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What does the community know? Assessing the mining-related knowledge in the Newmont Ghana gold limited enclave

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Abstract
In the era of precarious environmental and health impacts associated with mining activities, there is a dire need for full community understanding and appreciation of the impacts of mining activities. However, little is known empirically on community's knowledge with respect to environmental and health effects of mining in Ghana especially NGGL enclaves. The objective of the study was to examine community's knowledge on the environmental and health implications of mining. A cross-sectional survey involving simple random and purposive sampled participants (N = 120) was conducted. The main data collection instruments were questionnaires and in-depth interviews. Data were analyzed with a Pearson's Chi-square from the PASW for Windows application (V. 17.0). The study found that respondents have better knowledge on both the environmental and health effects of mining. However, non-parametric chi-square test showed no statistically significant relationship between knowledge on environmental and health effects of mining as regards place of residence. This adds to the scanty but growing documented literature on community knowledge on mining impacts. Based on the findings, it is recommended that NGGL follows environmental guidelines as stipulated in their sustainability report.

Keywords: Mining; Knowledge; Health; environment; Ghana,

INTRODUCTION

Mining development, mine operation, decommissioning and land rehabilitation are the various phases of mining activities (Donoghue, 2004). The products of mining activities such as mineral, metals, rocks in a form of sand, gravel and building stones from the surface of the earth are used by man to satisfy his needs. The benefits accrued from mining activities differ from nation to nation partly or wholly due to diverse resource endowment and the state of development (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, 2010).

Africa is famous for its mineral resource endowment. For instance, its portion of the world total mineral reserve base can be categorized as follows: cobalt and platinum (75%), diamond (50%), gold (30%), bauxite (26%), copper (14%), uranium (12%) and manganese (7%) (Maponga, 1999 cited in Akabzaa et al, 2007). Mineral exports contribute between 25% and 95% of annual export earnings of 13 African countries: Botswana, Ghana, Guinea, Liberia, Senegal, Mauritania, Namibia, Niger, Central African Republic, Sierra Leone, Zaire, Zambia and Zimbabwe (Campbell, 2001).

West Africa has played a beneficial role in mining for many centuries with activities dating back to the beginning of the fifth century (Ofosu-Mensah, 2011). Gold has still remained by far the most important commercial mineral in the mining environment contributing to employment generation, foreign exchange earnings and government revenue through various taxes and royalties (Akabzaa et al., 2007). The second and the ninth producer of gold in sub-Saharan Africa and the world respectively is Ghana (Aryee, 2012).

To date, mining offers employment to a substantial number of people. Globally, it is estimated that close to one per cent or 30,000,000 population of the energetic labour force are employed by mining activities (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, 2010). The mining sector accounted for 38.3% of Ghana's total corporate tax earnings, 27.6% of government revenue and 6% Gross Domestic Product (GDP) in 2011 (Aryee, 2012). The mining sector offers employment opportunity to 28,000 people in the large scale mining industry whilst over 1,000,000 people are engaged in the small scale mining, diamond, sand winning and quarry industry. In 2011, Ghana provided 3.6 million ounces of gold resulting in export revenue of over US$ 5 billion and the total Direct Investment (DI) into the minerals and mining sector from 1983 to 2011 amounted to US$ 11.5 billion (Aryee, 2012).

Nevertheless, legal and policy frames planned to regulate the activities of small scale mining are weak in carrying out in many countries (Suleman and Agyemang, 2015). Ackley (2008) expounds that there is an absence of legal policies that govern the environmental performance of mining activities in third world countries. Consequently, environmental and health implications are abound. Opoku-Ware (2010) argues that the ramification of mining activities on the environment mostly includes land degradation and environmental pollution. Soil erosion occurs in mining communities which, therefore, reduces the ability and potency of the land to support agricultural production (Akabzaa and Darimani, 2001).

Studies amply show that chemicals such as mercury and cyanide used by mining companies tend to pollute water bodies such as rivers and streams (Phiri, 2011; Budds and Hinojosa, 2012; Yeboah, 2011; Adjei, 2007) and this reduces the quality and quantity of the water resources (Budds and Hinojosa, 2012). This can have negative implication on the environment particularly water resources, air and land which further deteriorate the health of people after consuming this polluted water (Adjei, 2007). Furthermore, Ocansey (2013) explicitly indicates that the pollution of water bodies is also attributed to numerous kinds of metals generated from mining sites which further sink and get into contact with underground water.

Air and noise pollution are common phenomena in mining communities. The major causes of air pollution according to Yeboah (2011) are emission of dust, carbon, sulphur and arsenic induced by mining companies. In Tarkwa, Akabzaa and Darimani (2001) note that blasting and heavy machines trigger noise pollution in mining communities. Blasting is also noted to be the main contributing factor in the development of cracks in buildings *(ibid*). The challenges imposed as a result of blasting of mineral bearing rocks are noise and vibrations (Yeboah, 2011). Donoghue (2004) conceptualises that noise induced hearing problems are as a result of six variables. These include blasting, cutting,

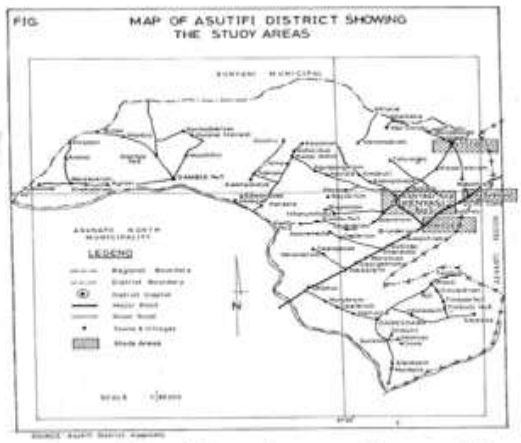
handling of materials, crushing, conveying and processing *(ibid).*

Ackley (2008) suggests that the understanding and appreciation of diverse impacts of mining activities is remarkable. In the opinion of Opoku-Ware (2010), knowledge and awareness of a problem constitute an important step in solving the problem as it helps to adopt coping strategies to deal with the problem. Boulander and Gorman (2004) indicate that people in mining communities do not have knowledge on the challenges that mining poses to their health until people in their community are afflicted with diseases or start showing symptoms of infections. Across the western part of US, a number of communities are being affected by mining activities yet few people have appreciable knowledge on the level of destruction (Boulander and Gorman, 2004). Yeboah (2011) establishes that people's understanding of the health effects of mining positively correlates with education.

Having adequate knowledge on the environmental and health ramifications of mining is essential. This is because it has the potency to inform people on how to adopt effective measures to cope with it since mining implications have come to stay with man. Although, an aspect of Boulander and Gorman's (2004) work touches on the issues of community awareness in relation to mining activities, findings may not be applicable in Ghana especially in the Newmont Ghana Gold Limited (NGGL) enclaves, due to contradictory issues such as different socio-cultural background. Yet, in the NGGL enclaves there is paucity of empirical studies on community knowledge with regard to environmental and health effects of mining. Therefore, this study seeks to fill this gap by examining community knowledge on the implications of mining activities with special reference to environment, health and coping strategies.

Figure 1:

Figure 2:



Source: Mapping Unit, Department of Geography and Rural Development, Kwame Nkrumah University of Science and Technology, Kumasi, 2014

METHODS

Overview of Asutifi District

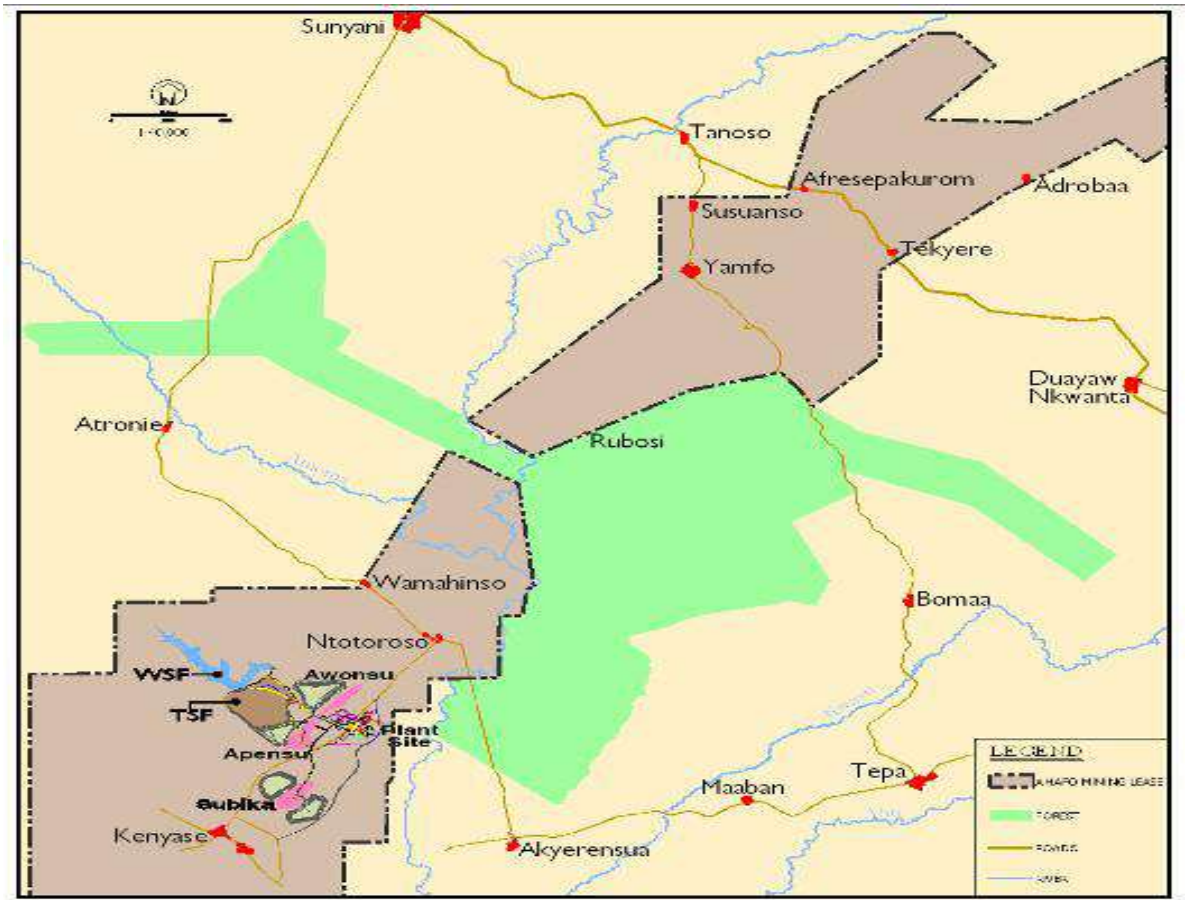
Asutifi District is located between latitudes 6°40' and 7°15' North and Longitudes 2°15' and 2°45' West. It shares boundaries with Sunyani District in the North, Tano South District to the North East, Dormaa District to North West, Asunafo North and South Districts in the South West and Ahafo Ano South and North Districts (Ashanti Region) in the South East. Asutifi District has a total land surface area of 1500 sq.km. The predominant occupation in Asutifi District is subsistence agriculture. Agriculture employs 66.7 per cent of the economically active labour force. The

population of the Asutifi district was 108,682 in 2009. The rapid increase of mining activities in the district has led to the influx of migrants and the demand for mining related services (Asutifi District Assembly, 2010). Due to the mining activities, the mining communities have experienced a growth in business activities in mining related industries (Asutifi District Assembly Composite Budget, 2012).

Profile of Newmont Ghana Gold Limited (NGGL)

NGGL was founded in 1921 and publicly traded on the New York Stock Exchange since 1925. Newmont is one of the world's largest gold mining companies. In 2012, Newmont sold 5.0 million equity ounces of gold, while employing a global work force of approximately 16,600 employees. In addition, approximately 22,000 people were working as contractors as of 2012. The 100- per cent- owned Ahafo operation is located in the Brong Ahafo Region of Ghana, approximately 290 kilometres (180 miles) North West of Accra. Newmont operates four open pits at Ahafo with reserves contained in 11 pits. Commercial production in the fourth pit, Amo, began in October 2010 (Newmont Sustainability Report, 2012). The process plant consists of a conventional mill and carbon-in-leach circuit. Ahafo produced 561,000 ounces of gold in 2012. Also, Newmont has 11.6 million ounces of gold reserves as of December 31, 2012 (Newmont Sustainability Report, 2012).

Figure 3: Ahafo Mines, showing North and South Area.



Source: Newmont Ghana RAP, 2009 cited in Asante- Manteaw, 2011

Setting, Research Design and Variables

In January 2014, a field survey was conducted in Asutifi District in the Brong Ahafo Region of Ghana. The area is well noted for various forms of mining activities and thus provides a suitable ground for the study. This research used a cross-sectional survey with a combined approach exhibiting both qualitative and quantitative. The type of the research instruments used made it flexible to work with this research design. This is because the use of both questionnaires and in-depth interview guides provided avenue to include both closed and open ended questions in the data collection instruments. The respondents' sex, age, religious affiliation, income, employment, years of stay in the community, marital status and ethnicity constituted the independent variables. Dependent variable was knowledge of mining activities. The measurements of the variables were based on the responses of the study participants. These were further coded and operationalized so that accuracy could be ensured. Information on the implication and type of mining activities were collected from NGGL officials, workers of the health centres and Asutifi District Assembly officials.

Sampling and Study Participants

Residents in the study areas who were at the age of 18 and above preceding the study were recruited to constitute the study participants. This strategy was adopted because the researchers were sure and confident that a person who has attained above 18 years would be able to show adequate knowledge on the implication of

mining activities in the area. The sampling techniques were simple random sampling and purposive sampling techniques. The simple random sampling was used to select 120 study participants from households in the study communities. A blind folded person was selected randomly to select the study participants. Additional room was created so that in situation where a selected respondent refused to take part in the study, another respondent was chosen by repeating the whole process. Also, the purposive sampling was used to recruit the study settlements (Acherensua, Kenyasi, Ntotroso and Hwidiem). Moreover, the purposive sampling technique was used to select 3 officials (one each from Newmont Ghana Gold Limited, the health centres and the Asutifi District Assembly) for the study.

Research instrument and Data Collection Procedure

In order to establish relationship between the field data and what has already been documented as far as community knowledge on the environmental and health implications of mining are concerned, primary data and secondary information were used. The secondary information was obtained from journals, and other related works relevant to this study. A preliminary study was conducted to help test the validity and reliability of research instruments. This helped to make necessary changes. Primary data were collected through formal face-to-face interviewer-administered questionnaires in order to aid in obtaining first-hand information and individual knowledge on the implication of mining activities in the study communities. This was done so as to increase response rate and full completion of the questionnaire items. Research assistants were recruited and trained to help in the data collection processes. Also, in-depth interview guides were developed and used to collect data from the officials of Newmont Ghana Gold Limited, Asutifi District Assembly and workers of health centres within the localities. This made it possible to compare the views of the residents to that of the officials of the institutions. The standpoints of the interviewees were recorded digitally to aid full records of the discussion.

Ethical Consideration

Ethical consideration is very important in every research. As a result, various ethical issues were considered before the field survey began. The leaders in the communities and the study participants were briefed as regards the purpose of the study and were assured of strict confidentiality of the data they provided.

Data Analysis

After the data collection, the researchers performed a formal validation checks before quantitative data were entered into electronic database and analyzed statistically through the Predictive Analytics Software (PASW) for Window application programme (Version17.0). Descriptive statistics were conducted to describe the study sample. Non-parametric Chi-square test was performed to measure differences and dependencies in the study variables. The qualitative data were analysed by editing some of the concerns of the study participants and presenting through direct quotation techniques.

RESULTS

Characteristics of the study participants

The study indicated that most (51.7%) of the respondents were males. Also, most (47.6%) of the respondents fell within the age cohort of 18-29 years. This shows that most of the respondents were youthful in nature considering their ages. Most (30.8%) of them, worked as (Masons, carpenters, cooks and drivers) with basic education status

(33.6%). Majority of the respondents were Akan (69.2%), professed Christian beliefs (79%), with monthly income (<GH¢100) and married (49.2%). Most of the respondents have lived in the community for more than 10 years (59%). A bivariate analysis was conducted to compare various sample characteristics of respondents with gender. We found a statistically relationship between males and females with regard to educational status (χ^2 [3, N = 116] = 11.171, p< 0.05) and kind of occupation study participants engaged in (χ^2 [4, N = 120] = 11.711, p< 0.05). See Table 1 below.

Table 1: Background characteristics by sex of study participants

		Sex						
Variable	Category	Male		Female		Total		*p*-value
		N	(%)	n	(%)	N	(%)	
Residence	Kenyasi	14	(22.6)	16	(27.6)	30	(25.0)	0.070
	Acherensua	21	(33.9)	9	(15.5)	30	(25.0)	
	Ntotrosu	16	(25.8)	14	(24.1)	30	(25.0)	
	Hwidiem	11	(17.7)	19	(32.8)	30	(25.0)	
	Total	62	(100.0)	58	(100.0)	120	(100.0)	
Age	18-29yrs	35	(56.5)	21	(36.2)	56	(46.7)	0.100
	30-39yrs	11	(17.7)	16	(27.6)	27	(22.5)	
	40-49yrs	8	(12.9)	11	(19.0)	19	(15.8)	
	50-59yrs	7	(11.3)	5	(8.6)	12	(10.0)	
	Above 60yrs	1	(1.6)	5	(8.6)	6	(5.0)	
	Total	62	(100.0)	58	(100.0)	120	(100.0)	
Occupation	Farming	15	(24.2)	18	(31.0)	33	(27.5)	0.020
	Trading	7	(11.3)	19	(32.8)	26	(21.7)	
	Teaching	11	(17.7)	5	(8.6)	16	(13.3)	
	Mining	5	(8.1)	3	(5.2)	8	(6.7)	
	Other specify	24	(38.7)	13	(22.4)	37	(30.8)	
	Total	62	(100.0)	58	(100.0)	120	(100.0)	
Highest level of education	Basic	13	(21.0)	26	(48.1)	39	(33.6)	0.011
	Secondary	17	(27.4)	14	(25.9)	31	(26.7)	
	Tertiary	18	(29.0)	8	(14.8)	26	(22.4)	
	None	14	(22.6)	6	(11.1)	20	(17.2)	
	Total	62	(100.0)	54	(100.0)	116	(100.0)	
Ethnicity	Akan	43	(69.4)	40	(69.0)	83	(69.2)	0.065
	Ewe	6	(9.7)	7	(12.1)	13	(10.8)	
	Ga	0	(.0)	5	(8.6)	5	(4.2)	
	Ga-Adamgbe	3	(4.8)	3	(5.2)	6	(5.0)	
	Other	10	(16.1)	3	(5.2)	13	(10.8)	
	Total	62	(100.0)	58	(100.0)	120	(100.0)	
Religion	Christianity	51	(82.3)	43	(75.4)	94	(79.0)	0.195
	Islam	8	(12.9)	8	(14.0)	16	(13.4)	

	Traditional	1	(1.6)	6	(10.5)	7	(5.9)	
	Other	2	(3.2)	0	(.0)	1	(1.6)	
	Total	62	(100.0)	57	(100.0)	119	(100.0)	
	> GH ¢100	28	(46.7)	26	(45.6)	54	(46.2)	0.269
Income	GH¢100-400	20	(33.3)	24	(42.1)	44	(37.6)	
	GH¢401-1000	6	(10.0)	6	(10.5)	12	(10.3)	
	Above GH¢1000	6	(10.0)	1	(1.8)	7	(6.0)	
	Total	60	(100.0)	57	(100.0)	117	(100.0)	
	Married	25	(40.3)	34	(58.6)	59	(49.2)	0.062
Marital status	Not married	27	(43.5)	14	(24.1)	41	(34.2)	
	Divorced	2	(3.2)	5	(8.6)	7	(5.8)	
	Other	8	(12.9)	5	(8.6)	13	(10.8)	
	Total	62	(100.0)	58	(100.0)	120	(100.0)	
	>2years	9	(14.8)	8	(14.3)	17	(14.5)	0.354
For how long have you lived in this community?	2-4years	6	(9.8)	7	(12.5)	13	(11.1)	
	5-7years	6	(9.8)	12	(21.4)	18	(15.4)	
	Above 7 years	40	(65.5)	29	(51.8)	69	(59)	
	Total	61	(100.0)	56	(100.0)	117	(100.0)	

Knowledge on the Method of Mining Activities

The study obtained information on the knowledge of people on mining activities in the study communities. The study revealed that majority (83.3%) of the respondents had adequate knowledge on the operation of mining activities in the study communities. In Kenyasi community, approximately 90% of the respondents had adequate knowledge on the operation of mining activities in the Newmont enclave. Similar cases occurred in Ntotroso where slightly above 93.3% reported to have adequate knowledge on the operation of the mining activities in the study areas. Comparatively, the knowledge level of the operation of mining activities in Acherensua (70%) and Hwidiem (80%) were high but they were below the recorded rate in Kenyasi and Ntotroso. Regardless of these variations, our study found no statistically significant differences between knowledge on mining activities as regards place of residence (χ^2 [3, N = 120] = 7.200, p > 0.05). See Table 2 below.

Table 2: Community knowledge on environmental and health effects of mining							
		Place of Residence					
		Kenyasi	Acherensu	Ntotroso	Hwidiem	Total	*p*-

				a								value
Variable	Category	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	
Do you have any idea about mining activities in this community?	Yes	27	90)	21	(70)	28	(93.3)	24	80)	100	(83.3)	0.066
	No	3	(10)	9	(30)	2	(6.7)	6	(20)	20	(16.7)	
If yes, what method of extraction is/are used by the company	Surface mining	12	(44.4)	11	(55)	17	(60.7)	12	(50)	52	(52.5)	0.404
	Underground mining	15	55.6)	9	(45)	9	(39.3)	10	(41.7)	43	(43.4)	
	Dredging	0	(.0)	0	(.0)	2	(2.0)	2	(8.3)	4	(4.0)	
Do you think the methods of operation have some effects on the environment	Yes	25	(83.3)	24	(80)	25	(83.3)	26	(86.7)	100	(83.3)	0.923
	No	5	(16.7)	6	20)	5	(16.7)	4	(13.3)	20	(16.7)	
If yes, what are some of the effects	Land degradation	7	(28)	10	(41.7)	8	(32)	10	(38.5)	35	(35.0)	0.527
	Water pollution	15	(60)	9	(37.5)	14	(56)	11	(42.3)	49	(49.0)	
	Air pollution	1	(4)	5	(20.8)	2	(8)	3	(11.5)	11	(11.0)	
	Noise pollution	2	(8)	0	(.0)	1	(4)	2	(7.7)	5	(5.0)	
What cause land degradation in this community	Use of heavy machines	21	(84)	11	(45.8)	9	(36)	14	(53.8)	55	(55.0)	0.020
	Used of chemicals	4	(16)	7	(29.2)	7	(28)	3	(11.5)	21	(21.0)	
	Blasting of rocks	0	(.0)	2	(8.3)	6	(24)	4	(15.4)	12	(12.0)	
	Soil erosion	0	(.0)	4	(16.7)	3	(12)	5	(19.2)	12	(12.0)	
What cause water pollution in this community	use of heavy machines	0	(.0)	5	(20.8)	0	(.0)	3	(11.5)	8	(8.0)	0.068
	use of chemicals	20	(80)	14	(58.3)	17	(68)	15	(57.7)	66	(66.0)	

	blasting of rocks	5	(20)	5	(20.8)	8	(32)	8	(30.8)	26	(26.0)	
What cause air pollution in this community	Use of heavy machines	0	(.0)	5	(20.8)	3	(12)	1	(3.85)	9	(9.0)	0.098
	use of chemicals	10	(40)	8	(33.3)	7	(28)	14	(53.85	39	(39.0)	
	Blasting	15	(60)	11	(45.8)	15	(60)	11	(42.30	52	(52.0)	
Are you aware that mining activities have implications to the health of people?	Yes	26	(89.7)	25	(83.3)	22	(78.6)	24	(82.8)	97	(83.6)	0.727
	No	3	(10.3)	5	(16.7)	6	(21.4)	5	(11.2)	19	(16.4)	
Do you protect yourself for safety purposes	Yes	17	(56.7)	21	(70)	18	(60)	14	(46.7)	70	(58.3)	0.330
	No	13	(43.3)	9	(30)	12	(40)	16	(53.3)	50	(41.7)	
Do you have health insurance	Yes	13	(43.3)	19	(63.3)	17	(56.7)	14	(46.7)	63	(52.5)	0.385
	No	17	(56.7)	11	(36.7)	13	(43.3)	16	(53. 3)	57	(47.5)	

Our study found surface mining as the dominant methods employed by Newmont Ghana Gold Limited (NGGL). This was confirmed by 52.5% of the respondents. Underground mining (43.4%) was found to be second followed by dredging (4%). On one hand, the officials of Newmont indicated that surface mining is now preferred than the underground mining due to the negative effects associated with underground mining. In Acherensua, Ntotroso and Hwidiem, approximately 55%, 60.7% and 50% respectively constituting the majority indicated that surface mining is the method of operation by NGGL. However, contrasting views were held by the respondents of Kenyasi (55.6%) alleging that underground mining is the predominant operation used by NGGL. We found no statistically significant relationship between knowledge on the method of mining as regards place of residence (χ^2 [6, N = 99] = 6.170, $p > 0.05$) See Table 2 above.

Knowledge on the Environmental Effects of Mining

Most of the respondents demonstrated in-depth knowledge with regard to the

environmental effects of mining activities. Most (83.3%) of them perceived that the method of operation has effect on the environment whereas 16.7% of the respondents failed to acknowledge this fact. Comparatively, most of the respondents sampled from the four study communities demonstrated in-depth knowledge on the effects of mining activities on the environment.

The study showed that water pollution was the most predominant form of environmental effects of mining. This was noted by 49% of the respondents. Also, 35% attributed land degradation as the second predominant form of environmental effects of mining. Lastly, 11% and 5% of the respondents identified air pollution and noise pollution respectively as other environmental effects of mining. The study found no statistically significant relationship between knowledge on environmental effects of mining and place of residence ((χ^2 [3, N = 120] = 0.480, p > 0.05) See Table 2 above.

Determinants of the Environmental Effects of Mining

The study found that the use of heavy machines was the main cause of land degradations. About 55% of the respondents indicated that the use of heavy machines was the sole cause of land degradation in the communities. Other factors included the use of chemicals, blasting of rocks and soil erosion. We found a statistically significant relationship between knowledge on the causes of land degradation in mining communities with regard to place of residence (χ^2 [9, N = 100] = 19.674, p < 0.05) See Table 2 above.

The study unearthed that the use of chemicals and the blasting of rocks were the two predominant causes of water pollution in mining areas. Approximately, 66% and 26% of the respondents indicated that the use of chemicals and blasting of mineral bearing rocks respectively are the causes of water pollution in mining areas. We found no statistically significant difference between knowledge on the causes of water pollution in mining areas in respect of place of residence (χ^2 [6, N = 100] = 11.757, p > 0.05).

The study revealed that air and noise pollution in mining areas are caused by blasting, the use of chemicals and heavy machines. Approximately 52%, 39% and 9% of the respondents alleged that blasting of rocks, use of chemicals and heavy machines respectively causes air and noise pollution in mining areas. Majority of the respondents in Kenyasi (60%), Acherensua (45.8%) and Ntotroso (60%) identified blasting as the leading cause of air and noise pollution in mining areas. However, majority of the respondents (53.8%) in Hwidiem did indicate that the use of chemicals was the leading factor in air and noise pollution in mining areas. Regardless of these varied responses in the causes of air and noise pollution, no significant differences were observed among the four study communities (χ^2 [6, N = 100] = 10.711, p>0.05).

Knowledge on the implication of mining activities on health

The study revealed that majority (83.6%) of the respondents had knowledge on the health implication of mining whereas 16.4% of the respondents failed to acknowledge this fact. The study revealed that, respondents who had basic, secondary or tertiary education were able to demonstrate a certain level of knowledge on health effects associated with mining activities. Table 3 shows that out of 39 respondents with basic education, 82.1% acknowledged that mining had effects on health. The officials at the Asutifi District and the health officials contacted in the

study communities added that there were health effects of mining activities in the communities.

Table 3: relationship between knowledge on the health implication of mining and education

	BASIC		SECONDARY		TERTIARY		NONE		TOTAL	
Response	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Yes	32	82.1	26	83.9	23	88.5	16	80	97	83.6
No	7	17.9	5	16.1	3	11.5	4	20	16	16.4
TOTAL	39	100	31	100	26	100	20	100	116	100

(χ^2 [3, N = 116] = 0.708, p>0.05).

Consequently, it became prudent to measure the respondents' knowledge level on the effects of mining based on their educational levels. Respondents' level of education was cross tabulated with the knowledge on mining effects on health as indicated in Table 3. It can be deduced that those with tertiary education had better knowledge of health effects of mining followed by the respondents who had attained secondary education as well as those with primary education placing third and those with no level of education being the last. However, we observed no statistically significant relationship between knowledge on the health implication of mining and the level of education.

Coping strategies

The study revealed that about 58.3% of the respondents protect themselves from the implications of mining activities for safety reasons. The study has shown that most of the respondents in Kenyasi (56.7%), Acherensua (70%) and Ntrotroso (60%) protect themselves for safety reasons. The study has established that most of the respondents (60%) in Hwidiem do not protect themselves from the implication of mining activities. It could be inferred that most of the people in the area were doing well to protect themselves in order to reduce the negative health impacts of mining on their lives. Furthermore, we found that about 52.5% of the respondents had enrolled in the National Health Insurance Scheme due to the implication of mining activities on their health. The reasons given by those enrolled in the scheme was to enable them enjoy health services regularly due to impact of mining activities on their lives. Others had enrolled in the scheme with the sole aim of reducing the cost of medical expenses. However, the reason given by those who had not enrolled in the scheme was their inability to pay for the service.

The study further found that respondents had devised coping strategies such as boiling of water before drinking and for cooking purposes. Other coping strategies of the health impacts of mining include sleeping in insecticide mosquito nets to reduce the rate of contraction of malaria. In an interview session with one respondent at Ntotroso, he mentioned that they had devised the following coping strategies to protect themselves

"*We don't drink rain water which is believed to have been polluted as a result of the mining activities* and *we also stay far from active mine sites as well so that we may be less prone to these deadly diseases associated with mining activities*".

DISCUSSION

This study sought to examine community knowledge on the environmental and health effects of mining in Ghana using Newmont

Ghana Gold Limited as the study prefecture. In the midst of the precarious environmental and health impacts associated with mining activities, there is a dire need for full community understanding and appreciation of the mining activities in Ghana. People's understanding of these impacts has the potency to help them adequately and fully employ coping strategies that can sustain and facilitate their stay in mining areas (Opoku-Ware, 2010). The study has shown that respondents demonstrated in-depth knowledge on the presence of mining activities in their communities. The high level of knowledge among the respondents in the study prefecture is attributed to their exposure to information, education and communication.

Our study found that surface mining is the dominant method employed by the NGGL. Surface mining was regarded as the most predominant method used by the miners and its implication on the environment was confirmed to be indeed very dangerous to the natural environment compared to other methods such as underground mining. The study revealed that surface mining has now become the most preferred means as it limits the severity of danger associated with underground mining. Although, the impact of surface mining on the environment was quite extensive compared to underground mining, it was recognised as lifesaving and less risky (for mining companies) hence the motivation for both large and small scale miners to adapt to it. This supports the findings of Adjei (2007) that surface mining poorly affects the environments and the health of people in mining communities.

The study has demonstrated that majority of the respondents demonstrated in-depth knowledge with regard to both environmental and health effects of mining activities. This is inconsistent with findings of Boulander and Gorman (2004) that across the western of US, a number of communities are being affected by mining activities yet few people have appreciable knowledge on the level of destruction. In the opinion of Boulander and Gorman (2004), people in mining communities do not have knowledge on the challenges mining poses to their health until people in their community are afflicted with diseases or start showing symptoms of infections. The difference in knowledge might be due to the number of years of operation of the mining company in the community prior to the field survey, the socio-cultural background of the people, awareness creation, sample size, response rate, access to information, the intensity of the negative implications of mining. This information that majority of the respondents have knowledge of mining operation in the areas is remarkable. The study revealed that there is no statistically significant relationship between knowledge on the health implication of mining and the level of education. This contradicts the findings of Yeboah (2011) that respondents' understanding of the health effects of mining positively correlate with education. This might be due to the sample size and the response rate.

The study revealed that land degradation, water pollution, air pollution as well as noise pollution are the major environmental effects of mining. This is corroborated by Opoku-Ware's (2010) assertion that the ramification of mining activities on the environment mostly includes land degradation and environmental pollution. These were as a result of the uncontrolled nature of the mining methods used by the company which pose severe consequences to the natural environment. The study found land degradation as the common environmental problem associated with the

mining activities in the area. The cause of land degradation was tied to the use of heavy machines, soil erosion and blasting of rocks. Due to the use of heavy machines in the mining process the land was severely degraded and devoid of vegetation cover.

Our study revealed that soil erosion was another environmental problem of mining activities which, therefore, renders the land incapable of supporting food production. This is akin to Akabzaa and Darimani (2001) indication that soil erosion occurs in mining communities which, therefore, reduces the ability and potency of the land to support agricultural production. Land is the most valuable resource which nature has blessed man with freely. However, the activities of mining undermine the value of land. Without land, it will be very difficult for man to survive especially those in mining areas who depend on the land for their sources of livelihood. In order not to compromise mining activities with the livelihood of the people, the need to regulate mining activities in the country would be essential in the midst of land degradation in mining areas.

Water pollution was another environmental problem associated with mining activities. Also, the use of chemicals (such as cyanide and mercury) was found to be the leading cause of water pollution. This finding has validated other research outputs (Phiri, 2011; Budds, and Hinojosa, 2012; Yeboah, 2011; Adjei, 2007). The researchers independently explicated that chemicals such as mercury and cyanide used by mining companies pollute water bodies such as rivers and streams. Water is the basic necessity of life. Without water, it will be difficult for man to survive. Since water is an essential commodity, NGGL should revisit its mercury management policy and health and safety standards as spelt out in their sustainability report in order to control the rate of water pollution in the study communities.

Air pollution is a common phenomenon in the study area which results from the emission of dust, carbon, sulphur and arsenic. Besides, blasting and the use of heavy machines lead to noise pollution. The challenges imposed as a result of blasting of mineral bearing rocks are noise and vibrations (Yeboah, 2011). Our findings have validated this research output. Air pollution results from blasting activities. Furthermore, noise pollution as another environmental effect of mining was linked to the blasting activities as well as the use of the heavy machines by the mining company. This is in consonance with the finding of Akabzaa and Darimani (2001) that blasting and heavy machines trigger noise pollution in mining communities in Tarkwa.

Our findings indicated that most of the respondents protect themselves from the negative health implication of mining activities. The study further found that majority of the respondents has enrolled in the National Health Insurance Scheme due to the implication of mining activities on their health. The reason given by some of those enrolled in the scheme was to enable them enjoy health services regularly due to impact of mining activities on their lives. Others had enrolled in the scheme with the sole aim of reducing the cost of medical expenses.

The study revealed that since respondents demonstrated in-depth knowledge on both the health and environmental implications of mining activities, it has influenced them to adopt coping strategies such as boiling of water before drinking and for cooking purposes. However, the study revealed that most people in the area do not use chemicals

to treat water. Appiah et al (2013) noted that in mining areas of Konongo and Odumasi, coping strategies such as boiling of water and using chemicals to treat water before use have not yet gained root in the communities since few people have resorted to these practices. With the issue of the use of chemicals to treat water, our finding is consistent with the findings of Appiah et al (2013). As regards the boiling of water before use, our findings invalidated what Appiah et al (2013) reported. This might be due to differences in access to other alternative sources of water and differences in knowledge as regards the rate of pollution of water bodies by the mining companies. The study further confirmed that coping strategies of the health impacts of mining include sleeping in insecticide mosquito nets to reduce the rate of contraction of malaria.

STRENGTH AND LIMITATION OF THE STUDY

The major strength of this study is that it has brought to bear community knowledge on the environmental and health effects of mining in Ghana particularly Newmont Ghana Gold Limited enclaves. To the best of our knowledge, this is the first population based study conducted in the area. The distinctive aspect of this study is that it has focused on the knowledge of the people in the community to investigate mining implication on the people. Furthermore, the study has helped to know the various coping strategies employed by respondents to cope with the mining implications particularly on their health. This information is vital as it will go a long way to inform the mining co-operation of Ghana (such as the Ghana Mineral commission) as well as the Environmental Protection Agency in the country to put up copious and pragmatic measures in place to erase the devastating effect caused by mining activities. The study was, however, challenged in the following areas. Firstly, the cross sectional survey employed might lead to recall bias. Lastly, data collection process was difficult because most of the respondents were not willing to respond to our questions. This is due to the fact that they claimed that the process is a waste of time since studies of this nature hardly improve their standard of living. Nevertheless, attempt was made to minimise their effects on the study and thus presented limited negative effects on the outcome of the study.

CONCLUSION

The study examined community's knowledge on the environmental and health implications of mining in Ghana using Newmont Ghana Gold Limited as the study prefecture. Major environmental problems were land degradation, water pollution, air pollution and noise pollution. The study has shown that respondents have better knowledge on both the environmental and health effects of mining. Their knowledge on health effects of mining has motivated them to adopt coping strategies such as boiling of water before drinking and for cooking purposes. The study recommended that since most of the water bodies have been polluted, NGGL should provide alternative sources of water for the communities.

RECOMMENDATIONS

Based on the findings of this study the following recommendations are deemed appropriate:

1. NGGL and community leaders in the study communities should intensify education in the area so that people will be more educated on how to cope with the problem. This should be done at regular intervals. Although, they were coping somehow with the situation, but the measures they have adopted were not

enough to enable them fully cope with the situation.

2. The NGGL should limit the use of mercury which was found to be the leading cause of water pollution. Furthermore, after mercury and cyanide are used, NGGL should find proper way of disposing them off so that they do not pollute water.

3. More so, intervention measures such as watering the untarred roads in order to minimise the dust emission on the roads should be deployed by Newmont.

4. NGGL should provide alternative sources of water for the affected communities such as bore holes and pipe borne to the affected communities.

5. Residents in the area should stay away from active mine sites so that they will be less prone to the deadly diseases associated with mining activities.

CONFLICT OF INTEREST

The authors declare no conflict of interest as far as this study is concerned.

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