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Investigation of safety conditions in small scale mining industries in the Philippines

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ABSTRACT

This study looked into occupational and environmental health and safety conditions in small scale mining in the Philippines. Survey questionnaires were given to 124 respondents, and 15 were key interviewees on mining hazards and safety compliance. A workplace inspection was done to assess the working conditions, work hazards, environmental waste management, and work practices of the miners. 49% reported being sick in the last 12 months because of work exposure. The workplace inspection of the underground tunnels and pits was not complaint to the standard requirements for mining safety. The study suggests that there is a need for an environmental agenda which addresses both the technical and social issues of mining in the area.

KEYWORDS

Small scale mining;
Environmental hazards;
Occupational safety and health;
Mercury, cyanide monitoring.

INTRODUCTION

Mining remains an important industrial sector in many parts of the world and although substantial progress has been made in the control of occupational health hazards, there remains room for further risk reduction[4]. One of the important industries in the Philippines is the mining sector, which contributes not just to the national economy but also to the regional income.

Benguet is one of the provinces in the Philippines where the industry of mining is widely practiced and accepted by the local population. However, health and safety factors are compromised. Small-scale and large-scale mining operations in Asia have often been characterized by poor environmental management and are frequently depicted as environmentally harmful[7]. Also, small-scale mining are known to lack capital that may lead to substandard working conditions[2]. Hatheway in 2007 said that the principles of maximum extraction are consistent with minimally acceptable factors of safety for the workers[7].

This research study aimed to determine occupational and environmental health and safety conditions small scale mining in a mining community in the largest gold producing area in the Philippines. The result of this investigation could be an essential tool for the establishment of an integrated program on awareness of the environmental hazards associ-

ated with mining for the safety and health of mine workers and the community.

MATERIALS AND METHODS

This was a cross sectional study of a mining community in Benguet, where mining activities are one of the major economic revenues. Questionnaires were also given to the community residents in the mining area. Data gathered included personal information, health history, work practice and conditions, environmental hazards in mining industry assessment that included factors considered harmful to the environment, and possible beneficial and harmful effects of mining on the environmental. Considering the sample size required for. 05 of sampling error, and 95% reliability of obtaining the sample size, the sample size is 124 for the two communities. Key interviews were done with 15 respondents on their perception of mining, as well as some issues and problems related to mining.

A workplace inspection was also done to assess the working conditions, work hazards, environmental waste management, and work practices of the miners. Data were analysed using SPSS program. Descriptive and inferential statistics were used. An informed consent was given to the respondents. This study was given ethics clearance by the Research Ethics Board of the University of the Philippines Manila.

RESULTS

Exposure Data

Interviews were also conducted among community residents in the mining area. There was a total of 124 respondents. 78.2 % were females and 21.8% were males. Majority were married (99, 79.8%), had high school educational level (59, 47.6%), worked also as agricultural workers (64, 51.6%) and with monthly income of less than 5,000 pesos (84, 67.7%). 36.3% said that they lived in their present address for more than 30 years.

Mining is an economic activity in the province of Benguet. Also, nearly 1/4 of the respondents (16.9%) reported that the mines were situated within 1000 to 3000 meters from their houses with a mean distance of 5214.35 meters (SD $\pm$ 7011.94). The mines were proximal mostly to rivers or lakes (28.2%), agricultural farms (8.1%) and houses (4.8%).

Gold was the most common mineral ore being extracted from the mines at 75.5% followed by copper (19.4%). Miners have been working in mines for an average of 16 years (SD $\pm$ 9.86). The miners were mostly working for 5-8 hours per day with a mean of 2.09 hours (SD$\pm$ 0.75). The most commonly used chemicals in mining were mercury (80%) and cyanide (40%).

10.5% of the miners habitually ate while in mining areas. For the use of personal protective equipments, only 13.7% reported use of PPEs. Further analysis on use of PPEs showed that although miners used PPEs, when itemized, majority of them were not using adequate protective equipments. 12.1% of them had never used coveralls, apron (10.5%), face shields (9.7%) and gauntlet gloves (9.7%). Only boots were consistently used by the miners (11.3%). See TABLE 1.

TABLE 1 : Frequency and Percentage Distribution of PPE use of Miners (N=124)

PPEs	*Never*	
	Freq	*%*
Coveralls	15	12.1
Eye Goggles	10	8.1
Face Shield	12	9.7
Respirator/Gas Mask	9	7.3
Apron	13	10.5
Gaunlet gloves	12	9.7
Boots	1	0.8

TABLE 2 : Assessment of exposure to occupational hazards

Hazards	*Frequency*	*Percentage*
Dust	86	69.4
Air Pollution	78	62.9
Poor Environmental Sanitation	41	33.1
Exposure to chemicals used in mining	38	30.6
Too much heat	36	29.0
Waste Products from Mines	20	16.1
Too much Noise	19	15.3

TABLE 3 : Frequency and percentage distribution of negative outcomes of mining

Hazards	*Frequency*	*Percentage*
Pollution (air, water, noise)	35	28.2
Erosion	28	22.6
Destruction of nearby farms, forestry and mountains	25	20.2
Dust	10	8.1
Health problems to men	4	3.2

TABLE 2 shows the presence of exposure to occupational hazards. More than half stated that they perceived to be exposed to dust (69.2%) and air pollution (62.9%), while still considerable percentages complained of exposure to poor environmental sanitation (33.1%), chemicals used in mining (30.6%) and too much heat (29.0%). However, 16.1% reported exposure to waste products arising from mines. Other occupational hazards mentioned included soil erosion and water pollution.

72.6% perceived that mining industries had adverse effect on environment such as pollution, erosion and environmental destruction (TABLE 3).

It was noted that mining affects various human activities. More than half of the respondents said that mining affected livelihood (83.1%), financial condition of the family (71.8%), farming and plantation, rivers and lake fisheries (both with 62.1%), employment of women and children (56.5%), and social condition of the community (49.2). See TABLE 4.

Workplace Inspection of the underground tunnels and pits

The workplace inspection of the underground tunnels and pits showed safety infarctions such as unsteady trenches, insufficient slopes to the trenches, possibility of collapse of trenches, and also the risk of subsidence TABLE 5.

DISCUSSION

Cyanide levels detected in the environment are usually residues from improper storage, handling and disposal of wastes in metal and organic chemicals industries. This was seen in this study where small scale miners disposed their wastewater contaminated with cyanide or mercury into the ground or a body of water. In this study, cyanide and mercury were used to extract gold from the rock materials.

The concentration of cyanide in rural areas, according to Leduc et al is dependent on the watershed size and seasonal runoff. Cyanide vaporizes readily and does not remain for a long time in the soil or water[6].

On the other hand, mercury has three primary categories of compounds namely- elemental mercury, inorganic mercury compounds (including mercurous chloride, mercuric chloride, mercuric acetate, and mercuric sulfide) and organic mercury compounds[6]. Over the years, mercurial contamination to water systems had been widely documented. Most incidents identified organomercury compounds (fungicides) as the primary culprit. In one study, mercury contamination led to several deaths of aquatic and biotic organisms[13].

Studies have shown environmental problems

TABLE 4 : Frequency and percentage distribution of effects of mining to various human activities

Social Activities	*Frequency*	*Percentage*
Livelihood	103	83.1
Financial Condition of the family	89	71.8
Farming and plantations	77	62.1
River or Lake Fisheries	77	62.1
Employment Opportunities for Women and Children	70	56.5
Social Condition of the Community	61	49.2

such as health degradation, air, water and noise pollution, declining in agricultural production, deforestation, displacement and other socio-economic impacts as results of exploitation of mineral through surface and underground mining[11]. Younger in 2004 explained that since the start of industrial-scale mining, substantial environmental impacts have been recorded as arising from both the mined voids and from the wastes left behind at the surface, resulting to five major impacts- air pollution, fire hazards, ground deformation, water pollution, and water resource depletion[1]. Among all environmental hazards in this study, air pollution was most significant[14].

Among the hazards identified by respondents in this study were air pollution, dust, mine waste, noise and the like. The same hazards were identified by Donoghue in 2004 stipulating the various physical, chemical, biological, ergonomic and psychosocial occupational health hazards of mining and associated metallurgical processes[4]. Working conditions in underground mining are also documented to be hazardous. Mustafa, et.al., in 2008 underscored these health risk factors such as physical workload, noise, vibration, radiation, heat humid environments, and dust exposure from the dispersed air through rock breakage, rock loading, and circulation of air, among others.

Tailings disposal and reclamation following mine closure are the most frequent examples of environmental concerns[2]. These waste materials are generated during mining, and since these are not useful to the mines workers, they are inappropriately disposed into the environment[3]. Mine waste was cited as a major environmental hazard by the respondents in this study. It was also one of the major problems seen in the workplace inspection of small scale miners where wastes were thrown into bodies of water or on ground.

The exposure to dust in not uncommon in both underground and surface mining. The study in stone crushing plants in Iran showed that workers were exposed to respirable silica dust above threshold limit value (Onder, et. al, 2008). Dust levels in underground coal mining was found to be high in production areas, and was suggested to be associated with pulmonary diseases [1]. The adverse effect of exposure to dust was also documented by Neghabi, et.al., in 2009 where they showed the association between raw materials used in ceramic production may be due to silica content in ceramic production with respiratory symptoms, radiographic abnormalities, and functional difficulties[9]. This exposure to dust in mining was also documented in Turkey where production areas with higher dust concentration levels were associated with the most number of workers diagnosed with coal workers' pneumoconiosis[10].

There can also be the simultaneous exposure to various hazards such as mine chemicals and pesticides. Miners are farmers, or farmers are also small scale miners. There is an interlocking connection between the mining and agricultural sectors because of the seasonality of both occupations or activities. The same was documented in Sierra Leon, Nicaragua[8].

Minerals can become a contested commodity. In sub-Saharan Africa, The artisanal and small-scale mining (ASM) sectors were usually associated with conflict minerals, fatal diseases, smuggling, criminal activity and civil war. The sector is burdened and plagued with issues of child labour, gender inequality, the spread of HIV/AIDS, environmental devastation, poor health and safety, migrant workers, lack of capital and fair markets, and conflict with the private large-scale mining sector. The pa-

TABLE 5 : Results of the workplace inspection of the underground tunnels and pits in regard standards

Results of the Workplace Inspection	Standards for Underground Trenches and Pits
The trenches for underground mining built for mining are not systematic and pose a treat.	When trenches are not built properly, collapse of trenches may happen and affect both the worker or the community at large.
The ground where trenches are built is now unsteady because of many years of underground mining.	Subsidence of the ground may happen and a community may be buried when there is soil erosion or heavy rains.
There is no firm wall inside for trenches.	The ground is not always stable, and may cave in.
Woods are used instead of steel or harder materials for reinforcement.	What looks like firm, stiff clay dries out and cracks when exposed to air or will soften and slip after rain.
	A cubic metre of earth weighs more than 1 tonne.
Workers stay very long time inside trenches.	Trenching is done in small scale mining. Trenches are not permanent, and can be used only for minutes or hours as they will eventually collapse. It is just a matter time when the trench will collapse. So workers should not agree to go inside trenches for too long.
Slopes to the trenches are not sufficient for safety.	Sloping such as a series of steps can be to the soil to provide stability to the trench. Even the slightest slope is reported beneficial.
Workers go inside trenches without any personal protective equipment or safety equipments.	Shields/ trench boxes should also be given to workers so that they protected when trenches collapse. Shields are generally made of steel or aluminum. The size is around 1 m to 3 m high and 2 to 7 m long
The walls of the trenches have minimum shores.	Shoring can also be done by putting some kind of support to the walls of the trench, with braces in between.
Workers go inside the trenches alone.	Workers should never work alone or remain alone in a pit or trench, even for a short period of time, as these excavations collapse easily and may bury themselves
The pits and trenches are not constructed according to the 45 degree angulation.	Pits and trenches should be constructed to meet safety guidelines with support systems or the sides cut back to 45 degrees to deter collapse.

per of D'Souza in 2005 discussed the complex of drivers, challenges, constraints and issues that characterize the sector and considers the potential solutions through sustainable livelihoods in the sector and overall poverty alleviation, institutional capacity, governance, assistance schemes, legislation, miners' organizations, gender mainstreaming, child labour, health and safety, environmental protection, mineral trading and marketing, adding value, finance and environmental protection[5]. Along with this, Quiroga in 2002 has shown in a case study that small scale miners are impoverished, and therefore outlines strategies on how to move forward towards social equity vis-à-vis foreign investors, among others[12].

CONCLUSION

The study showed that mining industry is indeed widely recognized in Benguet as part of the residents' livelihood. Mining, without sustainable management and proper waste control could lead to various environmental hazards creating negative impacts on environment and the community residents' health. Consequently, future investigations are needed to fully understand the effects of these hazards to local population over and above those mentioned in this study. It is recommended that intensive programs be formulated on awareness of community dwellers on the environmental hazards associated with small scale mining.

There is also a need for a mining and the environmental agenda which should address both the technical and social issues of mining. In this framework, sustainable development is sought such as improved metal recovery and less metal being present in waste material, planning for mine closure, public perception and community issues, environmental sustainability, and environmental integrity.

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