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Environmental Impacts of Artisanal Gold Mining: A case study of Nkaseim Community - Ghana

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Abstract

Artisanal gold mining [AGM] has numerous socio-economic benefits to communities involved. However, the four environmental variables or constructs used revealed that AGM significantly affects the environment. In other words; despite a source of livelihood; AGM communities are besieged with issues such as water pollution, land degradation and air pollution which affect almost all facets of the environment including humans. Most miners have no idea about alternative technologies to make AGM sustainable, yet Ghana ranks next to South Africa as the highest producers of gold in Africa. This paper, therefore, discusses the consequences of AGM for stakeholders to regularize AGM activities; and adopt alternative methods to mitigate the damage caused to the environment.

Keywords: Artisanal gold mining, environmental impacts, regularize, pollution

1.0 Introduction

Artisanal Gold mining [AGM] industry has undergone unprecedented growth worldwide. This is due to the rampant joblessness within the countries where it takes place. These redundancies coupled with modified patterns of trade have made millions of people with different skills resort to AGM [Tallechet et al., 2004]. Increase in gold prices, has led to the sector`s rapid progression. Usually, AGM operations are done informally without license and regulations. AGM is typical of developing economies. It employs to a substantial part of labour, vital in production and income. In sum, AGM provides survival opportunities for communities [ILO, 2004]. AGM is one of the main challenges in the mining sector which threatens community. Although AGM has been in existence as long as mainstream mining, research suggest a significant increase in AGM activities in the last decades [Marston, 2017].

Poverty remains common in rural Ghana thus making AGM [Hilson and Potter, 2005] – often the best survival route for rural people [Heintz, 2005]. AGM in Ghana has a long history about several decades ago [Hilson, 2002]. However, the sector had governmental attention in the late 1980s. Consequently the enactment of the small scale mining law in 1989 giving rise to two groups of AGM operators. That is, those permitted and those illegal otherwise known in the local parlance as ‘‘*galamsey*’’. These ‘‘*galamseyers’’* depend on concessions owned by other companies [Amankwah & Anim-Sackey, 2003]. Improper regularization coupled with issues in licensing, have culminated in a surge in AGM populations currently estimated at about 200,000 people [Appiah, 1998; Hilson & Potter, 2003]. Again, the weakening state of agriculture has made mining the alternative livelihood source in most communities in Ghana. The propensity to get income coupled with low technical knowhow makes AGM attractive. However, AGM affects the environment. Therefore, this study aims to determine the environmental impacts of artisanal gold mining using these four parameters air pollution, water pollution, land degradation and biodiversity loss.

2.0 Study area

Nkaseim Community lies in longitudes 20 25 W and latitudes 60 55 with a population of about 6000. It is bordered to the north by Woromoso and Goaso to the south. Krapo and Nkrankrom communities are to the east and west respectively. The area is rocky with a deciduous climate.

3. Artisanal Gold Mining [AGM]: Overview

Artisanal Gold mining [AGM] is an informal mining activities done with minimal machinery or low machinery. It is predominates developing economies with an estimated 100 million plus workforce [Hentschel, et al., 2002].

The term AGM connotes mining activities practised by individuals and/or groups commonly without license. AGM lacks a shared definition as its classification and differ place from to place. Similarly, the estimation of AGM is quite a challenge due to paucity of official data. In spite of the above, over a 100 million people depend directly on AGM [Hruschka, & Echavarria, 2011; Hentschel, et al., 2002].

AGM has become a popular phrase in developing countries. It is the monetary spine of some nations presently. It has gained popularity in Africa, Oceania among other continents [Villas Boas et al., 2001; Larceda Marins 1997]. The dawn of 1980's saw a steady rise in AGM activities and it's responsible for a quarter of total gold production. AGM is done for many reasons. The weakening state of agriculture is believed to have made AGM common in Africa [Banchirigah, & Hilson; 2010]. Other factors include poverty and the propensity to become rich within a short period [Hruschka, & Echavarria, 2011]. In communities where practised; AGM continues to play a vital role.

Ghana like any other country extracts its gold for economic development via the provision of raw materials to feed other industries. AGM activities minerals have led to a resplendent effect on social and economic lives of miners and their families as well their communities at large [Amankwah et al., 2003; MacDonald 2002]. AGM, denotes a major source of income for rural population and any other any poverty stricken community and provides employment for many people compared to mainstream mining [Ulrike et al., 2012; CASM, 2003] In sum, AGM is a global phenomenon happening in remote areas of most countries [Ulrike et al., 2012 ; Hentschel et al., 2002 ILO 1999; Jennings 1999]. AGM helps to mitigate poverty and provides a momentous effect at local and national domains [Datta, et al., 2004; Iddrisu, et al., 1998]

The World Bank estimates indicate about 80 countries are engaged in AGM activities. Approximately, there are a 100 million artisanal gold miners globally. AGM produces about 80%, 20% and up to about 20% of global sapphire, gold and diamond supply respectively. It is dominant in countries in Africa, Asia, Latin America and Oceania. The AGM sector is a key basis of livelihood for local communities [Wilson, et al., 2015] AGM employs about 100 million people as against the about 7 million people engaged in industrial mining globally [World Bank 2013].

AGM offers a major occupation for rural societies to help lessen poverty in such impoverished areas [CASM 2003]. No special expertise is required hence AGM dominates as they are usually characterised by limited jobs and opportunities [Amankwah et al., 2003; CASM 2003]. The basic motive for AGM miners, their families and larger communities is survival [Hentschel et al, 2002]. In sum, people are engaged in AGM because it generates income quickly [Hilson, 2001]; and divert to AGM despite risks associated with it. [Mitullah et al, 2003].

3.1 Nature of AGM activities

Due to the lack of a shared classification, AGM be characterized by its main attributes: [Hentschel, T., et al., 2002]

- Labour intensive due to low equipment used
- Usually done illegally
- Relatively a low output
- Inadequate welfare measures
- May be done casually , and
- Inadequate or lack of environmental protection

3.2 Ghana

Large scale commercial mining in Ghana started around 19th century. However, accounts show AGM existed in Ghana as at the 4th century. Natives' participation became popular with the arrival of the Europeans in the early 1470's [Akabzaa & Dramani, 2001; Tsikata, 1997].

Ghana implemented its structural adjustment programme [SAP]; with economic recovery programme a major component. The above programmes were to alleviate economic sluggishness back then. The ERP paid particularly attention to the gold mining subdivision. [Hilson& Potter, 200; Owusu, 2001; Jeong 1998; Lall, 1995].

Since the launch of the ERP the country's mineral sector has grown rapidly, for example between 1983and 1998 , as much as US$ 4 billion was invested in Ghana's mining industry for minerals exploration , the expansion and rehabilitation of existing mines.

In Ghana, the mining sector contributed to about 6% of Gross Domestic Product [GDP] and 27.6% of government revenue in 2011 [Ghana Statistical Service,2014; Aryee, 2012]. In the year 2005, Ghana noted a grand upturn in mineral productions especially-gold which replaced cocoa as the top foreign exchange earner. Total mineral revenue rose from about $798 million to $995.2 between 2004 and 2005. However, gold production increased from $731.2 million to $903.9 [Arthur, et al., 2015; Ghana Chamber of mines 2005].

However AGM has existed throughout most of Sub Sahara Africa for several decades to centuries. AGM subdivision produces nearly 8 % of Ghana's gold. As a unit, AGM is about a quarter largest gold producer in Ghana.

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Table 1. Top 20 Gold Producing Countries Production (tons)

Country	2011	Rank	2012	Rank	*2013	Rank	2014	Rank	2015	RANK
South Africa	197.9	5	202.9	6	177	6	159.3	6	151	8
United States	232.8	3	231.3	3	229.5	4	208.7	4	218.2	4
Australia	258.3	2	250.1	2	268.1	2	274.0	2	279.5	2
China	371.0	1	413	1	438.2	1	478.2	1	453.5	1
Russia	211.9	4	230.1	4	248.8	3	247.5	3	249.5	3
Indonesia	120.1	7	89	10	109.6	9	116.4	9	176.3	5
Peru	187.6	6	185	5	187.7	5	173.0	5	175.9	6
Canada	107.7	8	108.2	7	133.3	7	152.1	7	159	7
Uzbekistan	71.4	11	73.3	11	77.4	12	81.4	11	83.2	11
Ghana	91.0	9	95.8	8	107.4	10	107.4	10	95.1	10
Papua New Guinea	63.5	13	56.5	13	60.5	13	56.3	14	57.2	14
Mali	43.5	17	43.5	15	48.2	16	47.4	16	49.0	15
Brazil	67.3	12	67.3	12	80.1	11	81.2	12	81.8	12
Tanzania	49.6	15	49.1	16	46.6	17	45.8	17	46.8	18
Chile	44.5	16	48.6	17	48.6	15	44.2	18	n/a	n/a
Philippines	37.1	19	41	18	40.5	20	42.8	20	46.7	19
Argentina	59.3	14	54.6	14	50.1	14	59.7	13	63.8	13
Mexico	88.6	10	95.3	9	119.8	8	117.8	8	135.8	9
Colombia	37.5	18	39.1	20	41.2	19	43.1	19	47.6	17
Zimbabwe	n/a	n/a	n/a	n/a	0	21	n/a	n/a	n/a	n/a
Kyrgyzstan	n/a	n/a	n/a	n/a	0	0	n/a	n/a	n/a	n/a
Venezuela	n/a	n/a	n/a	n/a	0	0	n/a	n/a	n/a	n/a

Kazakhstan	36.7	20	40	19	42.6	18	48.9	15	48.2	16
Dep. Rep. of Congo									45.7	20
Rest of the World	452.9	-	465	-	506.4	-	550.6	-	548.5	-
World Total	**2,838.1**	-	**2,860.6**	-	3,061.5	-	3,131.5	-	3208.6	-

Source: Gold Fields Mineral Survey (GFMS) 2017

Table 2. Revenue from Small Scale Mining

Year	Sales ($ millions)	Ounces	% Small-scale mining in total Ghana
1989	3.4	9272	2.2
1990	6.3	17,233	3.2
1991	5.3	15,601	1.8
1992	6.1	17,297	1.7
1993	11.5	35,144	2.8
1994	34.7	89,520	6.2
1995	48.7	127,025	7.4
1996	36.0	112,349	7.1
1997	28.4	107,094	5.9
1998	36.6	128,334	5.4
1999	35.2	130,833	5.2
2000	40.9	145,662	6.2
2001	39.3	185,596	8.7
2002	48.9	160,879	7.2
2003	79.8	211,414	9.5
Total	461.1	1,593,253	

Source: Amankwah &Anim-Sackey, [2004]; Yakubu, [2002].

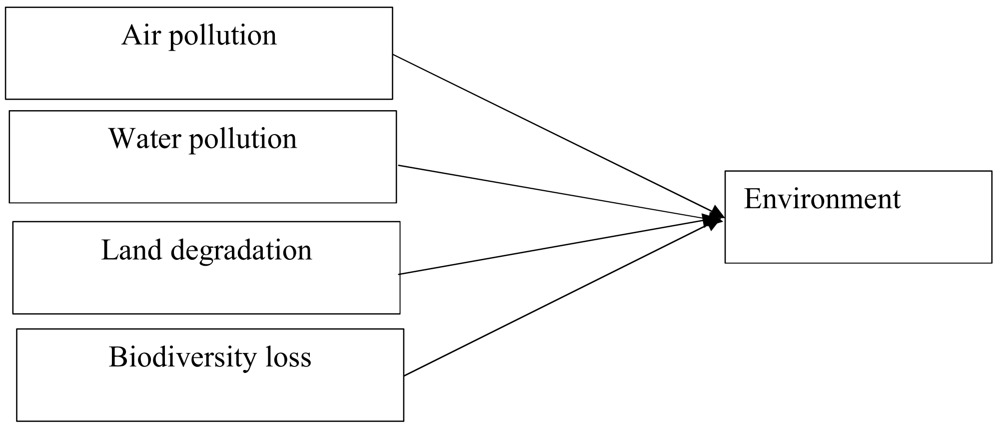
Currently, Ghana ranks next to South Africa as the highest gold producer in Africa, and overall tenth globally. [GFMS 2017; Hentschel et al., 2002].

4.0 Methodology

This research, used both qualitative and quantitative research methods. Qualitatively, the views of key stakeholders, focus groups and key informants were sought to determine the extent of their knowledge on AGM and its' potential effects on the environment. Questionnaire responses used were to run multiple regression models to provide quantitative data for the analyses and discussions.

Environmental Impacts

Conceptual Framework



1. *Air pollution*

It's estimated that about 80% of anthropogenic mercury [Hg] emissions to the atmosphere are via AGM activities. Mercury is put in the gold particles in concentrates to form fairly large balls of a mixture termed ‘‘amalgam’’. The mixture or amalgam is then heated or burnt to evaporate and liberate both the mercury and any other impurities in order to get a relatively fine gold [GAHP 2014; UNEP 2013]. These miners, their families and communities at large inhale huge amounts of mercury vapour during the amalgam burning process as it occurs usually in their dwellings [UNEP 2012; Tschakert & Singha 2007; ATSDR 1999]. The Hg vapours found in amalgam burning locations are commonly high and normally top the World Health Organization's [WHO] limit of 1.0 $\mu g/m^3$. While some of the vapour maybe absorbed by the brains and kidneys of these workers and their families; the rest ends up in the soil, sediments of water bodies and converted into [MeHg] by these aquatic organisms which gets bio accumulated in fishes consumed by these miners and those downstream [Gibb H, O'Leary KG. 2014; GAHP 2014; UNEP 2012]. Moreover, using explosives such as dynamites and activities like drilling, blasting and transportation air major sources of emissions such as carbon monoxide and soot which pollutes the air. This in turn increases the suspended particulate matter in the atmosphere. Consequently, miscarriages, respiratory diseases, cardiovascular diseases, deaths among others may be common among AGM miners, their families and their communities with children and pregnant women endangered the most.

2. *Water pollution*

Artisanal gold mining activities require maximum use of water hence occur in and around water bodies as these alluvial zones are vital to separating gold from the gold-bearing rocks [Marston, 2017; Donkor et al., 2009]. However, a major component of the AGM activity is amalgamation process by which mercury [Hg] is applied to obtain gold from the ore [Gibb H, O'Leary KG. 2014]. The above method of gold extraction is deemed cheaper, easily to be independently used and is quick [Hammond et al., 2013; UNEP 2012]. In addition, AGM is responsible for about [37%] of Hg emissions globally as a result of the amalgamation, heating and burning processes used by miners in gold recovery [UNEP 2013c]. Considerable amounts of Hg are left in the tailings which subsequently end up in rivers, lakes, stream and other water bodies close to these AGM sites causing severe pollution [GAHP-Global Alliance on Health and Pollution, 2014]. Also, cyanide, which is toxic is sometimes used to extract further gold from these tailings before finding their ways into water bodies [GAHP, 2014]. Heavy metals contamination in aquatic environments are noted for toxicity, abundance, persistence and possible accumulation in the aquatic habitats. Typically, these metals may accumulate in microorganisms, aquatic flora and fauna and subsequently find their ways to the food chain [Sin, et al 2001]. Anaerobic organisms found in these water bodies convert elemental mercury [Hg] into methyl mercury [MeHg] which find their paths to the food chain and thus ending up in humans[Gibb H, & O'Leary KG. 2014]. Both chemicals are harmful to humans and could affect the various organs and systems in the body [Gibb H, & O'Leary KG. 2014]. AGM, especially its impacts on water have attracted public awareness. Publicly, there is a negative opinion of AGM, due to the uncontrolled environmental pollution associated with such activities [Buxton, 2013].

In Ghana, the direct usage of riverine systems by AGM operators; and release of mine wastes or tailings into such watercourses have rendered water bodies in mining communities unwholesome for consumption [Arah, 2015; Oduro et al, 2012; Tschakert & Singha, 2007; Donkor et al., 2006]. There is a clear distinction between clean and contaminated water sources in mining communities. It therefore justifies the cries of affected communities in defending their resources against AGM activities [Marston, 2017]

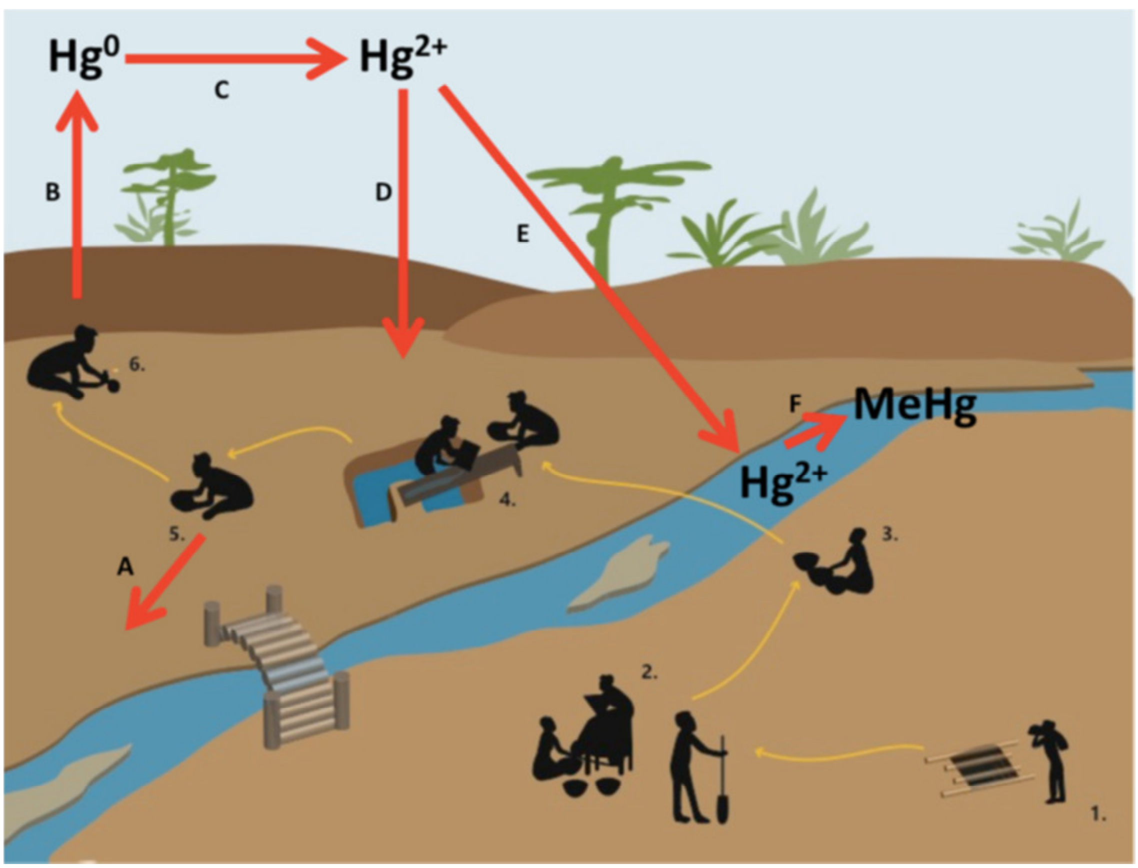


Figure 3. Mercury cycle in artisanal gold mining. Numbers and letters represent major steps and mercury cycle in the AGM process respectively.

Adapted from Rajaee et al; 2015

1. Excavation. **A.** residual mercury through amalgamation discharged into water bodies.

2. Crushing/ grinding. **B.** Mercury volatilizes into the air

3. Sifting/ shaking. **C.** Mercury oxidation.

4. Washing/sluicing. **D.** Mercury gets deposited on land surface.

5. Amalgamation. **E.** Discharge into aquatic bodies.

6. Burning/heating. **F.** Inorganic mercury converts to methyl mercury.

3. Land degradation

Small scale surface mining a major cause of land destruction. AGM has degraded about 13% of lands in Ghana [Tetteh, 2010]. Similarly, AGM is responsible for about 58% land degradation and a sizeable 45% loss of farmland in mining areas in Ghana [Schueler et al. 2011].Excavations done in mining operations destroys lands [Yelpaala 2004; Aryee 2003]. Depths of between 35m to 60m wide are sometimes excavated even near rivers [Hilson 2002]. Biodiversity conservation is endangered due to these deep excavations. These land destructions have altered soil ecosystems especially soil temperature and topography [Tetteh 2010]. Consequently, exclusive habitats, flora and fauna and lands have become unproductive [Asiedu 2013]. AGM has greatly affected the availability of land for other uses [Tetteh 2010]. For instance land uses such as farming and livestock grazing are halted on AGM sites. Generally, mining affects the topography of the area mined and scenic features. Again, the vegetation cover is destroyed which displaces wildlife from their natural habitat. Soil removal during mining ultimately alters the general soil features thus affecting its productivity especially for agriculture. AGM makes the area mined susceptible to erosion.

In addition artisanal gold miners, are notorious for polluting soils and rivers with mercury which find their ways into human bodies through the food chain [Van Straaten, 2000; Veiga & Hinton, 2002].

4. Biodiversity loss

Mining activities alter habitats due to poison from chemicals and anthropogenic activities. Habitat modification due to AGM affects vegetation, microorganisms and animals are brutally affected. Soil temperature and pH are all altered thus affecting communities in such habitats. The usage of cyanide used to extract gold from tailings affect aquatic organisms as tailings eventually get in dumped water bodies [GAHP, 2014]. Also, endemic species which require peculiar conditions to thrive risk extinction due to excavations. The modification of their habitats ultimately threatens biodiversity conservation.

On the hand, river banks mined to depths of between 30m and 60m wide [Hilson, 2002]. This brings about increased soil temperature, loss of soil nutrients, and topography change which destroys ecosystems and their habitats, and alters microbial activities [Asiedu, 2013; Tetteh, 2010].

Table 3 **Reliability Statistics**

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
.759	.826	5

5.0 Results and Discussions

Constructs reliability

Preceding the analysis, a consistency and reliability of the variables or constructs were performed. According to Girden [2001] the standard Cronbach Alpha which is an ideal for any analysis were obtained, thus ≥ 0.7. This is paramount as it highlights the degree to which the measuring scale yields the same outcome if it is measured repeatedly in different research.

Cronbach's alpha is the most widely used method. Table above details the outcomes of Cronbach's alpha coefficient.

Regression Analysis

Multiple regression analyses was performed to find the relationship that exist between AGMactivities and the environment. In the multiple regression model, the independent variables were air pollution, biodiversity loss, water pollution and land degradation; with the dependent variable being the environment. The result from the regression model indicates a statistically significant R-square value of 0.919. In other words when air pollution, biodiversity loss, water pollution and land degradation, were regressed on the environment, the regression model was significant in its prediction of negative environmental impacts, explaining 91.9 percent of its variability. The result also shows a Sig=.000 of the F-statistics, which means that the model is statistically significant [Costello & Osborne, 2011]. In addition, results from the regression also indicate all four variables or constructs four constructs were significant, air pollution [β =0.076, t=2.885, p=0.005, < 0.05], biodiversity loss [β = 0.046, t = 2.698, p =0.008, < 0.05], water pollution [β = 0.835, t= 18.675, p=0.00, < 0.05], and land degradation [β= 0.181, t= 2.683, p =0.008, < 0.05]

Table 4. Regression

Variables	β	SE	t	Prob
Constant	-1.088	0.507	-2.147	0.034
AIRPOLL	0.076	0.027	2.885	0.005
BIODLOS	0.046	0.017	2.698	0.008
WATPOLL	0.835	0.045	18.675	0.000
LANDEG	0.181	0.067	2.683	0.008
R^2	0.919	F-statistic		369.536
Adj. R^2	0.917	Prob. (F-stats.)		0.000

5.1 Discussions

The study sought to determine the environmental impacts of Artisanal Gold Mining at Nkaseim Community.

The factors considered were air pollution, water pollution, land degradation and biodiversity loss. A regression analysis carried out revealed that the parameter estimates of air pollution, water pollution, land degradation and biodiversity loss were significant.

Air pollution

The results indicate that adequate air pollution is common in AGM areas and has a significant impact on the environment [β =0.076, t=2.885, p=0.005, < 0.05]. This resonates with researches done by [GAPH 20014; UNEP

2013]. They established about 80% of anthropogenic mercury [Hg] emissions to the atmosphere are through AGM activities. Mercury is mixed with gold particles in concentrates to form relatively large balls of amalgam.

''I'm very much aware of the health effects of burning the amalgam. I have no choice since this is the cheapest and easiest way of refining gold''- Miner

The g amalgam is heated or burnt to evaporate and rid of both the mercury and any other impurities in order to get a relatively fine gold which pollutes the air. Similarly, these miners, their families and communities at large inhale huge amounts of mercury vapour during the amalgam burning process as it occurs usually in their dwellings as postulated in researches by [UNEP 2012; Tschakert & Singha 2007; ATSDR 1999]. As a result miscarriages, respiratory diseases, cardiovascular diseases, deaths among others are common in AGM communities [Gibb H, O'Leary KG. 2014; GAHP 2014; UNEP 2012]. Again, mercury inhalation exposures leads to respiratory and death [Landrigan & Etzel, 2013].

''Sometimes, our eyes become so reddish after burning the amalgam. Again, we sometimes cough after inhaling smoke from burning the amalgam''- Miner

Biodiversity Loss

Similarly, biodiversity loss was also found to significantly impact the environment [$\beta = 0.046$, $t = 2.698$, $p = 0.008$, < 0.05]. This is consistent with previous studies by GAHP [2014]; Asiedu [2013]; and Tetteh [2010] who found that AGM has led to huge biodiversity losses, reduction in microbial activities, destruction of ecosystems among others due to excavations, discharge of mining waste- tailings on both land and in water bodies. To them, AGM poses a threat to biodiversity conservation.

''AGM has done huge damage to biodiversity. To say the least; the plants, flowers and even butterflies I grew up playing with are no more'' – Community member

Water Pollution

The study revealed a strong correlation between AGM and water pollution [$\beta = 0.835$, $t= 18.675$, $p=0.00$, < 0.05]. The findings here is similar to previous studies by Gibb H., and O'Leary KG. [2014], GAHP [2014], and

Donkor et al [2009] who found artisanal gold mining to be a major water pollutant mainly due to the proximity of such activities to water bodies. They also revealed mercury is used in the gold recovery- *amalgamation* after which the waste-*tailings* find their ways into such water bodies with considerable amounts of mercury left in them. The gold recovery method is quite cheaper and easy to use among the miners as revealed by Hammond, et al., [2013] and UNEP [2013c].

''My elementary teacher said was is colourless but galamsey has changed the colour of our rivers''- A resident.

Again, direct access to water bodies by miners have made harmful and unfit for human-drinking, cooking, washing, among other uses in Ghana [Arah, 2015; Donkor et al., 2006], due to the conversion of elemental mercury [Hg] to methyl-mercury by anaerobic organisms.

''Recently, we are losing our rivers to miners and their activities''- Ex-Assemblyman

These chemicals find their ways to the food chain which end up in humans especially fish-eaters thereby affecting the nervous, digestive and immune systems; just to name a few. Mercury intoxication leads to neurological, kidney and autoimmune impairment [WHO 2013a].

''Our waters have become so dirty unlike before. It looks too yellowish to consume''- A resident.

Land Degradation

The results indicate that land degradation from AGM has a significant impact on the environment of the community [β= 0.181, t= 2.683, p =0.008, < 0.05]. The findings support the works of Shueler et al [2011] and Tetteh [2010]; who found that small scale surface mining is a major cause of land degradation and destruction within mining communities in Ghana. Yelpaala [2004] and Aryee [2003] found excavations in mining activities to be common and very destructive in mining areas of Ghana.

''We have lost our lands to these miners. We can't find space to grow crops to feed ourselves''. - An elder in the community

Vast areas of forested lands have had to be cleared to undertake such mining activities. In addition, pits and trenches are created only to be abandoned after the operations. Consequently, inadequate clean water, stagnant water, mosquitoes, loss of arable lands and vegetation are common in such places [Hilson, 2001].This has led to reduction in availability of land for other uses.

'' Galamsey, has destroyed almost everything on our lands''- A farmer

5.2 Recommendations

- Environmental Protection Agency [EPA] together with all other regulatory bodies should ensure AGM activities in Ghana are duly regularized to avoid indiscriminate destruction of the environment.
- Minerals Commission, EPA and all regulatory entities should educate miners to adopt new methods such retorts instead of their current practices to help reduce environmental hazards.
- The regulatory bodies could contract local craft manufacturers to produce retorts at affordable prices and sold to these miners.
- EPA, Community members, Minerals Commission, and all stakeholders should identify safe designated areas for these miners to reduce proximity to settlements as well as human exposure to mercury from AGM activities.

Conclusion

Artisanal gold mining [AGM], remains a key source of livelihood for most communities in Ghana. It promises the quickest source of income for miners, families and individuals. It provides jobs for many due to its' minimal requirement of complex knowhow and capital compared to large-scale mining. The weakening state of agriculture has made AGM very popular and a viable livelihood alternative. However, AGM has culminated in numerous adverse environmental impacts as revealed in the study. The four constructs namely air pollution, water pollution, land degradation and biodiversity loss are rife in most AGM communities. To date, most AGM miners do not know about retorts or other alternative technologies. Finally, suggested future works could consider alternative technologies and develop retorts locally to be used for AGM.

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