner and the affected community.

Recommendations for Government Indonesia

The Indonesian government also supervises ¹⁴ artisanal small-scale gold mining. Especially the existence and operation of an occupational safety and health system or procedure. In addition to ensuring the compliance of mine owners in providing access to health for their workers. The government needs to facilitate and develop a management system, especially in sectoral participation. The government must reduce the crime rate at or around the mine. Establish multisectoral collaboration in the equity of health facilities. In addition, the government needs to ratify the legitimacy, to maintain the sustainability of the environment and public health to protect vulnerable groups. The government must enforce and discipline ¹³ international conventions, such as the Basel Convention, the Stockholm Convention, and the Minamata Convention on Mercury. The government must adopt the International Labor Organization (ILO) which is then set out in regulations to be implemented. The government must facilitate miners and mine owners in integrating access to health. The government helps in increasing marketing so that gold production from ⁴⁴ artisanal small-scale mining can enter and compete in the international market.

Recommendations for mine owners and workers

Owners of small-scale artisanal mines have ⁴³ a responsibility to create a safe and secure working environment for their workers. Miners must use personal protective equipment and comply with work safety and environmental sustainability procedures. Mine owners must carry out Corporate social responsibility.

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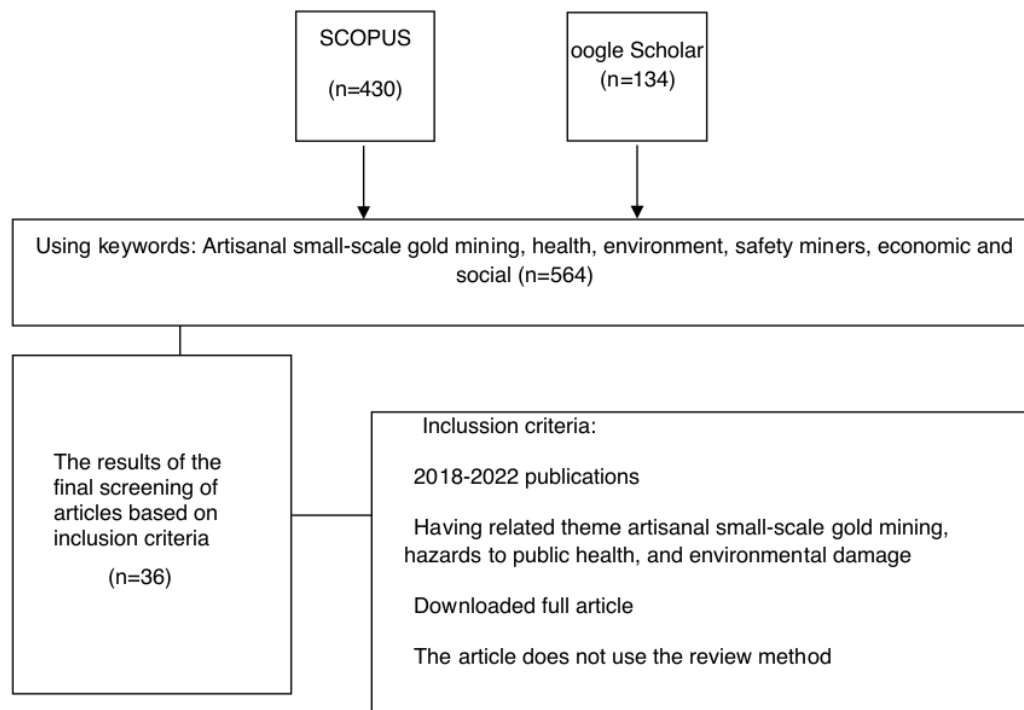


Figure 1. Article Screening Flowchart 2018-2022 from Online Database

Table 1. Results of Reviewed Aspects of The Article 2018-2022

Aspects reviewed	Study Finding	Reference
Disease and disorder in human	1. Malaria is most commonly reported infectious disease in Venezuela, Brazil, French Guiana, and Sudan due to artisanal small-scale gold mining. Brazil has also reported other diseases such as hantavirus and yellow fever. Meanwhile, French Guiana reported another disease, namely Measles.	(12,13,14,15,16,17, 18,19)
	2. Noise pollution from the use of tools for artisanal small-scale gold mining that exceeds the threshold value can cause hypertension, hearing loss, social effects, and even disability.	(20,21,22)
	3. Some artisanal small-scale gold mining in Indonesia harms public health. For example, the outbreak of chronic and acute diseases. In Indonesia, illegal artisanal small-scale gold mining in the North Lebong sub-district, Lebong Regency, Bengkulu province has health effects on the surrounding community in the form of impaired lung function, coughing, and tuberculosis. Artisanal small-scale gold mining in Merangin, Sarolangun, Bungo, and Tebo, Jambi province have health effects on pregnant women and children around the location such as impaired child development and permanent disability	(23,24,25,26,27,28)
Toxic substances	1. Of the total 15% supply of artisanal small-scale gold mining worldwide, it produces 40% mercury pollution.	(28,29)

	<p>Apart from being a toxic material for humans, mercury is also a toxic material for ecology. As reported in a study, mercury was identified with a concentration of 1.4 g/g in the leaves of plants growing around the mine. Plants around artisanal small-scale gold mining in the Districts of Rarowatu and Rarowatu Utara Bombana were contaminated with mercury with a concentration of 9.9 ± 14 g/g d.w.</p> <p>2. Other toxic metals used in artisanal small-scale gold mining are cadmium, arsenic, and lead. Cadmium, arsenic, and lead help in gold exploration geochemistry so that later it produces gold with a good level of purity</p> <p>3. The discovery of silica dust during the crushing process of artisanal small-scale gold mining hard rock.</p>	(30) (31)
Public and miners safety	<p>1. In Indonesia, in 2021 the Ministry of Energy and Mineral Resources reported a total of 36 minor injuries, an estimated 57 serious injuries, and a total death toll of 11. Work accident data in artisanal small-scale gold mining is reported in 2021, the total number of miners who suffer injuries is 25 and work-related accidents are 25.</p> <p>2. Psychosocial hazards also threaten the safety of the public and miners. Psychosocial threats such as prostitution, criminalization, violence, substance abuse, and the displacement of indigenous peoples. These threats certainly affect the quality of life of the public and miners.</p>	(32,33) (34,35)
Environmental Damage	<p>1. Water pollution is one of the environmental damage caused by artisanal small-scale gold mining. In Indonesia, several rivers such as the Sekonyer river basin, Central Kalimantan; In Kayeli Bay, Kayeli Bay sub-district, Buru Regency, Maluku province; the Batanghari River, Dharmasraya Regency, West Sumatra contaminated with mercury, high concentrations of mercury in water, sediment, and aquatic life are the impact of artisanal small-scale gold mining.</p> <p>2. In Madre de Dios, Peru, artisanal small-scale gold mining resulted in the loss of 3900 hectares of land. This happened because of the conversion of land use into mining activities. In Indonesia, the geology of world heritage sites along the Marupa and Kahayan rivers, Central Kalimantan, is threatened by artisanal small-scale gold mining activities</p> <p>3. The emission of mercury in the air which is also the cause of air pollution is classified into three forms, the first is mercury in the form of gaseous elements, secondly mercury in the form of reactive gases, and thirdly mercury in the form of particulates</p>	(36,37,38) (21,39,40,41) (42)
Economic and social	<p>1. Artisanal small-scale gold mining in West Nusa Tenggara (Sekotong island, Lombok) and East Nusa Tenggara (Taliwang-Sumbawa), has been proven to contribute to improving the community's economy. In the North Lebong sub-district, Lebong Regency, Bengkulu province, where the existence of the mine does not have a socio-economic impact on the community. In Sulawesi does not have a long and large economic impact on the community</p> <p>2. The existence of artisanal small-scale gold mining has two impacts, such as in Bakan village, Bolaang Mongondow Regency, North Sulawesi province, the positive impact is increasing economic welfare for miners, while the negative impact is the danger that threatens public health and environmental health.</p> <p>3. Artisanal small-scale gold mining in Pongkor, West Java, does not yet have regulations regarding the labor system</p>	(43,44,45) (46) (47)

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