# Mining Industry in Northern Mindanao: Its Environmental, Social and Health Impact Toward Responsible Mining

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## Abstract

*The study focused on analyzing the entire dynamics of small-scale mining in Northern Mindanao by looking at the impact of mining on the community in terms of environmental, socio-cultural, economics, production-market flow and health toward responsible mining. The survey was conducted through a survey and ocular visit in the mining sites namely: (1) Gango, Libona, Bukidnon, (2) Barangay Tumpagon and (3) Barangay Pigsag-an in Cagayan de Oro City, (4) Nangcaon, Opol, Misamis Oriental, and (5) Rogongon, Iligan City, and had a total of 1,405 respondents who were involved in mining and 60 key informants (barangay officials) who participated in the discussion during the FGD. Results of the survey indicated that mining is the main source of income among the respondents from the five mining areas. In a specific mining site of Gango, drift mining with tunneling system or underground mining is more appropriate and preferred to this kind of mining area. The other four mining sites engage in gold panning activities due to its location along the Iponan River. ANOVA results revealed that gold production differed significantly with respect to the mining sites. Regression analysis showed the method of mining is the most important predictor that contributed significantly to gold production with the highest gold value of 24 karats. In the aspect of health, most miners from the five selected areas are aware of the health risks and hazards associated with mining. Most of them have experienced fracture, exacerbate shoulders, and fatigue. Moreover, environmental impacts commonly mentioned by the respondents were landslide, flash floods, soil erosion, biodiversity loss, loss of organic fertility and soil-water contamination.*

***Keywords:*** small-scale mining, responsible mining, Northern Mindanao

## 1. Introduction

Mining and responsible mining initiatives/practices had been identified as very poor record in the Philippines in terms of scientific or empirical data support from scientists, researchers, investors and policy makers. Similarly, this limited scientific output may be attributed to multi-dimensional factors "in question" that mining operations may be totally suspended or stopped, that mining may be continued or sustained, that mining may be rationalized its policies locally and nationally; that mining should be ecologically sound and or balance the concerns of the environment and protection and economic gains. These propositions are hypothetical and require further studies.

Furthermore, mining has a large potential for economic growth and development. It is a global industry creating jobs and wealth for the country. Meanwhile, records showed that 35 million people are employed in mineral extraction across the globe, both in large-scale mines owned by international companies and small-scale/artisanal mining.

According to the recent study made by Israel (2011), the country stands to give more economic benefits from mining by focusing on value addition particularly in terms of downstream processing and manufacturing activities. However, the report also showed that the sector is faced with issues well beyond question of return on investment (ROI) (Angara, 2012). This issue may not be limited only on how much monetary gain can be made but further studies must be examined on the aspects of socio-economics, socio-cultural, socio-political and environmental impacts of mining in Mindanao.

Moreover, Mindanao in particular is known to have inexhaustible wealth of natural minerals. Unfortunately, harmful mining activities that employ crude practices will not only deplete the country's rich mineral resources, but this can diminish development prospects, (Angara, 2012). In Northern Mindanao, particularly Bukidnon, the Provincial Government has urged the group of small scale miners in Sitio Manlauyan, Barangay Gango, Libona to produce the requirements for the declaration of 58 hectares in the area as "Minahan ng Bayan", that would accommodate the mining operation from the created mining association, organization in Bukidnon. However, the status of their application has not been granted up to this time due to conflict in terms of land use, conflict between the intention and mining operations over the same piece of land.

In the light of these scenarios, these issues can be critically examined together with integrated impact of mining and how mining operations are affecting social factors (as economics, culture, health and policy concerns) and physical environment such as loss of biodiversity habitat, surface and ground water contamination, etc. Likewise, mining related activities can impact local communities both IP's and non-IPs through cultural adjustments due to the presence of various miners in the area.

It is in the context of this study to build on several efforts to identify environmentally and socially responsible mining practices initiated or undertaken by industries, NGO's, tribal communities, academic communities and the like. Along this thought, it is imperative to generate baseline information related to multi-faceted factors/variables in the four (4) areas of social aspects of mining including program intervention for responsible mining in Northern Mindanao.

More specifically, this study aims to: (1) assess and analyze the socio-economic situation and impacts of mining in terms of sources of income, number of years engaged in mining, methods of mining, and purification method; (2) determine the socio-cultural characteristics and impacts of mining in terms of ethnic origin, cultural belief system and many others; (3) determine the volume of production of mining per visit; (4) determine if there is a significant relationship between the volume of gold production and related predictors on the number of years in mining, methods used in mining, and belief in rituals; (5) assess the health hazards and impacts of mining; and (6) identify practices or initiatives of responsible mining among GOs, NGOs and LGUs.

## 2. Methodology

### *2.1 Research Site / Area of the Study*

The actual research site was the Iponan River interconnected watershed that encompasses the gold mining/panning sites in the upperstream areas of Gango, Libona in Bukidnon, Tumpagon and Pigsag-an in Cagayan de Oro City, Nangcaon, Opol Misamis Oriental and Rogongon, Iligan City.

*2.2 Sampling Plan*

A proportionate random sampling was done in the selection of the respondents, a total of 1405 respondents who were involved in mining was included in the study. Interview on policies related to mining was conducted to every mining site. Participants were the barangay officials in every mining sites as key informants. A total of 60 barangay officials participated in the discussion.

*2.3 Instrumentation and Method of Data Collection*

This study employed both primary and secondary data. The main instrument was an 8-page questionnaire which deals with the socio-economics, socio-cultural, production to market, health and safety standards, and environmental impact.

*2.4 Methods of Data Analysis*

The study used Descriptive and Inferential Statistics. Descriptive statistics was used to determine the socio-cultural, economic and health impacts. The test of significant differences of variables was appropriated for a certain inferences of results. Data processing involved three steps: coding, data entry and table generation. Data analysis was done through SPSS.

## 3. Results and Discussion

*3.1 Socio-economic Profile*

3.1.1 Sources of Income

Table 1 shows the main sources of income of the respondents on the five mining areas. It was observed that mining is the primary source of income among all areas. Tumpagon obtained the highest number of respondents (346) or 93.1% whose main source of income is mining and only two percent considered mining as their secondary source. This is followed by Gango, Bukidnon (93%). The data suggest that residents in the mining sites are actually involved in mining activities either as a main source or a secondary source of livelihood. About 10% of those whose main source of income is non-mining, had engaged to mining activities as their secondary source of income, while about 25% of the miners had engaged in non-mining activities

as their secondary source of income. Also, about 60% of the respondents relies solely on mining as their source of income. Secondary sources of income include farming, business like *sari-sari* store and construction laborers. Over-all, about 85% of the respondents had mining as their primary source of income and only 11% were engaged in non-mining activities. For those 156 who were engaged in non-mining activities as their primary source of income, 136 or 87% were engaged in mining as their secondary source of income. The data show that the residents in these areas depend more on mining as their source of livelihood.

Table 1. Sources of Income

| Income | Mining Sites' Population (N) | Mining | | Non Mining | | No Answer | |
|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % |
| Main Source (Mining) | | | | | | | |
| Gango | 400 | 372 | 93.0 | 13 | 3.2 | 15 | 3.8 |
| Tumpagon | 346 | 324 | 93.1 | 13 | 3.2 | 9 | 2.6 |
| Nangcaon | 295 | 228 | 77.3 | 56 | 19.0 | 11 | 3.7 |
| Pigsag-an | 195 | 167 | 85.6 | 21 | 10.8 | 7 | 3.6 |
| Rogongon | 169 | 104 | 61.5 | 53 | 31.4 | 12 | 7.1 |
| Total | 1405 | 1195 | 85.1 | 156 | 11.1 | 54 | 3.8 |
| Secondary Source (Farming, sari-sari store, etc.) | | | | | | | |
| Gango | 400 | 8 | 2.0 | 34 | 8.5 | 358 | 89.5 |
| Tumpagon | 346 | 7 | 2.0 | 67 | 19.4 | 272 | 78.6 |
| Nangcaon | 295 | 52 | 17.6 | 128 | 43.4 | 115 | 39.0 |
| Pigsag-an | 195 | 22 | 11.3 | 67 | 34.4 | 106 | 54.4 |
| Rogongon | 169 | 47 | 27.8 | 50 | 29.6 | 72 | 42.6 |
| Total | 1405 | 136 | 9.7 | 346 | 24.6 | 923 | 65.7 |

$\chi^2 = 232.355$* *$p < .05$ $df = 3$

These aforementioned data are supported with the statement of Rolfe (2007) on her study on "Social and Economic Impact of Mining", that a certain source of livelihood in the locality can boost economic and social growth in general, thus it has a greater impact to the community where the mining industry is locally situated. This finding on the main livelihood as miners gives general implication toward resource utilization like the presence of mineral ores in the locality which can serve as an opportunity for settlers as main source of income.

Application of $\chi^2$-test revealed significant differences on the sources of income by mining sites ($\chi^2$ = 232.355) at .05 level. This finding indicates that there is high association between the respondents' source of income as miners and the mining site. In essence, the said mining area is dominated with miners as their main source of income or livelihood. Similarly in this finding, John Roefi and Stewart Leckie (2007), supported this claim when they reported that utilization of resources in their locality can be a potential source of income.

Furthermore, brgy. Gango had the highest daily income average of PhP 500.00 among the respondents everytime they work. Among the five (5) mining sites, Gango also obtained the highest generated income from mining, since it is already an established-mining area and has even applied for the *Minahan ng Bayan* in the Bukidnon Provincial Government in 2011.

### 3.1.2 Respondents' Engaged in Mining and the Number of Years in the Mining Sector

Eighty-five percent of miners belongs to brgy. Rogongon, Iligan City, considering their large land area of 285.034 square kilometers (28,503.4 ha.) and population of more than 7,000. Although Pigsag-an has the least percentage (63%) of miners compared to the other mining areas, nonetheless, more than half of their population are involved in mining activities. With regards to the number of years' experience in mining, Pigsag-an is considered the highest (median = 19 years), since most of the respondents are natives in the area and have been mining for a long time. This is similarly with Tumpagon and Nangcaon (14-19 years engage in mining), due to the fact that the mining areas are basically adjacent to one another. Gango on the other hand has the least average number of years primarily because there are more migrants in the area. These migrants moved or traversed from one mining site to the other or vice versa in order to participate in the mining activities.

Generally, this finding implies that the larger the number of the mining areas, the higher the opportunity of the local residents/settlers to mine. Further, there can be a possibility for migrant miners to traverse the mining sites of Tumpagon, Nangcaon, Pigsag-an, Rogongon and vice versa, since these areas are geographically bordering the provinces of Misamis Oriental and Lanao del Norte.

### 3.1.3 Methods of Mining Used by Miners

The methods of mining depend greatly on the geographic characteristics of the location. As presented in Table 2, out of the five mining areas, Gango, Libona is the only area that practices tunneling since the mining sites are not near river system and their topography ranges from flat to very steep hills. While brgys. Nangcaon, Pigsag-an, Tumpagon, and Rogongon are into gold panning, because these areas can be found along the river.

Furthermore, the methods of gold mining for small-scale mining industries in Northern Mindanao have been identified as a major problem on the aspects of environmental pollution and degradation. Generally, gold panning as commonly used by the local residents and seasoned gold miners is usually a manual technique of separating gold from other materials. These ground materials, being left over in the river system, continue to contaminate the Iponan River ecosystem with high loads of sediments and continue to increase suspended deposition that could bring about river bed shallowing and scouring. With those aforementioned methods of mining, siltation also poses danger to fish and other aquatic life as silts which also clog gills, lessen sunlight penetration affecting photosynthesis and lower water temperature and decreasing water habitat productivity.

Table 2. Methods of Mining

| Methods | Frequency | Percent |
|---|---|---|
| Gango (N = 400) | | |
| Tunneling | 394 | 98.50 |
| Panning / Gold Washing | 3 | 0.75 |
| Other Mining Sites (N = 1005) | | |
| Panning | 978 | 97.31 |
| Flushing / sluicing | 23 | 2.29 |
| Panning and flushing | 18 | 1.79 |
| Tunneling | 3 | 0.30 |

Moreover, majority of the respondents practice indigenous ways in their purification method, specifically in Gango where about 57% of the miners observed the use of leaves *(tuog)*, soap, water and vinegar. Their application for the *Minahan ng Bayan* is one of the factors why indigenous practices are widely-practiced. Moreover, the use of mercury in any mining activities is strongly prohibited, yet there is still a mere portion of the population using

mercury. For the other mining sites, the use of water to remove other impurities is a common method as well as *bilingan* or panning because it would serve as a strainer.

### *3.2 Socio-cultural Profile*

#### 3.2.1 Performance of Rituals during Mining

Table 3 shows the ritual practices of the respondents with regards to mining activities in their respective areas. Only 15.87% of the respondents perform rituals before engaging in any mining activities and their usual practices include the offering of slaughtered animals, prayers and food offering. Tradition and their culture are the main factors as to why most respondents believe in performing rituals, contrary to those who do not believe in rituals where they answer that hard work is more important than any rituals of good luck.

Table 3. Performance of Rituals

| Indicators N=1405 | Frequency | Percent |
|---|---|---|
| Performing Rituals | 223 | 15.87 |
| Kind of Rituals | | |
| Food offering | 34 | 2.4 |
| Prayers | 44 | 3.1 |
| Offering of slaughtered animals | 132 | 9.4 |
| Believe in Rituals | 320 | 22.8 |
| Reasons | | |
| If YES, why? | | |
| For luck | 61 | 4.3 |
| Gift/payment for the earth elementals | 21 | 1.5 |
| More blessings | 2 | 0.1 |
| Thanksgiving | 4 | 0.3 |
| To keep the workers from harm | 22 | 1.6 |
| Tradition | 103 | 7.3 |
| If NO, why? | | |
| Against the teachings of the church | 33 | 2.3 |
| Rituals are not effective | 24 | 1.7 |
| Hard work | 63 | 4.5 |
| Does not believe | 19 | 1.4 |

$\chi^2 = 81.572^*$ $df = 3$ $^*p < .05$

Generally, these aforementioned statements are supported by Castro (2006) that IP's had evolved worship rituals and traditional knowledge in any field of endeavor. These rituals are accompanied with belief and knowledge system and transmitted to some members or local indigenous communities. Practicing rituals before mining when grouped by mining sites showed significant differences at .05 level.

### 3.2.2 Presence of Mining Groups and their Operation to IPs and Non-IP Territories/Amenities

Table 4 shows the effects or impact of mining in the selected communities. It indicates that almost all respondents have not experienced displacement. For those who were displaced, majority of them left the area because they were arrested and their mining equipment and tools were confiscated. Some of them also needed to leave because there were warnings and orders to stop any mining activities. Other reasons of displacement included the critical status of the area, lacking of approved documents resulting to the illegality of mining activities, and because they don't own the land. Out of all the five selected mining areas, Nangcaon and Rogongon have processed their Certificate of Ancestral Domain Title (CADT) application; specifically, Nangcaon is in its final process while Rogongon is in its 3rd reading. Tumpagon and Pigsag-an mining areas were awarded contracts for the Community-Based Forest Management (CBFM) which is renewable for 25 years. There is an ongoing dispute regarding the land ownership in Gango's location of the *Minahan ng Bayan*, that's why their application for CADT is deferred.

Table 4. Presence of Mining Firms and their Operation to IPs and Non-IP Territories/Amenities

| Indicators | N=1405 | Frequency | Percent |
|---|---|---|---|
| Experience displacement | | | |
| Yes | | 34 | 2.4 |
| No | | 1369 | 97.4 |
| Mining activity brought changes | | | |
| Yes | | 455 | 32.4 |
| No | | 950 | 67.6 |
| In favor of mining activities within locality | | | |
| Yes | | 1224 | 87.1 |
| No | | 180 | 12.8 |
| $\chi^2 = 517.699$* | $df = 3$ | *$p < .05$ | |

As to the changes in their way of life brought by mining activity, more than half of the respondents, with 67.6%, believed that mining hasn't brought any changes in their lives. They reasoned that the money they get from mining is still not enough to meet their daily needs because they have small yields and thus low income. Others implied that they have too many dependents with so many expenses. However, Barangay Gango has a more positive assessment on mining activities since 399 of respondents (n=400) answered that mining has improved their lives. Some indicators of these changes included (1) the ownership of a house/car; (2) children going to school; (3) enough money to satisfy their daily needs; (4) ownership of a small business; and (5) spare money to be sent to families in the provinces.

Even though more than half of the respondents said that mining hasn't changed their lives, majority of them are in favor of mining in their locality. 87.1% of them would want mining activities to go on in their community since it is their main source of income and can help support their families. Moreover, several respondents who are also engaged in farming said the income they get from mining is a big help to them while they are waiting for farm harvests. These differences of opinion differed significantly at .05 level ($\chi^2 = 517.699$, $df = 3$).

### *3.3 Production – Market Distribution*

#### 3.3.1 Gold Yield of Mining per Visit

Table 5 indicates that Gango mining sites have more yield compared to the other sites with an average of 2.694 g per visit. Gango miners can go as much as 200 g. Furthermore, it has the highest maximum and minimum yield of all five mining sites. Gango has a more established mining system, the money they get from it doesn't necessarily come from gold yield, rather, they get it through paid labor as *abantero* or *atrasero.* This is different from the other four mining areas where the miners get to keep and sell their own yield. This is followed by Tumpagon which has an average yield of .209 g. Notably, almost all respondents from this area consider mining as their main source of income, almost all members of the family including children took the free gold mining along the upper source of Iponan River where the common method of mining is panning and free gold is made available all the time.

Table 5. Gold Yield in Grams By Mining Sites Per Visit

| Mining Sites | N | Mean | Standard Deviation | Minimum Yield | Maximum Yield |
|---|---|---|---|---|---|
| Gango | 337 | 2.694 | 13.27 | $2 \times 10^{-4}$ | 200.0 |
| Pigsag-an | 181 | 0.017 | 0.74 | .003 | 1.0 |
| Nangcaon | 240 | 0.032 | 0.27 | .001 | 4.0 |
| Rogongon | 116 | 0.166 | 0.55 | $3 \times 10^{-4}$ | 5.0 |
| Tumpagon | 319 | 0.204 | 1.64 | .001 | 20.0 |
| $F = 8.015$* | | $df = 4$ | | *$p < .05$ | |

One-way Analysis of Variance ($F = 8.015$, $df = 4$) reveal that the gold yield/production differed significantly with respect to the mining sites at .05 level of significance.

### 3.3.2 Methods of Marketing Gold

Table 6 shows that majority of the respondents sell their yield to a middle man or a local buyer and only 13% are into the direct selling of their gold. Furthermore, cash is the most common term of payment and only very few of the respondents sell it through credit or payment for debt. This indicates that the respondents have sufficient income to not resorting to debt.

Table 6. Methods of Marketing Gold

| Methods | Frequency | Percent |
|---|---|---|
| Presence of middle man (local buyer) | 1313 | 93.5 |
| Direct selling | 183 | 13.0 |
| Black market | 1 | 0.1 |

The presence of middlemen or local buyers who willingly offered credit to the miners in times of dire need and necessity to feed their family compromise assurance of payment every time the miners get gold from mining. Hence, the preference of miners for the marketing of available free gold are the middlemen or local buyers. It was found out that there are no direct buyers of gold which give a better price advantageous to the miners.

### 3.3.3 Problems Encountered in Gold Mining Production, Marketing and Financing

Figure 1 presents the categorized problems encountered in gold mining in terms of production level, marketing and financing aspects. Findings reveal that the common problems in mining is the low production where 68% of the respondents affirmed as their main problem in gold mining. This is due to the unavailability of tools and equipment specific to Gango mining sites, where there are also specific tools and materials that the local residents/miners cannot afford to purchase. Furthermore, Gango miners traditionally practiced tunneling which requires investment of capital to be able to equip themselves in structuring or re-structuring the tunnels underground. Hence, there is a relationship of the production level and financing aspects and the slow return of investment due to marketing problem. The common problem in marketing is the low pricing of due to the presence of middlemen as buyers of gold.

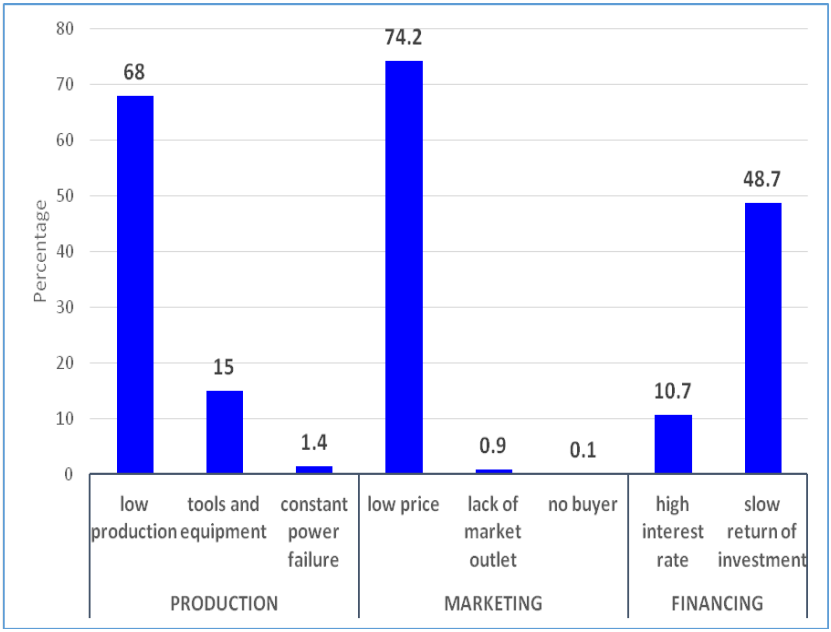


Figure 1. Problems Encountered in Gold Mining Production, Marketing and Financing

For small-scale mining specifically Tumpagon and the like, where there is an absence of regulations and appropriate policies, several problems arise most specifically in the production, marketing and financing of gold. The most common problems that miners experienced in these areas are the low production and low price of gold and as a result, there is a slow return of their investment. Low production of gold can be attributed to the current scenario of the mining areas where there are more miners now than in the previous years, specially on the arrival of numerous migrants. Because of this, competition among miners on the production of gold becomes tighter. The low pricing of gold is another problem that miners face. According to the respondents, there are buyers or middlemen who refuse to buy gold if the yield is only below five grams. Arguably, when the miners sell their yield to end-users, such as pawnshops and jewelry stores, they will be given a much higher price for the gold.

### 3.3.4 Mining Taxes and Other Tax Related Issues

As shown in Table 7, 19.75% of Gango's respondents pay taxes with an average of 5% tax rate. There is a big difference on the payment of taxes between Gango and the other mining sites where only 0.8% or almost 1% of the population of the four mining sites pays taxes.

Table 7. Taxes and Other Tax Related Issues

| Indicators | Frequency | Percent |
|---|---|---|
| Payment of Taxes | | |
| Gango | 79 | 19.75 |
| Other Mining Sites | 8 | 0.80 |
| Tax Rate (Gango) | | |
| 5% | 4 | 0.40 |
| Where to Pay | | |
| Gango | | |
| Municipality of Libona | 34 | 8.5 |
| Other Mining Site | | |
| City Hall | 2 | 0.20 |

In Gango, tunnel owners, bullmill owners, gold buyers, jewelers and gold processing owners are required to pay taxes per year. Their taxes, with a tax rate of 5%, are usually paid in the Municipality of Libona. Tax from mining

as well as the nonpayment of tax from other small-scale mining areas is one of the many factors why the mining's contribution to the Gross Domestic Product is merely one percent (Asia News Monitor, 2014).

There is a pronounced difference between Gango and the other mining sites when it comes to income sufficiency: as such, 74.5% of Gango's population has sufficient income while only a total of 16.2% from the other mining sites has sufficient income. Those who have sufficient income reasoned out that their earnings can still be budgeted, enough to buy food, pay debts, and meet other necessities. Income sufficiency in Gango is usually related to the continuous work provided by the tunnel owners.

### 3.3.5 Gold Production

#### 3.3.5.1 Regression Analysis Output Between Gold Production and Related Predictors (Number of years in Mining and the Method Used in Mining)

Results of the regression analysis presented in Table 8 reveal that two out of six predictors contributed significantly to the gold production of the miners. The most important predictor is the method used in mining. This indicates that the miners who used tunneling as their method of mining yielded more gold than those who practiced gold panning. Obviously, large scale mining yielded more gold than the small-scale mining. The regression coefficient of .030 with regards to the number of years engaged in mining suggests that those who are more experienced yield more gold than those who are new in the said venture.

Table 8. Regression Analysis Output Between Gold Production and Related Predictors

| Predictors | Regression Coefficient | Standard Error | Standardized Coefficients | *t* | *p*-value |
|---|---|---|---|---|---|
| Mining sites | -.157 | .290 | -.029 | -.543 | .588 |
| Source of income | .014 | .443 | .001 | .031 | .975 |
| Status of employment | -.209 | .387 | -.021 | -.540 | .589 |
| No. of years engaged in mining | .030 | .015 | .076 | 2.077* | .038 |
| Frequency of mining | -.044 | .180 | -.010 | -.244 | .808 |
| Method used | -1.803 | .544 | -.171 | -3.313* | .001 |
| Constant | 4.035 | .883 | | 4.570 | <.0005 |

$F = 5.008$* $R^2 = .037$ *$p<.05$

To determine the magnitude of influence of the significant predictors for gold yield, the F-value yielded 5.008 which is significant at $\alpha$.05. This means that taken jointly the six predictors, formed a very significant set of predictors for gold production. Moreover, 3.7% ($R^2$=.037) of the variance in the observed responses is explained by the joint effects of the six predictors considered with most of the variance explained by the two significant predictors.

3.3.5.2 Regression Analysis Output Between GoldProduction and Related Predictors (EthnicOrigin, Rituals and Belief)

Results from the regression analysis identified ethnic origin as best single predictor for gold production. The computed regression coefficient of 1.091 shows that non-Higaonon tribes which consist of Cebuano, Visaya and others have more gold production than the Higaonon tribes. Practicing rituals and the belief of practicing rituals did not contribute effectively to the increase of production.

Table 9. Regression Analysis Output Between Gold Production and Some Related Predictors (Ethnice, Practice of Rituals and Belief)

| Predictors | Regression Coefficient | Standard Error | Standardized Coefficients | *t* | *p*-value |
|---|---|---|---|---|---|
| Ethnic Origin | 1.091 | .338 | .095 | 3.227* | .001 |
| Practice rituals | -.527 | .919 | -.027 | -.573 | .567 |
| Belief of rituals | .503 | .833 | .028 | .604 | .546 |
| Constant | -.643 | .729 | | -.882 | .378 |
| *F* = 3.565* | | *R* = .009 | *$p$<.05 | | |

*3.4 Safety Related Standards for Goldmining and Health Impacts*

3.4.1 Training/ Workshop/ Information Provided for Safety Mining

As shown in Figure 2, majority of the respondents in the five selected barangays answered that they were not given training/workshop nor an information provided on safety mining. Noticeably in Barangay Gango, 34.3% were aware regarding safety measures on mining and other related information. Since Gango is currently applying for a *Minahan ng Bayan*, miners needed to be knowledgeable on this extraction activity. Pigsag-an and

Rogongon have a close to no respondents who are informed and educated concerning mining activities.

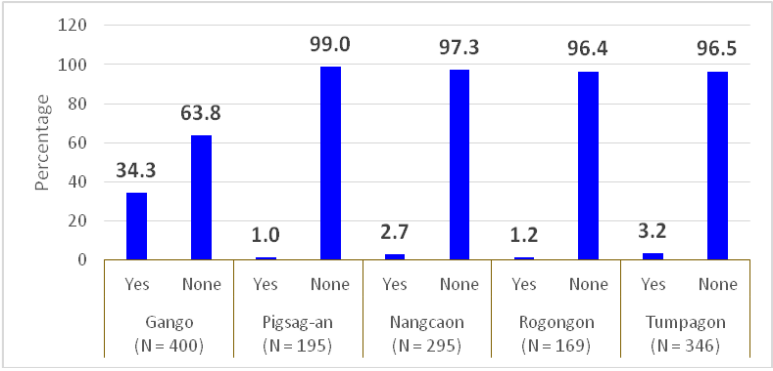


Figure 2. Training/ Workshop/ Information Provided for Safety Mining to the Respondents

Similarly, the traditional practice in artisanal or small-scale mining in the mining areas of Tumpagon, Pigsag-an and many others, usually the local residents went to the mining area to secure free gold to be sold to assure themselves of food daily. Generally, this implies that there are no regulatory control or ordinances and safety standards for mining activities in the mining areas of Cagayan de Oro, Misamis Oriental and Iligan City. This gold panning or locally known as *biling-biling*, which is practiced daily by local residents contributes to the load of sediments along Iponan River.

The most common trainings conducted in Gango mining site were safety mining, rescue, first aid and sanitation. The same information were learned by a few miners in Tumpagon mining area. Generally, trainings for safety mining are well-established in Gango mining sites as they employ tunnel method in mining.

### 3.4.2 Hazards of Mining Activities

Figure 3 illustrates the awareness level of respondents on the different hazards of mining. Most respondents are acquainted with and have even experienced ergonomic hazards (91.7%) such as fracture, exacerbate shoulders and fatigue, and only 17% of them have experienced accidents or any other physical hazards in the mining area. Over all, majority of the

respondents (88.4%) are aware of the health risks and hazards that are associated with mining.

In terms of the common hazards that the respondents were exposed, most respondents went through ergonomic hazards which shows that 80.5% have exacerbate shoulder fatigue (*pamaul/pangalay sa abaga*). Other hazards experienced are (1) injury caused by rock/fall/fire/explosion (physical hazards); (2) skin disease/allergy (chemical hazards); (3) dengue (biological hazard); and (4) post-traumatic stress disorder (psychological hazard).

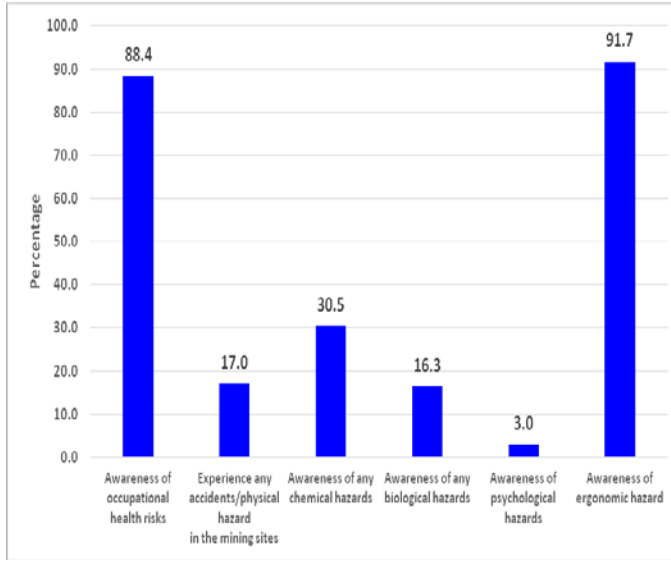


Figure 3. Hazards of Mining Activities Encountered by Respondents.

### *3.5 Environmental Impact*

#### 3.5.1 Negative Impact on Environment brought by Mining Activities

Table 10 displays the views of the respondents on the negative impact of mining in their area. Environmental impact commonly mentioned were landslides, flash floods, soil erosion, biodiversity loss, loss of organic fertility and soil contamination. The least mentioned impact is the improper disposal of waste/mine tailing which was only mentioned by 6.9% of the respondents.

Seventy percent of the respondents from all the five mining sites believed that mining, despite the positive effects it brought in their lives, can still lead to adverse consequences especially in the environment. Moreover, there is a noticeable difference between Gango and the other mining sites regarding these consequences. Only 36% of Gango's population (n=400) admitted of these negative impact compared to the 83% from the population of the other mining sites.

Table 10. Negative Impacts on Environment brought about by Mining Activities

| Environmental Problems | Frequency | Percent |
|---|---|---|
| Landslide | 805 | 57.3 |
| Flashflood | 778 | 55.4 |
| Soil Erosion | 532 | 37.9 |
| Soil Degradation | 524 | 37.3 |
| Acidification (N=524) | 23 | (4.4) |
| Loss of Organic Fertility (N=524) | 155 | (29.6) |
| Soil Contamination (N=524) | 173 | (33.0) |
| Biodiversity Loss | 370 | 26.3 |
| Decrease of Aquatic species (N=370) | 237 | (64.1) |
| Decrease of terrestrial floral species (N=370) | 202 | (54.6) |
| Decrease of faunal species and microorganism (N=370) | 80 | (21.6) |
| Extinction of different valuable species (N=370) | 66 | (17.8) |
| Deforestation | 294 | 20.9 |
| Improper disposal of waste/mine tailing | 97 | 6.9 |

Figure 4 shows the views of respondents on whether or not mining has an effect to the community's agriculture and water resources. Only very few from Gango's population believed that mining has an effect in those particular resources. Ninety percent (90%) of the respondents from the other mining sites believed that water resources were the most affected by mining activities.

Mining has affected the agriculture of the five selected mining areas. Gango has been affected simply because residents did not have time to farm since

mining is their main source of income. For the other mining sites, the common causes of agricultural degradation are the mining activities that take place in the river and soil erosion due to flashflood and landslides.

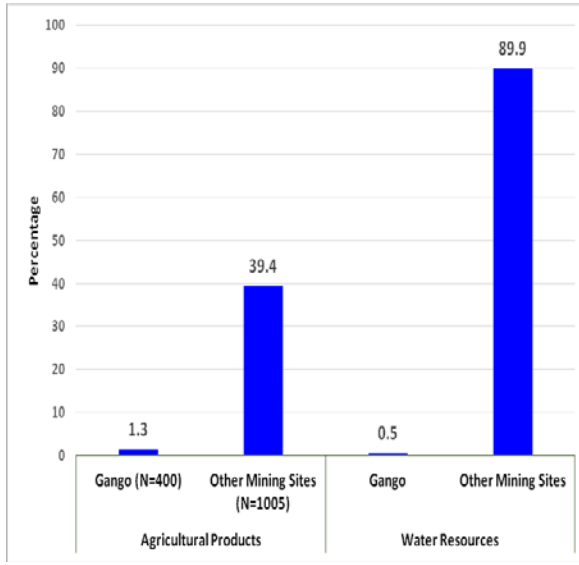


Figure 4. The effects of mining activities to the agricultural products and water resources.

The other mining sites, with the exception of Gango, has a few water resources that are affected by mining such as rivers and streams. Mining has an effect in the turbidity and contamination of water as evidenced by the discoloration of water and absence of living organisms and other aquatic weeds.

The respondents also differed significantly on the responses as to the effect of mining to agricultural products ($\chi^2$ = 222.284*, *df* = 3, *$p$<.05) and to water resources ($\chi^2$ = 1037, 944*, *df* = 3, *$p$<.05) when grouped by mining sites. Although these findings are based from the survey of the respondents technical gaps on the ground level can be a possible source of intervention toward this end.

### 3.5.2 Agencies/Institutions Promoting Responsible Mining

Table 11 shows the involvement/presence of several agencies in promoting responsible mining. From the five mining sites, 70.4% of the respondents stated that there are agencies and other institutions who visited their area in order to advocate and train the miners on responsible mining practices. The Department of Environment and Natural Resources (including Mines and Geosciences Bureau) and Local Government Units are the common agencies which provide trainings and information dissemination in the mining areas.

Table 11. Agencies / Institutions Taking Necessary Actions to Promote Responsible Mining

| Indicator | N = 1405 | Frequency | Percent |
|---|---|---|---|
| **Presence of agencies / institutions** | | | |
| Yes | | 989 | 70.4 |
| No | | 416 | 29.6 |
| **Agencies / Institutions** | | | |
| DENR | | 737 | 52.5 |
| LGU | | 307 | 21.9 |
| NGO | | 13 | 0.9 |
| MGB | | 52 | 3.7 |
| Academic Organizations | | 5 | 0.4 |
| PNP | | 5 | 0.4 |
| Bureau of Mines | | 2 | 0.1 |
| PENRO | | 1 | 0.1 |
| Religious Organization | | 1 | 0.1 |

So far, DENR is so vigilant in monitoring the mining areas specifically on the use of inappropriate methods of gold extraction. Generally, promoting responsible mining in the areas are still debatable and conflict issues still exist at the ground level, specifically in the mining areas of Cagayan de Oro, Opol, Misamis Oriental and Rogongon, Iligan City and Lanao del Norte.

## 3. Conclusion and Recommendations

*4.1 Conclusions*

On the foregoing general findings, the following conclusions are drawn:

The Mining Industry in Northern Mindanao is generally characterized as "Small-Scale Gold Mining or Artisanal Mining" where the majority of the practices used by miners were *gold panning* along the river beds and or the entire river system in the form of nuggets or "free gold" that are readily available all the time. The other specific mining site practiced *drift mining* or the use of tunnel and ball mills in the processing of gold ores with a tailing pond. Similarly, the method of gold panning in relation to the *Environmental Impact* of mining had the greatest environmental damage to Iponan River System and revealed as very high concentration of total suspended solids and sediment load deposition. The other major impact specifically in drift mining using tunnel is the cyanide contamination of the Bigaan River and the formation of sinkholes from sub-surface excavation which could suddenly and dangerously collapsed.

Along with the social factors affecting mining, the source of livelihood in the locality can boost economic and social growth in general and it has a great impact to the community where the mining industry is locally situated.

In the case of safety-related standards for mining, generally, there was no information provided for safety mining of the miners-respondents in so far as four (4) mining areas adopted the gold panning or locally known as "biling-biling". Similarly the safety related standards and training are very established in Gango, Bukidnon mining sites in consonant with the application requirement as "Minahan ng Bayan".

On health-related impact of mining activities, most respondents experienced ergonomic hazards which are cumulative trauma disorders caused by manual handling. Examples of which are exacerbate shoulder (*pamaul*) and fatigue. Other hazards mentioned were chemical and psychological hazards.

Along the negative effects of mining activities to the environment, most of the respondents mentioned landslides, flash flood, soil erosion, biodiversity loss, loss of organic fertility and soil contamination. In addition, their water resources and agricultural production are affected as well.

On the side of responsible mining initiatives, there were government line agencies (GOs and NGOs) who took the necessary action to promote responsible mining. DENR played a crucial role in the mining sites regarding the inappropriate methods of gold mining.

*4.2 Recommendations*

On the basis of findings and analysis, the following recommendations are provided, to wit;

The small-scale mining sites in Northern Mindanao particularly along the watershed areas in Iponan River and Bigaan River may be recommended for rehabiltation to be able to restore some ecological damage of the watershed areas. LGU's/DILG should take action and include this rehabilitation efforts in the Comprehensive Land Use Program (CLUP) in their respective units.

With the main source of livelihood which is mining, it is recommended that the alternative source of livelihood may be operationalized or mobilized by the local residents to minimize mining activities/operations in the area. Thus, minimizing environmental damage. LGU's should consider the balance equation of Economy versus Natural or Mineral Resource Utilization.

It is recommended that Socio-cultural Identity of Higaonon and other IP communities within the mining sites should be preserved and be respected of their own belief system. In this sense, IPRA law may be fully exercised specifically in relation to ancestral territories.

The illegal mining which is rampant to the mining areas of Northern Mindanao has no proper documentation of the volume of gold production from previous years to present. Hence, records on tax revenues of mining is not consistent and GNP cannot be accounted nor appreciated. In this sense, local barangay officials should establish proper documentation with accurate data on tax revenues of mining computed in monthly and annual basis.

There is a need to have a strong advocacy to the local residents and miners in relation to the negative impacts or effects of the environment brought about by mining activities. LGU's should take the lead in the advocacy.

It is recommended that Gango, Libona Bukidnon mining sites should be granted with official declaration permit as "Minahan ng Bayan". This area

has well established standards for mining or safety-related guidelines, policies and training in the area. As such, programs and projects for responsible mining are visible in the area.

Appropriate ecological solutions specifically the political and social parameters should also be provided such that the involvement of the various local government units, non-government agencies, and indigenous peoples are required to achieve a holistic solutions to the various issues and problems related to mining. Participatory approaches in the search of solutions to social and environmental issues and co-existence with IP's and miners should be required.

Formulation of associations among small-scale miners should be strongly required to enable member groups to monitor their works on the proper way of mining and mineral processing so as not to create more devastating impact or effect on the environment.

There should be the introduction and adoption of green technology within the perspective of bioremediation specifically phytoremediation technology. This technology uses the capabilities of plants to absorb metals into its parts and its tissues thus the concept that plants can clean-up metal contaminated areas can be learned by the miners and community folks.

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