

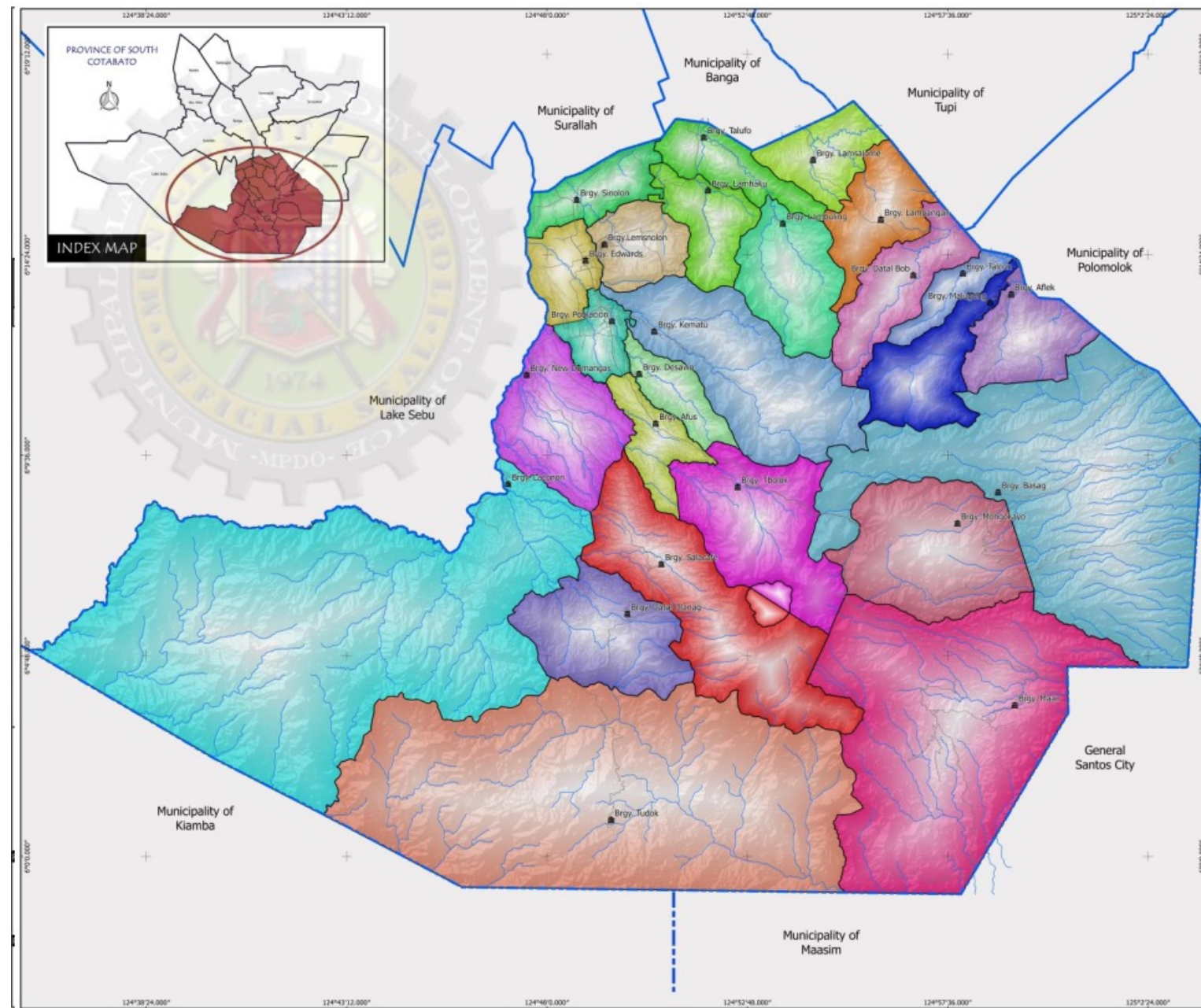
# **Occupational and Environmental Hazards Associated With Small Scale Mining in T'boli, South Cotabato**

**Project under the-  
National Institutes of Health, University of the Philippines Manila**

**Program Leader- Dr Jinky leilanie LU  
Project Leader- Hon. Secretary Teodoro J. Herbosa**

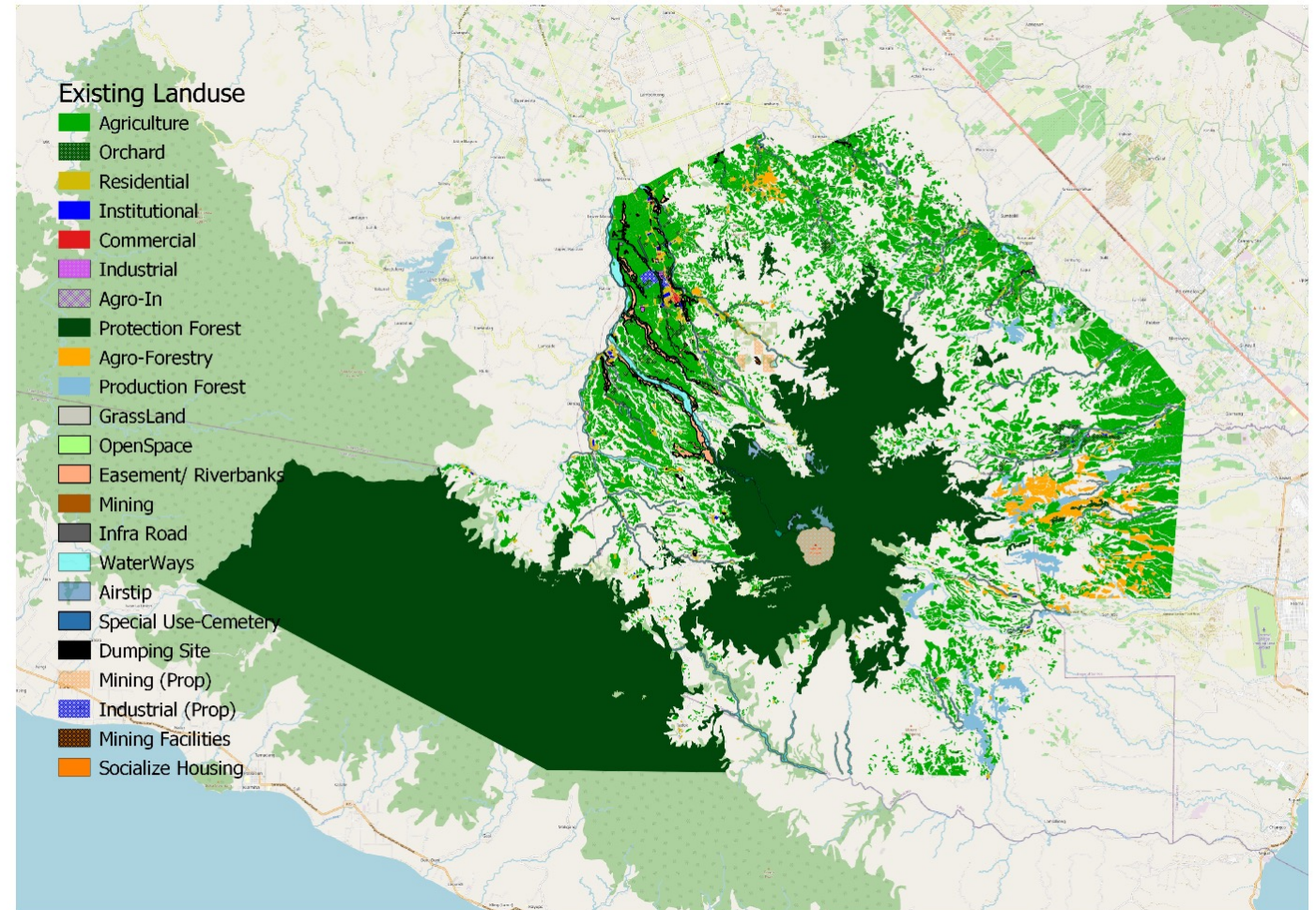
# Introduction

- Small-scale mining is a source of livelihood and a significant contributor to the local economy in the municipality of T'boli, South Cotabato.
- A move to formalize the industry was done in the province in order to benefit small-scale mining sector and improve safety for registered small-scale miners.
- However, the work conditions and methods employed in this extraction process still lack the required standards of the International Labor Organization and the United Nations. For Occupational Safety and Health (OSH), and decent work.
- As a result, the miners face a myriad of occupational hazards, exposing them to precarious working conditions that endanger their health and well-being.
- This program seeks to delve deeper into the intricate web of challenges faced by the small-scale mining industry in T'boli by investigating the interplay between occupational and environmental risks that small scale miners face in the region with climate change and other environmental disasters such as landslides, seismologic, meteorologic and hydrologic events.



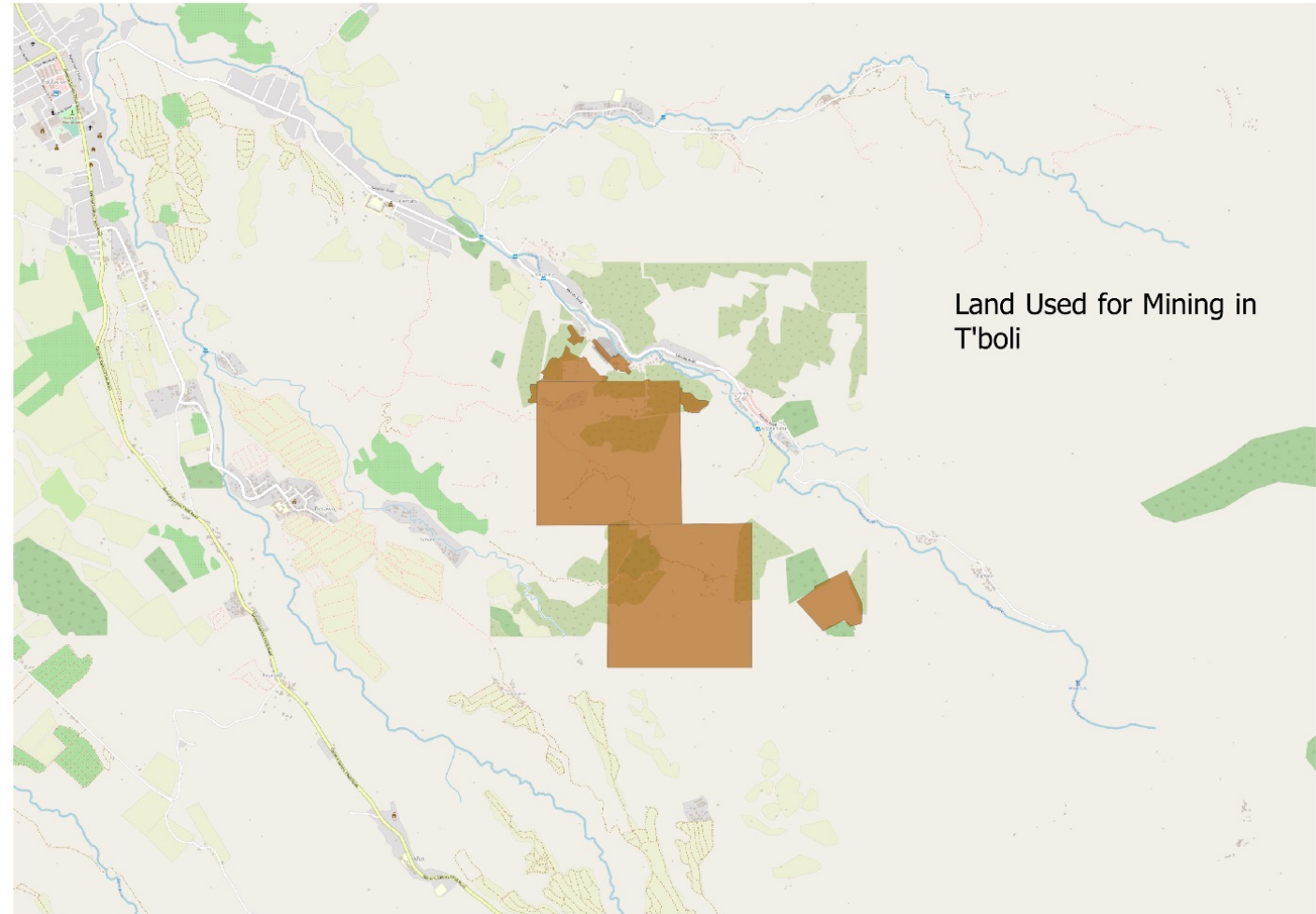
# Existing Land Use Map of T'boli

- The municipality has a total of 104, 986 hectares of existing General Land Use in which the largest percentage of 39.34% (41, 301 Ha) is occupied by Forest Area (Production and Protection),
- An area that covers 34.89% (36, 625 Ha) of the land is utilized for Pasture or Grassland
- The third largest land area is 20.16% (21,165 Ha) which is being cultivated for the agriculture sector of the municipality.



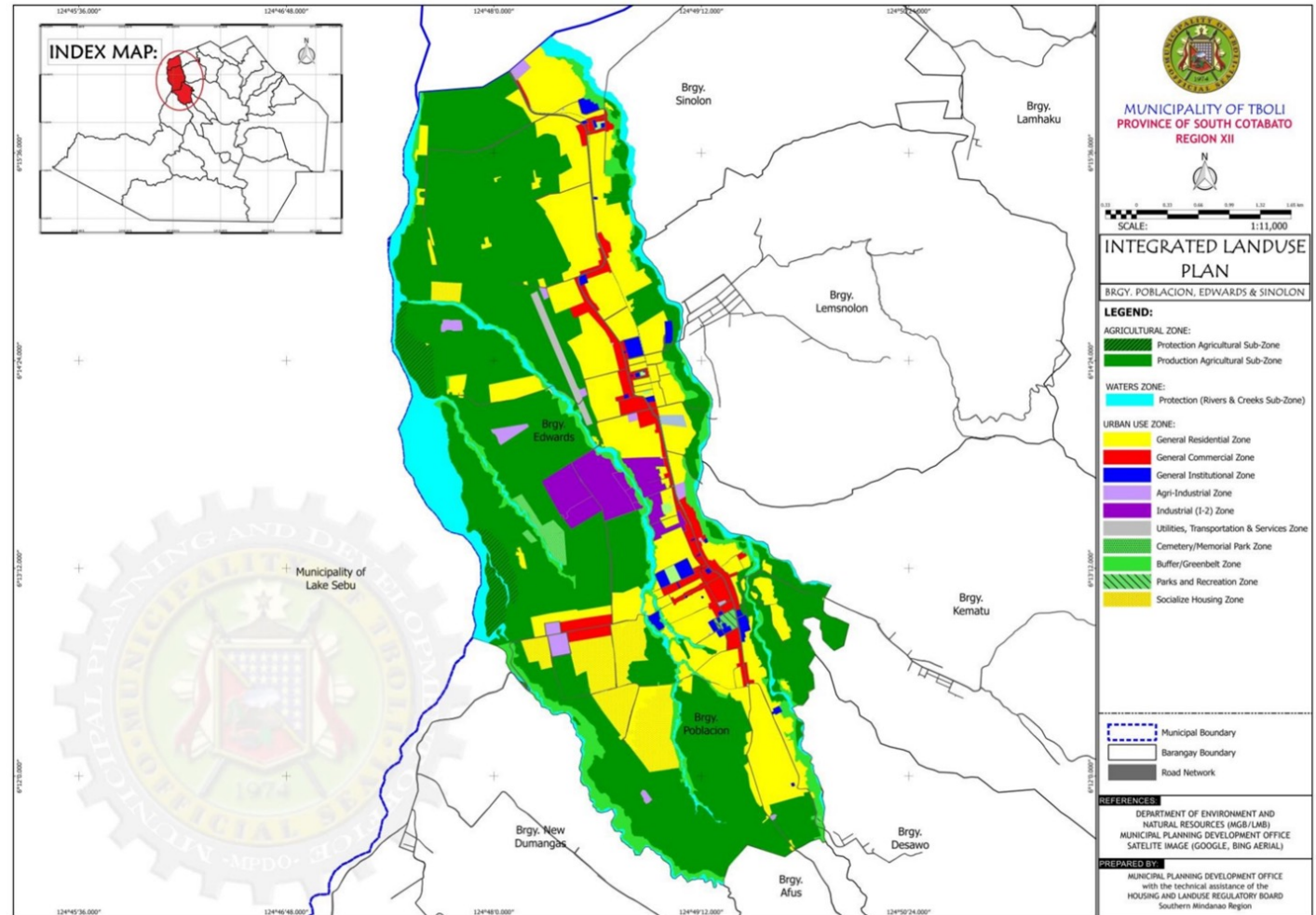
# Small-Scale Mining (SSM) Areas

- As for mining, 438.7 hectares or 0.42% of the total land area of T'boli is allocated for Minahang Bayan purposes (small scale mining only).
- This increased from 358.7 hectares in previous years after the approval of new mining settlements.
- The increase of small-scale mining activity in the Municipality is due to various mining claims with viable gold production output.
- Currently, there are three (3) Minahang Bayan Cooperatives, the MCSMMAI, DISSMAI, and TMBMPC, which are the only registered and recognized by the local government units (LGU).
- There are no large scale mining companies in T'boli as it is allocated only for small scale mining under the supervision and monitoring of the LGU.



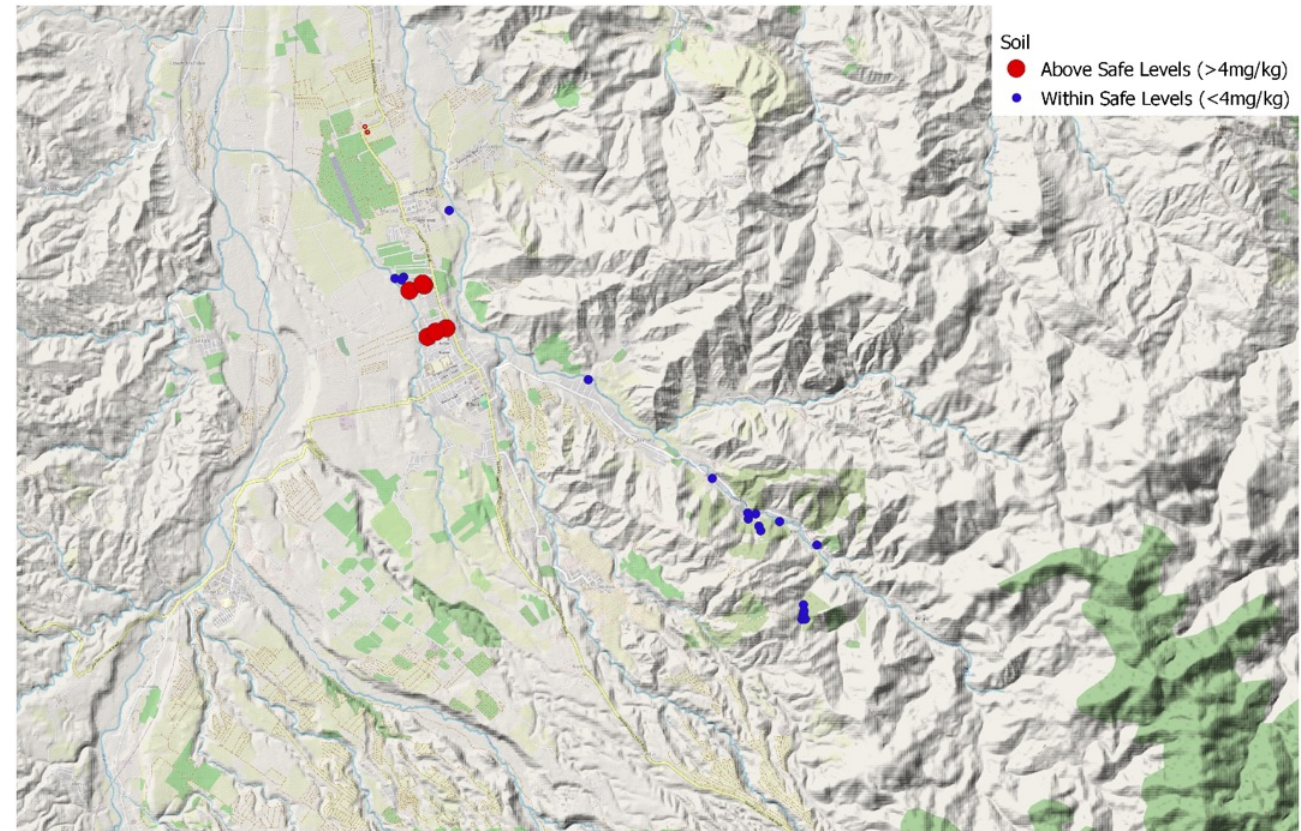
# Mine Processing Areas

- The actual extraction of ores is in the approved mining areas, while the processing of minerals is conducted in the municipality's central business district, specifically, two barangays: Brgy. Edwards and Brgy. Poblacion.
- In Brgy. Poblacion, 528 hectares or 60.89% are allotted as "Production Areas", while settlement/housing area consists of 303.8 hectares (35.04%).
- In Brgy. Edwards, on the other hand, Production Areas consist of 665.6 hectares or 59.27% of the barangay land use, while settlement/housing has an accumulated area of about 342.9 hectares (30.53%).
- In the "Production Areas", a significant portion is used for the more than 100 approved ball milling sites and four approved processing plants.



# Soil Samples

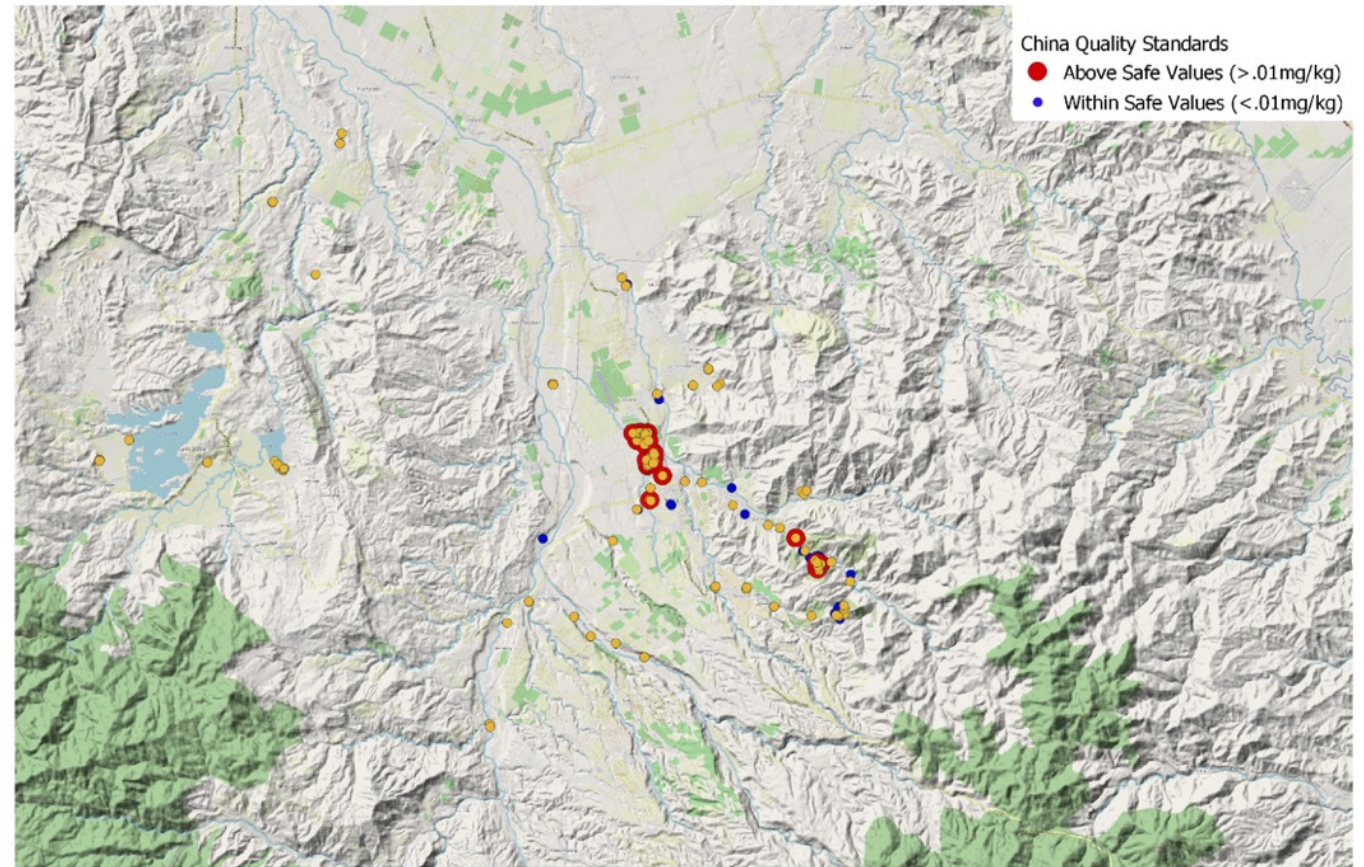
- There is a total of 25 soil samples, and 24% (6 samples) are found to have mercury concentration that is above the recommended 4 mg/Kg safe levels for mercury.
- This contamination of the soil may cause problems to agricultural products of the municipality, if not already. While there are designated Minahang Bayan areas in T'boli, the mercury contamination in the soil could possibly be spread to other areas through erosion due to heavy rainfall and rain-induced landslides.



Soil Samples Gathered in T'boli, South Cotabato

# Plant/ Crop Samples

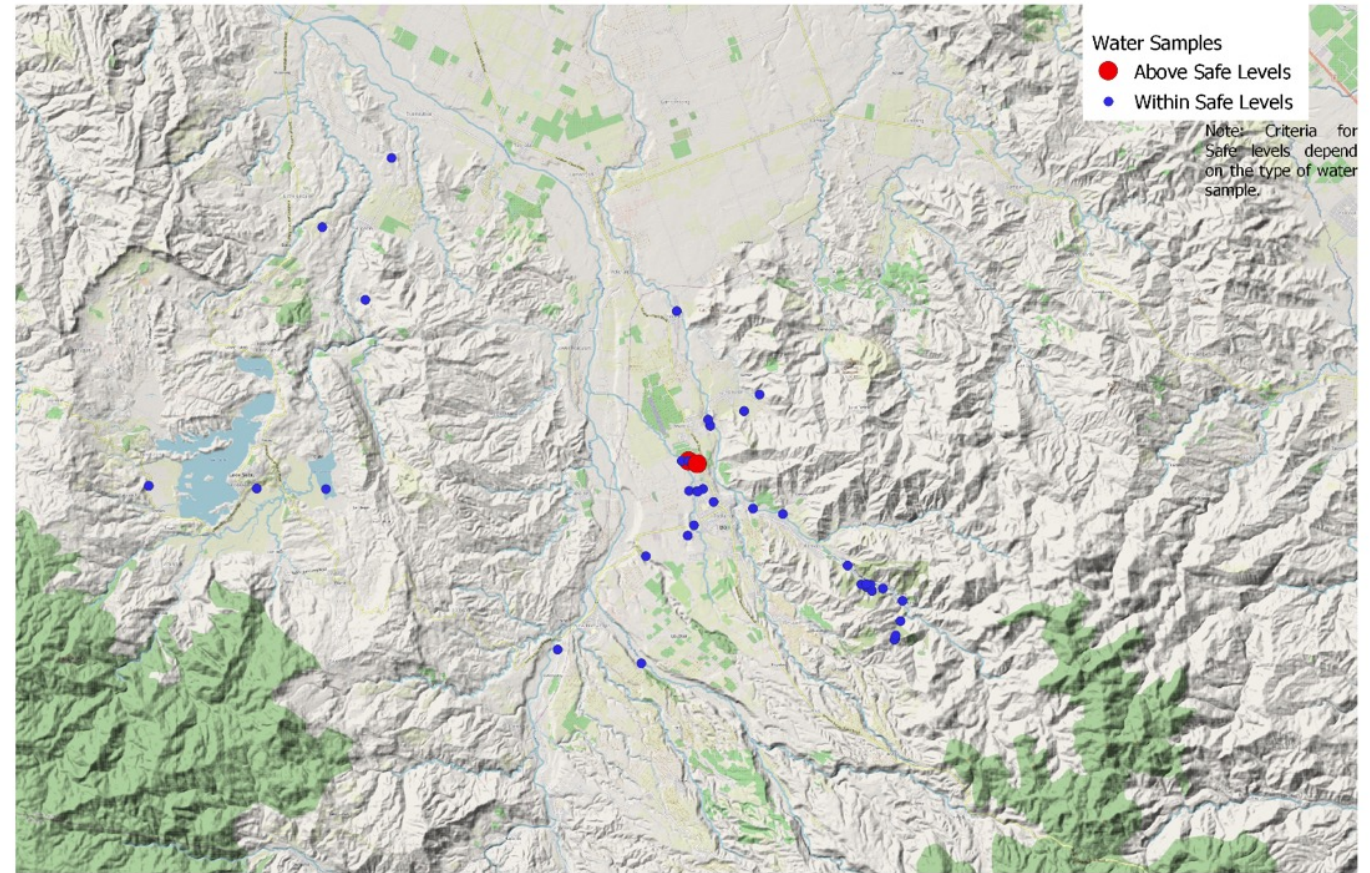
- There is a total of 76 plant/ crop samples analyzed for mercury content.
- 36.84% of the samples are above recommended quality standards based on China's stricter food contaminants standards, while 21.05% are above quality standards using the Indonesian food quality standards. Either way, this is a concerning proportion of contamination of the plants/ crops. Based on interviews, miners are consuming these crops grown in in the processing plants' vicinity to save money.
- The quality standards are based on the Indonesian National Agency of Drug and Food Control Quality Standards (QS) with a limit of 0.5 mg/kg, and China's Limits of Contaminants in Food recommending a level of 0.01 mg/kg.



Crop Mercury Monitoring in T'boli (China Quality Standards)

# Water Samples

- There is a total of 44 water samples from various sources tested for mercury concentration.
- For mining effluent and tunnel water, based on DENR (DAO-2016-08) General Effluent Standards 2016, the Maximum Allowable Limit (MAL) is 0.004 mg/L for release to Class C water bodies. For water bodies, based on DENR (DAO-2016-08) Water Quality Guidelines 2016, the Maximum Allowable Limit (MAL) is 0.002 mg/L for Class C water bodies. For drinking water, based on DOH (AO-2017-0010) Philippine National Standards for Drinking Water 2017, Maximum Allowable Level (MAL) is 0.001 mg/L.
- There is one effluent water source above maximum allowable limit in mining areas.
- There is also one above MAL drinking water source which is alarming. The others are from waters flowing through ball mill tailings and tailing ponds, and the “Sumbong Creek”, which suggest that even with the mercury ban, there may still be operations which use mercury.

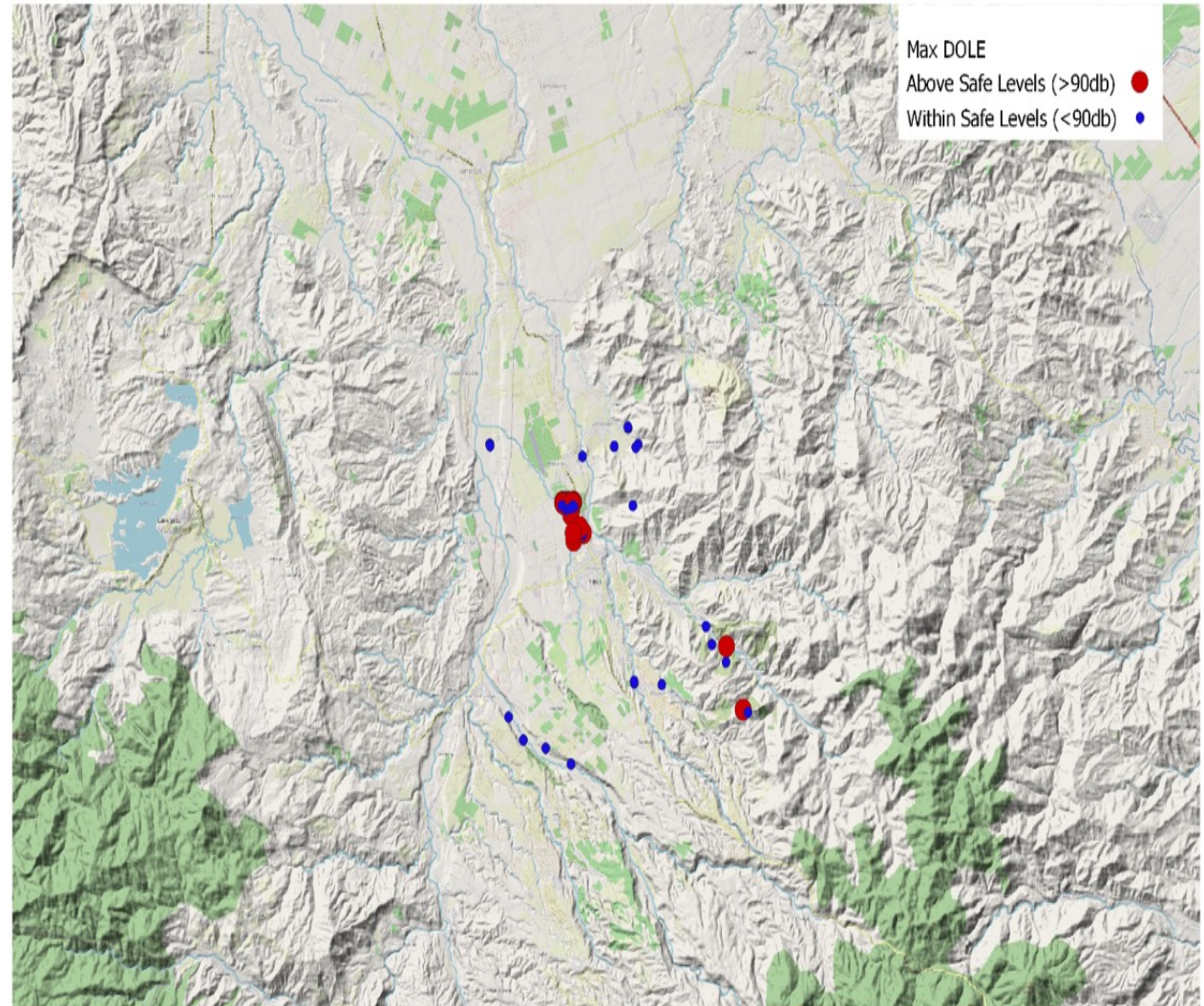


Water Mercury Monitoring in T'boli, South Cotabato



# Noise Level in Mining Areas and Mine Processing Areas

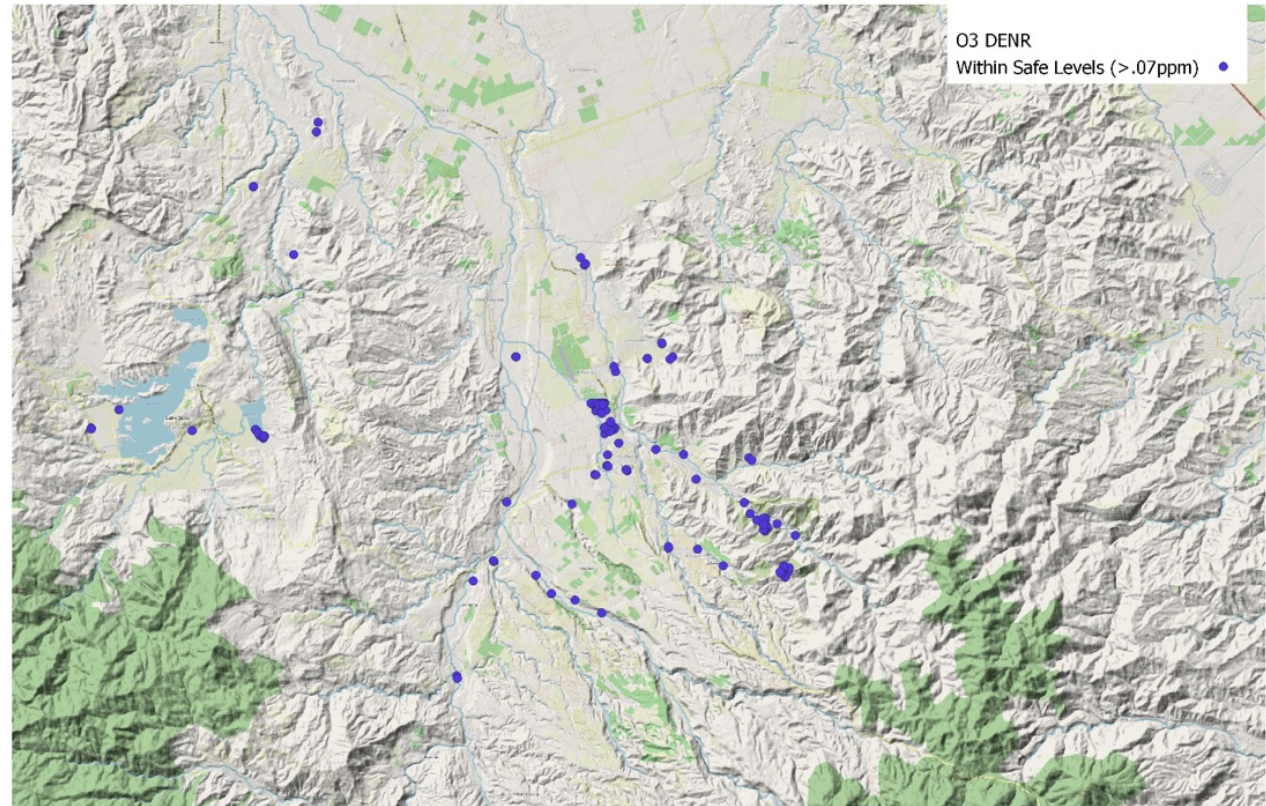
- Noise pollution is a significant environmental concern associated with mining activities.
- 49 sites are measured for noise. 8.16% of the measurements exceed the noise level based on DOLE-OSH Standards.
- Mining operations involve a multitude of machinery, equipment, vehicles, drilling, blasting, and material handling processes that collectively generate high levels of noise.
  - This noise can have adverse effects on both the environment and human health, impacting workers within mining sites and neighboring communities.
- Prolonged exposure to high noise levels in mining environments can lead to hearing loss and other auditory issues among workers.
- Results of measurement of noise reveal that operational plants often register noise levels above permissible exposure limit of 90 decibels A.
- Particularly, the source of noise come from ball milling operations which run for hours, exposing not only the plant worker to noise, but also the neighbors.



Noise Pollution Monitoring (DOLE Standard)

# Ozone Levels

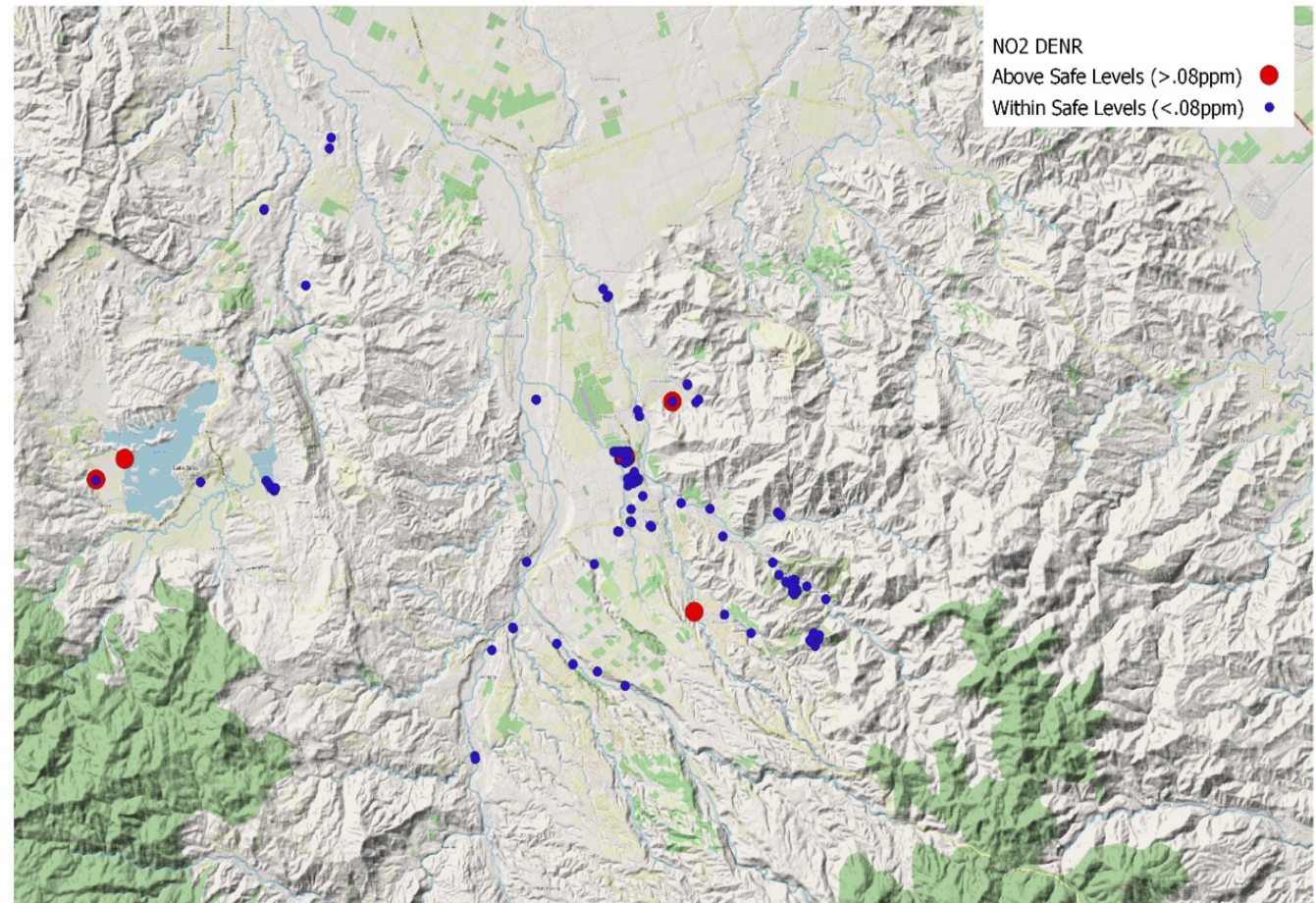
- There is a total of 134 sites measured for Ozone levels.
- All of the sites have revealed low ozone readings.
- Based on visual observation, machines in the processing zones are properly covered from sunlight. This helps in lowering the probability of chemicals reacting with sunlight to form ozone.
- The mining sites also have little to no machineries aside from the standard ventilation machines, hence ozone pollution is less likely.



Air Quality Monitoring (DENR Standard) for Ozone

# Nitrogen Dioxide Levels

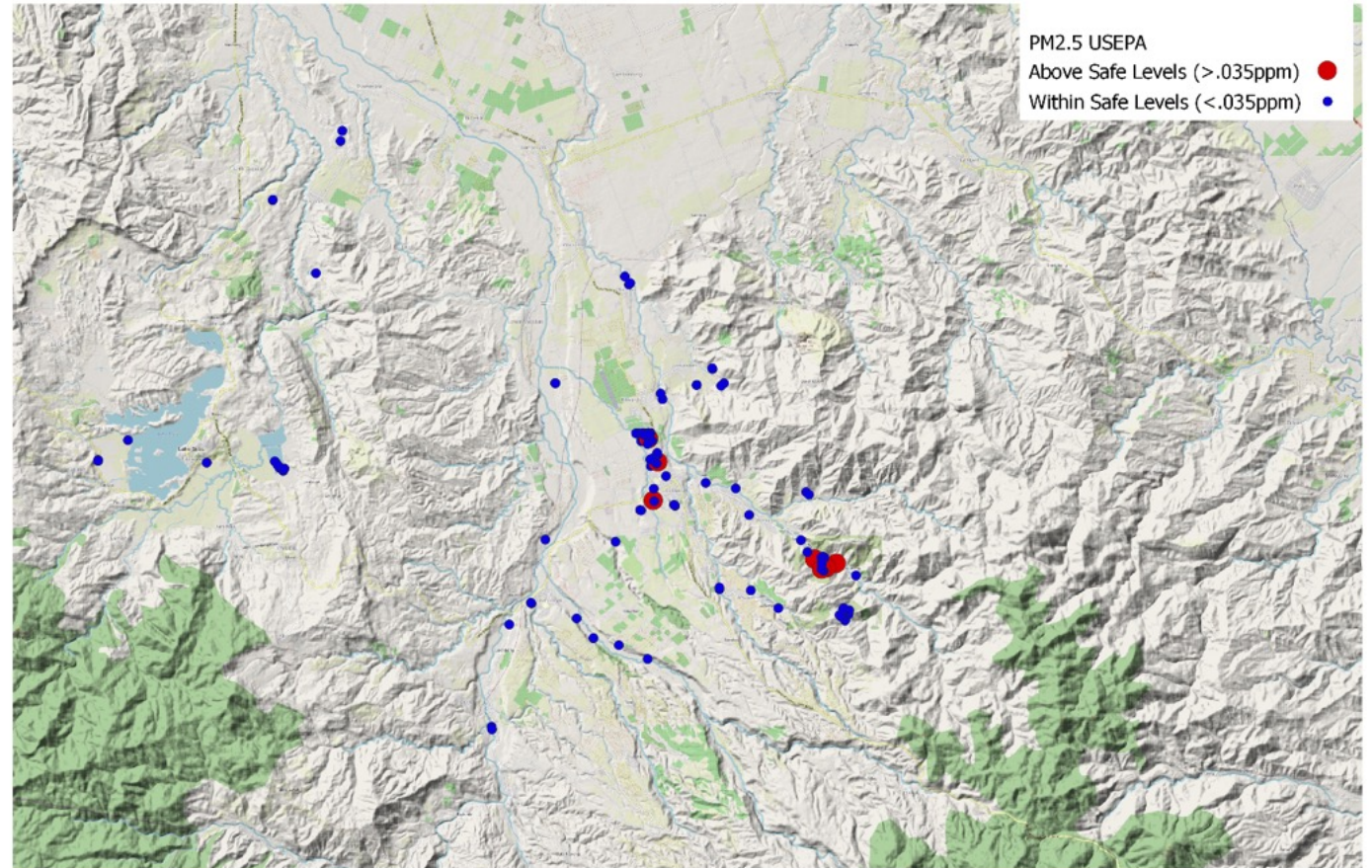
- There are also 134 sites measured for nitrogen dioxide levels.
- 5 areas have NO<sub>2</sub> levels above recommended normal. These areas are found in both the processing and the tunneling areas, as well as in the fish ponds.
- While there is burning involved in the processing of gold, it seems that the surrounding areas still have a relatively safe level of NO<sub>2</sub> level.
- The DENR EMB recommended levels were used for the recommended levels of pollutants.



Air Quality Monitoring (DENR Standard)

# Particulate Matter PM 2.5 Levels

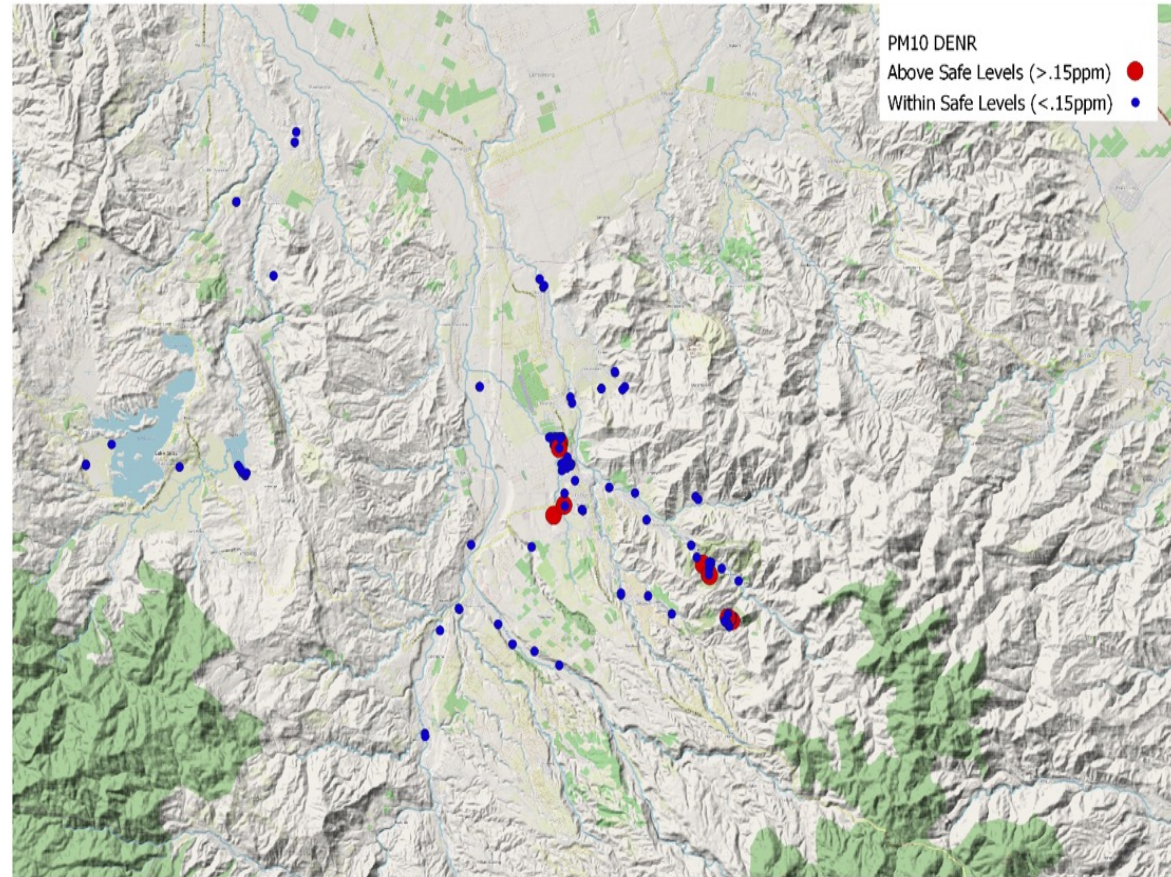
- There are 134 sites measured for PM<sub>2.5</sub> levels.
- 22.66% of the sites have registered an above safe level of Particulate Matter (PM) based on the WHO standards.
- Particulate Matter (PM) refers to tiny particles suspended in the air. These particles are extremely small and can be inhaled deeply into the lungs, posing significant health risks to humans and the environment. Mining activities such as drilling, blasting, grinding, disposal of mine waste, and ore processing can produce fine particles that could be inhaled.
- The sites in the processing measured to be above safe levels are both near tailings pond.
- The higher measurement is in a location where there is currently an operation and is in the process of dissolving the gold ores.



Air Quality Monitoring (USEPA Standard) for PM<sub>2.5</sub>

# Particulate Matter PM 10 Levels

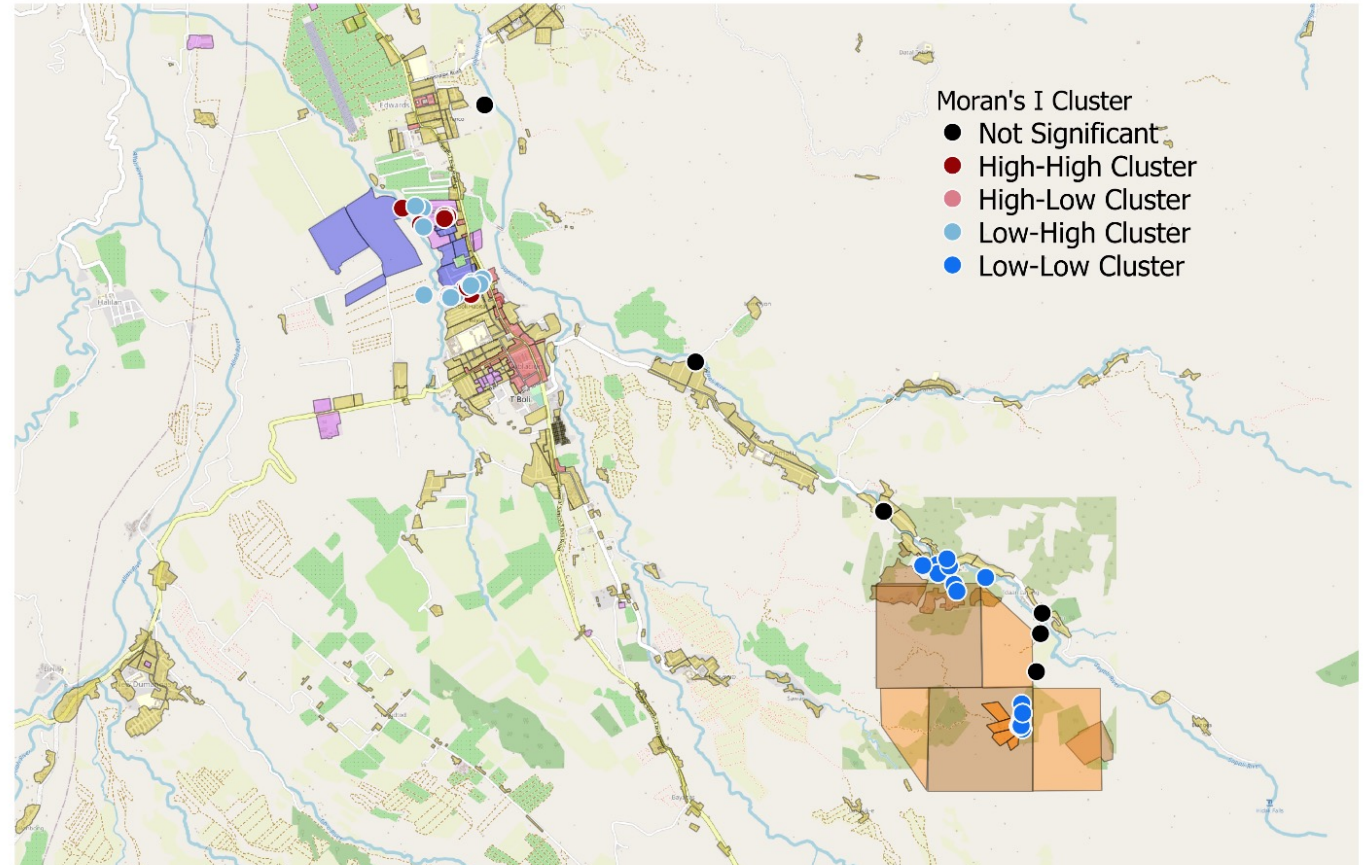
- There are 134 sites measured for PM10 levels.
- 3.03% are found to have above safe levels of PM10.
  - This site is also the same site with the higher PM2.5 reading. The location of the area is near a tailing pond and a currently operating plant.
- The PM2.5 measurement on this location was 0.265ppm, while the PM10 measurement is at .234ppm, both of which is 4 to 5 times higher than the reference value for safe levels of particulate matter in the atmosphere.
- This is a cause of concern since excessive exposure to particulate matter pollutants have been shown to cause cardiopulmonary diseases to the miners.



Air Quality Monitoring (DENR Standard) for PM10

# Moran's I Spatial Clustering Map of Samples Gathered in T'boli

- Moran's I test reveals that there are significant high-high clusters in the processing area (marked in dark red).
  - the values of measurements in these sampling locations are generally high and are close in proximity (space).
- Significant low-low clusters have formed in the Tunneling areas, suggesting that generally the measurements in the mining areas are homogeneously low.
  - in previous maps, most measurements in the mining areas are below reference value or below detection limits.



Moran's I Spatial Clustering Map of Samples Gathered in T'boli

# HUMAN BLOOD MERCURY MONITORING

# Human Blood Mercury Content Monitoring

- Of the 210 subjects, 43.06% of respondents/ belong to the category of HBM between HBM-I and HMB-II.
- All of the samples were gathered from miners who reported to have history of being exposed to or using mercury.
- Human biomonitoring (HBM) values, are derived on the basis of toxicological and epidemiological studies. Two levels are defined: HBM-I and HBM-II.

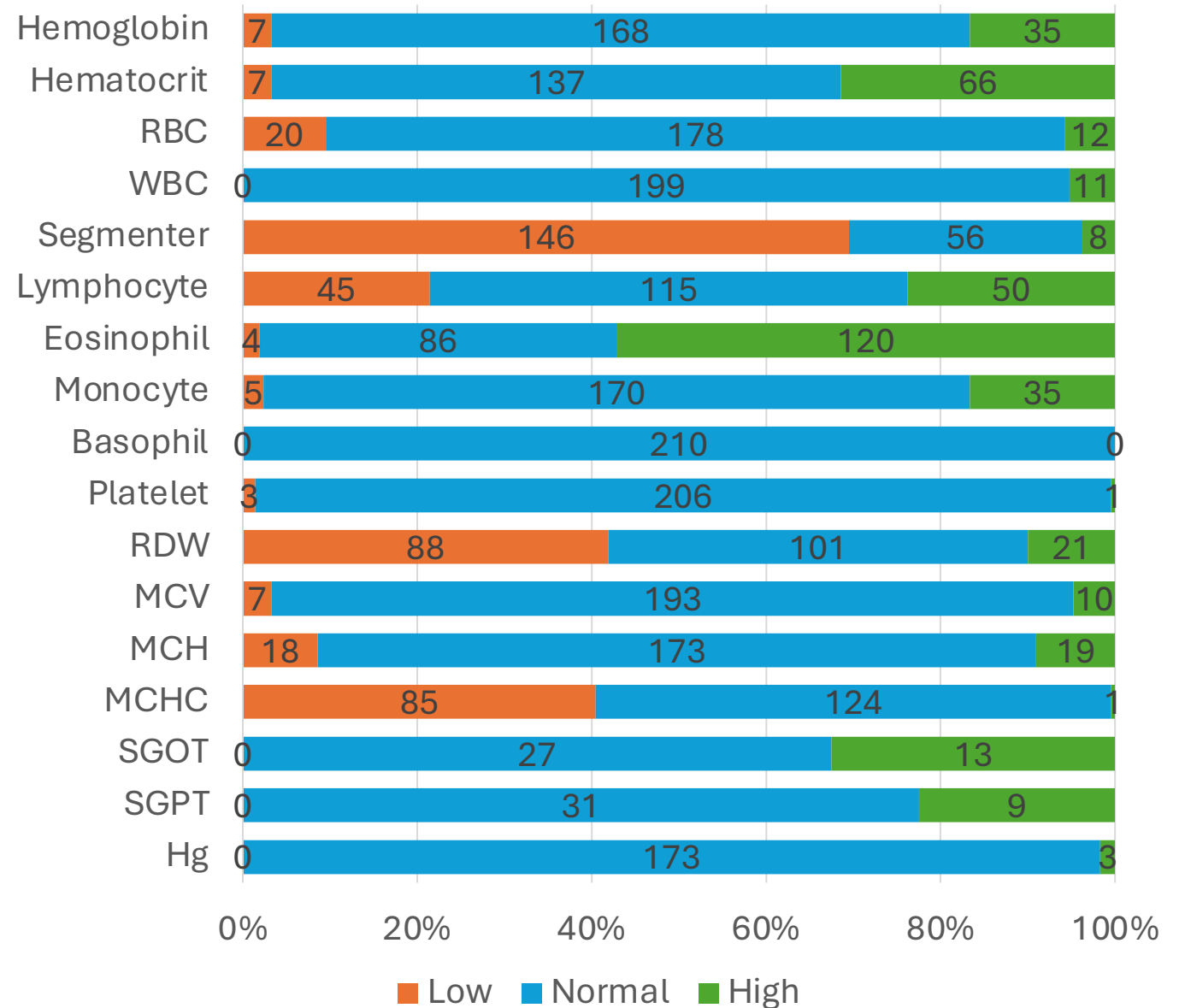
	< HBM-I (no risk of adverse effects)	HBM-I ≤ X < HBM-II (confirm for potential sources)	≤ HBM-II (intervention needed)	Total
Male	85	76	15	176
Col%	83.33%	84.44%	88.24%	
Female	17	14	2	33
Col%	16.67%	15.56%	11.76%	
Total	102	90	17	209
	49%	43.06%	8.13%	100%

- The HBM-I-value represents the concentration of a substance in human biological material below which – according to the knowledge and judgement of the HBM Commission – there is no risk for adverse health effects and, consequently, no need for action.
- At a concentration level higher than the HBM-I- and lower than the HBM-II-value the result should be verified by further measurements. If these measurements confirm the initial result a search for potential sources of exposure should be undertaken. Exposure to such sources should be minimized or eliminated where necessary and achievable with an acceptable level of input. The HBM-I-value should thus be regarded as a verification or control value.
- The HBM-II-value represents the concentration of a substance in a human biological material above which – according to the knowledge and judgement of the HBM Commission – there is an increased risk for adverse health effects and, consequently, an acute need for exposure reduction measures and the provision of biomedical advice. The HBM-II-value should thus be regarded as an intervention or action level.



# Complete Blood Count (CBC) of Miners

- There is a total of 210 respondents that have participated in the blood examination.
- There is a notable number of respondents with higher than normal levels of eosinophil, hematocrit, and lymphocyte.
- On the other hand, there is a notable number of respondents with significantly lower than normal levels of segmenter, RDW, and MCHC.



# Cause of Injury/Death of Small Scale Miners (MGB Region XII)

<b>Year</b>	<b>Cause of Death/Injury</b>
<b>2016</b>	Cardiorespiratory arrest due to asphyxiation
<b>2018</b>	Cardiorespiratory arrest due to asphyxiation
<b>2020</b>	Cardiorespiratory arrest, with an antecedent cause of acute myocardial infarction (heart attack)
<b>2021</b>	Head injury (cut on the head) and minor scratches on back and lower leg.
<b>2021</b>	Cardiac arrest secondary to respiratory failure secondary to traumatic brain injury
<b>2023</b>	Increased intracranial pressure secondary to acute cerebrovascular accident (Acute Stroke). Antecedent cause of hemorrhagic left middle cerebral artery (bleeding)
<b>2023</b>	Cardiogenic shock with an antecedent cause of Acute Myocardial Infarction (heart attack)

# Cause of Injury/Death of Small Scale Miners (MGB)

Interestingly, out of the six fatalities, three died of lifestyle diseases, particularly due to heart attack and stroke.

- Mining work is an inherently demanding and challenging physically. That often requires physical endurance and resilience.
- The presence of lifestyle diseases can significantly exacerbate the difficulty of carrying out such work.
- The strain and stress on the body due to mining activities can escalate health problems, leading to increased complications or exacerbation of existing conditions.
- The combination of strenuous physical exertion and the potential lack of access to immediate medical care in remote mining locations can significantly heighten the dangers faced by miners with these health concerns.

In the case from 2020, the victim who had a history of heart attack was observed to have been especially fatigued during his shift.

- In the brink of another attack, he still have to climb a 60-meter vertical manway so he could reach the portal tunnel for first aid.

The fatal cases from 2016, 2018, and the injurious case from 2021 illustrates the dangers of a poorly designed tunnel to the mine worker.

- The common denominator in these three cases is the lack of sufficient ventilation inside the tunnel.

On the injurious case, while it did not fatal, the lack of ventilation increased the level of fatigue to the worker causing him to slip and fall and hit his head.

- This highlights the importance of providing correct facilities to tunnel workers because it could mean life and death.

# Factors and Details leading to Injury/Death of Small Scale Miners (MGB)

Year	Factors/Details
2016	<ul style="list-style-type: none"><li>• After their shift, one miner decided to leave behind and extract more ore.</li><li>• The miners was later found on a dead end of the tunnel, 30 meters away from the last active working area.</li><li>• Ventilation can only reach active working area, but failed to ventilate the accident site.</li></ul>
2018	<ul style="list-style-type: none"><li>• Before the day of the accident, there was a power interruption which led to the ventilation system being shut off.</li><li>• The ventilation system was turned on at 4:00AM, 2 hours before miners started working at 6:00AM.</li><li>• It was found during investigation that there are perforated/leaking ventilation sacks in the tunnel which may have caused the ventilation system to lose air before reaching the working face.</li><li>• There were also cigarette packaging and cigarette butts found inside the tunnel which suggests that miners are smoking inside the tunnel.</li><li>• Rotten timbers were also found in the tunnels, which produces carbon dioxide due to biological oxidation. This could have further increased the carbon dioxide levels in the mine.</li></ul>
2020	<ul style="list-style-type: none"><li>• The victim only has one kidney left and has a history of heart attack. During the shift, he was observed to have been drinking unusually plenty of water.</li><li>• When the miners were leaving, the victim told other miners that he would like to stay for a while to take a rest before climbing.</li><li>• Around 20 mins after they left, fellow miners of the victim went back where they left him and found him unconscious.</li><li>• The vertical manway has a height of 60 meters, with only the bottom 30 meters with a ladder.</li><li>• The accident area has a good ventilation system, but there were cigarette butts, suggesting that miners are smoking inside the tunnel.</li><li>• There is also part of the vertical manway where two ventilation fans were found to have been facing each other which suggests a short-circuited ventilation.</li></ul>

# Factors and Details leading to Injury/Death of Small Scale Miners (MGB)

Year	Factors/Details
2021	<ul style="list-style-type: none"><li>• The victim was not wearing the hard hat when the accident happened.</li><li>• He claimed that while leaving their work area, he slipped and fell when he stepped at the wet 4"x6" platform.</li><li>• Investigation of the tunnel revealed that there were insufficient ventilation in the tunnel which would have added to the exhaustion of the victim, causing him to slip and fall on the wet wooden platform.</li></ul>
2021	<ul style="list-style-type: none"><li>• While installing timber support, the victim was accidentally hit in the back by a falling boulder with approximately 1-meter radius.</li><li>• This caused him to fall down unconscious and bleeding with face on the ground.</li><li>• At exactly 10:00AM, he was declared dead on arrival at the hospital he was brought to.</li></ul>
2023	<ul style="list-style-type: none"><li>• The victim was 58 years old and was only employed for 2 weeks before the accident happened.</li><li>• He has a history of hypertension but despite this he has to work due to financial needs.</li><li>• He was found "sleeping" on the mainline of the tunnel, which turns out that he already had a heart attack.</li><li>• He is a smoker.</li><li>• He was not registered as a small-scale miner.</li><li>• Portal guard barred the victim from working in the tunnel upon the order of the management because of his coughs, however was not aware whether the victim went back to the tunnel since he napped at around 4:00PM.</li><li>• He was apparently alone inside the tunnel during the stroke event.</li></ul>
2023	<ul style="list-style-type: none"><li>• The victim was 56 years old and had the event while they were resting at the bunkhouse of the tunnel.</li><li>• He was a veteran miner and the event happened during their day off.</li><li>• He has no vices. He also has no strenuous activity since as a portal guard.</li><li>• He has no medical history.</li><li>• The environment of the bunkhouse was generally comfortable.</li></ul>

# Recommendations to Prevent Further Injury/Death to Small Scale Miners (MGB)

Year	Recommendations
2016	<ul style="list-style-type: none"><li>• A safety inspector shall be required for every 25 workers/miners (DENR Rule 8).</li><li>• Underground workings must be provided with adequate supply of fresh air (DENR rule 16).</li><li>• A miner shall not be allowed to work alone underground where he could not be seen or heard in case of emergency (DENR Rule 22).</li><li>• Workers shall not be assigned to work at a place unless a safety inspector deemed it safe (DENR Rule 23).</li><li>• When workers feel the symptoms of oxygen deficiency such as dizziness, vomiting, fainting, ringing sensation in the ears or presence of toxic or explosive gases, they shall immediately retreat and report such places to the safety inspector</li></ul>
2018	<ul style="list-style-type: none"><li>• Rotten timber supports should be replaced immediately (DAO rule 42).</li><li>• No smoking inside the tunnel should be strictly enforced (DAO rule 144).</li><li>• Ventilation fans should be upgraded and leaks should be fixed (DAO rule 16).</li><li>• No miner shall be allowed to enter working areas not reached by ventilation. 2 hours of ventilation is not enough to completely dilute mine gases.</li></ul>
2020	<ul style="list-style-type: none"><li>• Buddy system should be implemented (DENR rule 22).</li><li>• No Smoking should be strictly enforced (DAO rule 144).</li><li>• Physical and medical examination of miners should be done at least once a year to see if miners are still fit to work (DAO rule 14.16).</li></ul>

# Recommendations to Prevent Further Injury/Death to Small Scale Miners (MGB)

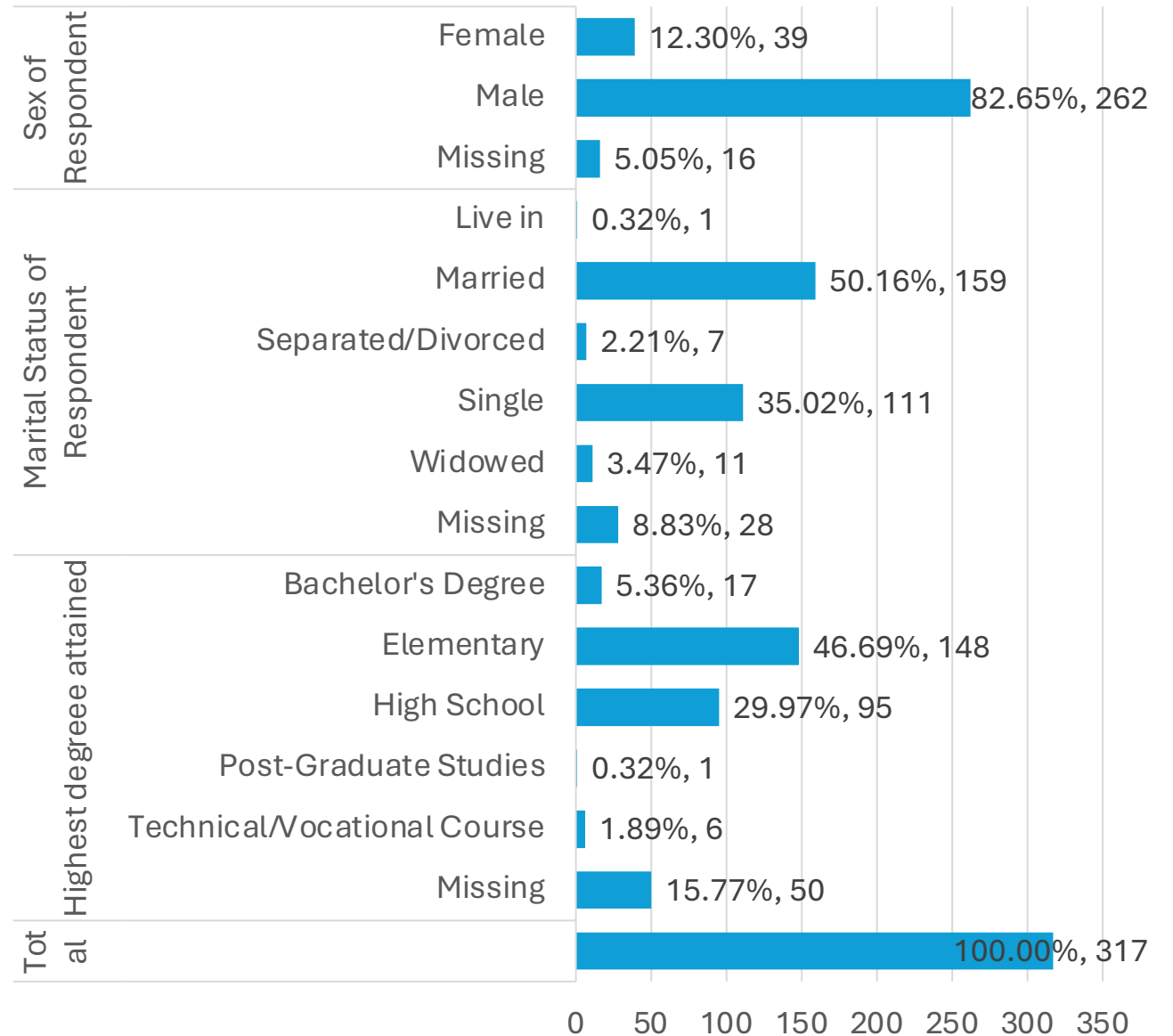
Year	Recommendations
2021	<ul style="list-style-type: none"><li>• Change the wooden platform to 4"x8" to allow for a wider space for the feet.</li><li>• Walkways should also be kept clean of rubbish, materials, and spillages at all times (DAO rule 148).</li><li>• Strictly implement wearing of hard hat when inside the tunnel.</li><li>• Install additional mechanical ventilation and provide canals along the manways to divert water away from the walkway.</li></ul>
2021	<ul style="list-style-type: none"><li>• Hanging or loose rocks at the roof of the tunnel should be barred down.</li></ul>
2023	<ul style="list-style-type: none"><li>• Physical and medical examinations should regularly be conducted on miners to ensure their fitness to work (DAO rule 14.16).</li><li>• Portal guard should be alert during his shift so he can be aware of the comings and goings of persons in the tunnel.</li><li>• Buddy system should be implemented (DENR rule 22).</li><li>• Small scale miners should be registered first before being able to work, to ensure accountability.</li><li>• The qualification of a person for the work should seriously be considered especially for those who are working inside the mines.</li></ul>
2023	<ul style="list-style-type: none"><li>• Physical and medical examinations should regularly be conducted on miners to ensure their fitness to work (DAO rule 14.16).</li><li>• This could have prevented any chance that people may have just been denying about their current medical condition.</li><li>• First aid kits should also be always available, not only in the tunnels but also in their bunkhouses.</li></ul>

# Survey on Miners and Processing Plant Operators



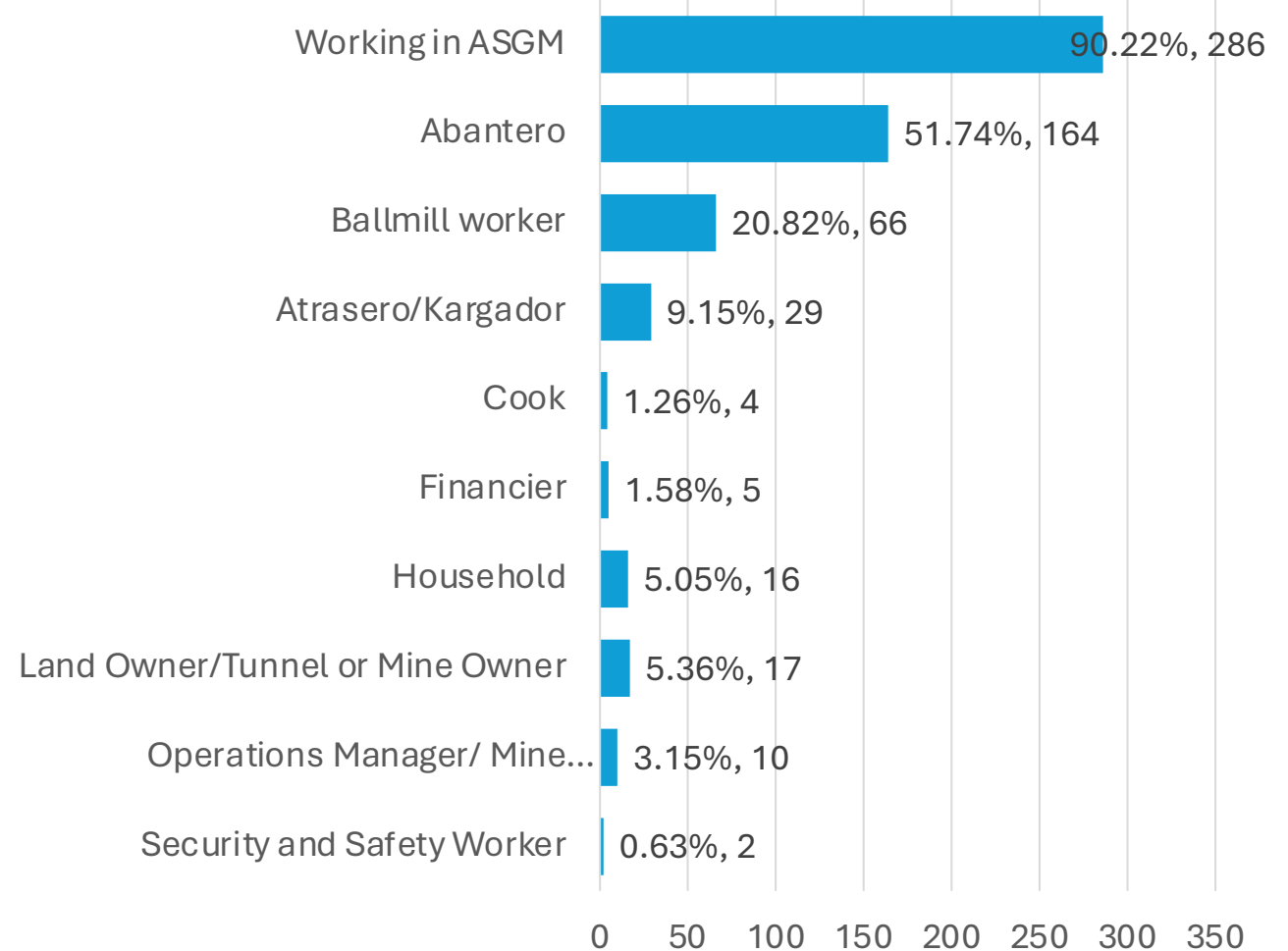
# Socio-demographics

- There is a total of 317 respondents on the survey conducted for small-scale miners in T'boli.
- 82.65% are males, 50.2% are married while 35% are single, and almost half have only finished elementary school.



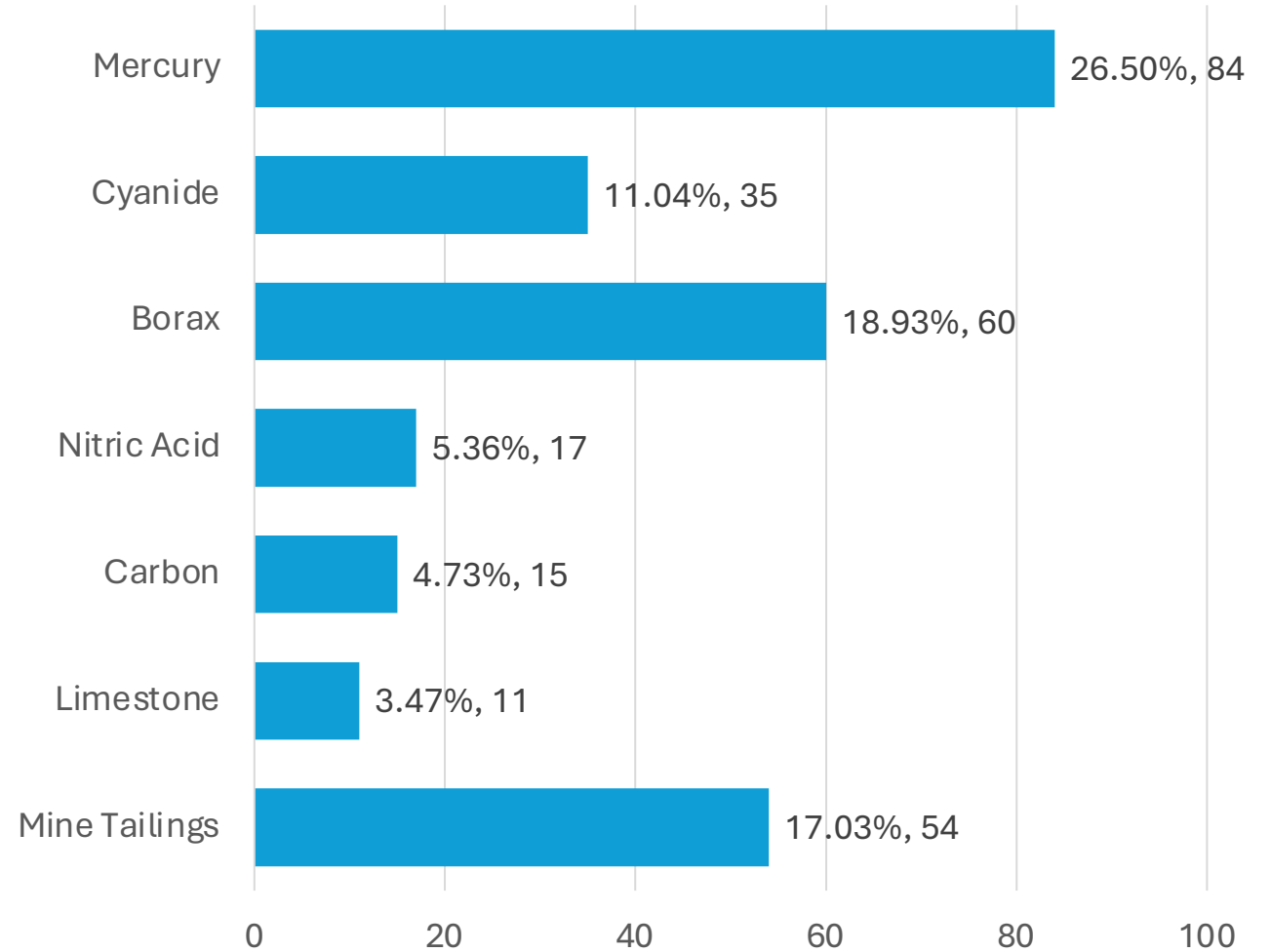
# Role in Artisanal Small-Scale Gold Mining

- 90.22% of the 317 respondents have worked in Artisanal Small-Scale Gold Mining in some way.
- Regarding roles, more than half (51.74%) are “abantero”, or those who dig and blast ores in the tunnels, while 9.15% are “atrasero/kargador” or those who carry the ores down to the processing plants in the lowlands.
- 20.82% are Ballmill workers, and workers in gold processing plants in the city center. There are 17 mine owners, 10 mine supervisors, 2 safety workers, and 5 financiers.
- Mining role is a multiple-response question which explains the total being greater than the sample size.



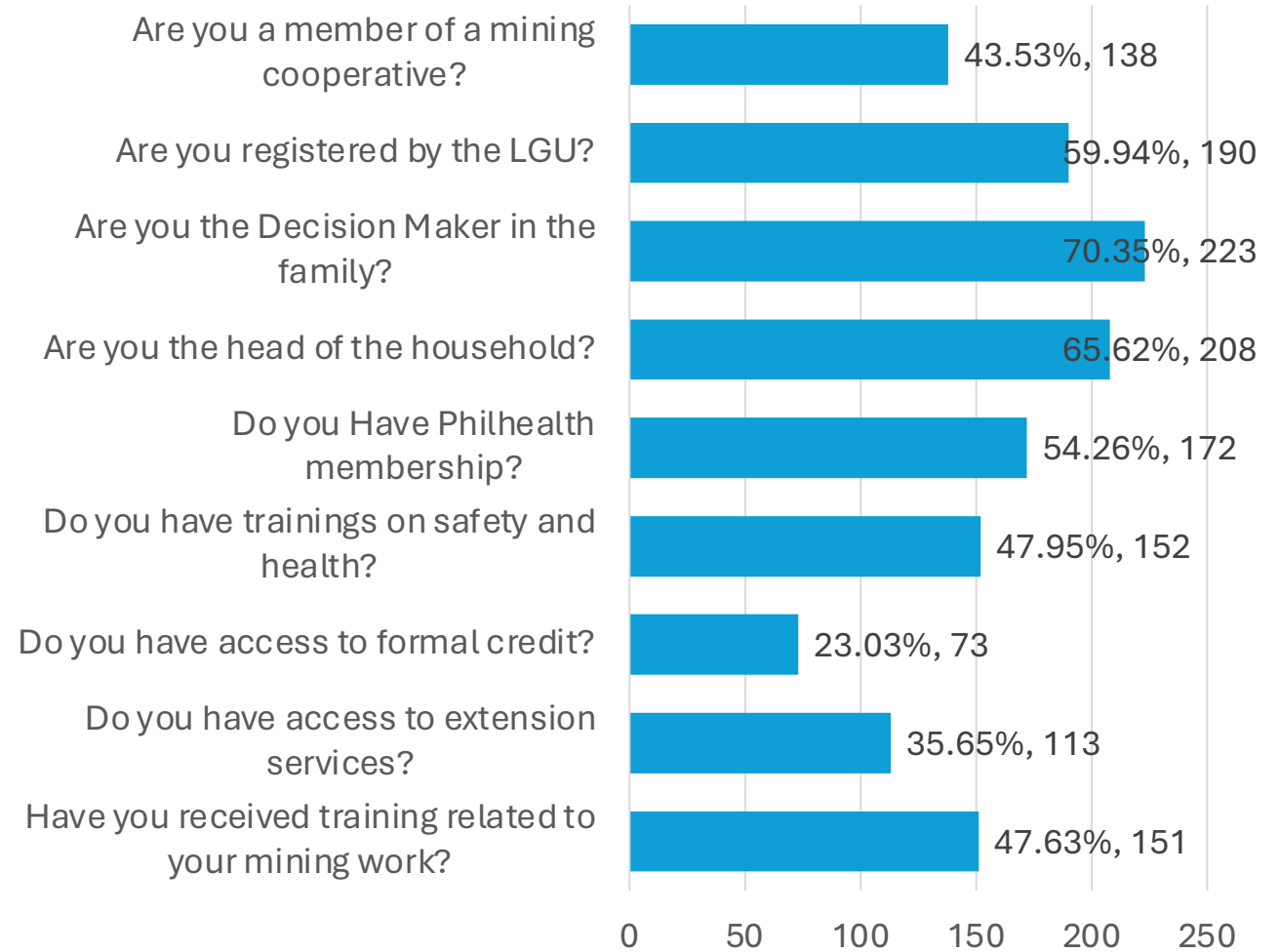
# Chemical Used in Small Scale Mining

- 26.5% reported to have used mercury in their operations.
- 18.93% of the miners have used borax
- 5.36% have used Nitric Acid,
- 4.73% have used activated carbon
- 17.03% reported that working with mine tailings is part of their work.



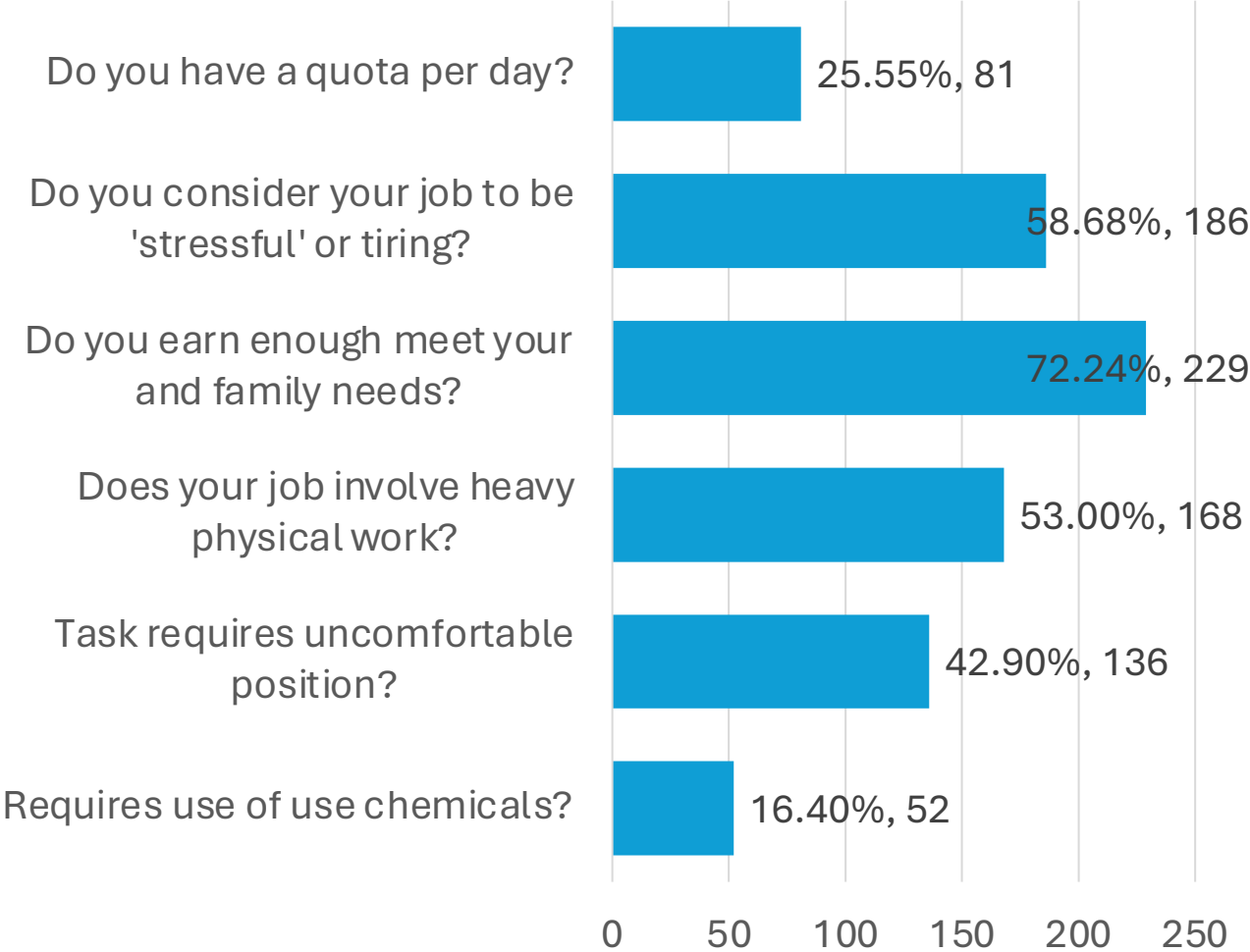
# Mining Support and Training

- 43.5% are members of a mining cooperative. 59.9% are registered miner by the local government.
- 70% are decision makers in their family, while 65.6% are the head of their household.
- 54% have health insurance in the form of PhilHealth.
- 48% have received trainings on safety and health, while 47.6% have received training related to mining work.
- Only 23% have access to formal credit, and only 35.65% have access to extension services.



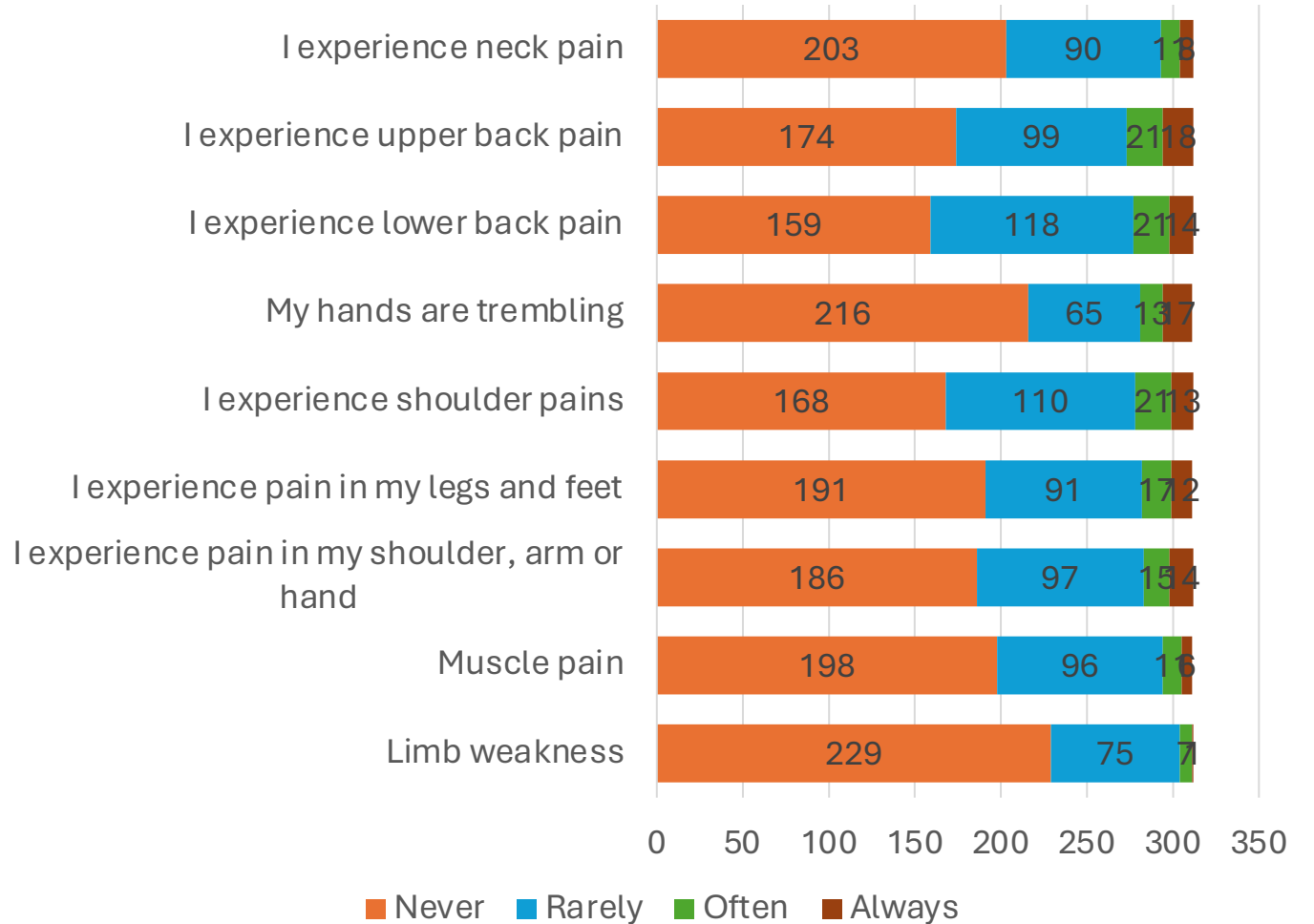
# Nature of Task in Mining

- 25.5% have a quota every day.
- 58.7% reported that their job is stressful or tiring.
- 72.24% stated that their income is enough to meet their and their family's needs
- 53% have work involve heavy physical work
- 42.9% have work that requires them to be in uncomfortable position
- 16.4% have work that requires the use of chemicals.



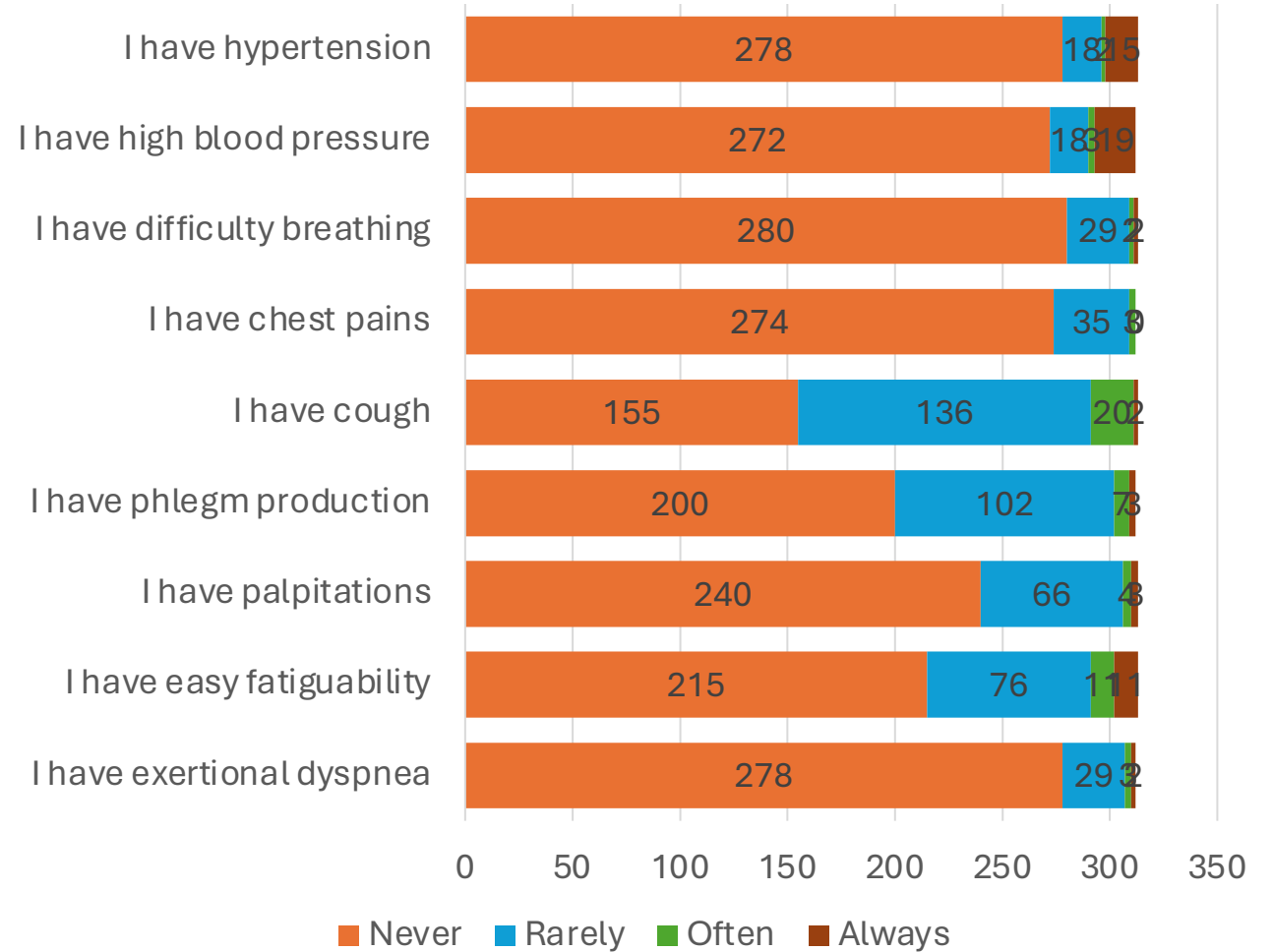
# Musculoskeletal and Ergonomic Disorders

- The most common musculoskeletal and ergonomic symptoms (that miners always experience) are **upper back pain, trembling hands, lower back pain, and pain in shoulder, arm or hand.**
- On the other hand, the symptoms that miners experience **often** are **upper and lower back pain, shoulder pain, and pain in legs and feet.**



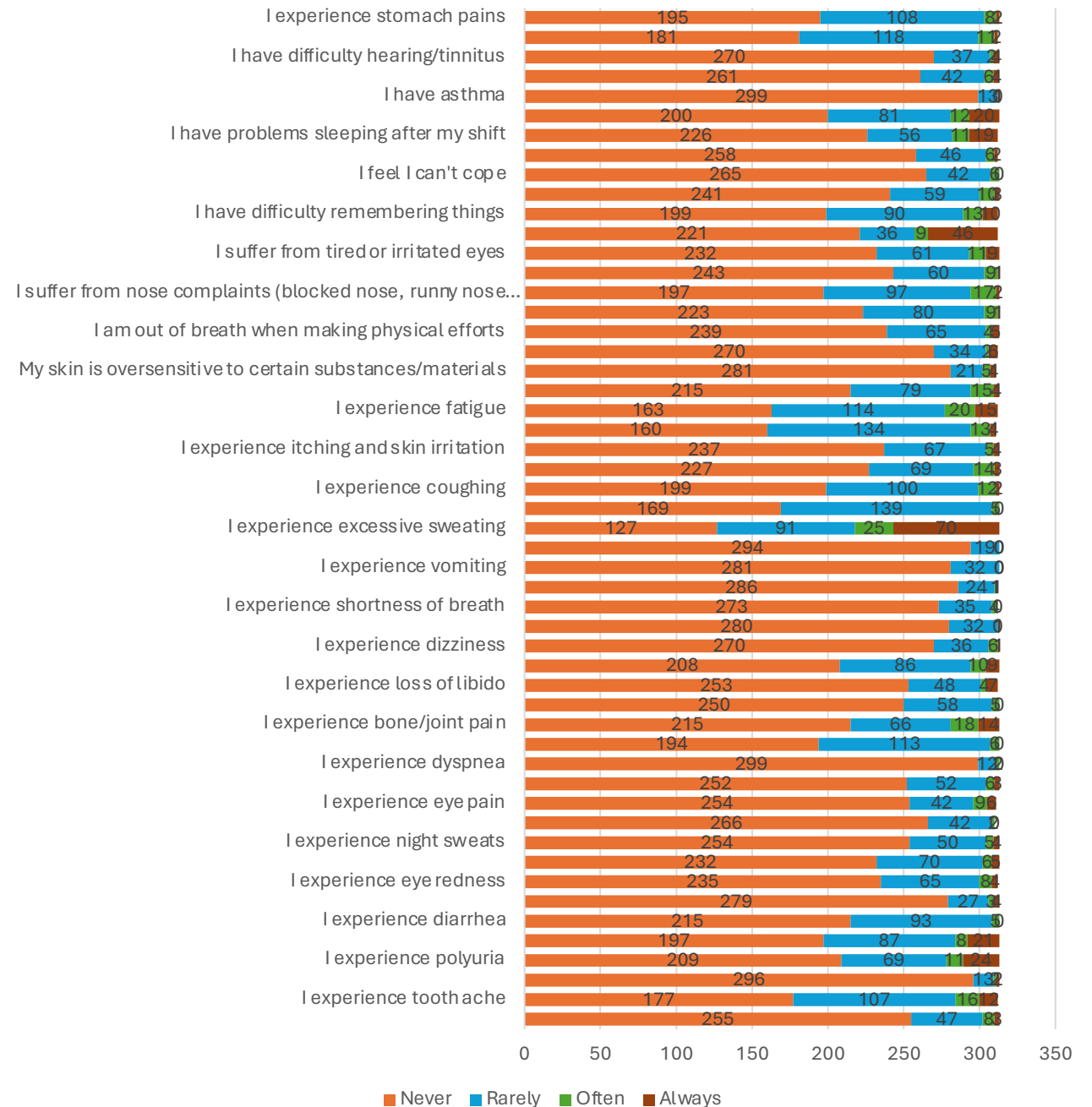
# Cardiovascular and Respiratory Problems

- The most common cardiovascular and respiratory symptom (that miners always experience) are **high blood pressure, hypertension, and easy fatiguability.**
- On the other hand, the symptoms that respondents experience **often** are **coughs, and easy fatiguability.**



# Other Physical Health Problems

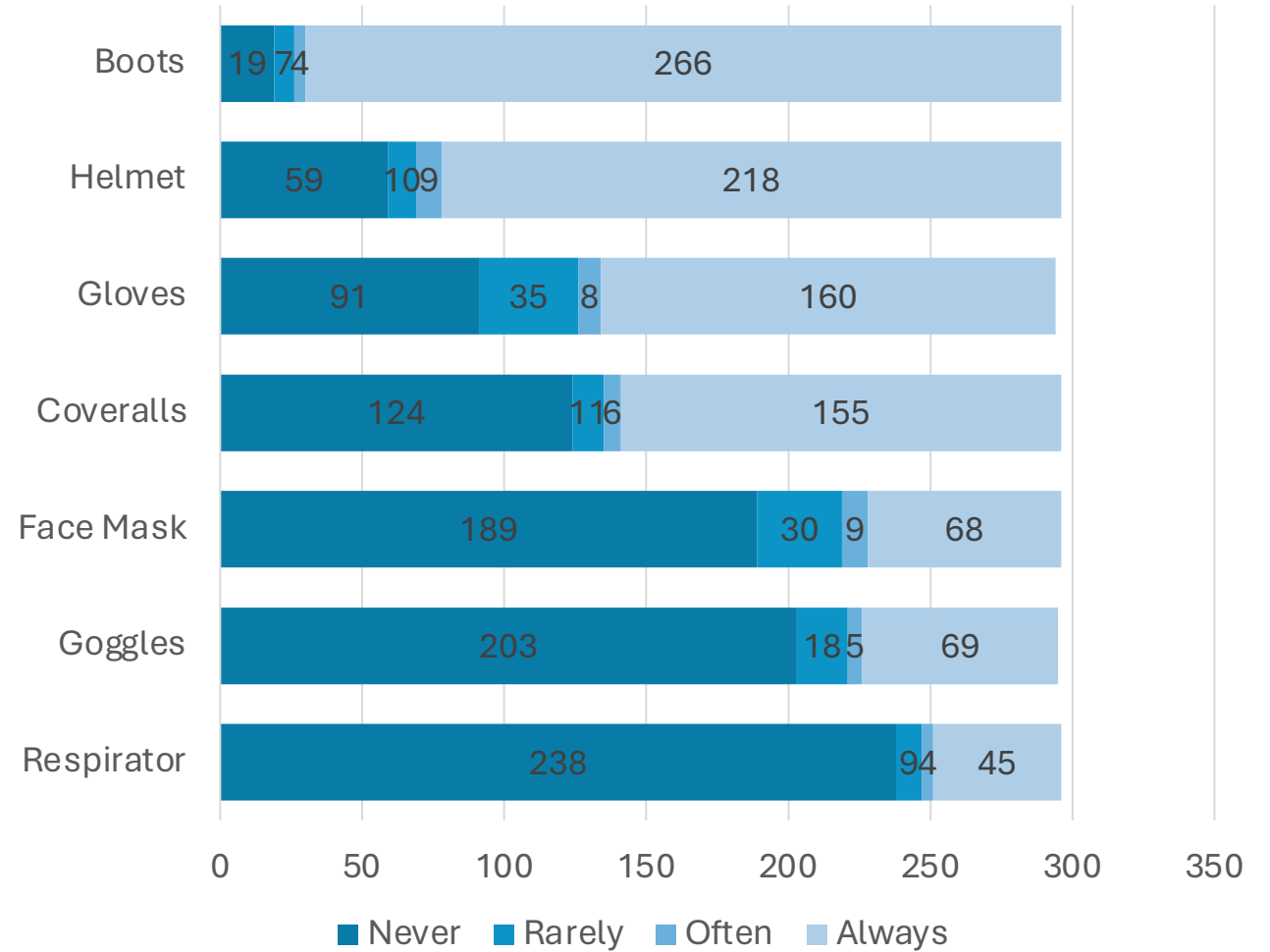
- The most common physical problems (that miners always experience) are **excessive sweating, vision problems, and polyuria.**
- On the other hand, the symptoms that miners experience **often** are **excessive sweating, fatigue, and bone/joint pain.**





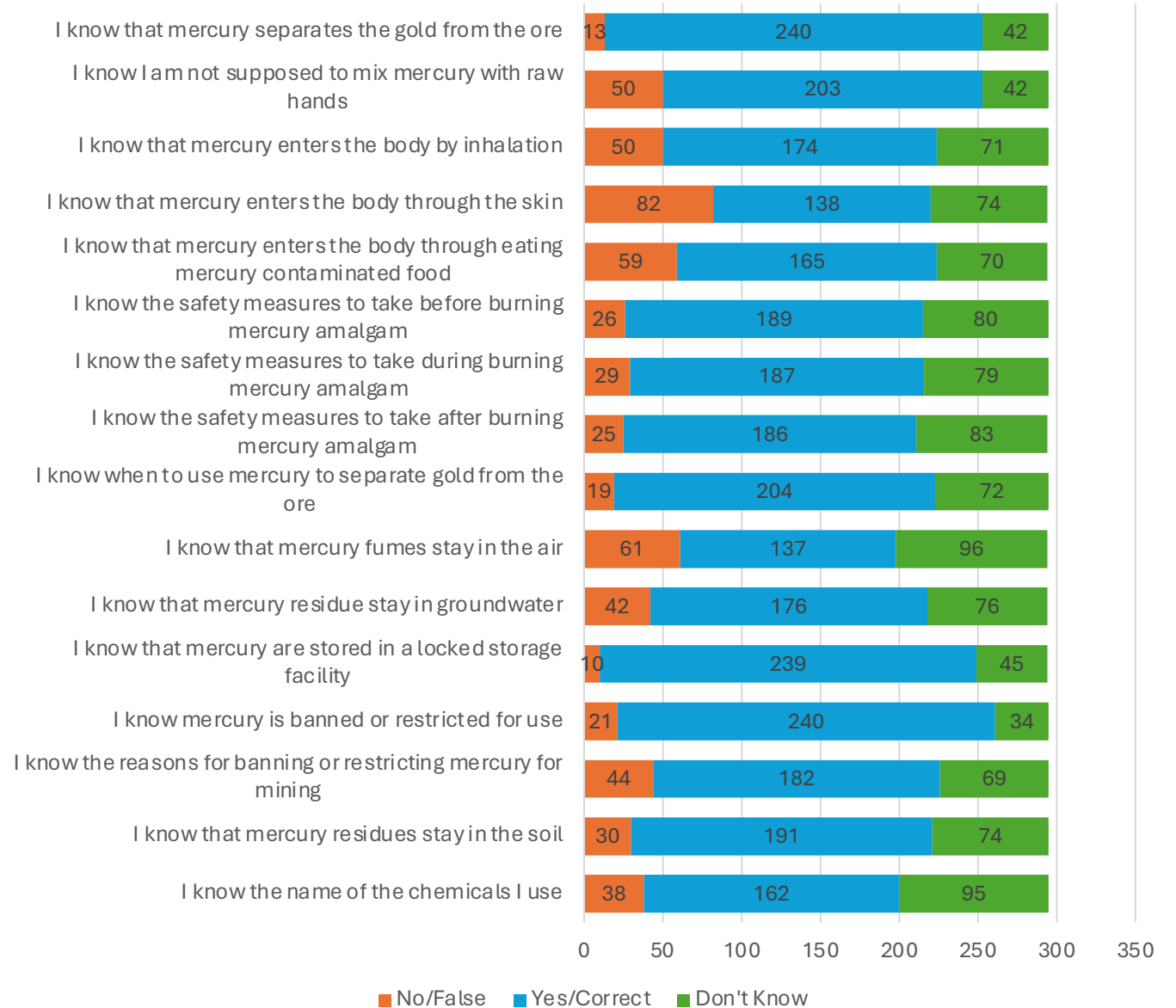
# Personal Protective Equipment Use

- Miners generally use boots, helmet, and gloves on a regular basis.
- On the other hand, only a small proportion of respondents feel the need to use coveralls, face mask, goggles, and respirator.



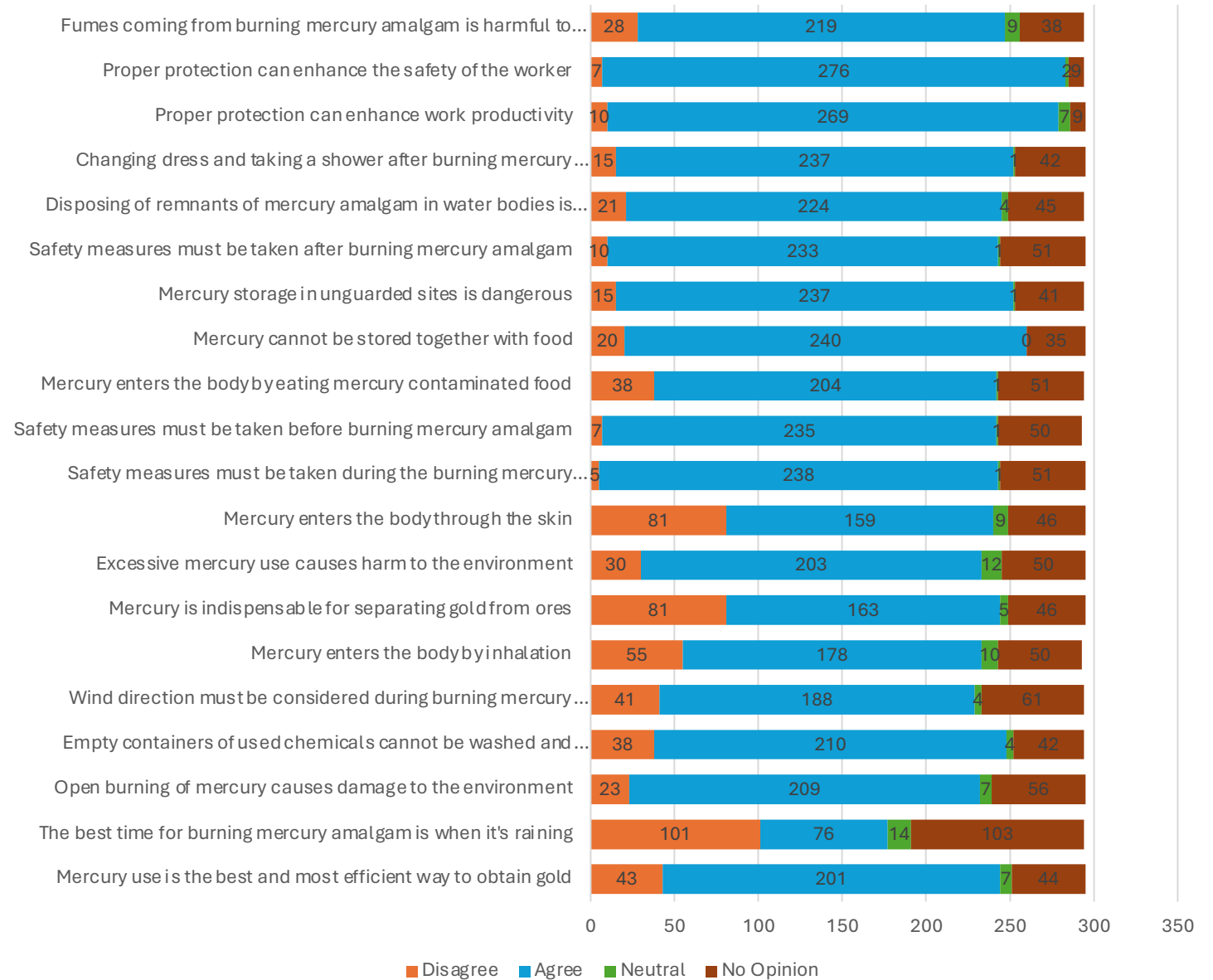
# Knowledge on Mining and Mercury

- 27.89% of the 295 miners do not know that mercury can enter the body through the skin
- 20.75% do not know that mercury fumes can remain in the air.
- 20.07% do not know that mercury enters the body thru eating mercury-contaminated food
- There are many questions where a significant portion of respondents answered with “I don’t know”
  - 32.2% of respondents do not know the name of the chemicals they use.
  - More than 25% of respondents do not know the safety measures to take before, during, and after using mercury.
  - More than 25% of respondents do not know the ways mercury can enter through the body.



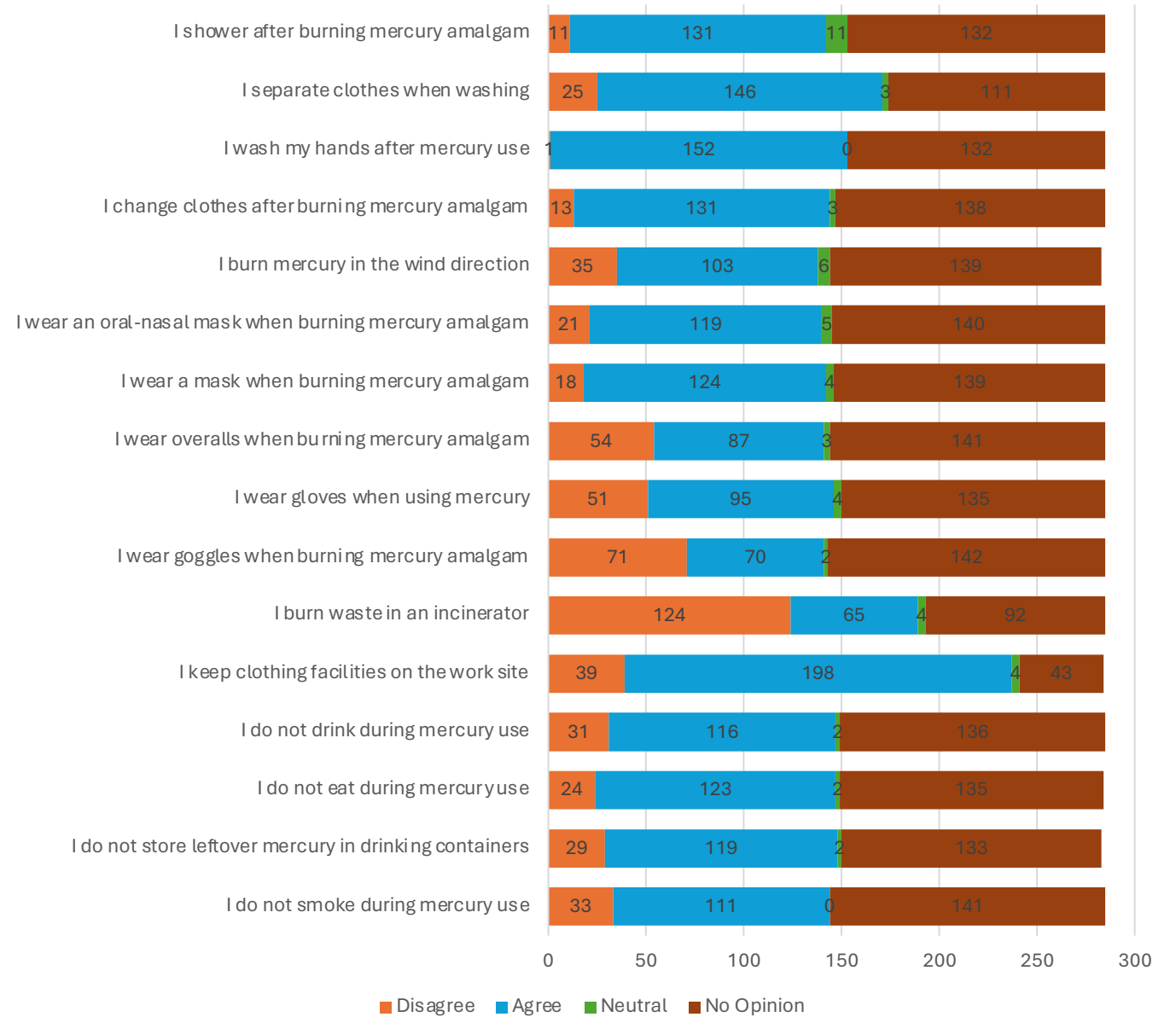
# Attitudes on Mining and Mercury

- 27.46% of the miners disagree that mercury enters the body through the skin
- 55.25% agree that mercury is indispensable for separating gold from ores
- 68.14% agree that using mercury is the best and most efficient way to obtain gold
- 12.93% disagree that mercury enters the body by eating mercury contaminated food
- 18.77% disagree that mercury enters the body through inhalation



# Practices on Mining and Mercury

- On most of the questions, almost half of the respondents have “No Opinion” regarding the practices
- 24.91% disagree on wearing goggles when burning mercury amalgam
- 18.95% disagree about wearing coveralls when burning mercury amalgam
- 17.89% disagree about wearing gloves when using mercury
- 10.25% disagree about storing leftover mercury in drinking containers



# Aspirations on Mining and Mercury

- 33.33% of the miners aspire to always have access to mercury
- 23.47% do not aspire to have access to other chemicals to extract gold
- 11.9% do not aspire to have access to a chemical storage facility

