BUKTI KORESPONDENSI ARTIKEL

“Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)”

SUBMISSION

Gmail Sri Maryati <sri.maryati.geo@gmail.com>

[JPSL] Submission Acknowledgement

Dr. Yudi Setiawan, SP., M.Env.Sc <jurnal@apps.ipb.ac.id> 6 Desember 2021 pukul 17.29
Kepada: Sri Maryati <sri.maryati.geo@gmail.com>

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Thank you for submitting the manuscript, "Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)" to Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan (Journal of Natural Resources and Environmental Management). With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

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Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)

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Abstract: *This research focuses on villages where the community mostly works in the small-scale gold mining sector (ASGM), namely Hulawa Village and Buladu Village, North Gorontalo Regency. Mercury has remained being used by the community in this location for gold processing since a long time. It is important to increase the environmental literacy of the community around the ASGM area considering the dangers of mercury to health and the environment. This study aims to improve the environmental literacy of the community around ASGM regarding the mercury dangers to health and environment. Raising the community environmental literacy is carried out through a mercury dangers awareness campaign by playing videos of mercury dangers, distributing mercury-free gold processing leaflets, resources person explanation concerning mercury impact. Public knowledge about the dangers of mercury before and after the campaign was measured through questions. This study shows that there is a rise in the number of people who understand the dangers of mercury after a mercury awareness campaign. The increase in the number of people who understand the mercury dangers shows that audio-visual and printed media are effectively used to increase public awareness of the dangers of mercury in ASGM areas.*

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INTRODUCTION

The primary source of livelihood of community members is strongly influenced by the availability of natural resources in their regions. Utilizing natural resources in Indonesia refers to the applicable laws and regulations. Article 33 Section 3 of The 1945 Constitution states that “earth, water and natural resources contained therein shall be controlled by the State and used for people's maximum prosperity”. The government has regulated the utilization of natural resources intended for sustainable development and environmental protection.

In addition to using natural resources, the community should have concerned about environmental sustainability. An unprotected environment may lead to environmental damage, pollution, health hazards, and even natural disasters. Environmental pollution poses a serious threat to public health.

Sumalata Timur District is among the regions in Gorontalo Province with traditional gold mining. Artisanal and small-scale gold mining (ASGM) in this district is located in some areas, including Hulawa Village and Buladu Village. The community started manual gold mining and processing 25 years ago, and gold processing using drums began in 2008. Based on the Report of Technical Review of Regional Action Plan of Mercury Reduction and Elimination of North Gorontalo Regency (2020), there were 200 workers of ASGM in Sumalata Timur District. The gold processing methods applied by the community in ASGM in the site area include processing with drum, vat, and panning.

The present work focuses on villages in Sumalata Timur District, namely Hulawa Village and Buladu Village, whose livelihoods are dominated by ASGM work. Both villages are located near the gold mining and processing site. An interview with the local community has shown that 85% of villagers in Hulawa Village and >50% of villagers in Buladu Village work in the ASGM sector. Besides, the field observation indicates that gold processing majorly uses mercury.

Mercury is detrimental to health (World Health Organization -WHO, 2007) and the ecosystem (Viana et al., 2019). It particularly affects the nervous, digestive, and immune systems, lungs, and kidneys. Consumption of foods containing mercury is hazardous for children and can interfere with fetal development. Mercury in the environment comes from natural processes and human activities. Slotton and Jones (1996) contend that mercury resulted from human activities include gold mining, steam power plant, fuel combustion, and smelting.

Several previous studies on mercury content in the human body and the environment around the ASGM in Hulawa and Buladu villages have been conducted. A study by Mahmud, et al. (2018) suggests that mercury content in the hair of the people in Buladu gold mining reaches 20% (higher than the threshold), 20% (close to the threshold), and 60% (lower than the threshold). The threshold is recommended by the Nation Research Council (NCR) of 12 ppm. Moreover, Hiola's research in 2017 shows that the highest and lowest mercury contents in the urine of the gold miners in Hulawa Village are 0.0040 ppm (sample A) and 0.0010 ppm (sample B), respectively. Arifin et al. (2020) discover that ASGM activities in North Gorontalo Regency are harmful to the environment, miners, and local people.

This research has also observed that the small-scale gold mining and processing sites are close to residential areas; gold processing waste is disposed of in the surrounding environment and flows into the river; the workers wear inadequate personal protective equipment. The local community has been using mercury to process gold for years, and they assume that utilizing this chemical element is the easiest way to obtain the gold. As of today, health issues due to the use of mercury have never occurred.

It is also shown from the observation that environmental problems in the research site require close attention. Environmental literacy of the community is of importance to deal with environmental issues. Srbinovski et al. (2010) argue that environmental literacy is the primary outcome of environmental education. Further, Atabek et al. (2014) state that environmental education is promising to prevent environmental problems. One's environmental literacy can be instilled through environmental education. In view of the significantly increasing environmental issues, the community should learn the activity or behavior that may lead to environmental hazards (Geith, 2019.)

WHO (2007) recommends reducing mercury exposure, eliminating mercury (if possible), and finding alternatives to the use of mercury. Saturday (2018) also encourages public education regarding the reduction in using mercury-containing products. According to Viana et al. (2019), the impacts of mercury on health should be a global concern related to its toxicity and the wide range of sources of human exposure. Mostafalou and Abdollahi (2013) point out that educational and informative programs are required to lower the use of mercury.

The Gorontalo Provincial Government has issued the Regulation of Gorontalo Governor Number 71 of 2020 concerning the Regional Action Plan of Mercury Reduction and Elimination. The government of North

Gorontalo Regency has also issued the Regulation of North Gorontalo Regent Number 35 of 2020 concerning the Regional Action Plan of Mercury Reduction and Elimination. These regulations are issued in response to the Presidential Regulation of the Republic of Indonesia Number 21 of 2019 concerning the National Action Plan of Mercury Reduction and Elimination. The regional action plan (henceforth, RAD) covers the reduction and elimination of mercury in energy, ASGM, and health sectors. RAD establishes strategies and activities regarding mercury reduction and elimination in North Gorontalo Regency. The movement of "STOP MERCURY" as one of the activities in the ASGM sector is carried out with the campaign of the impacts of mercury use on vulnerable people.

Environmental literacy of the community is gradually developed through various programs and activities to better their knowledge and awareness of environmental protection. As Hamzah (2013) claimed, attitude change of society towards the environment is affected by promotions through education, discussion, and public participation. Information on environmental problems can be provided through formal and non-formal education, along with media utilization.

Drawing upon the problem in the research area, the improvement of environmental literacy of the community is crucial, especially about the dangers of mercury to the environment and health. The present work aims to improve the environmental literacy of the community in connection with the impacts of using mercury in the ASGM sector, particularly the dangers of mercury to health and the environment.

METHOD OF STUDY

Site and Time of Research

This research was conducted in Hulawa Village and Buladu Village, Sumalata Timur District, North Gorontalo Regency, Gorontalo Province. Sumalata Timur District is located on the northern coast of Gorontalo Province. According to Statistics Indonesia of North Gorontalo Regency (2019), the total population of Hulawa Village and Buladu Village was 637 people and 810 people, respectively. The map of the research site is presented in Figure 1.

Data Collection Techniques

The improvement of environmental literacy of the local community in the ASGM area of Hulawa Village and Buladu Village was performed through a campaign of mercury dangers awareness and knowledge. The campaign targeted those vulnerable to mercury exposure, including the workers in the ASGM sector, their family members, and youths around the ASGM area.

This campaign was done by distributing leaflets on free-mercury gold processing, playing videos of the dangers of mercury to health and the environment, and presenting the concepts of mercury, forms of mercury, and impacts of mercury on health and the environment. Some questions were given to the local people to discover their knowledge before and after joining the campaign.

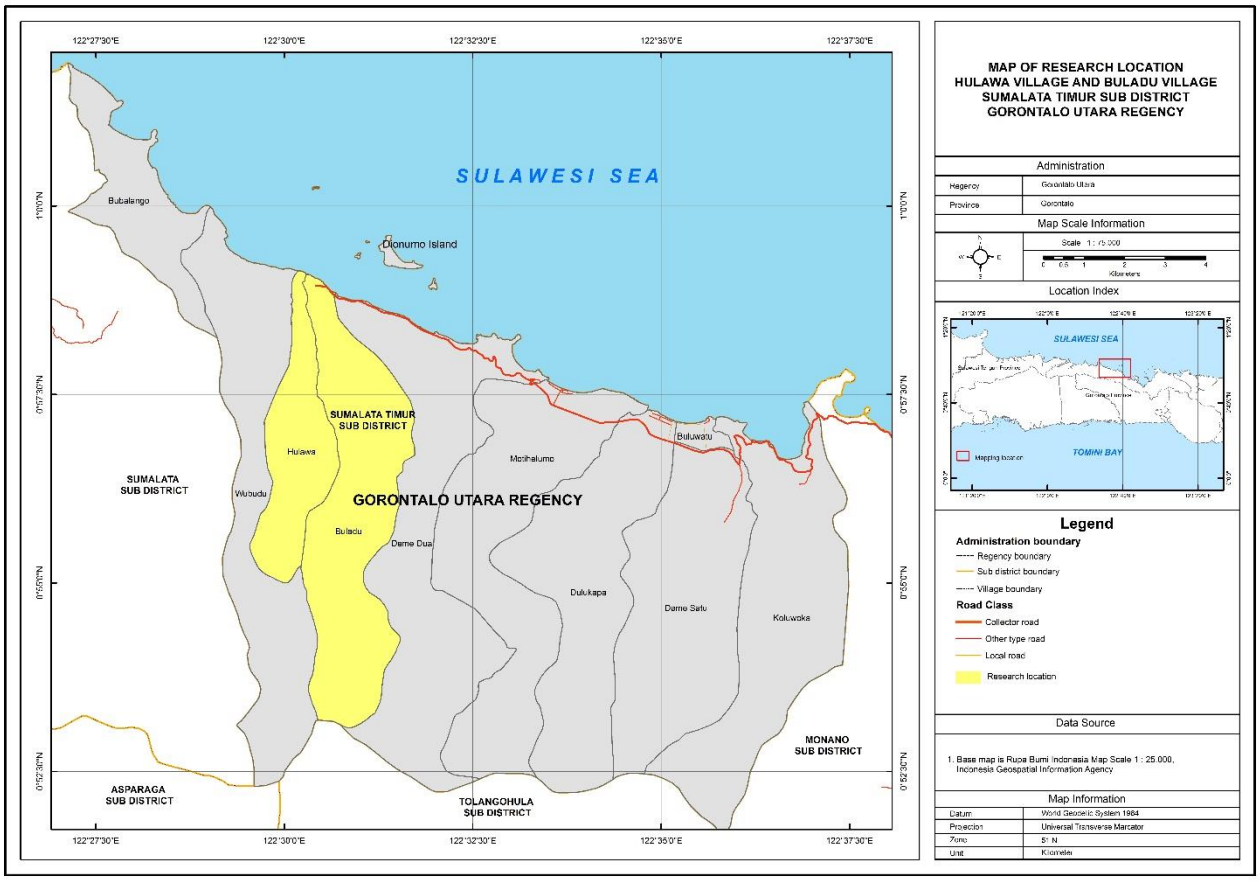

Figure 1. Research Site Map

Media used in the campaign of mercury dangers to health and the environment are as follows.

1. Video of mercury impacts on the environment
   The video displays data on the amount of mercury released in Indonesia (340-ton m3). A total of 60% of mercury releases come from mines. This chemical element is a hazardous and toxic waste that can damage nature, pollute air and water, and seep into the ground.
2. Video of mercury impacts on health
   The video contains information on how mercury spreads from the polluted areas; the dangers of mercury to health, namely damage to the central nervous system, kidneys, lungs, liver, digestion, brain, mental disorders, blindness, convulsive seizures, and impaired growth of infants and fetuses; cases caused by mercury in Indonesia are spread across 275 regencies and 32 provinces; prohibition of mercury use based on Law Number 11 of 2017 on the Ratification of the Minamata Convention on Mercury and Regulation of the Minister of Health Number 57 of 2016 concerning National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020.
3. Leaflets of free-mercury gold processing
   The leaflets contain information on the future of mercury, the dangers of mercury to families and the environment, mercury-free gold processing techniques, and the advantages of mercury-free gold processing. Provided in Figure 2 and Figure 3 are the leaflets.

Figure 2. Leaflet front page

Figure 3. Leaflet back page

4. Presentation media about mercury and its impacts on human life
   The presentation delivered by the source person to the campaign participants comprises information about forms of mercury, mercury release sources and their availability in nature, and dangers of mercury to the environment and health.

RESULTS AND DISCUSSION

Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

The campaign in Hulawa Village is run in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure shows the campaign of mercury dangers awareness and knowledge in Hulawa Village.

Figure 4. Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

An overview of the Hulawa villagers' knowledge before participating in the campaign is presented in Table 1 below.

Table 1. Hulawa Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	31	65	23	50	0	0
Have seen mercury	54	112	0	3	0	0
Have received information on the dangers of mercury	22	59	32	56	0	0

Note: The data source is processed from the results of data collection

The above table shows that 56.80% of the people have known about mercury and 43.20% are the other way around. Further, 47.93% of Hulawa villagers have received information on the dangers of mercury from the GOLD-ISMIA Program through different activities. This determines that the delivery of information on the dangers of mercury must be carried out in stages to reach the entire community. An overview of the Hulawa villagers' knowledge after joining the campaign is displayed in Table 2 below.

Table 2. Hulawa Villagers' Knowledge of Mercury after Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	109	5	6	0	0
Willing to leave the practice of using mercury	53	105	1	10	0	0
Willing to encourage the family not to use mercury	51	100	3	15	0	0

Note: The data source is processed from the results of data collection

Table 2 indicates that after participating in the campaign of mercury dangers, 6.51% of the villagers have not understood such dangers. The same percentage (6.51%) goes to those who are not willing to eliminate the use of mercury. Lastly, 10.65% of them are not willing to encourage their family not to use mercury. Their socio-economic conditions influence their response to the message of eliminating mercury in gold processing.

Hulawa villagers, consisting of 324 males and 303 females, are dominated by farmers (70.60%) and miners (13.51%). The rest of them are fishers, sellers, private employees, and government employees. Common farmers in this village also work in the ASGM sector, either in mining or processing sites. The limited sources of livelihood in Hulawa Village cause the local community to be very dependent on the ASGM sector, which is considered to make money quickly.

Based on the level of education, the people living in Hulawa Village are mostly elementary school graduates (47.55%) and those who do not attend school (35.55%). Such an educational characteristic of Hulawa villagers has an effect on their responses and knowledge regarding the environment, making them unwilling to leave behind the practice of using mercury in gold processing. This is consistent with Agfar et al. (2018) that educational background contributes to the level of environmental literacy.

The environmental literacy level of society can be developed through formal, non-formal, and informal education at any age. According to the data of Hulawa Village population by the group of age, the majority of the villagers are aged 10 to 20 years (25.68%) and 21-30 years (18.18%). Meanwhile, 14.19% of the villagers are 41-50 years old, and 10.53% are over 50. Community awareness and knowledge of mercury dangers can be developed and improved by the non-formal education, e.g., regular extension. In addition to school, mercury dangers awareness and knowledge of pre-school-age and school-age children can be acquired through family and environmental education as a form of formal education. Regular extension, community outreach, and training by the government and non-government agencies provided to the community are able to enhance the knowledge and awareness of mercury dangers.

Education, socio-economic level, and the environment influence the behavior and perspective of the community in understanding environmental problems. This is reflected by how the villagers consider mercury harmless to health and the environment as this chemical element has not adversely impacted their condition to date. Mercury has been used for a long time and has been passed down from generation to generation. For this reason, they are unwilling to eliminate mercury for gold processing since many of them also believe that using mercury is the easiest and fastest way to obtain gold.

Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

The campaign in Buladu Village is implemented in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure displays the campaign of mercury dangers awareness and knowledge in Buladu Village.

Figure 5. Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

An overview of the Buladu villagers' knowledge before participating in the campaign is presented in Table 3 below.

Table 3. Buladu Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	49	71	0	0	0	0
Have seen mercury	49	71	0	0	0	0
Have received information on the dangers of mercury	26	24	23	47	0	0

Note: The data source is processed from the results of data collection

Table 3 signifies that 100% of the campaign participants have understood the concept of mercury and have seen it. Moreover, 41.67% of the community has received information on mercury dangers, and 58.33% has not. In terms of the level of education, those living in Buladu Village are primarily elementary school graduates (49.34%) and senior high school graduates (36.11%). Only 11.72% of the villagers graduate from junior high school. The high number of the population who have attended secondary school (junior and senior high school) affect the knowledge of mercury and its dangers, as reflected in the data of Buladu villagers' knowledge before and after joining the campaign. An overview of the Buladu villagers' knowledge after participating in the campaign is displayed in Table 4 below.

Table 4. Buladu Villagers' Knowledge of Mercury After Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	71	0	0	0	0
Willing to leave the practice of using mercury	49	71	0	0	0	0
Willing to encourage the family not to use mercury	49	71	0	0	0	0

Note: The data source is processed from the results of data collection

Table 4 reveals that 100% of Buladu villagers, as the campaign participants, have understood the dangers of mercury, are willing to eliminate mercury, and encourage their families and relatives not to use mercury. The characteristics of Buladu villagers that influence their knowledge and understanding of mercury dangers in ASGM practice are education and livelihood. The high number of villagers who graduate from secondary school (47.83%) makes it easy for them to grasp the information on mercury dangers in the campaign.

Buladu villagers work as farmers, fishers, sellers, civil servants, and private employees. Hence, the dominant livelihoods are farming (38.83%) and fishing (5.32%). Such diverse livelihoods imply that the community depends not only on one kind of natural resource to meet their needs, but also on agricultural and marine resources.

The willingness of all Buladu villagers to leave the practice of using mercury and encourage their families to do the same way is also driven by the campaign of mercury dangers conducted by UNDP GOLD-ISMIA Project since 2020. This campaign comprises community outreach activities of mercury dangers to the local people and students, dissemination of information on mercury dangers through leaflets, t-shirts, banners, water bottles, pencil cases, and others.

This study suggests that the number of villagers who understand the dangers of mercury after the campaign are increased due to the audiovisual and printed media utilized in the campaign. Such media are then considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. Campaign media are adjusted to the age, education, and job of the people.

CONCLUSION

Key findings of the study reveal that:

1. Before joining the mercury dangers awareness and knowledge campaign, 56.80% of Hulawa villagers and Buladu villagers have understood the dangers of mercury. In contrast, 43.20% of the people living in the aforementioned villages have not known about this concept.
2. After participating in the campaign, 6.51% of Hulawa villagers have not known about mercury dangers, and 93.49% have been familiar with this concept. Meanwhile, 100% of Buladu villagers have understood the dangers of this chemical element.
3. The increasing number of Hulawa and Buladu villagers who comprehend the dangers of mercury is due to the audiovisual and printed media utilized in the campaign. Such media are considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area.

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UNDER REVIEW

EDITOR DECISION

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[JPSL] Editor Decision

Lasriama Siahaan <jurnal@apps.ipb.ac.id> 26 Februari 2022 pukul 21.38
Kepada: Sri Maryati <sri.maryati.geo@gmail.com>

Sri Maryati:

We have reached a decision regarding your submission to Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan (Journal of Natural Resources and Environmental Management), "Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)".

Our decision is to: major revision

This research is very interesting, although there are some parts that need to be improved and/or added so that the results obtained further strengthen the scientific findings.
1. The number of respondents analyzed needs to be consistent, between before and after participating in the environmental awareness campaign.
2. The method of analysis needs to be explained. In discussing the phenomena obtained, researchers are advised to use statistical analysis methods, one of which is regression or correlation analysis. Use various variables as material for statistical analysis based on the concept of environmental knowledge literacy used. The results of the analysis will strengthen the scientific argument against the results of this study.
In addition, researchers are advised to use a reference management application such as Mendeley in the article, making it easier to check between the references used in the article and the reference list. Set the reference writing style according to the writing guidelines that have been set by the journal manager.

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Abstract: *This research focuses on villages where the community mostly works in the small-scale gold mining sector (ASGM), namely Hulawa Village and Buladu Village, North Gorontalo Regency. Mercury has remained being used by the community in this location for gold processing since a long time. It is important to increase the environmental literacy of the community around the ASGM area considering the dangers of mercury to health and the environment. This study aims to improve the environmental literacy of the community around ASGM regarding the mercury dangers to health and environment. Raising the community environmental literacy is carried out through a mercury dangers awareness campaign by playing videos of mercury dangers, distributing mercury-free gold processing leaflets, resources person explanation concerning mercury impact. Public knowledge about the dangers of mercury before and after the campaign was measured through questions. This study shows that there is a rise in the number of people who understand the dangers of mercury after a mercury awareness campaign. The increase in the number of people who understand the mercury dangers shows that audio-visual and printed media are effectively used to increase public awareness of the dangers of mercury in ASGM areas.*

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INTRODUCTION

The primary source of livelihood of community members is strongly influenced by the availability of natural resources in their regions. Utilizing natural resources in Indonesia refers to the applicable laws and regulations. Article 33 Section 3 of The 1945 Constitution states that “earth, water and natural resources contained therein shall be controlled by the State and used for people's maximum prosperity”. The government has regulated the utilization of natural resources intended for sustainable development and environmental protection.

In addition to using natural resources, the community should have concerned about environmental sustainability. An unprotected environment may lead to environmental damage, pollution, health hazards, and even natural disasters. Environmental pollution poses a serious threat to public health.

Sumalata Timur District is among the regions in Gorontalo Province with traditional gold mining. Artisanal and small-scale gold mining (ASGM) in this district is located in some areas, including Hulawa Village and Buladu Village. The community started manual gold mining and processing 25 years ago, and gold processing using drums began in 2008. Based on the Report of Technical Review of Regional Action Plan of Mercury Reduction and Elimination of North Gorontalo Regency (2020), there were 200 workers of ASGM in Sumalata Timur District. The gold processing methods applied by the community in ASGM in the site area include processing with drum, vat, and panning.

The present work focuses on villages in Sumalata Timur District, namely Hulawa Village and Buladu Village, whose livelihoods are dominated by ASGM work. Both villages are located near the gold mining and processing site. An interview with the local community has shown that 85% of villagers in Hulawa Village and >50% of villagers in Buladu Village work in the ASGM sector. Besides, the field observation indicates that gold processing majorly uses mercury.

Mercury is detrimental to health (World Health Organization -WHO, 2007) and the ecosystem (Viana et al., 2019). It particularly affects the nervous, digestive, and immune systems, lungs, and kidneys. Consumption of foods containing mercury is hazardous for children and can interfere with fetal development. Mercury in the environment comes from natural processes and human activities. Slotton and Jones (1996) contend that mercury resulted from human activities include gold mining, steam power plant, fuel combustion, and smelting.

Several previous studies on mercury content in the human body and the environment around the ASGM in Hulawa and Buladu villages have been conducted. A study by Mahmud, et al. (2018) suggests that mercury content in the hair of the people in Buladu gold mining reaches 20% (higher than the threshold), 20% (close to the threshold), and 60% (lower than the threshold). The threshold is recommended by the Nation Research Council (NCR) of 12 ppm. Moreover, Hiola's research in 2017 shows that the highest and lowest mercury contents in the urine of the gold miners in Hulawa Village are 0.0040 ppm (sample A) and 0.0010 ppm (sample B), respectively. Arifin et al. (2020) discover that ASGM activities in North Gorontalo Regency are harmful to the environment, miners, and local people.

This research has also observed that the small-scale gold mining and processing sites are close to residential areas; gold processing waste is disposed of in the surrounding environment and flows into the river; the workers wear inadequate personal protective equipment. The local community has been using mercury to process gold for years, and they assume that utilizing this chemical element is the easiest way to obtain the gold. As of today, health issues due to the use of mercury have never occurred.

It is also shown from the observation that environmental problems in the research site require close attention. Environmental literacy of the community is of importance to deal with environmental issues. Srbinovski et al. (2010) argue that environmental literacy is the primary outcome of environmental education. Further, Atabek et al. (2014) state that environmental education is promising to prevent environmental problems. One's environmental literacy can be instilled through environmental education. In view of the significantly increasing environmental issues, the community should learn the activity or behavior that may lead to environmental hazards (Geith, 2019.)

WHO (2007) recommends reducing mercury exposure, eliminating mercury (if possible), and finding alternatives to the use of mercury. Saturday (2018) also encourages public education regarding the reduction in using mercury-containing products. According to Viana et al. (2019), the impacts of mercury on health should be a global concern related to its toxicity and the wide range of sources of human exposure. Mostafalou and Abdollahi (2013) point out that educational and informative programs are required to lower the use of mercury.

The Gorontalo Provincial Government has issued the Regulation of Gorontalo Governor Number 71 of 2020 concerning the Regional Action Plan of Mercury Reduction and Elimination. The government of North

Gorontalo Regency has also issued the Regulation of North Gorontalo Regent Number 35 of 2020 concerning the Regional Action Plan of Mercury Reduction and Elimination. These regulations are issued in response to the Presidential Regulation of the Republic of Indonesia Number 21 of 2019 concerning the National Action Plan of Mercury Reduction and Elimination. The regional action plan (henceforth, RAD) covers the reduction and elimination of mercury in energy, ASGM, and health sectors. RAD establishes strategies and activities regarding mercury reduction and elimination in North Gorontalo Regency. The movement of "STOP MERCURY" as one of the activities in the ASGM sector is carried out with the campaign of the impacts of mercury use on vulnerable people.

Environmental literacy of the community is gradually developed through various programs and activities to better their knowledge and awareness of environmental protection. As Hamzah (2013) claimed, attitude change of society towards the environment is affected by promotions through education, discussion, and public participation. Information on environmental problems can be provided through formal and non-formal education, along with media utilization.

Drawing upon the problem in the research area, the improvement of environmental literacy of the community is crucial, especially about the dangers of mercury to the environment and health. The present work aims to improve the environmental literacy of the community in connection with the impacts of using mercury in the ASGM sector, particularly the dangers of mercury to health and the environment.

METHOD OF STUDY

Site and Time of Research

This research was conducted in Hulawa Village and Buladu Village, Sumalata Timur District, North Gorontalo Regency, Gorontalo Province. Sumalata Timur District is located on the northern coast of Gorontalo Province. According to Statistics Indonesia of North Gorontalo Regency (2019), the total population of Hulawa Village and Buladu Village was 637 people and 810 people, respectively. The map of the research site is presented in Figure 1.

Data Collection Techniques

The improvement of environmental literacy of the local community in the ASGM area of Hulawa Village and Buladu Village was performed through a campaign of mercury dangers awareness and knowledge. The campaign targeted those vulnerable to mercury exposure, including the workers in the ASGM sector, their family members, and youths around the ASGM area.

This campaign was done by distributing leaflets on free-mercury gold processing, playing videos of the dangers of mercury to health and the environment, and presenting the concepts of mercury, forms of mercury, and impacts of mercury on health and the environment. Some questions were given to the local people to discover their knowledge before and after joining the campaign.

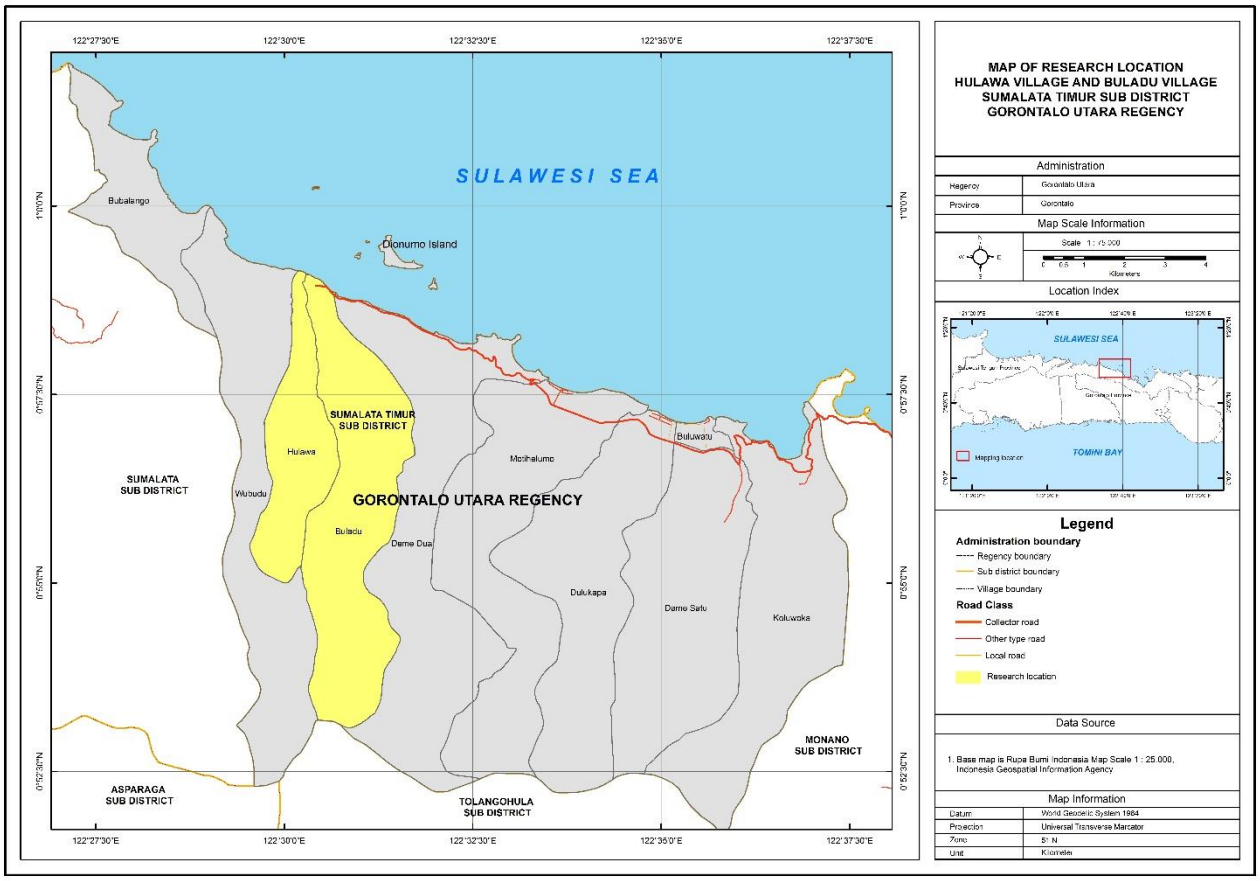

Figure 1. Research Site Map

Media used in the campaign of mercury dangers to health and the environment are as follows.

1. Video of mercury impacts on the environment
   The video displays data on the amount of mercury released in Indonesia (340-ton m3). A total of 60% of mercury releases come from mines. This chemical element is a hazardous and toxic waste that can damage nature, pollute air and water, and seep into the ground.
2. Video of mercury impacts on health
   The video contains information on how mercury spreads from the polluted areas; the dangers of mercury to health, namely damage to the central nervous system, kidneys, lungs, liver, digestion, brain, mental disorders, blindness, convulsive seizures, and impaired growth of infants and fetuses; cases caused by mercury in Indonesia are spread across 275 regencies and 32 provinces; prohibition of mercury use based on Law Number 11 of 2017 on the Ratification of the Minamata Convention on Mercury and Regulation of the Minister of Health Number 57 of 2016 concerning National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020.
3. Leaflets of free-mercury gold processing
   The leaflets contain information on the future of mercury, the dangers of mercury to families and the environment, mercury-free gold processing techniques, and the advantages of mercury-free gold processing. Provided in Figure 2 and Figure 3 are the leaflets.

Figure 2. Leaflet front page

Figure 3. Leaflet back page

4. Presentation media about mercury and its impacts on human life
   The presentation delivered by the source person to the campaign participants comprises information about forms of mercury, mercury release sources and their availability in nature, and dangers of mercury to the environment and health.

RESULTS AND DISCUSSION

Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

The campaign in Hulawa Village is run in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure shows the campaign of mercury dangers awareness and knowledge in Hulawa Village.

Figure 4. Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

An overview of the Hulawa villagers' knowledge before participating in the campaign is presented in Table 1 below.

Table 1. Hulawa Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	31	65	23	50	0	0
Have seen mercury	54	112	0	3	0	0
Have received information on the dangers of mercury	22	59	32	56	0	0

Note: The data source is processed from the results of data collection

The above table shows that 56.80% of the people have known about mercury and 43.20% are the other way around. Further, 47.93% of Hulawa villagers have received information on the dangers of mercury from the GOLD-ISMIA Program through different activities. This determines that the delivery of information on the dangers of mercury must be carried out in stages to reach the entire community. An overview of the Hulawa villagers' knowledge after joining the campaign is displayed in Table 2 below.

Table 2. Hulawa Villagers' Knowledge of Mercury after Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	109	5	6	0	0
Willing to leave the practice of using mercury	53	105	1	10	0	0
Willing to encourage the family not to use mercury	51	100	3	15	0	0

Note: The data source is processed from the results of data collection

Table 2 indicates that after participating in the campaign of mercury dangers, 6.51% of the villagers have not understood such dangers. The same percentage (6.51%) goes to those who are not willing to eliminate the use of mercury. Lastly, 10.65% of them are not willing to encourage their family not to use mercury. Their socio-economic conditions influence their response to the message of eliminating mercury in gold processing.

Hulawa villagers, consisting of 324 males and 303 females, are dominated by farmers (70.60%) and miners (13.51%). The rest of them are fishers, sellers, private employees, and government employees. Common farmers in this village also work in the ASGM sector, either in mining or processing sites. The limited sources of livelihood in Hulawa Village cause the local community to be very dependent on the ASGM sector, which is considered to make money quickly.

Based on the level of education, the people living in Hulawa Village are mostly elementary school graduates (47.55%) and those who do not attend school (35.55%). Such an educational characteristic of Hulawa villagers has an effect on their responses and knowledge regarding the environment, making them unwilling to leave behind the practice of using mercury in gold processing. This is consistent with Agfar et al. (2018) that educational background contributes to the level of environmental literacy.

The environmental literacy level of society can be developed through formal, non-formal, and informal education at any age. According to the data of Hulawa Village population by the group of age, the majority of the villagers are aged 10 to 20 years (25.68%) and 21-30 years (18.18%). Meanwhile, 14.19% of the villagers are 41-50 years old, and 10.53% are over 50. Community awareness and knowledge of mercury dangers can be developed and improved by the non-formal education, e.g., regular extension. In addition to school, mercury dangers awareness and knowledge of pre-school-age and school-age children can be acquired through family and environmental education as a form of formal education. Regular extension, community outreach, and training by the government and non-government agencies provided to the community are able to enhance the knowledge and awareness of mercury dangers.

Education, socio-economic level, and the environment influence the behavior and perspective of the community in understanding environmental problems. This is reflected by how the villagers consider mercury harmless to health and the environment as this chemical element has not adversely impacted their condition to date. Mercury has been used for a long time and has been passed down from generation to generation. For this reason, they are unwilling to eliminate mercury for gold processing since many of them also believe that using mercury is the easiest and fastest way to obtain gold.

Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

The campaign in Buladu Village is implemented in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure displays the campaign of mercury dangers awareness and knowledge in Buladu Village.

Figure 5. Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

An overview of the Buladu villagers' knowledge before participating in the campaign is presented in Table 3 below.

Table 3. Buladu Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	49	71	0	0	0	0
Have seen mercury	49	71	0	0	0	0
Have received information on the dangers of mercury	26	24	23	47	0	0

Note: The data source is processed from the results of data collection

Table 3 signifies that 100% of the campaign participants have understood the concept of mercury and have seen it. Moreover, 41.67% of the community has received information on mercury dangers, and 58.33% has not. In terms of the level of education, those living in Buladu Village are primarily elementary school graduates (49.34%) and senior high school graduates (36.11%). Only 11.72% of the villagers graduate from junior high school. The high number of the population who have attended secondary school (junior and senior high school) affect the knowledge of mercury and its dangers, as reflected in the data of Buladu villagers' knowledge before and after joining the campaign. An overview of the Buladu villagers' knowledge after participating in the campaign is displayed in Table 4 below.

Table 4. Buladu Villagers' Knowledge of Mercury After Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	71	0	0	0	0
Willing to leave the practice of using mercury	49	71	0	0	0	0
Willing to encourage the family not to use mercury	49	71	0	0	0	0

Note: The data source is processed from the results of data collection

Table 4 reveals that 100% of Buladu villagers, as the campaign participants, have understood the dangers of mercury, are willing to eliminate mercury, and encourage their families and relatives not to use mercury. The characteristics of Buladu villagers that influence their knowledge and understanding of mercury dangers in ASGM practice are education and livelihood. The high number of villagers who graduate from secondary school (47.83%) makes it easy for them to grasp the information on mercury dangers in the campaign.

Buladu villagers work as farmers, fishers, sellers, civil servants, and private employees. Hence, the dominant livelihoods are farming (38.83%) and fishing (5.32%). Such diverse livelihoods imply that the community depends not only on one kind of natural resource to meet their needs, but also on agricultural and marine resources.

The willingness of all Buladu villagers to leave the practice of using mercury and encourage their families to do the same way is also driven by the campaign of mercury dangers conducted by UNDP GOLD-ISMIA Project since 2020. This campaign comprises community outreach activities of mercury dangers to the local people and students, dissemination of information on mercury dangers through leaflets, t-shirts, banners, water bottles, pencil cases, and others.

This study suggests that the number of villagers who understand the dangers of mercury after the campaign are increased due to the audiovisual and printed media utilized in the campaign. Such media are then considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. Campaign media are adjusted to the age, education, and job of the people.

CONCLUSION

Key findings of the study reveal that:

1. Before joining the mercury dangers awareness and knowledge campaign, 56.80% of Hulawa villagers and Buladu villagers have understood the dangers of mercury. In contrast, 43.20% of the people living in the aforementioned villages have not known about this concept.
2. After participating in the campaign, 6.51% of Hulawa villagers have not known about mercury dangers, and 93.49% have been familiar with this concept. Meanwhile, 100% of Buladu villagers have understood the dangers of this chemical element.
3. The increasing number of Hulawa and Buladu villagers who comprehend the dangers of mercury is due to the audiovisual and printed media utilized in the campaign. Such media are considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area.

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The present work was funded by the GOLD-ISMIA Project, a Mercury Reduction Program initiated by the Ministry of Environment and Forestry, the Agency for the Assessment and Application of Technology, and the United Nations Development Programme. We would like to express our deep gratitude to GOLD ISMIA Project – UNDP of Indonesia for providing us the opportunity to collaborate in the campaign of improving the community awareness and knowledge of mercury dangers in Sumalata Timur District, North Gorontalo Regency. We would also like to give our warmest thanks to the Rector of Universitas Negeri Gorontalo and the Dean of Faculty of Mathematics and Natural Sciences of Universitas Negeri Gorontalo for their approval and support.

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REVISION

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I do apologize for this delay. Please kindly find the attached revised document in this message.
Thank you and I look forward to hearing from you.

Best,

Sri Maryati
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Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)

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Several previous studies on mercury content in the human body and the environment around the ASGM in Hulawa and Buladu villages have been conducted. A study by Mahmud *et al*. (2018) suggests that mercury content in the hair of the people in Buladu gold mining reaches 20% (higher than the threshold), 20% (close to the threshold), and 60% (lower than the threshold). The threshold is recommended by the Nation Research Council (NCR) of 12 ppm. Moreover, the highest and lowest mercury contents in the urine of the gold miners in Hulawa Village are 0.0040 ppm (sample A) and 0.0010 ppm (sample B), respectively (Hiola, 2017). (Arifin *et al*. (2020) discover that ASGM activities in North Gorontalo Regency are harmful to the environment, miners, and local people.

This research has also observed that the small-scale gold mining and processing sites are close to residential areas; gold processing waste is disposed of in the surrounding environment and flows into the river; the workers wear inadequate personal protective equipment. The local community has been using mercury to process gold for years, and they assume that utilizing this chemical element is the easiest way to obtain the gold. As of today, health issues due to the use of mercury have never occurred.

It is also shown from the observation that environmental problems in the research site require close attention. Environmental literacy of the community is of importance to deal with environmental issues. Srbinovski *et al*. (2010) argue that environmental literacy is the primary outcome of environmental education. Further, Atabek-yiğit *et al*. (2014) state that environmental education is promising to prevent environmental problems. One's environmental literacy can be instilled through environmental education. In view of the significantly increasing environmental issues, the community should learn the activity or behavior that may lead to environmental hazards (Gheith, 2019).

WHO (2007) recommends reducing mercury exposure, eliminating mercury (if possible), and finding alternatives to the use of mercury. Saturday (2018) also encourages public education regarding the reduction in using mercury-containing products. According to Vianna *et al*. (2019), the impacts of mercury on health should be a global concern related to its toxicity and the wide range of sources of human exposure. (Mostafalou and Abdollahi (2013) point out that educational and informative programs are required to lower the use of mercury.

The Gorontalo Provincial Government has issued the Regulation of Gorontalo Governor Number 71 of 2020 concerning the Regional Action Plan of Mercury Reduction and Elimination (Gorontalo Provincial Government, 2020). The government of North Gorontalo Regency has also issued the Regulation of North

Gorontalo Regent Number 35 of 2020 concerning the Regional Action Plan of Mercury Reduction and Elimination (Local Government of North, 2020). These regulations are issued in response to the Presidential Regulation of the Republic of Indonesia Number 21 of 2019 concerning the National Action Plan of Mercury Reduction and Elimination (President Republik Indonesia, 2019). The regional action plan (henceforth, RAD) covers the reduction and elimination of mercury in energy, ASGM, and health sectors. RAD establishes strategies and activities regarding mercury reduction and elimination in North Gorontalo Regency. The movement of "STOP MERCURY" as one of the activities in the ASGM sector is carried out with the campaign of the impacts of mercury use on vulnerable people.

Environmental literacy of the community is gradually developed through various programs and activities to better their knowledge and awareness of environmental protection. As Hamzah (2013) claimed, attitude change of society towards the environment is affected by promotions through education, discussion, and public participation. Information on environmental problems can be provided through formal and non-formal education, along with media utilization.

Drawing upon the problem in the research area, the improvement of environmental literacy of the community is crucial, especially about the dangers of mercury to the environment and health. The present work aims to improve the environmental literacy of the community in connection with the impacts of using mercury in the ASGM sector, particularly the dangers of mercury to health and the environment.

METHOD OF STUDY

Site and Time of Research

This research was conducted in Hulawa Village and Buladu Village, Sumalata Timur District, North Gorontalo Regency, Gorontalo Province. Sumalata Timur District is located on the northern coast of Gorontalo Province. According to (Statistics Indonesia of North Gorontalo Regency (2019), the total population of Hulawa Village and Buladu Village was 637 people and 810 people, respectively. The map of the research site is presented in Figure 1.

The Campaigns Implementation Stages

The improvement of environmental literacy of the local community in the ASGM area of Hulawa Village and Buladu Village was performed through a campaign of mercury dangers awareness and knowledge. The campaigns implementation stages consisted of determining target groups, determining techniques for delivering campaigns materials, determining types of campaign media, and implementing the campaigns to increase environmental literacy regarding the dangers of mercury.

Determining Target Groups

Determination of the target group for increasing community environmental literacy in ASGM was based on the activity objectives, namely improving awareness of mercury dangers awareness and knowledge in ASGM. The indicators for determining the target of the campaigns was people who were vulnerable to exposure to the dangers of mercury, including people who have direct contact with ASGM activities and people living around ASGM areas. Based on these indicators, the community groups targeted for this campaigns were the workers in the ASGM sector, their family members, and youths around the ASGM area.

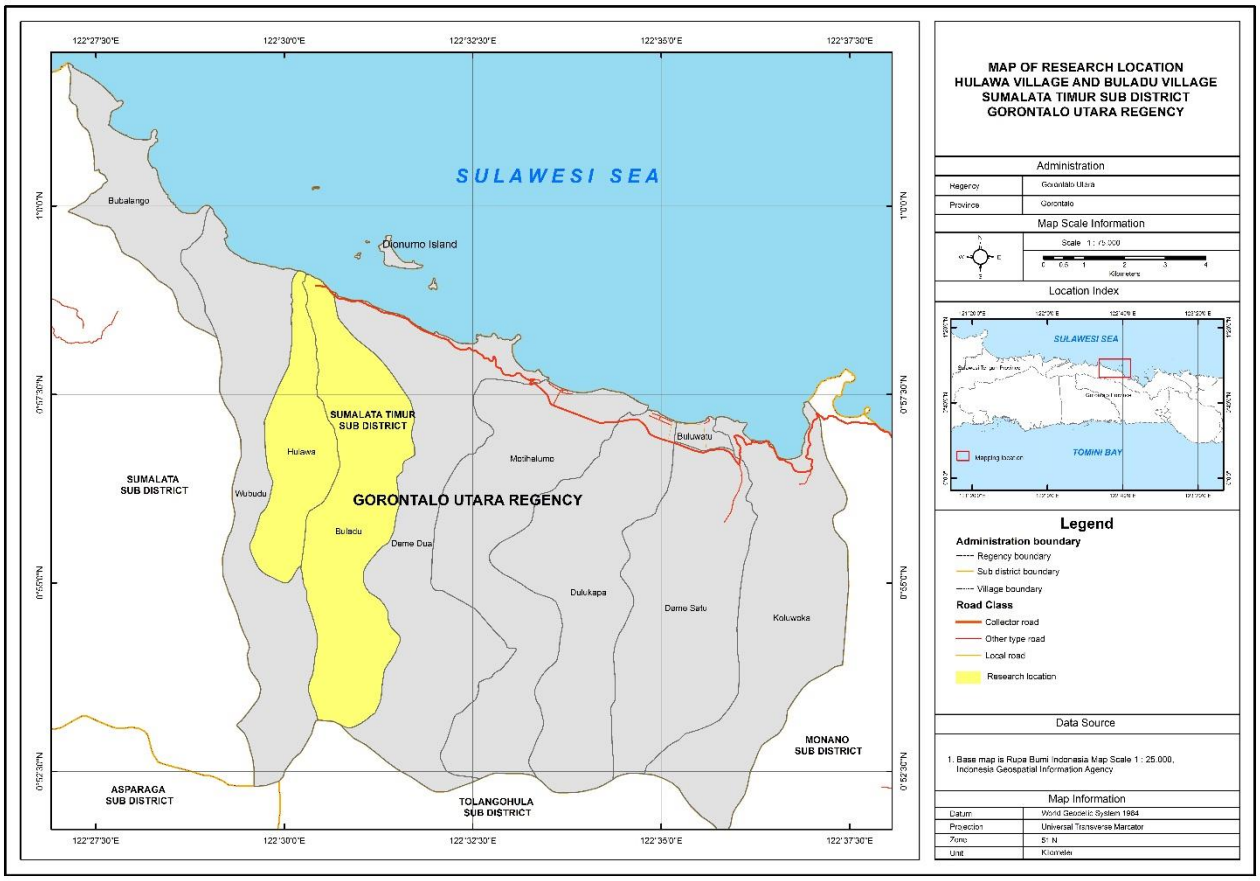

Figure 1. Research Site Map

Determining Techniques for Delivering Campaigns Materials

The determination of the technique for delivering campaign materials was based on several parameters, including the target groups, the socio-economic characteristics of the community, and the daily activities of the community. Based on these parameters, the technique of delivering material was done by:

1. Distributing the leaflets of free-mercury gold processing
2. Showing the video regarding the dangers of mercury to health and the environment
3. Presenting the materials by experts regarding mercury, forms of mercury, the impact of mercury on health and the environment
4. Carrying out discussion and Q&A

Determining Types of Campaign Media

The media campaigns used to increase environmental literacy for the community in ASGM of Hulawa Village and Buladu Village were both in the form of print media and audiovisual media. The types of campaign media used were selected based on the characteristics of the community group and the technique of delivering campaign materials. Media used in the campaign of mercury dangers to health and the environment are as follows.

1. Leaflets of free-mercury gold processing
   The leaflets contain information on the future of mercury, the dangers of mercury to families and the environment, mercury-free gold processing techniques, and the advantages of mercury-free gold processing. Provided in Figure 2 and Figure 3 are the leaflets.

Figure 2. Leaflet front page

Figure 3. Leaflet back page

2. Video of mercury impacts on the environment
   The video displays data on the amount of mercury released in Indonesia (340-ton m3). A total of 60% of mercury releases come from mines. This chemical element is a hazardous and toxic waste that can damage nature, pollute air and water, and seep into the ground.
2. Video of mercury impacts on health
   The video contains information on how mercury spreads from the polluted areas; the dangers of mercury to health, namely damage to the central nervous system, kidneys, lungs, liver, digestion, brain, mental disorders, blindness, convulsive seizures, and impaired growth of infants and fetuses; cases caused by mercury in Indonesia are spread across 275 regencies and 32 provinces; prohibition of mercury use based on Law Number 11 of 2017 on the Ratification of the Minamata Convention on Mercury and Regulation of the Minister of Health Number 57 of 2016 concerning National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020 (Minister of Health of the Republic of Indonesia, 2016).

4. Presentation media about mercury and its impacts on human life
   The presentation delivered by the source person to the campaign participants comprises information about forms of mercury, mercury release sources and their availability in nature, and dangers of mercury to the environment and health.

Implementing the Campaigns

The implementation of activities to increase community environmental literacy regarding the dangers of mercury in ASGM began with a pre-test to determine the community's initial knowledge about the dangers of mercury. Further, the campaign was done by distributing leaflets on free-mercury gold processing, playing videos of the dangers of mercury to health and the environment, and presenting the concepts of mercury, forms of mercury, and impacts of mercury on health and the environment, as well as conducting discussions and Q&A sessions. At the end of the activity, some questions were given to the local people to discover their knowledge before and after joining the campaign.

RESULTS AND DISCUSSION

Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

The campaign in Hulawa Village is run in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure shows the campaign of mercury dangers awareness and knowledge in Hulawa Village.

Figure 4. Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

An overview of the Hulawa villagers' knowledge before participating in the campaign is presented in Table 1 below.

Table 1. Hulawa Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	31	65	23	50	0	0
Have seen mercury	54	112	0	3	0	0
Have received information on the dangers of mercury	22	59	32	56	0	0

Note: The data source is processed from the results of data collection

The above table shows that 56.80% of the people have known about mercury and 43.20% are the other way around. Further, 47.93% of Hulawa villagers have received information on the dangers of mercury from the GOLD-ISMIA Program through different activities. This determines that the delivery of information on the dangers of mercury must be carried out in stages to reach the entire community. An overview of the Hulawa villagers' knowledge after joining the campaign is displayed in Table 2 below.

Table 2. Hulawa Villagers' Knowledge of Mercury after Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	109	5	6	0	0
Willing to leave the practice of using mercury	53	105	1	10	0	0
Willing to encourage the family not to use mercury	51	100	3	15	0	0

Note: The data source is processed from the results of data collection

Table 2 indicates that after participating in the campaign of mercury dangers, 6.51% of the villagers have not understood such dangers. The same percentage (6.51%) goes to those who are not willing to eliminate the use of mercury. Lastly, 10.65% of them are not willing to encourage their family not to use mercury. Their socio-economic conditions influence their response to the message of eliminating mercury in gold processing.

Hulawa villagers, consisting of 324 males and 303 females, are dominated by farmers (70.60%) and miners (13.51%). The rest of them are fishers, sellers, private employees, and government employees. Common farmers in this village also work in the ASGM sector, either in mining or processing sites. The limited sources of livelihood in Hulawa Village cause the local community to be very dependent on the ASGM sector, which is considered to make money quickly.

Based on the level of education, the people living in Hulawa Village are mostly elementary school graduates (47.55%) and those who do not attend school (35.55%). Such an educational characteristic of Hulawa villagers has an effect on their responses and knowledge regarding the environment, making them unwilling to leave behind the practice of using mercury in gold processing. This is consistent with Agfar *et al.* (2018) that educational background contributes to the level of environmental literacy.

The environmental literacy level of society can be developed through formal, non-formal, and informal education at any age. According to the data of Hulawa Village population by the group of age, the majority of the villagers are aged 10 to 20 years (25.68%) and 21-30 years (18.18%). Meanwhile, 14.19% of the villagers are 41-50 years old, and 10.53% are over 50. Community awareness and knowledge of mercury dangers can be developed and improved by the non-formal education, e.g., regular extension. In addition to school, mercury dangers awareness and knowledge of pre-school-age and school-age children can be acquired through family and environmental education as a form of formal education. Regular extension, community outreach, and training by the government and non-government agencies provided to the community are able to enhance the knowledge and awareness of mercury dangers.

Education, socio-economic level, and the environment influence the behavior and perspective of the community in understanding environmental problems. This is reflected by how the villagers consider mercury harmless to health and the environment as this chemical element has not adversely impacted their condition to date. Mercury has been used for a long time and has been passed down from generation to generation. For this reason, they are unwilling to eliminate mercury for gold processing since many of them also believe that using mercury is the easiest and fastest way to obtain gold.

Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

The campaign in Buladu Village is implemented in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure displays the campaign of mercury dangers awareness and knowledge in Buladu Village.

Figure 5. Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

An overview of the Buladu villagers' knowledge before participating in the campaign is presented in Table 3 below.

Table 3. Buladu Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	49	71	0	0	0	0
Have seen mercury	49	71	0	0	0	0
Have received information on the dangers of mercury	26	24	23	47	0	0

Note: The data source is processed from the results of data collection

Table 3 signifies that 100% of the campaign participants have understood the concept of mercury and have seen it. Moreover, 41.67% of the community has received information on mercury dangers, and 58.33% has not. In terms of the level of education, those living in Buladu Village are primarily elementary school graduates (49.34%) and senior high school graduates (36.11%). Only 11.72% of the villagers graduate from junior high school. The high number of the population who have attended secondary school (junior and senior high school) affect the knowledge of mercury and its dangers, as reflected in the data of Buladu villagers' knowledge before and after joining the campaign. An overview of the Buladu villagers' knowledge after participating in the campaign is displayed in Table 4 below.

Table 4. Buladu Villagers' Knowledge of Mercury After Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	71	0	0	0	0
Willing to leave the practice of using mercury	49	71	0	0	0	0

Willing to encourage the family not to use mercury	49	71	0	0	0	0

Note: The data source is processed from the results of data collection

Table 4 reveals that 100% of Buladu villagers, as the campaign participants, have understood the dangers of mercury, are willing to eliminate mercury, and encourage their families and relatives not to use mercury. The characteristics of Buladu villagers that influence their knowledge and understanding of mercury dangers in ASGM practice are education and livelihood. The high number of villagers who graduate from secondary school (47.83%) makes it easy for them to grasp the information on mercury dangers in the campaign.

Buladu villagers work as farmers, fishers, sellers, civil servants, and private employees. Hence, the dominant livelihoods are farming (38.83%) and fishing (5.32%). Such diverse livelihoods imply that the community depends not only on one kind of natural resource to meet their needs, but also on agricultural and marine resources.

The willingness of all Buladu villagers to leave the practice of using mercury and encourage their families to do the same way is also driven by the campaign of mercury dangers conducted by UNDP GOLD-ISMIA Project since 2020. This campaign comprises community outreach activities of mercury dangers to the local people and students, dissemination of information on mercury dangers through leaflets, t-shirts, banners, water bottles, pencil cases, and others.

This study suggests that the number of villagers who understand the dangers of mercury after the campaign are increased due to the audiovisual and printed media utilized in the campaign. Such media are then considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. Campaign media are adjusted to the age, education, and job of the people.

CONCLUSION

Key findings of the study reveal that:

1. Before joining the mercury dangers awareness and knowledge campaign, 56.80% of Hulawa villagers and Buladu villagers have understood the dangers of mercury. In contrast, 43.20% of the people living in the aforementioned villages have not known about this concept.
2. After participating in the campaign, 6.51% of Hulawa villagers have not known about mercury dangers, and 93.49% have been familiar with this concept. Meanwhile, 100% of Buladu villagers have understood the dangers of this chemical element.
3. The increasing number of Hulawa and Buladu villagers who comprehend the dangers of mercury is due to the audiovisual and printed media utilized in the campaign. Such media are considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area.

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EDITOR DECISION

Gmail **Sri Maryati <sri.maryati.geo@gmail.com>**

[JPSL] Editor Decision

Lasriama Siahaan <jurnal@apps.ipb.ac.id> 19 April 2022 pukul 17.12
Kepada: Sri Maryati <sri.maryati.geo@gmail.com>

Sri Maryati:

We have reached a decision regarding your submission to Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan (Journal of Natural Resources and Environmental Management), "Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)".

Our decision is to : major revision

This paper has not explained the method used properly. This requires a systematic explanation of the following:
1. The concept used to explain the variables used and explain the results and discussion to be able to answer the research objectives.
2. Data collection techniques; and
3. The data analysis technique.

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Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)

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Abstract: *This research focuses on villages where the community mostly works in the small-scale gold mining sector (ASGM), namely Hulawa Village and Buladu Village, North Gorontalo Regency. Mercury has remained being used by the community in this location for gold processing since a long time. It is important to increase the environmental literacy of the community around the ASGM area considering the dangers of mercury to health and the environment. This study aims to improve the environmental literacy of the community around ASGM regarding the mercury dangers to health and environment. Raising the community environmental literacy is carried out through a mercury dangers awareness campaign by playing videos of mercury dangers, distributing mercury-free gold processing leaflets, resources person explanation concerning mercury impact. Public knowledge about the dangers of mercury before and after the campaign was measured through questions. This study shows that there is a rise in the number of people who understand the dangers of mercury after a mercury awareness campaign. The increase in the number of people who understand the mercury dangers shows that audio-visual and printed media are effectively used to increase public awareness of the dangers of mercury in ASGM areas.*

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INTRODUCTION

Environmental problems show an increasing trend from year to year in both developed and developing countries. Environmental issues that have become important global issues include global warming, climate change, air and water pollution, deforestation, and various other issues related to biodiversity. In Indonesia, environmental problems that have become important environmental issues in various regions are air pollution, groundwater and surface water pollution, decreased groundwater quantity, forest damage, land conversion, damage to coastal ecosystems, and other environmental issues in terms of natural resource utilization.

In addition to using natural resources, the community should have concerned about environmental sustainability. The awareness to preserve the environment must be owned by every community regardless of age and education as an unprotected environment may lead to environmental damage, pollution, health hazards, and even natural disasters. Environmental pollution (i.e., water pollution, soil pollution, and air pollution) can be caused by unmanaged domestic waste, industrial waste, agricultural waste, mining waste, and so on.

Sumalata Timur District is among the regions in Gorontalo Province with traditional gold mining. Artisanal and small-scale gold mining (ASGM) in this district is located in some areas, including Hulawa Village and Buladu Village. The community started manual gold mining and processing for about 25 years ago, and gold processing using drums began in 2008. Based on the Report of Technical Review of Regional Action Plan of Mercury Reduction and Elimination of North Gorontalo Regency (2020), there were 200 workers of ASGM in Sumalata Timur District. The gold processing methods applied by the community in ASGM in the site area include processing with drum, vat, and panning. Besides, the field observation indicates that gold processing majorly uses mercury.

Mercury is detrimental to health (WHO, 2007) and the ecosystem (Vianna *et al*. (2019). It particularly affects the nervous, digestive, and immune systems, lungs, and kidneys. Consumption of foods containing mercury is hazardous for children and can interfere with fetal development. Mercury in the environment comes from natural processes and human activities. Jones dan Slotton (1996) contend that mercury resulted from human activities include gold mining, steam power plant, fuel combustion, and smelting. Moreover, Viana *et al*. (2019) state that the impact of mercury on health should be a global concern regarding its toxicity and the breadth of sources of human exposure. WHO (2007) recommends reducing mercury exposure, eliminating the use of mercury (if possible), and seeking alternative uses of mercury.

Several previous studies on mercury content in the human body and the environment around the ASGM in Hulawa and Buladu villages have been conducted. A study by Mahmud *et al*. (2018) suggests that mercury content in the hair of the people in Buladu gold mining reaches 20% (higher than the threshold), 20% (close to the threshold), and 60% (lower than the threshold). The threshold is recommended by the Nation Research Council (NCR) of 12 ppm. Moreover, the highest and lowest mercury contents in the urine of the gold miners in Hulawa Village are 0.0040 ppm (sample A) and 0.0010 ppm (sample B), respectively (Hiola, 2017). (Arifin *et al*. (2020) discover that ASGM activities in North Gorontalo Regency are harmful to the environment, miners, and local people.

This research has also observed that the small-scale gold mining and processing sites are close to residential areas; gold processing waste is disposed of in the surrounding environment and flows into the river; the workers wear inadequate personal protective equipment. The local community has been using mercury to process gold for years, and they assume that utilizing this chemical element is the easiest way to obtain the gold. As of today, the communities opine that health issues due to the use of mercury have never occurred.

The description of the environmental conditions in the research location above shows that there are environmental problems that need to be considered by the government, non-government organizations and the community. Environmental pollution caused by mining waste and the use of mercury in gold processing is a serious threat to public health. Furthermore, Mostafalou and Abdollahi (2013) point out that educational and informative programs are required to lower the use of mercury. WHO (2007) also mentions that one of the strategic actions to eliminate mercury-related diseases is to carry out educational activities for the health, environmental and other sectors.

According to Stevenson *et al*. (2013), people who have environmental literacy are needed to reverse the tendency of decreasing environmental quality. Maknun *et al*. (2017) stated that the purpose of increasing environmental literacy is to prepare people who understand and can overcome environmental problems. According to NAAEE in Nasution (2021), environmental literacy is an action based on environmental concern. Environmental literacy has four domains, namely knowledge, cognitive skills, attitudes and behavior. Atabek *et al*. (2014) wrote that environmental literacy has four components, namely knowledge, attitudes,

behavior and care. NAAEE (2010) states that environmental literacy is the ability to learn, evaluate, and act in dealing with environmental issues.

Environmental literacy of the community is gradually developed through various programs and activities to better their knowledge and awareness of environmental protection. As Hamzah (2013) claimed, attitude change of society towards the environment is affected by promotions through education, discussion, and public participation. Information on environmental problems can be provided through formal and non-formal education, along with media utilization. It is also shown from the observation that environmental problems in the research site require close attention. Environmental literacy of the community is of importance to deal with environmental issues. Srbinovski *et al*. (2010) argue that environmental literacy is the primary outcome of environmental education. Further, Atabek-yiğit *et al*. (2014) state that environmental education is promising to prevent environmental problems. One's environmental literacy can be instilled through environmental education. In view of the significantly increasing environmental issues, the community should learn the activity or behavior that may lead to environmental hazards (Gheith, 2019).

Drawing upon the problem in the research area, providing the environmental education for the improvement of environmental literacy of the community is crucial, especially about the dangers of mercury to the environment and health. The present work aims to improve the environmental literacy of the community in connection with the impacts of using mercury in the ASGM sector, particularly the dangers of mercury to health and the environment. This is also in line with the local action plan of the Gorontalo Provincial Government and North Gorontalo Regency Government which established the movement of "STOP MERCURY" as one of the activities in the ASGM sector is carried out with the campaign of the impacts of mercury use on vulnerable people.

The present work focuses on villages in Sumalata Timur District, namely Hulawa Village and Buladu Village, whose livelihoods are dominated by ASGM work. Both villages are located near the gold mining and processing site. An interview with the local community has shown that 85% of villagers in Hulawa Village and >50% of villagers in Buladu Village work in the ASGM sector.

METHOD OF STUDY

As a harmful material to the health and the environment, mercury is still used by people in the ASGM sector. In fact, the public does not yet have a correct understanding of the dangers of mercury to health and the environment. The results of the Saturday (2018) study recommend public education about reducing the use of products containing mercury. In this study, public education about the dangers of mercury and alternatives to gold processing without using mercury was carried out through a mercury awareness campaign. This quantitative descriptive study measured the increase in literacy of the people who participate in the mercury awareness campaign on the component of knowledge and awareness about the dangers of mercury. Leaflets and videos were used as the campaign media in this activity; those media were taken from the GOLD-ISMIA Project by UNDP.

Site and Time of Research

This research was conducted in Hulawa Village and Buladu Village, Sumalata Timur District, North Gorontalo Regency, Gorontalo Province. Sumalata Timur District is located on the northern coast of Gorontalo Province. According to Statistics Indonesia of North Gorontalo Regency (2019), the total population of Hulawa Village and Buladu Village was 637 people and 810 people, respectively. The map of the research site is presented in Figure 1.

The Campaigns Implementation Stages

The improvement of environmental literacy of the local community in the ASGM area of Hulawa Village and Buladu Village was performed through a campaign of mercury dangers awareness and knowledge. The campaigns implementation stages consisted of determining target groups, determining techniques for

delivering campaigns materials, determining types of campaign media, and implementing the campaigns to increase environmental literacy regarding the dangers of mercury.

Determining Target Groups

Determination of the target group for increasing community environmental literacy in ASGM was based on the activity objectives, namely improving awareness of mercury dangers awareness and knowledge in ASGM. The indicators for determining the target of the campaigns was people who were vulnerable to exposure to the dangers of mercury, including people who have direct contact with ASGM activities and people living around ASGM areas. Based on these indicators, the community groups targeted for this campaigns were the workers in the ASGM sector, their family members, and youths around the ASGM area.

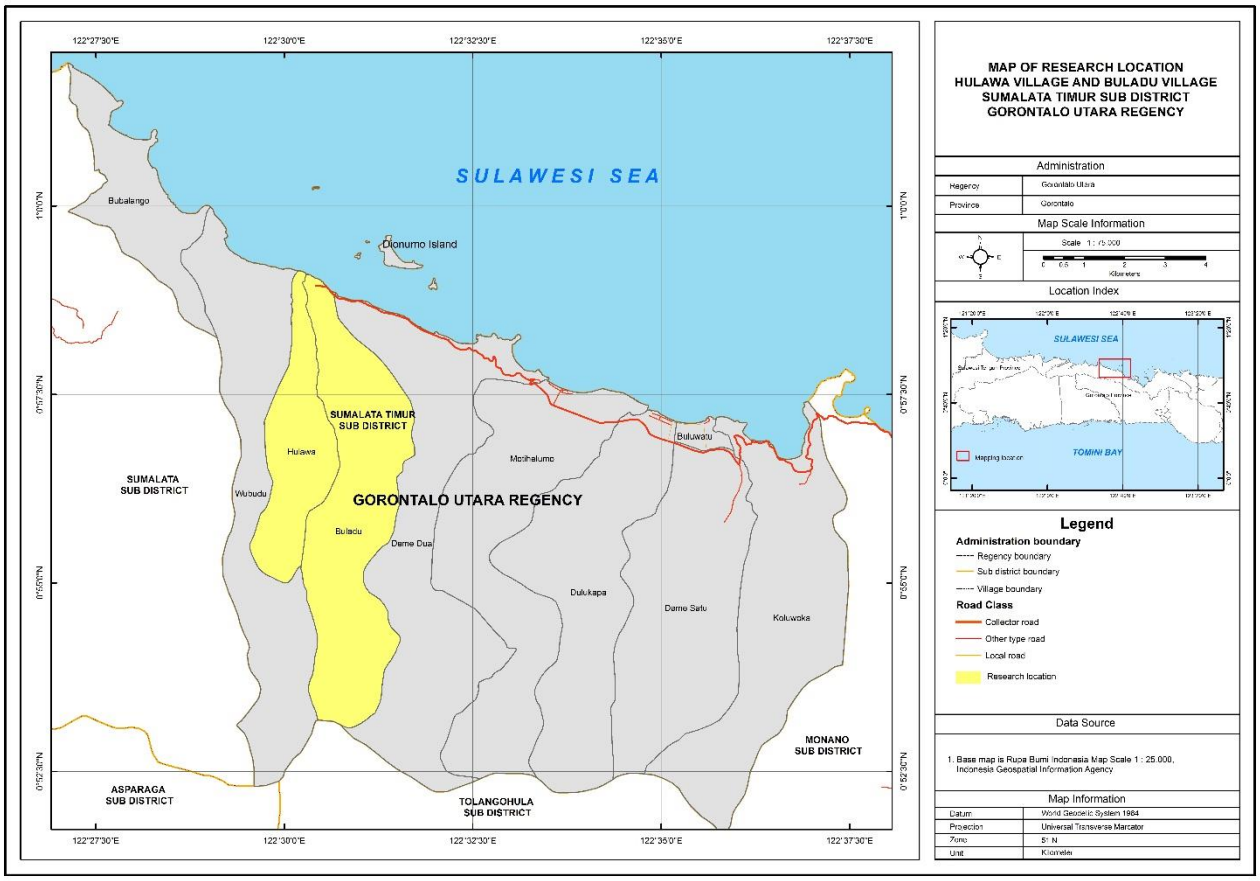

Figure 1. Research Site Map

Determining Techniques for Delivering Campaigns Materials

The determination of the technique for delivering campaign materials was based on several parameters, including the target groups, the socio-economic characteristics of the community, and the daily activities of the community. Based on these parameters, the technique of delivering material was done by:

1. Distributing the leaflets of free-mercury gold processing
2. Showing the video regarding the dangers of mercury to health and the environment
3. Presenting the materials by experts regarding mercury, forms of mercury, the impact of mercury on health and the environment
4. Carrying out discussion and Q&A

Determining Types of Campaign Media

The media campaigns used to increase environmental literacy for the community in ASGM of Hulawa Village and Buladu Village were both in the form of print media and audiovisual media. The types of campaign media used were selected based on the characteristics of the community group and the technique of delivering campaign materials. Media used in the campaign of mercury dangers to health and the environment are as follows.

1. Leaflets of free-mercury gold processing
   The leaflets contain information on the future of mercury, the dangers of mercury to families and the environment, mercury-free gold processing techniques, and the advantages of mercury-free gold processing. Provided in Figure 2 and Figure 3 are the leaflets.

Figure 2. Leaflet front page

Figure 3. Leaflet back page

2. Video of mercury impacts on the environment
   The video displays data on the amount of mercury released in Indonesia (340-ton m3). A total of 60% of mercury releases come from mines. This chemical element is a hazardous and toxic waste that can damage nature, pollute air and water, and seep into the ground.
2. Video of mercury impacts on health

The video contains information on how mercury spreads from the polluted areas; the dangers of mercury to health, namely damage to the central nervous system, kidneys, lungs, liver, digestion, brain, mental disorders, blindness, convulsive seizures, and impaired growth of infants and fetuses; cases caused by mercury in Indonesia are spread across 275 regencies and 32 provinces; prohibition of mercury use based on Law Number 11 of 2017 on the Ratification of the Minamata Convention on Mercury and Regulation of the Minister of Health Number 57 of 2016 concerning National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020 (Minister of Health of the Republic of Indonesia, 2016).

4. Presentation media about mercury and its impacts on human life
   The presentation delivered by the source person to the campaign participants comprises information about forms of mercury, mercury release sources and their availability in nature, and dangers of mercury to the environment and health.

Technique of Collecting Data

An increase in public literacy regarding the dangers of mercury was measured through questions given at the pretest and posttest regarding the knowledge, attitudes, and concerns of the community about mercury and its dangers. The implementation of activities to increase community environmental literacy regarding the dangers of mercury in ASGM began with a pre-test to determine the community's initial knowledge about the dangers of mercury.. At the end of the activity, some questions were given to the local people to discover their knowledge before and after joining the campaign.

Technique of Collecting Data

Data analysis in this study used descriptive analysis method on the results of cross tabulation of answers to community questions at the pretest and posttest stages. This descriptive analysis aims to get an overview of the answers from the research subjects regarding the knowledge and public awareness about the dangers of mercury.

RESULTS AND DISCUSSION

Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

The campaign in Hulawa Village is run in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure shows the campaign of mercury dangers awareness and knowledge in Hulawa Village.

Figure 4. Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

An overview of the Hulawa villagers' knowledge before participating in the campaign is presented in Table 1 below.

Table 1. Hulawa Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	31	65	23	50	0	0
Have seen mercury	54	112	0	3	0	0
Have received information on the dangers of mercury	22	59	32	56	0	0

Note: The data source is processed from the results of data collection

The above table shows that 56.80% of the people have known about mercury and 43.20% are the other way around. Further, 47.93% of Hulawa villagers have received information on the dangers of mercury from the GOLD-ISMIA Program through different activities. This determines that the delivery of information on the dangers of mercury must be carried out in stages to reach the entire community. An overview of the Hulawa villagers' knowledge after joining the campaign is displayed in Table 2 below.

Table 2. Hulawa Villagers' Knowledge of Mercury after Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	109	5	6	0	0
Willing to leave the practice of using mercury	53	105	1	10	0	0
Willing to encourage the family not to use mercury	51	100	3	15	0	0

Note: The data source is processed from the results of data collection

Table 2 indicates that after participating in the campaign of mercury dangers, 6.51% of the villagers have not understood such dangers. The same percentage (6.51%) goes to those who are not willing to eliminate the use of mercury. Lastly, 10.65% of them are not willing to encourage their family not to use mercury. Their socio-economic conditions influence their response to the message of eliminating mercury in gold processing.

Hulawa villagers, consisting of 324 males and 303 females, are dominated by farmers (70.60%) and miners (13.51%). The rest of them are fishers, sellers, private employees, and government employees. Common farmers in this village also work in the ASGM sector, either in mining or processing sites. The limited sources of livelihood in Hulawa Village cause the local community to be very dependent on the ASGM sector, which is considered to make money quickly.

Based on the level of education, the people living in Hulawa Village are mostly elementary school graduates (47.55%) and those who do not attend school (35.55%). Such an educational characteristic of Hulawa villagers has an effect on their responses and knowledge regarding the environment, making them unwilling to leave behind the practice of using mercury in gold processing. This is consistent with Agfar *et al.* (2018) that educational background contributes to the level of environmental literacy.

The environmental literacy level of society can be developed through formal, non-formal, and informal education at any age. According to the data of Hulawa Village population by the group of age, the majority of the villagers are aged 10 to 20 years (25.68%) and 21-30 years (18.18%). Meanwhile, 14.19% of the villagers are 41-50 years old, and 10.53% are over 50. Community awareness and knowledge of mercury dangers can be developed and improved by the non-formal education, e.g., regular extension. In addition to school, mercury dangers awareness and knowledge of pre-school-age and school-age children can be acquired through family and environmental education as a form of formal education. Regular extension, community outreach, and training by the government and non-government agencies provided to the community are able to enhance the knowledge and awareness of mercury dangers.

Education, socio-economic level, and the environment influence the behavior and perspective of the community in understanding environmental problems. This is reflected by how the villagers consider mercury harmless to health and the environment as this chemical element has not adversely impacted their condition to date. Mercury has been used for a long time and has been passed down from generation to generation. For this reason, they are unwilling to eliminate mercury for gold processing since many of them also believe that using mercury is the easiest and fastest way to obtain gold.

Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

The campaign in Buladu Village is implemented in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure displays the campaign of mercury dangers awareness and knowledge in Buladu Village.

Figure 5. Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

An overview of the Buladu villagers' knowledge before participating in the campaign is presented in Table 3 below.

Table 3. Buladu Villagers' Knowledge of Mercury before Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	49	71	0	0	0	0
Have seen mercury	49	71	0	0	0	0
Have received information on the dangers of mercury	26	24	23	47	0	0

Note: The data source is processed from the results of data collection

Table 3 signifies that 100% of the campaign participants have understood the concept of mercury and have seen it. Moreover, 41.67% of the community has received information on mercury dangers, and 58.33% has not. In terms of the level of education, those living in Buladu Village are primarily elementary school graduates (49.34%) and senior high school graduates (36.11%). Only 11.72% of the villagers graduate from junior high school. The high number of the population who have attended secondary school (junior and senior high school) affect the knowledge of mercury and its dangers, as reflected in the data of Buladu villagers' knowledge before and after joining the campaign. An overview of the Buladu villagers' knowledge after participating in the campaign is displayed in Table 4 below.

Table 4. Buladu Villagers' Knowledge of Mercury After Participating in the Campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	71	0	0	0	0
Willing to leave the practice of using mercury	49	71	0	0	0	0
Willing to encourage the family not to use mercury	49	71	0	0	0	0

Note: The data source is processed from the results of data collection

Table 4 reveals that 100% of Buladu villagers, as the campaign participants, have understood the dangers of mercury, are willing to eliminate mercury, and encourage their families and relatives not to use mercury. The characteristics of Buladu villagers that influence their knowledge and understanding of mercury dangers in ASGM practice are education and livelihood. The high number of villagers who graduate from secondary school (47.83%) makes it easy for them to grasp the information on mercury dangers in the campaign.

Buladu villagers work as farmers, fishers, sellers, civil servants, and private employees. Hence, the dominant livelihoods are farming (38.83%) and fishing (5.32%). Such diverse livelihoods imply that the community depends not only on one kind of natural resource to meet their needs, but also on agricultural and marine resources.

The willingness of all Buladu villagers to leave the practice of using mercury and encourage their families to do the same way is also driven by the campaign of mercury dangers conducted by UNDP GOLD-ISMIA Project since 2020. This campaign comprises community outreach activities of mercury dangers to the local people and students, dissemination of information on mercury dangers through leaflets, t-shirts, banners, water bottles, pencil cases, and others.

This study suggests that the number of villagers who understand the dangers of mercury after the campaign are increased due to the audiovisual and printed media utilized in the campaign. Such media are then considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. Campaign media are adjusted to the age, education, and job of the people.

CONCLUSION

The results of this study indicate that public education through awareness campaigns on the dangers of mercury is effective in reaching various levels of society to increase public knowledge and understanding of the dangers of mercury. Before joining the mercury dangers awareness and knowledge campaign, 56.80% of Hulawa villagers and Buladu villagers have understood the dangers of mercury. In contrast, 43.20% of the people living in the aforementioned villages have not known about this concept. After participating in the campaign, 6.51% of Hulawa villagers have not known about mercury dangers, and 93.49% have been familiar with this concept. Meanwhile, 100% of Buladu villagers have understood the dangers of this chemical element. The increasing number of Hulawa and Buladu villagers who comprehend the dangers of mercury is due to the audiovisual and printed media utilized in the campaign. Such media are considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. This study recommends that education on the dangers of mercury and alternative mercury substitutes in gold processing to be carried out from an early age by schools/educational institutions, implementing agencies in the environmental sector, and other organizations.

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Improving community environmental literacy regarding the impact of mercury use in the artisanal small-scale gold mining sector (A study in Sumalata Timur District, North Gorontalo Regency, Gorontalo Province)

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Abstract. *This research focuses on villages where the community mostly works in the small-scale gold mining sector (ASGM), namely Hulawa Village and Buladu Village, North Gorontalo Regency. Mercury has been used by the community in this location for gold processing for a long time. It is important to increase the environmental literacy of the community around the ASGM area, considering the dangers of mercury to health and the environment. This study aims to improve the environmental literacy of the community around ASGM regarding the mercury's dangers to health and the environment. Raising the community's environmental literacy is carried out through a mercury dangers awareness campaign by playing videos of mercury dangers, distributing mercury-free gold processing leaflets, and providing resource person explanations concerning mercury impact. Public knowledge about the dangers of mercury before and after the campaign was measured through questions. This study shows a rise in the number of people who understand the dangers of mercury after a mercury awareness campaign. The increase in the number of people who understand mercury dangers shows that audio-visual and printed media are effectively used to increase public awareness of the dangers of mercury in ASGM areas.*

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INTRODUCTION

Environmental problems show an increasing trend from year to year in both developed and developing countries. Environmental issues that have become important global issues include global warming, climate change, air and water pollution, deforestation, and other biodiversity-related issues. In Indonesia, environmental problems that have become critical environmental issues in various regions are air pollution, groundwater and surface water pollution, decreased groundwater quantity, forest damage, land conversion, damage to coastal ecosystems, and other environmental issues in terms of natural resource utilization.

In addition to using natural resources, the community should have concerned about environmental sustainability. The awareness to preserve the environment must be owned by every community regardless of age and education, as an unprotected environment may lead to environmental damage, pollution, health hazards, and even natural disasters. Environmental pollution (i.e., water pollution, soil pollution, and air pollution) can be caused by unmanaged domestic waste, industrial waste, agricultural waste, mining waste, and so on.

Sumalata Timur District is among the regions in Gorontalo Province with traditional gold mining. Artisanal and small-scale gold mining (ASGM) in this district is located in some areas, including Hulawa Village and Buladu Village. The community started manual gold mining and processing about 25 years ago, and gold processing using drums began in 2008. Based on the North Gorontalo Regent Regulation Number 35 concerning Regional Action Plans for Mercury Reduction and Elimination (2020), there were 200 workers of ASGM in Sumalata Timur District. The gold processing methods applied by the community in ASGM in the site area include processing with drum, vat, and panning. Besides, the field observation indicates that gold processing majorly uses mercury.

Mercury is detrimental to health (WHO 2007) and the ecosystem (Vianna *et al.* 2019). It particularly affects the nervous, digestive, and immune systems, lungs, and kidneys. Consumption of foods containing mercury is hazardous for children and can interfere with fetal development. Mercury in the environment comes from natural processes and human activities. Jones and Slotton (1996) contend that mercury resulted from human activities, including gold mining, steam power plant, fuel combustion, and smelting. Moreover, Vianna *et al.* (2019) state that the impact of mercury on health should be a global concern regarding its toxicity and the breadth of sources of human exposure. WHO (2007) recommends reducing mercury exposure, eliminating the use of mercury (if possible), and seeking alternative uses of mercury.

Several previous studies on mercury content in the human body and the environment around the ASGM in Hulawa and Buladu Villages have been conducted. A study by Mahmud *et al.* (2018) suggests that mercury content in the hair of the people in Buladu gold mining reaches 20% (higher than the threshold), 20% (close to the threshold), and 60% (lower than the threshold). The Nation Research Council (NCR) recommended a threshold of 12 ppm. Moreover, the highest and lowest mercury contents in the urine of the gold miners in Hulawa Village are 0,0040 ppm (sample A) and 0,0010 ppm (sample B), respectively (Hiola 2017). Arifin *et al.* (2020) discover that ASGM activities in North Gorontalo Regency are harmful to the environment, miners, and local people.

This research has also observed that the small-scale gold mining and processing sites are close to residential areas; gold processing waste is disposed of in the surrounding environment and flows into the river; the workers wear inadequate personal protective equipment. The local community has been using mercury to process gold for years, assuming that utilizing this chemical element is the easiest way to obtain it. As of today, the communities opine that health issues due to the use of mercury have never occurred.

The description of the environmental conditions in the research location above shows that there are environmental problems that need to be considered by the government, non-government organizations, and the community. Environmental pollution caused by mining waste and the use of mercury in gold processing is a serious threat to public health. Furthermore, Mostafalou and Abdollahi (2013) point out that educational and informative programs are required to lower the use of mercury. WHO (2007) also mentions that one of the strategic actions to eliminate mercury-related diseases is to carry out educational activities for the health, environmental and other sectors.

According to Stevenson *et al.* (2013), people with environmental literacy need to reverse the tendency to decrease environmental quality. Maknun *et al.* (2017) stated that the purpose of increasing environmental literacy is to prepare people who understand and can overcome environmental problems. According to NAAEE in Nasution (2021), environmental literacy is an action based on environmental concern. Environmental literacy has four domains: knowledge, cognitive skills, attitudes, and behavior. Atabek-yiğit *et al.* (2014) wrote

that environmental literacy has four components: knowledge, attitudes, behavior, and care. NAAEE (2010) states that environmental literacy is the ability to learn, evaluate, and act in dealing with environmental issues.

Environmental literacy in the community is gradually developed through various programs and activities to better their knowledge and awareness of environmental protection. As Hamzah (2013) claimed, the attitude change of society toward the environment is affected by promotions through education, discussion, and public participation. Information on environmental problems can be provided through formal and non-formal education, along with media utilization. It is also shown from the observation that environmental problems in the research site require close attention. Environmental literacy of the community is important in dealing with environmental issues. Srbinovski *et al.* (2010) argue that environmental literacy is the primary outcome of environmental education. Further, Atabek-yiğit *et al.* (2014) state that environmental education is promising to prevent environmental problems. One's environmental literacy can be instilled through environmental education. In view of the significantly increasing environmental issues, the community should learn about the activity or behavior that may lead to environmental hazards (Gheith 2019).

Drawing upon the problem in the research area, providing environmental education for the improvement of environmental literacy in the community is crucial, especially regarding the dangers of mercury to the environment and health. The present work aims to improve the environmental literacy of the community in connection with the impacts of using mercury in the ASGM sector, particularly the dangers of mercury to health and the environment. This is also in line with the local action plan of the Gorontalo Provincial Government and North Gorontalo Regency Government, which established the movement of "STOP MERCURY" as one of the activities in the ASGM sector is carried out with the campaign of the impacts of mercury use on vulnerable people.

The present work focuses on villages in Sumalata Timur District, namely Hulawa Village and Buladu Village, whose livelihoods are dominated by ASGM work. Both villages are located near the gold mining and processing site. An interview with the local community has shown that 85% of villagers in Hulawa Village and > 50% of villagers in Buladu Village work in the ASGM sector.

DATA AND METHODS

As a harmful material to the health and the environment, mercury is still used by people in the ASGM sector. In fact, the public does not yet have a correct understanding of the dangers of mercury to health and the environment. The results of the Saturday (2018) study recommend public education about reducing the use of products containing mercury. In this study, public education about the dangers of mercury and alternatives to gold processing without using mercury was carried out through a mercury awareness campaign. This quantitative descriptive study measured the increase in literacy of the people who participated in the mercury awareness campaign on the component of knowledge and awareness about the dangers of mercury. Leaflets and videos were used as the campaign media in this activity, those media were taken from the GOLD-ISMIA Project by UNDP.

Study Location and Period

This research was conducted in Hulawa Village and Buladu Village, Sumalata Timur District, North Gorontalo Regency, Gorontalo Province. Sumalata Timur District is located on the northern coast of Gorontalo Province. According to Statistics Indonesia of North Gorontalo Regency (2019), the total population of Hulawa Village and Buladu Village was 637 people and 810 people, respectively. The map of the research site is presented in Figure 1.

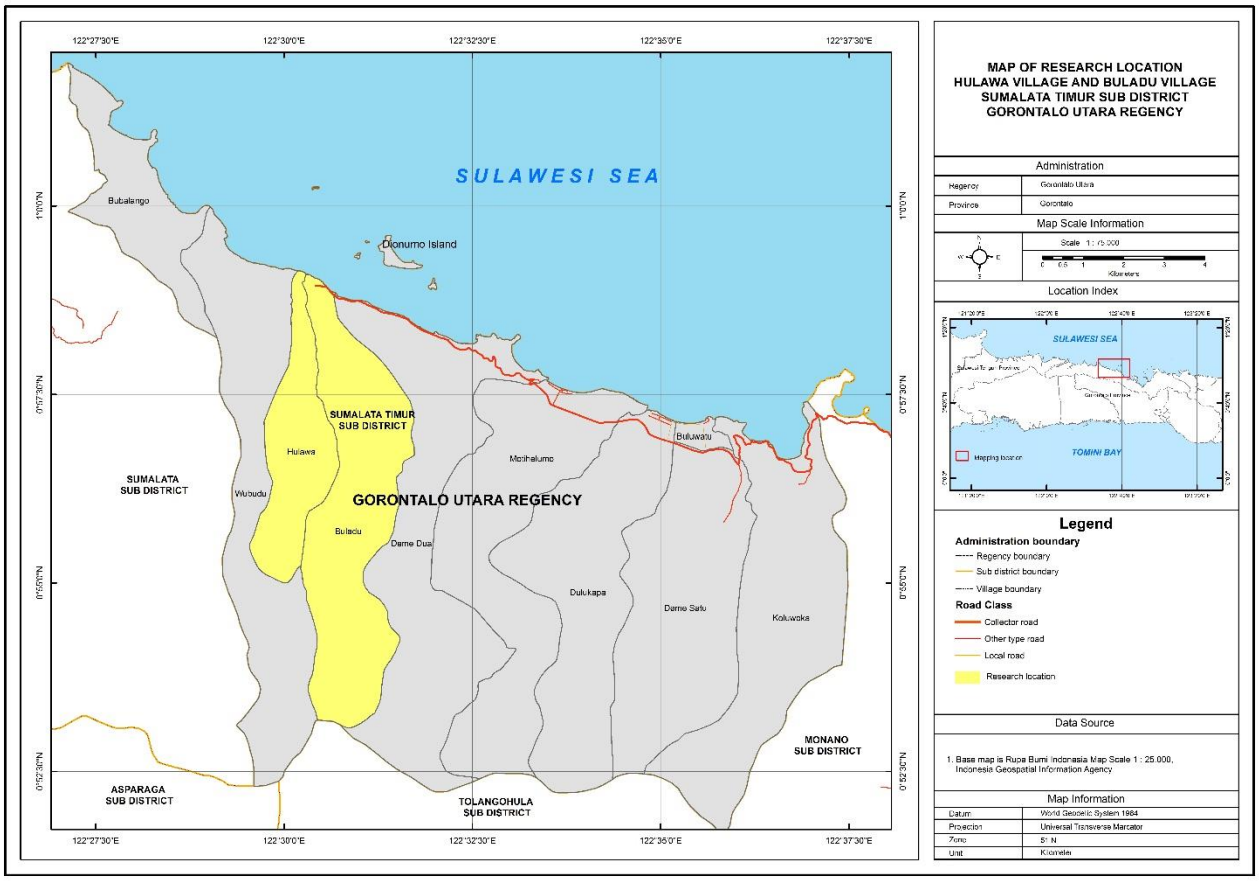

Figure 1 Research site map

The Campaigns Implementation Stages

The improvement of environmental literacy of the local community in the ASGM area of Hulawa Village and Buladu Village was performed through a campaign for mercury dangers awareness and knowledge. The campaign's implementation stages consisted of determining target groups, determining techniques for delivering campaign materials, selecting types of campaign media, and implementing the campaigns to increase environmental literacy regarding the dangers of mercury.

Determining Target Groups

Determination of the target group for increasing community environmental literacy in ASGM was based on the activity objectives, namely improving awareness of mercury dangers awareness and knowledge in ASGM. The indicators for determining the target of the campaigns were people who were vulnerable to exposure to the dangers of mercury, including people who have direct contact with ASGM activities and people living around ASGM areas. Based on these indicators, the community groups targeted for this campaign were the ASGM sector workers, their family members, and youths around the ASGM area.

Determining Techniques for Delivering Campaigns Materials

The determination of the technique for delivering campaign materials was based on several parameters, including the target groups, the socio-economic characteristics of the community, and the daily activities of the community. Based on these parameters, the technique of delivering material was done by:

1. Distributing the leaflets of free-mercury gold processing
2. Showing the video regarding the dangers of mercury to health and the environment

3. Presenting the materials by experts regarding mercury, forms of mercury, the impact of mercury on health and the environment
4. Carrying out discussion and Q&A

Determining Types of Campaign Media

The media campaigns used to increase environmental literacy for the community in ASGM of Hulawa Village and Buladu Village were both in the form of print media and audio-visual media. The types of campaign media used were selected based on the characteristics of the community group and the technique of delivering campaign materials. Media used in the campaign on mercury dangers to health and the environment are as follows.

1. Leaflets of free-mercury gold processing

The leaflets contain information on the future of mercury, the dangers of mercury to families and the environment, mercury-free gold processing techniques, and the advantages of mercury-free gold processing. Provided in Figure 2a and 2b are the leaflets.

(a) (b)

Figure 2 (a) leaflet front page and (b) back page (Source: Gold Ismia Project)

2. Video of mercury impacts on the environment

The video displays data on the amount of mercury released in Indonesia (340-ton m^3). A total of 60% of mercury releases come from mines. This chemical element is a hazardous and toxic waste that can damage nature, pollute air and water, and seep into the ground.

3. Video of mercury impacts on health

The video contains information on how mercury spreads from polluted areas, including: (1) the dangers of mercury to health, namely damage to the central nervous system, kidneys, lungs, liver, digestion, brain, mental disorders, blindness, convulsive seizures, and impaired growth of infants and fetuses; (2) cases caused by mercury in Indonesia are spread across 275 regencies and 32 provinces; (3) prohibition of mercury use based on Law Number 11 of 2017 on the Ratification of the Minamata Convention on Mercury and Regulation of the Minister of Health Number 57 of 2016 concerning National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020 (Minister of Health of the Republic of Indonesia 2016).

4. Presentation media about mercury and its impacts on human life

The presentation delivered by the source person to the campaign participants comprises information about forms of mercury, mercury release sources and their availability in nature, and the dangers of mercury to the environment and health.

The Technique of Collecting Data

An increase in public literacy regarding the dangers of mercury was measured through questions given at the pretest and posttest regarding the knowledge, attitudes, and concerns of the community about mercury and its dangers. The implementation of activities to increase community environmental literacy regarding the dangers of mercury in ASGM began with a pretest to determine the community's initial knowledge about the dangers of mercury. At the end of the activity, some questions were given to the local people to discover their knowledge before and after joining the campaign.

The Technique of Analyzing Data

Data analysis in this study used the descriptive analysis method on the results of cross-tabulation of answers to community questions at the pretest and posttest stages. This descriptive analysis aims to get an overview of the answers from the research subjects regarding the knowledge and public awareness of the dangers of mercury.

RESULTS AND DISCUSSION

Campaign of Mercury Dangers Awareness and Knowledge in Hulawa Village

The campaign in Hulawa Village is run in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area (Figure 3). The following figure shows the campaign for mercury dangers awareness and knowledge in Hulawa Village. An overview of the Hulawa villagers' knowledge before participating in the campaign is presented in Table 1.

Figure 3 Campaign of mercury dangers awareness and knowledge in Hulawa Village

Table 1 Hulawa Villagers' knowledge of mercury before participating in the campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	31	65	23	50	0	0
Have seen mercury	54	112	0	3	0	0
Have received information on the dangers of mercury	22	59	32	56	0	0

Note: The data source is processed from the results of data collection

The above table shows that 56,80% of the people have known about mercury and 43,20% belong the other way around. Further, 47,93% of Hulawa villagers have received information on the dangers of mercury from the GOLD-ISMIA Program through different activities. This determines that the delivery of information on the dangers of mercury must be carried out in stages to reach the entire community. An overview of the Hulawa villagers' knowledge after joining the campaign is displayed in Table 2 below.

Table 2 Hulawa Villagers' knowledge of mercury after participating in the campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	109	5	6	0	0
Willing to leave the practice of using mercury	53	105	1	10	0	0
Willing to encourage the family not to use mercury	51	100	3	15	0	0

Note: The data source is processed from the results of data collection

Table 2 indicates that after participating in the campaign on mercury dangers, 6,51% of the villagers have not understood such dangers. The same percentage (6,51%) goes to those who are not willing to eliminate the use of mercury. Lastly, 10,65% are unwilling to encourage their family not to use mercury. Their socio-economic conditions influence their response to the message of eliminating mercury in gold processing.

Hulawa villagers, consisting of 324 males and 303 females, are dominated by farmers (70,60%) and miners (13,51%). The rest of them are fishers, sellers, private employees, and government employees. Common farmers in this village also work in the ASGM sector, either in mining or processing sites. The limited sources of livelihood in Hulawa Village cause the local community to be very dependent on the ASGM sector, which is considered to make money quickly.

Based on the level of education, the people living in Hulawa Village are mostly elementary school graduates (47,55%) and those who do not attend school (35,55%). Such an educational characteristic of Hulawa villagers has an effect on their responses and knowledge regarding the environment, making them unwilling to leave behind the practice of using mercury in gold processing. This is consistent with Agfar *et al.* (2018) that educational background contributes to the level of environmental literacy.

The environmental literacy level of society can be developed through formal, non-formal, and informal education at any age. According to the data of Hulawa Village population by group of age, the majority of the villagers are aged 10 to 20 years (25,68%) and 21-30 years (18,18%). Meanwhile, 14,19% of the villagers are 41-50 years old, and 10,53% are over 50. Community awareness and knowledge of mercury dangers can be developed and improved by non-formal education, e.g., regular extension. In addition to school, mercury dangers awareness and knowledge of pre-school-age, and school-age children can be acquired through family and environmental education as a form of formal education. Regular extension, community outreach, and training by the government and non-government agencies provided to the community are able to enhance the knowledge and awareness of mercury dangers.

Education, socio-economic level, and the environment influence the behavior and perspective of the community in understanding environmental problems. This is reflected by how the villagers consider mercury harmless to health and the environment, as this chemical element has not adversely impacted their condition to date. Mercury has been used for a long time and has been passed down from generation to generation. For this reason, they are unwilling to eliminate mercury for gold processing since many of them also believe that using mercury is the easiest and fastest way to obtain gold.

Campaign of Mercury Dangers Awareness and Knowledge in Buladu Village

The campaign in Buladu Village is implemented in small groups of participants, including the ASGM workers, their family members, and youths around the ASGM area. The following figure displays the campaign for mercury dangers awareness and knowledge in Buladu Village (Figure 4). An overview of the Buladu villagers' knowledge before participating in the campaign is presented in Table 3 below.

Figure 4 Campaign of mercury dangers awareness and knowledge in Buladu Village

Table 3 Buladu Villagers' knowledge of mercury before participating in the campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Knowledge of mercury	49	71	0	0	0	0
Have seen mercury	49	71	0	0	0	0
Have received information on the dangers of mercury	26	24	23	47	0	0

Note: The data source is processed from the results of data collection

Table 3 signifies that 100% of the campaign participants have understood the concept of mercury and have seen it. Moreover, 41,67% of the community has received information on mercury dangers, and 58,33% has not. In terms of the level of education, those living in Buladu Village are primarily elementary school graduates (49,34%) and senior high school graduates (36,11%). Only 11,72% of the villagers graduate from junior high school. The high number of the population who have attended secondary school (junior and senior high school) affects the knowledge of mercury and its dangers, as reflected in the data of Buladu villagers' knowledge before and after joining the campaign. An overview of the Buladu villagers' knowledge after participating in the campaign is displayed in Table 4.

Table 4 reveals that 100% of Buladu villagers, as the campaign participants, have understood the dangers of mercury and are willing to eliminate it and encourage their families and relatives not to use it. The characteristics of Buladu villagers that influence their knowledge and understanding of mercury dangers in ASGM practice are education and livelihood. The high number of villagers who graduate from secondary school (47,83%) makes it easy for them to grasp the information on mercury dangers in the campaign. Buladu villagers work as farmers, fishers, sellers, civil servants, and private employees. Hence, the dominant livelihoods are farming (38,83%) and fishing (5,32%). Such diverse livelihoods imply that the community depends not only on one kind of natural resource to meet their needs but also on agricultural and marine resources.

Table 4 Buladu Villagers' knowledge of mercury after participating in the campaign

Parameters	Yes		No		Do not know	
	Male	Female	Male	Female	Male	Female
Understanding the dangers of mercury	49	71	0	0	0	0
Willing to leave the practice of using mercury	49	71	0	0	0	0
Willing to encourage the family not to use mercury	49	71	0	0	0	0

Note: The data source is processed from the results of data collection

The willingness of all Buladu villagers to leave the practice of using mercury and encourage their families to do the same way is also driven by the campaign on mercury dangers conducted by UNDP GOLD-ISMIA Project since 2020. This campaign comprises community outreach activities on mercury dangers to the local people and students, and dissemination of information on mercury dangers through leaflets, t-shirts, banners, water bottles, pencil cases, and others.

This study suggests that the number of villagers who understand the dangers of mercury after the campaign has increased due to the audio-visual and printed media utilized in the campaign. Such media are then considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. Campaign media are adjusted to the age, education, and job of the people.

CONCLUSION

The results of this study indicate that public education through awareness campaigns on the dangers of mercury is effective in reaching various levels of society to increase public knowledge and understanding of the dangers of mercury. Before joining the mercury dangers awareness and knowledge campaign, 56,80% of Hulawa villagers and Buladu villagers understood the dangers of mercury. In contrast, 43,20% of the people living in the aforementioned villages have not known about this concept. After participating in the campaign, 6,51% of Hulawa villagers do not know about mercury dangers, and 93,49% are familiar with this concept. Meanwhile, 100% of Buladu villagers understand the dangers of this chemical element. The increasing number of Hulawa and Buladu villagers comprehend mercury's dangers is due to the audio-visual and printed media utilized in the campaign. Such media are considered effective in improving mercury dangers awareness and knowledge of the community around the ASGM area. This study recommends that education on the dangers of mercury and alternative mercury substitutes in gold processing be carried out from an early age by schools/educational institutions, implementing agencies in the environmental sector, and other organizations.

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