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IMPACT OF ILLEGAL GOLD MINING IN JAMBI, INDONESIA

DAMPAK PENAMBANGAN EMAS ILEGAL DI JAMBI, INDONESIA

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ABSTRACT

Illegal gold mining caused various environmental damages in the world. Indonesia is one of the countries with abundant mineral reserves, especially Jambi Province. Jambi has much of natural resources, such as coal and gold. Unfortunately, the management of these natural resources has not been appropriately managed, which has resulted in much illegal gold mining. Illegal mining activities have caused environmental damage, mainly decreased water quality and changed landscapes. This paper explains the illegal mining activities at Jambi Province, including its history, socio-economic and environmental impacts, as well as recent technologies to reduce the environmental damage. Quantitative and qualitative methods were used in this research, including interviews, questionnaires, and laboratory measurements. The results showed that the people of Sarolangun, Bungo, and Tebo were aware that their illegal gold mining activities caused environmental damage. However, economic conditions and insufficient employment opportunities made unlawful gold miners have no other choice. Illegal gold mining activities have also shifted people's livelihoods who previously worked as farmers.

Keywords: illegal mining, social-economy impact, environmental impact.

ABSTRAK

Penambangan emas illegal dilaporkan telah menyebabkan berbagai permasalahan lingkungan di dunia. Indonesia merupakan salah satu negara dengan cadangan sumberdaya alam berlimpah. Salah satu wilayah yang memiliki cadangan emas berlimpah adalah Provinsi Jambi. Sayangnya potensi sumberdaya alam yang dimiliki belum dikelola dengan baik sehingga menghasilkan banyak penambang emas ilegal. Penambangan emas illegal telah menyebabkan kerusakan lingkungan seperti penurunan kualitas air dan perubahan bentang lahan. Tulisan ini menjelaskan aktivitas penambangan emas ilegal di Provinsi Jambi meliputi sejarah, dampak sosial-ekonomi dan lingkungan serta teknologi terbaru yang dapat digunakan untuk menurunkan kerusakan lingkungan yang terjadi. Metode penelitian kualitatif dan kuantitatif digunakan pada penelitian ini meliputi kuesioner dan pengukuran di laboratorium. Hasil penelitian menginformasikan bahwa masyarakat Kabupaten Sarolangun, Bungo dan Tebo sadar bahwa kegiatan penambangan emas ilegal yang mereka lakukan telah menyebabkan kerusakan lingkungan. Namun, kondisi ekonomi dan lapangan kerja yang tidak mencukupi membuat para penambang emas ilegal tidak punya pilihan lain. Kegiatan penambangan emas ilegal juga telah menggeser mata pencaharian masyarakat yang sebelumnya berprofesi sebagai petani.

Kata kunci: penambangan ilegal, dampak sosial-ekonomi, dampak lingkungan.

INTRODUCTION

Environmental pollution has become the international community's focus because it increases. The IPCC reported that the world's focuses are land degradation and climate change (Nachtergaele, Petri and Biancalani, 2016). Land degradation is reported to impact the surface water quality. The International Water Association has also

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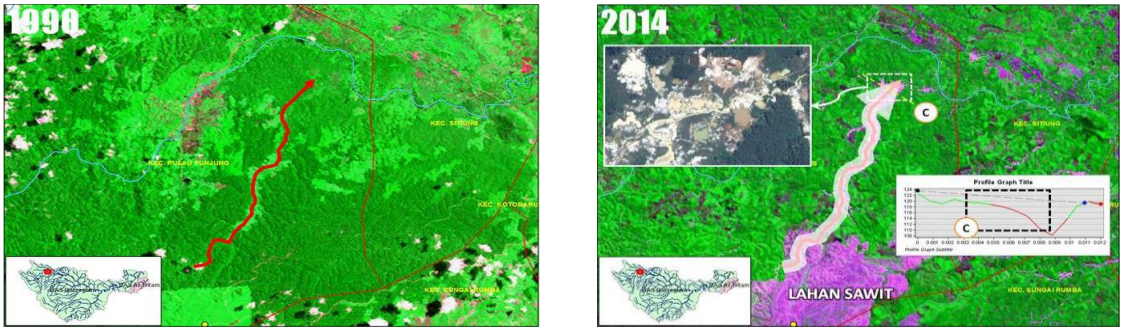
reported that there has been a problem of water pollution almost all over the world due to the land degradation (International Water Association, 2018). Water pollution in various countries in the world are caused by multiple reasons including legal and illegal industrial activities (Khademi *et al.*, 2019) and illegal community activities (Vitali *et al.*, 2021) such as artisanal Small Scale Gold Mining (ASGM). The ASGM is one of the illegal activities that impact on land degradation, decreasing surface water quality, and the high number of human populations that cause the use of goods can pollute the environment (Bansah *et al.*, 2018; Cuya *et al.*, 2021).

Indonesia is one of the highest populated countries in the world. According to the Central Bureau of Statistics, the population of Indonesia is more than 273 million in 2021. The high population and inequality of development and job opportunities have caused people in various regions to carry out illegal activities as a livelihood. Unlicensed Gold Mining generally called ASGM is one of the activities carried out by many people in poor regions and rural areas (Yoshimura, Suemasu and Veiga, 2021). Jambi Province is one of the Province that has high ASGM activities in several regions. The ASGM activities in Jambi spread at Sarolangun, Bungo dan Tebo Regencies. The ASGM high activities caused a decrease in environmental quality (Velásquez Ramírez *et al.*, 2021). Based on the observations, it was found that there was a decrease in Batanghari River water quality of Jambi Province. Previous research reported that the decline of the water quality of the Batanghari River was caused by the high activity of ASGM in the upstream area of the river (Desrizal, Carlo and Syah, 2019).

Landsat-7 ETM satellite image showed that illegal activities had damaged the river (Figure 1). This figure informed that the ASGM was found in 2014 (Marhendi, Rasyid and Kresnanto, 2015). A study in another region in Indonesia was reported in Gorontalo. In Gorontalo, a recent study reported that the mercury was found in all of human hair. The mercury contamination was also found in the non-miner (Arifin, Sakakibara and Sera, 2015). Based on this research, the mercury contamination should be detected to the resident of Tebo, Bungo and Sarolangun Regencies. Many papers have been published and reported regarding the mercury impacts on humans and the environment, but the different locations give different results. Thus, the information of historical mining activities is crucial information to have the information about the potential contamination of mercury in human bodies and their environmental damages. The report of the ASGM activities in Jambi Province is rare due to it is a sensitive issue. In addition, the complicated access to ASGM locations in remote and rural districts are another challenges in finding research data for evaluating the ASGM impact.

This paper provides the comprehensive information about the history of the ASGM in Jambi, its impact on the environment and human health based on the interview, questionnaire, and laboratory measurement. This study also provides a different perspective on the impact of the illegal mining activities in Jambi, education quality improvement, and the social and economic life of the community, which will be one of the positive impacts of the ASGM's activities to be explored in balanced.



Source: (Marhendi, Rasyid and Kresnanto, 2015)

Figure 1. Batanghari River in 1990 (a) and 2014(b)

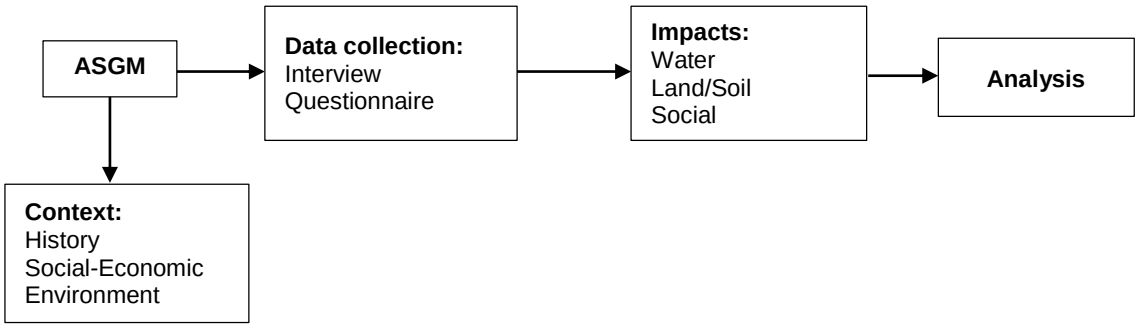


Figure 2. Summary of ASGM-Socio, economic and environment collision course

METHOD

To highlight the emerging themes of the ASGM impact on the environment and social economics in Jambi Province, Indonesia, questionnaires and interviews were used to collect information about the social-economic, history, and environmental effects of ASGM activity in Jambi Province. The mercury concentration in surface water is measured by atomic absorption spectrophotometry instrument.

RESULT AND DISCUSSION

Illegal mining activities in Jambi Province have caused various environmental damage. The most damaging impact changed the landscape and decreased water quality upstream of the Batanghari River. Illegal gold miners in this area keeps much information, such as the history of the first miners. Various institutions should have been involved in monitoring resources, residents, impacts on the economy, society, and environment.

Historical of ASGM

ASGM activities in the Sarolangun Regency have been going on for years since transmigrants from Java, and West Sumatra arrived in this area. Some activities reported had existed since 1998. This information was collected from the interview. Several other informants even confirmed that the gold mining activities had existed since 1990. These activities continued until the 2000s. Since 2000, 760 units of traditional machines have been operating in the Sarolangun Regency and increased to 1,250 units in 2012. These activities had also damaged the forest ecosystem and changed the land use from forest to the illegal gold mining area of about 2,071.5 hectares in 2012. Limun District became the area with many ASGM activities in Sarolangun District, with more than 3000 miners in 2012.

The ASGM activities in Limun area (Sub-district of Sarolangun Regency) has existed since the local people's ancestors came from the Batin and Penghulu areas, Minangkabau. These peoples were interested in the discovery of gold deposits in the area. The Minangkabau people came and settled in the Sarolangun Regency, especially in the Limun District. The miners of Limun area comes from Luhak, Minangkabau. They had illegal mining activities in a group scheme. A mining group is about six to 10 people. The movement of these communities brings its local customs and culture, norms, laws, various forms of social organization, and new livelihood technologies as gold miners.

Another study informed that the Minangkabau people have existed since 1728 to mining gold (Azmi, 2018). These people were scattered about 15 to 20 people in each village. The Minangkabau people who came to the Sarolangun Regency area for the first time carried out mining activities by making mine pits into passageways to follow the gold flow. This situation was due to gold deposits in veins (Luis and Benitez, 2008). When they first came to the Sarolangun Regency, especially the Limun area, the community only mined during the dry season and looked for spices during the rainy season. The immigrant colonies were the only gold miners that existed in the early period of gold mining, while the natives had their eyes searching as food producers to supply the food of the gold seekers. In early 1740, the immigrant community from Minangkabau asked the Jambi sultanate to open the Limun area as a gold mining area (Azmi, 2018).

Since 2000, the local communities of mining engineering have improved using traditional machine and hydraulic system. This technology is proven to produce more gold than the others traditional technologies. The conventional machine is used as an alluvial exploitation tool. Besides that, to determine areas that have potential gold reserves, also use a conventional machine such as hydraulic and wallet (*Dompeng* in traditional term). The traditional machine commonly used in the Limun sub-district is a traditional machine about 4 to 6 inches.

Figure 3. Traditional machine in Sarolangun ASGM

After 2000, all gold miners switched from making healthy holes to use traditional machines with a spray system. It is recognized by the community that the use of spray and traditional machine mining systems can reduce the number of deaths caused by the collapse of holes opened by miners. Based on information from the surrounding community, when using the opening holes, work accidents caused by illegal mining continue to occur every day, but after the miners switch to using traditional machines and mine from the surface, the number of work accidents that occur decreases significantly. Although this technology can reduce the rate of work accidents, this mining method requires a high investment cost. In addition, this technology is one of the causes of the cloudiness of the Limun River in Limun District, Sarolangun Regency, which has its head in the Batanghari River.

Since 2018, the community's mining techniques have begun to improve. The people of the Limun District area have started mining using heavy equipments such as the excavator with type PC-200. The use of the excavator reduces the number of deaths caused by work accidents during mining, besides the use of heavy equipment also increases the number of gold miners get. The heavy equipment used by the community varies from renting to buying heavy equipment personally. The district informed that the results obtained from this activity were very economical and exceeded the purchase value of the excavator. One of the interviewed respondents even said that his income could exceed IDR 72 million in one day.

Apart from Sungai Limun district, the ASGM activities were conducted in Tebo and Bungo Regencies. The ASGM activities in these two areas were also very high and caused significant damages to the Batanghari River. The surface water in Batanghari is decreasing in physical parameters (color, smell and taste). ASGM activities in Bungo Regency also recorded frequent work accidents; in 2016, a significant flash flood occurred for the first time in Bungo Regency, which was caused by river sedimentation and damage to the water and land ecosystem. The ASGM activities in the Bungo area have been going on since 1998 and have continued today. The distribution of illegal gold miners in Bungo Regency is spread across several regions. This condition is due to the economic condition of gold deposits in the area.

Social-Economic Impacts of ASGM

Illegal mining in Sarolangun, Tebo, and Bungo Regencies were changed the socio-economic conditions of the surrounding communities. The survey showed that more than 90% of the people in the Limun District area carry out ASGM activities using traditional machines and heavy equipment. ASGM actions carried out by the

communities in the three districts in Jambi Province have harmed the state budget. This activity causes tax collection not to be included as original regional income or state tax. Also, the ASGM activities in Jambi Province have positively impacted increasing the surrounding community's income.

Based on the survey results conducted during the research period, the income of the people who carry out the ASGM activities using heavy equipment can reach about IDR. 72,000,000- (seventy-two million rupiah) within one mining day. Meanwhile, people who mine using a traditional machine can reach a maximum of IDR. 20,000,000,- (twenty million rupiah) per day. This income does not include heavy equipment operators, miners on duty, heavy equipment rental or traditional machines, and other incidentals. The survey results also inform that miners can earn at least IDR in one day 200.000,- (two hundred thousand rupiah) and the machine owner or the miner's boss gets the rest. This minimal income is obtained from hitching a ride on the mine landowner.

The increase in the economic value of the communities were significantly impacted the way of life and education standards of the people in the three districts. Our preliminary survey informed that more than 70% miner children or ASGM actors have successfully attained an education equivalent to undergraduate and postgraduate program. Before ASGM activities, the average education of the community and children in ASGM actors was the top high school. Significantly few people were able to send their children to tertiary education. ASGM activities are also reported to have changed 90% of the livelihoods of the surrounding community, and it is recorded that until now. People who previously worked as rubber farmers are scarce, rubber farmers who are still tapping are only rubber farmers who also have land to the illegal mine for gold.

ASGM also impacts the resident economy; a recent study reported that the ASGM has an increasing local economic impact (Like Bungo, Tebo, and Bangko). Previous research also reported the high ASGM activities and implications for economic growth in China (Shen and Gunson, 2006). Jambi has also regulated small-scale legal gold mining. This effort is contained in the Institutionalization of People's Mining. This program was proposed by the Ministry of Environment and Forestry of the Republic of Indonesia to reduce the number of illegal gold mining (Yunianto and Saleh, 2011). The principle raised in this program is Social Acceptance; sustainable technical community mining activities can be ensured that they are socially accepted, including Social Justice, where community mining management must promote justice for all community mining actors. Work safety and community mining management activities are expected to minimize social risks in community mining management, such as work safety and social conflicts.

Community mining management activities must encourage the togetherness of all stakeholders in community mining management for a long-term benefit. Community mining management must promote the internalization of environmentally friendly values in community mining activities to encourage long-term benefits from people's mining activities (Ministry of Environment and Forestry Republic of Indonesia, 2005).

Illegal gold mining activities in Bungo, Tebo, and Sarolangun Regencies have increased community income. This activity had also reduced the income of the people who work in the agricultural sector. This condition is due to a decrease in the quality and quantity of the land used for farming. Gold mining activities cause farmers to lose money. This situation is due to the increase in rental prices for various tools used in the agricultural sector. Daily labor wages (hoeing, fertilizing, weeding, and harvesting activities) increased by 100% after mining was established, while wages for transplanting on a wholesale basis increased by 90% from the original price before the existence of mining. The cost of tilling or leasing tracts increased 84%, and *rent increased 86% after mining*.

Environmental Impact of ASGM

Mercury can exist in 3 forms: metal, inorganic compounds, and organic compounds. Mercury and its derivatives are very toxic, so their presence in the aquatic environment can be detrimental. The effect of mercury pollution on ecology is long-term, including damage to community structures, genes, food networks, behavior, and physiology of aquatic animals. In the environment, mercury found in the waste of public waters is

converted by the activity of microorganisms into methyl mercury components (organic compounds). Methyl mercury has high toxicity. It is challenging to decompose compared to its original substance, and has a high binding power to body tissues, especially in aquatic biota. Therefore, the mercury concentrations are usually higher in marine biota than that of the terrestrial animals. The entry of methyl mercury into the fish body or another aquatic biota can occur through the process of water absorption through the gills and the food chain process, then accumulates through the process of bioaccumulation and bio magnification in the body's tissues (Munthe *et al.*, 2007; Liu, Cai and O'Driscoll, 2012).

The intestines will absorb about 95 percent of the methyl mercury that enters the body, and only less than 1 percent is excreted again from the body (Rice, 2004). Thus, large predatory fish are more likely to have high levels of mercury due to eating small fish that have been contaminated with mercury through plankton consumption (Chan *et al.*, 2003). Mercury accumulated in the bodies of aquatic animals will damage the enzymatic system, which results in a decrease in the adaptability of the animal concerned to the polluted environment. In fish, the organs that accumulate the most mercury are the kidneys, liver, and eye lens. The results of exposure to metal mercury tested on several types of fish revealed that each class and species of fish had a different sensitivity level, depending on the activity of the biota. Research results also report that mercury can agglomerate mucus on the surface of the gills and damage gill tissue so that fish die. The existence of injuries to the gills and other external tissue structures can cause death to fish caused by the anoxemia process, namely obstruction of the respiratory function, namely circulation and excretion from the gills (Andres, Laporte and Mason, 2002).

A study informed that 0.001 ppm of mercury can be removed by goldfish egg bags *(Cyprinus carpio*) (Khaniki *et al.*, 2005). The accumulation of mercury in the body of marine life is also concentrated in the reproduction organ. It will affect the development of marine life, especially in developing their offspring. In addition, mercury can also harm human health (Budihardjo *et al.*, 2021). Humans can be exposed to the mercury through the immediate livelihood process of mercury vapor or the food chain process if they eat fish and aquatic biota contaminated with mercury. Mercury exposure in the human body can cause serious health problems, even in low concentrations. Inorganic mercury poison can result in impaired kidney and liver function. Organic mercury from methyl mercury can enter the placenta and damage the fetus in pregnant women causing congenital disabilities, DNA and chromosome damage, disrupting blood vessels to the brain, and causing brain damage (Gilbert-Barness, 2010).

The most prominent case of mercury pollution occurred in Minamata Bay, Japan. A company that produces acetic acid dumps its liquid, climbing into Minamata Bay, high concentrations of methyl mercury. The tragedy known as Minamata disease occurred between 1932-1968. Minamata Bay is an area rich in fish and shellfish resources. For years, no one realized that the fish, shellfish, and other marine resources in the bay were contaminated with mercury. Methyl mercury enters the bodies of marine organisms either directly from water or following the food chain. Then it reaches high concentrations in shellfish, crustaceans, and daily fish consumption for the Minamata people. As a result of the bioaccumulation and bio magnification processes, the mercury concentration in 1,694 fishermen from the Siranui Sea showed the contamination mercury in Shermanan hair reached 0-357 ppm in 1670s (Tsuda *et al.*, 2009). At that time, at least 50,000 people were affected, and more than 2,000 cases of Minamata disease were certified. The Minamata people who consume the contaminated seafood have neurological disorders, paralysis, loss of their sense of taste, inconsequential speech, and many have even died (Tomiyasu *et al.*, 2006; Ekino *et al.*, 2007; Mackey, Contreras and Liang, 2014).

Mercury can contaminate water and soil. A recent study informed that soil was contaminated by mercury in Kenya. The ground was contaminated between 20-1,000 $\mu g.kg^{-1}$ mercury in this location. The average mercury contamination of mercury in the soil is recorded at about 10-200 $\mu g.kg^{-1}$ (Odumo *et al.*, 2014). Soil contaminated will impact microorganisms and plants. Mercury in contaminated soil was also detected due to long-term phosphate fertilizer production.

The soils sample was collected from Rio Grande, Brazil. This research informed that using phosphate to contaminate the soil with mercury (Odumo *et al.*, 2014). In China, most of the agricultural soil was contaminated with mercury. A current review informed that more than 486 articles showed that China's soil was contaminated by mercury (Huang *et al.*, 2019).

Not only in a worldwide, the ASGM activities have a significant environmental impact in Sarolangun, Tebo, and Bungo Regencies. A decrease in water quality is one of the most significant impacts that can be seen with the eye (without the need for laboratory instruments), such as discoloration and silting caused by sedimentation. The color change is also one of the impacts of decreasing water quality that can be seen without using tools. In the Sarolangun Regency, there has been a change in the color of the water from clear to cloudy brown; a similar thing that is also happened in Bungo and Tebo Regencies. The illegal mining activities have damaged the water and land ecosystems. This condition is dangerous for the balance and survival of organisms around the mining area. The environmental impact that occurs is not only decreasing water quality and quantity; this activity is also reported to be the cause of flooding in six villages in Sarolangun Regency. According to one respondent, the floods in 2019 occurred due to breaking the water line in a town in Sarolangun Regency, carrying out massive ASGM activities. One of the rivers severely affected by the ASGM activity is Limun River in Monti Village. The upstream and downstream areas of the Limun River appear to have suffered quite severe damage when viewed from the color of the river flow. A part of the Limun River is the Dam Kutur, the water flowing in this area is also seen to be experiencing very severe environmental degradation.

The problem of illegal gold mining is not only a problem in Jambi Province (Indonesia) but has occurred in various other countries. A recent study reported that the ASGM has also happened in the southwestern region of Ecuador (Schudel *et al.*, 2019). In that area, the Hg content occurred in several locations, such as starting materials active tailings contain mercury levels up to 15 mg/kg; besides that, Hg+ NaCN content is also found in active tailings (Schudel *et al.*, 2019). Surface water containing inactive tailings at the research location have also been taken. In the measurement process, the results of the analysis of mercury content from ASGM in the Jambi Province will be reported in a follow-up study. However, based on the results of field observations and research, it is known that gold miners use mercury, not at the mining site. The following process after gold is attached to the ashtray carpet (a simple tool for mining gold) is the use of mercury to unite gold ore; the process is carried out in a small vessel and conducted in residents' houses, the results of observations and interviews revealed that only the people of Sarolangun uses mercury in the mining area.

Based on the interview results, the community acknowledged that before the illegal gold mining activity, the water flow in the river was excellent. The district could find various types of fish to catch. Still, after illegal mining gold activities increased, the community did not even see any water biota that lived along the river in their territory. Besides, the water condition has physically turned brown due to the combination of water and soil (into colloids) in the gold mining process using a traditional machine. In addition to decreasing water quality, it is also recognized that significant changes in the landscape have occurred; besides that, the former ASGM areas in the Sarolangun, Bungo, and Tebo Districts were not reclaimed. This situation was due to the high cost of land reclamation. The community will leave the land that has been mined. The image below shows one example of ex-legal gold mining land that the community has abandoned.

Figure 4. The former illegal gold mining area in Jambi Province

ASGM caused an environmentally negative impact, especially on water quality. According to the previous study, the ASGM will increase the mercury content in the area (Pirrone and Mason, 2009). This contamination will impact the animals around there. The results of mercury levels according to laboratory analysis showed in Table 1.

The result informed that most of them were contaminated by mercury, which was higher to be found in Benteng River, ASGM area in each area, Buluh River, Kandang village, Penapalan village, and ASGM in Moenti village. The lowest mercury level was found in Moenti village (far from source of ASAGM), Semabu River, and Moenti village.

This condition will have some negative impacts on human health. A recent study informed that mercury was found in miners' and non-miner hair in Gorontalo, Indonesia (Arifin, Sakakibara and Sera, 2015). Thus, the residents in this area are potentially contaminated by mercury. It is also reported that the mercury was found in water, fish, hair, and sediment (Arifin, Sakakibara and Sera, 2015), although the village location is far from the ASGM site. This phenomenon showed that the mercury flows in the river water from pollutant sources.

Mercury is one of the most dangerous heavy metals and has the most hazardous toxic effects (Budihardjo *et al.*, 2021). Mercury usually associated with Cd, and Pb. There are the three essential and most dangerous heavy metals with the highest toxicity level to human health. WHO also list mercury as the ten most hazardous chemicals for the human body. Mercury is considered a dangerous metal because it is easy to be absorbed into the body in its ion or specific compounds. In the body, mercury can inhibit the function of various enzymes and can even cause cell damage.

Table 1. Mercury levels

Location	Concentration (mg/L)	Limit of Mercury in River (mg/L)
Semabu river	0.0019	
Benteng river	0.0028	
ASGM area	0.0030	
Buluh river	0.0028	
Kandang village	0.0024	0.002
Penapalan village	0.0196	
Kerch river	0.0037	
Moenti Village	0.0013	
ASGM Moenti Village	0.0024	
River in Moenti Village	0.0013	

Strategies for Reducing Environmental Impact from ASGM

ASGM in Jambi Province has caused significant environmental damage. Although the economic and social conditions of the community have increased, the damage to landscapes and water quality has reached a critical stage. This condition is due to the activities of ASGM, which uses a traditional machine that causes soil and water to merge into a colloid system. This phenomenon causes the water in the upstream to downstream areas of the Batanghari River to turn brown. Special efforts are needed to reduce environmental degradation caused by ASGM activities in Jambi. The conventional machine *(Dompeng)* that used in ASGM activities is a crucial source that changed soil and water particle combine to colloid system. The different technology was used in Sarolangun Regency, in this area miners used excavators and does not use dompeng. This more modern technology is known not to push water and soil colloids to form, but this technology is expensive.

One of the efforts that have been made to reduce the environmental impact caused by ASGM is making regulations that prohibit illegal mining activities from taking place. Apart from that, efforts to control them have also been carried out by conducting raids and burning various tools used by miners. Unfortunately, the multiple actions that have been made have not been optimal in reducing the number of miners. Another step that can be made is to develop technology that can reduce mercury levels in the environment. Various studies and reports have been published on how humans and diverse aquatic biota are contaminated with methylmercury (Lehnherr, 2014). The United Nations Environmental Program report states that mercury concentrations have been found in human teeth, Beluga teeth, ringed seal teeth, polar bear hair, gyrfalcon feathers, and peregrine falcon feathers (United Nations Environmental Programme, 2013). Various researchers in worldwide are trying to reduce mercury content in water and soil. The most economic and promising method to solve this problem is adsorption (Wibowo *et al.*, 2022). The adsorption method is still being developed and combined because it is one of the simplest, inexpensive, and environmentally friendly ways. Recent research has developed a material to reduce mercury content in polluted water using sulfur copolymers containing micro and macroporous structures using Divinylbenzene (80% purity), elemental sulfur (99.55%), sodium chloride (99.55%), and poly (sodium 4-styrene sulfonate, Mw-70000) purchased from Sigma Aldrich, UAE. This research has succeeded in reducing the mercury content in polluted water significantly due to the excellent pore structure of the material as an adsorbent (Wadi *et al.*, 2020).

The environmental impact caused by illegal gold mining in Jambi Province comes from several stages of ASGM, such as the spraying process in gold deposit areas, sluice boxes, and mercury to unite gold ore. Various preventive efforts carried out by the Regional and Central Governments through various regulations, but all efforts are still not optimal, which try to be solved by several approaches such as education for the community. The education for community is still no optimal due to the economic aspect. Miners need a new profitable job, according to the interview miner will be leave as ASGM miners if they have another profitable job. The suggestion effort are classified the rules that must be done as an effort to fight illegal mining includes social pressure, education to change the behavior of miners, strict rules on prohibitions and penalties for violating communities, and manipulation of market forces by making legal mining permits or give the miners another profitable jobs.

Limitation Research

The limitation of this study lies in access to information. The people of Sarolangun, Tebo, and Bungo Regencies are not open to foreigners who want to get any information related to ASGM because this activity is illegal, and there are frequent clashes between the government, police and the community. It is feared that foreigners who come to them will interfere with their mining process. Besides that, they are afraid that their livelihoods as illegal gold miners will be disturbed.

CONCLUSION AND SUGGESTION

ASGM's activities have caused significant environmental damage in the Jambi Province area. The worst damage is the landscape changes and the decline in surface water

quality. The community knows that ASGM's activities have caused environmental damage in their area, but the illegal mining activities continue due to economic needs.

Illegal gold mining activities in Jambi Province existed in 1740. Immigrants from West Sumatra initiated those; then, unlawful gold mining activities became the primary livelihood in Sarolangun, Bungo, and Tebo districts. Due to its higher income, this activity has substituted their previous livelihoods (farming) from farmers to illegal gold miners.

Jambi Gold mining activities do not cause social conflicts among miners and the surrounding community. The war happened strictly between mining and the government or agencies that would limit illegal mining activities. The environmental impact, significantly decreasing water quality, can be seen from the changing color of water in each surface water flow in the Sarolangun, Bungo, and Tebo districts. These activities have also caused the loss of river biota, sedimentation, and significant changes in the landscape. Further research is to measure mercury levels in surface water in the Sarolangun, Bungo, and Tebo areas. Mercury has been found in water, stream and river sedimentation, fish and other aquatic biota and human body parts; mercury also reported an infected human placenta, umbilical cord, cord blood, and amniotic fluid; it is necessary to measure the levels of mercury in that section.

The simple, inexpensive, and rapid mass-produced technology must be developed immediately. Furthermore, research plans and the offered solutions must involve all agencies such as the Central Government, Regional Governments, Universities, Research or Research Institutes, International Organizations, Village Apparatuses, and all levels of society.

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