Environmental Impact of Artisanal and Small-Scale Gold Mining in Borgu Local Government Area

Mukaila[1] O. O*, Abdulraman[2] S. O, Ayuba[3] A.B & Jimoh I[4]

[1]Haleem Educational Centre, New Bussa, Niger State. Nigeria

[2]Department of Material Science and Engineering Kwara State University, Malete, Ilorin Nigeria

[3]Department of Product Development and Engineering, National Institute for Freshwater Fisheries Research, New Bussa, Niger State Nigeria

[4]Works Department, Moro Local Government Bode Saadu, Kwara State

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ABSRACT

This study was conducted to assess the environmental impact of artisanal and small-scale gold mining in Borgu Local Government Area, Niger State, located in North Central Nigeria. Samples were gathered from areas presumed free of gold mining activities to serve as controls, as well as from gold processing (washing) sites and downstream locations along Mayera water. These samples were analysed at the National Institute for Freshwater Fisheries Research (NIFFR) central laboratory for heavy metals using atomic absorption spectrometry (AAS). The levels of cadmium, copper, chromium, iron, lead, and mercury were measured using AAS techniques. The concentrations found in samples from the control site (upstream) are cadmium (0.001mg/L) copper (0.006mg/l), chromium (0.025mg/l), iron (.01mg/l) lead (0.009mg/l) and mercury (.0088mg/l) are all below the acceptable permissible limit of WHO/NAFDAC. While the result from the mining processing (washing) site show a very high increase in the heavy metal concentration of cadmium (0.008mg/L) copper (0.032mg/l), chromium (0.091mg/l), iron (0.447mg/l) lead (0.032mg/l) and mercury (0.031mg/l).the mean concentration of cadmium are (0.0.0058mg/l),chromium(0.027mg/l) and iron (0.1624) on(0.1624mg/l) are below the acceptable permissible limit of NAFDAC while copper(0.02mg/l),lead(0.0257mg/l) and mercury(0.0267mg/l)are above the acceptable permissible limit of NAFDAC. Cadmium (0.0.0058mg/l), copper (0.02mg/l), chromium (0.027mg/l) and iron (0.1624) are below WHO limit while, lead (0.0257mg/l) and mercury (0.0267mg/l)/l) are above the acceptable permissible limit of WHO. The result shows heavy metal concentration due to artisanal and small-scale mining activities in the Borgu local government which is the most silent but significant environmental side effect.

Keywords: Gold mining, Artisanal, heavy metals, Lead poisoning.

INTRODUCTION

Money comes from artisanal and small-scale mining operations, a broad categorization that ranges from subsistence miners with shovel and gold pan to small outfit equipped with basic machinery.

The practice, which provides a livelihood for an estimated 100million people directly and indirectly, also comes at a cost: large-scale deforestation, air and water contamination and chronic human diseases, particularly from mercury used to process the gold ore.

Artisanal and small-scale mining is the no.1anthropogenic cause of mercury pollution in the world and major sources of fund to finance the activities of bandits and terrorists in Africa especially Nigeria.

Mining activities, including prospecting, exploration, construction, operation, maintenance, expansion, abandonment, decommissioning and repurposing of a mine can impact social and environmental systems in a range of positive and negative, and direct and indirect ways. Mining can yield a range of benefits to societies,

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but it may also cause conflict, not least in relation to above ground and sub-surface land use. Similarly, mining can alter environments, but remediation and mitigation can restore systems. The activities affected both social and environmental systems. Native ecosystems and aboriginal human communities are typically affected by multiple stressors, including climate change and pollution, for example.

Borgu LGA is located in Niger Sate and the Au mines of Borgu are located mostly in the communities of Popo-Kere, Koro, Daban Oli and Daban Fura. Extraction of the Au ore under artisanal mining in Borgu area is an extremely strenuous and hazardous activity. Prospective Au mines are usually located based on intuition and experience. Mining of Au is Mining of gold has being left in the hands of artisanal miners who do not have enough resources and adequate equipment and technology required for the mining activities.

Borgu and its environment as a major gold field suffer in the hands of artisanal miners particularly in New Bussa. This work therefore will be studying the environmental problems associated with artisanal gold mining in new bussa using both physical observations and laboratory analysis of samples.

Artisanal mining broadly refers to mining by individuals, groups, families or cooperatives with minimal mechanization, often in the informal sector of the market. Artisanal gold mining is carried out in developing countries of Africa, Oceania and Central and South America. According to Hentschel *et al*. (2002), globally the number of people estimated to be involved in this activity is 80–100 million people. Africa produces more than 60 metal and mineral products and is a major producer of several of the world’s most important minerals and metals, including gold. Although underexplored, Africa hosts about 30% of the planet’s mineral reserves, including 40% of gold, 60% of cobalt and 90% of the world’s precious gems and mineral reserves (Tieguhong *et al*. 2009).According to the World Bank Group (2001

The process of mining also causes environmental destruction (land, soil, vegetation) leading to loss of forest resources, wildlife habitat, and/or agricultural cropland (Tiffany, 2012).

Studies on the Environmental impacts of ASGM have not been extensively carried out in Borgu local government area. The main environmental damage in this region is soil degradation, land damage and river pollution. Also, the presence of several abandoned open pits scattered in areas of ancient or recent gold mining cause’s severe disturbance of the land surface and disappearance of cultivable land and gallery forest (Joseph & Joseph, 2013).

Artisanal Gold Mining In Borgu

Borgu LGA is located in Niger Sate (Figure 1) and the Au mines of Borgu are located mostly in the communities of Popo-Kere, Koro, Daban Oli and Daban Fura. Extraction of the Au ore under artisanal mining in Borgu area is an extremely strenuous and hazardous activity. Prospective Au mines are usually located based on intuition and experience. Mining of gold has being left in the hands of artisanal miners who do not have enough resources and adequate equipment and technology required for the mining activities.

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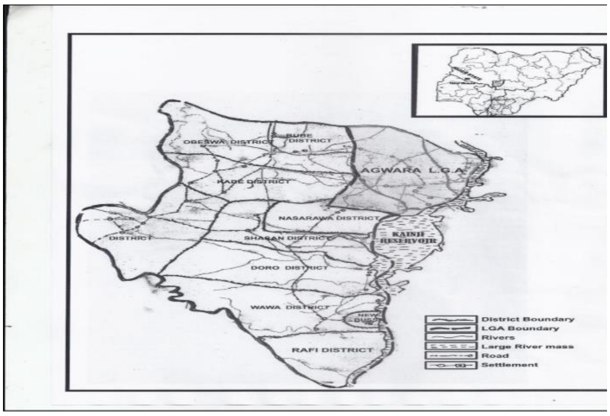

Figure 1: Map of Borgu Local Government Area.

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Artisanal and small-scale mining (ASM) are mining operations which are easily controlled technologically and financially by under-equipped populations with limited means and exploited as individuals, families, associations or cooperatives (Seydou, 2002). An estimated 20 million people around the world rely on ASGM for livelihood, working in more than 80 countries. They produce some 10% of the world's mined gold (The World Bank, 2013).

Generally, there are two types of mining exploitation in NIG. The artisanal and the semi-mechanized mining. The mining processes are basically the same for both but only differ in their degrees of mechanization – in artisanal mining, rudimentary tools like spades, shovels, pickaxes and crowbars are used, while the semi-mechanized mining involves the use of heavy machines like excavators and bulldozers. However, both forms of exploitation are classified as artisanal and small-scale mining (ASM).

Forms Of Mining Activities

Mining can be divided into three based on the processes involved in the extraction. Open Pit mining is the form where material is excavated from an open pit; it is one of the most common forms of mining for strategic minerals that are available in small deposits as shown in Figure 2 (Dontala *et al.* 2015). Underground Mining involves large-scale movements of waste rock and vegetation. These two forms are believed to have the potential for tunnel collapses and land subsidence (Betournay, 2011).In situ leach (ISL), mining which is done underground, is believed to have environmental and safety advantages over the other two (World Nuclear Association, 2012) because there is no ore dust or direct ore exposure to the environment and lower consumption of water is needed in the mining process (International Atomic Energy Agency (IAEA), 2005).

Figure 2: Gold processing (washing) pond.

MATERIAL AND METHODS

The Study Site

The area of the study, The Nasarawa-Kainji gold processing (washing) site and the adjoining Mayara River which shared boundary with Borgu and Mashegu Local Government area Niger State Nigeria.

Sample Collection And Pre-Treatment

Samples were collected from 4 locations by dipping 1L white polyethylene plastic bottles into the source and the river.

Bottles were previously washed thoroughly with detergents and deionized water and then soaked by filling with 20% dil HNO3 for 24hrs.Then the bottles were then washed with tap water and then with distilled deionized water.

During collection of samples, bottles were rinsed properly with the river water samples and then the samples were collected from the side of the riverbank, the washing pond, the discharge area and river source (no activities area).

The collected samples were immediately carried to the National Institute of Fresh Water Fisheries Research (NIFFR) Central Laboratory for AAS analysis.

RESULT AND DISCUSSION

Result Of Heavy Metals Content Of Borgu Local Govt. Asgm Processing Field And Mayera River

Table 4.1 present the results obtained after the analysis of the collected samples

Table 4.1 result of heavy metals analysis using BUCK 200 AAS (AOAC, 975.23).

S/NO	SAMPLE IDENTIFICATION	CADMIUM mg/L	CHROMIUM mg/L	COPPER mg/L	IRON mg/L	LEAD mg/L	MERCURY mg/L
1	SAMPLE1	0.0060	0.0240	0.0480	0.4040	0.0240	0.0250
2	SAMPLE2	0.0034	0.0180	0.0620	0.0385	0.0210	0.0230
3	SAMPLE3	0.0010	0.0060	0.0250	0.0100	0.0090	0.0088
4	SAMPLE4	0.0080	0.0320	0.0910	0.4470	0.0320	0.0320
7	NAFDAC	0.0500	0.0500	0.0500	0.3000	0.0100	0.0500

DISCUSSION OF RESULT

Heavy metal concentration collected from different sampling site in artisanal and small scale gold processing (washing) site in Borgu local government area and MAYERA RIVER using Atomic absorption spectrometer (AAS) had been studied and analyzed. The graphs plotted are concentration (ppm) against elements for each sampling point, concentration (ppm) for each element against sampling points and relationship between the elements such as cadmium, chromium, copper, iron, lead and mercury.

Concentration Of Element For Each Sample Point

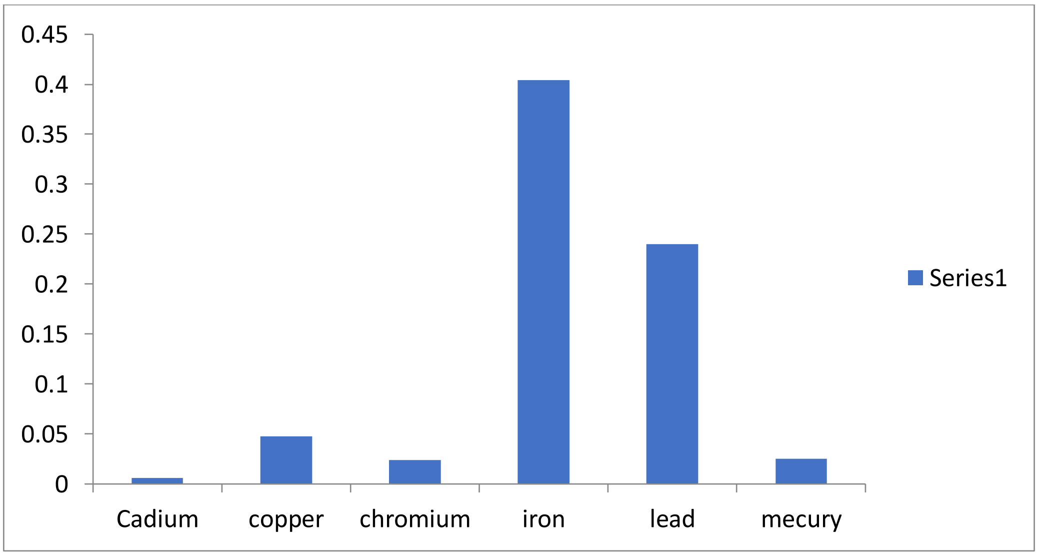

Figure 3: Concentration of element against sample one

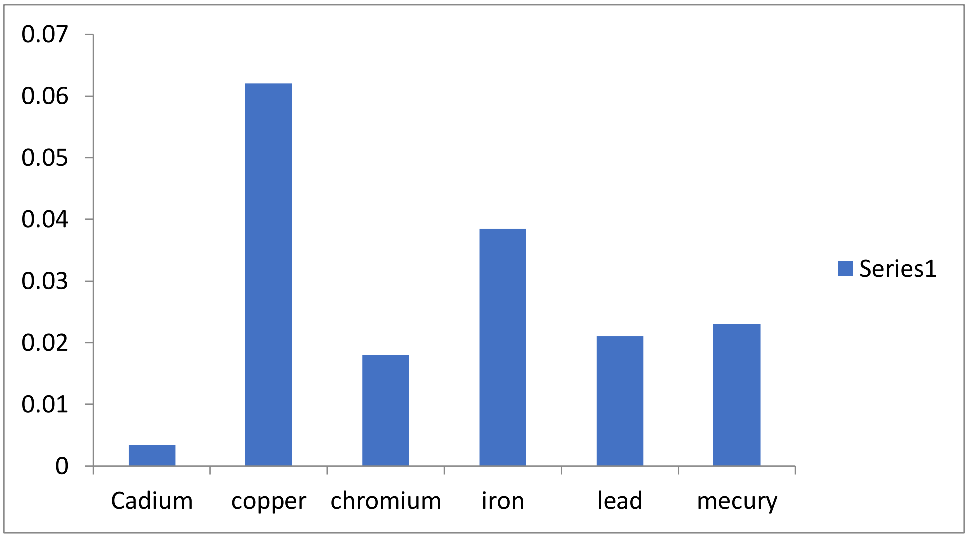

Figure 4: Concentration of element against sample two

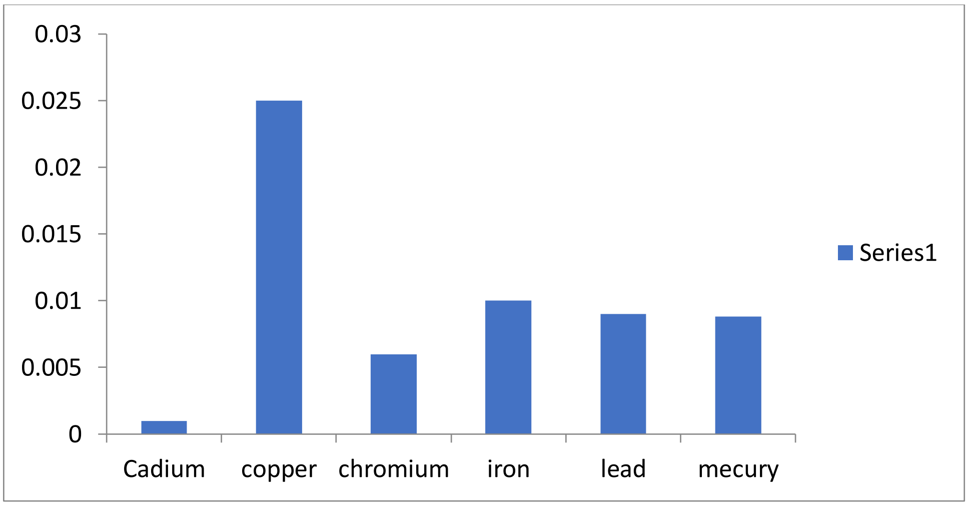

Figure 5: Concentration of element against sample three

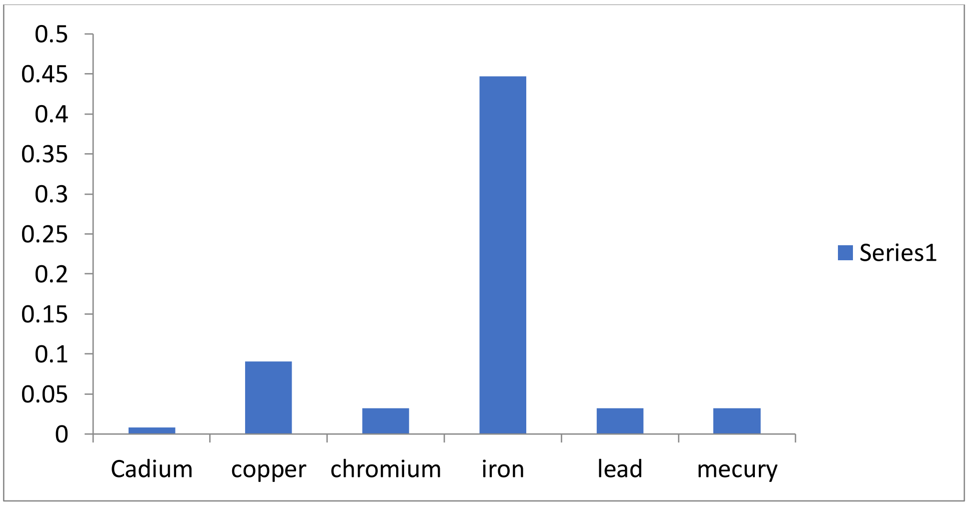

Figure 6: Concentration of element against sample four

Key

Sample1 river joining

Sample2 down stream

Sample3 up stream

Sample4 point of mining (discharge)

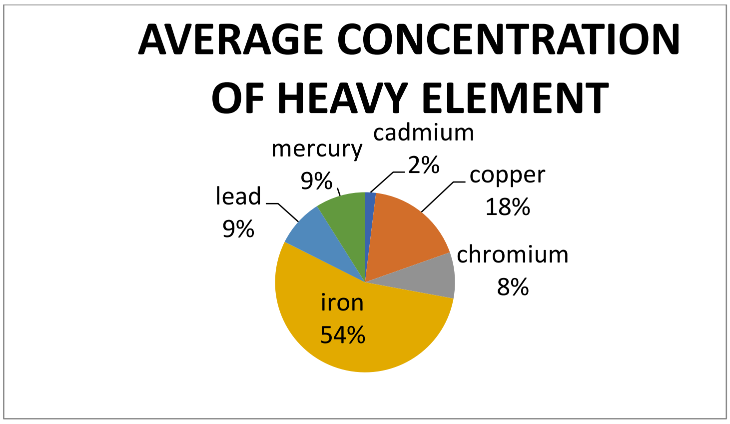

Figure 7: Average concentration of heavy element.

Figure 3 show the concentration (ppm) of each trace element for lake site where gold processing discharge is joining the MAYERA RIVER, the chart indicated that , all the trace element are below the acceptable permissible limit standard control for USEPA of value

The element mercury, chromium and iron value are 0.025, 0.024 and 0.404 are above the acceptable permissible of USEPA of values 0mg/l, 0mg/l and 0.3mg/l respectively. The element lead and mercury of value 0.024mg/l, 0.025mg/l are above acceptable permissible limit of WHO and NAFDAC.

Figure 4. Shows that the concentration of trace elements recorded for Downstream where lively activity take place and the effect of impact of the contamination from gold mining will be felt. The element mercury, lead of value 0.023mg/l and 0.021mg/l are above the acceptable permissible limit of WHO of value 0.01 and 0.001 respectively. The element mercury and chromium of value 0.023 and 0.018 respectively are above the acceptable permissible limit of USEPA of value 0mg/l. the element copper, lead, mercury of value 0.062mg/l, 0.021mg/l and 0.032mg/l respectively are above the acceptable permissible limit for NAFDAC.

Figure 5. Shows the concentration of the heavy element recorded for upstream where the activity of gold miners has no effect (CONTROL SAMPLE) .it was observed that all elements are mostly below the acceptable permissible limit of all the control standard USEPA, NAFDAC and WHO except mercury and chromium that showed slightly difference for USEPA.

Figure 6. Shows the concentration of trace element recorded for point of processing (washing) of Gold. The element mercury of value 0.032mg/l is above the acceptable limit of all the standard control organizations WHO/NAFDAC and USEPA of value 0.001mg/l and 0mg/l respectively while lead is above WHO /NAFDAC and USEPA 0.001mg/l and 0mg/l respectively. While lead is above WHO limit. The elements of copper, lead, mercury and iron of value 0.091, 0.032, 0.031 and 0.447 are above the acceptable permissible limit of NAFDAC of value 0.05, 0.01, 0.001 and 0.3 respectively. Table 4.2 and 4.3 shows the comparison between heavy metal with different standards

Table 4.2: Comparisons between the averages measured heavy metal with the maximum permissible limit set by NAFDAC

ELEMENT	AVERAGE CONC. (mg/L)	MAX.PERMISSIBLE CONC. (mg/L) NAFDAC	REMARK
CADMIUM	0.0058	0.0500	BPL
COPPER	0.0526	0.0500	APL

CHROMIUM	0.0247	0.0500	BPL
IRON	0.1624	0.3000	BPL
LEAD	0.0257	0.0100	APL
MERCURY	0.0267	0.0010	APL

Table 4.3: Comparison between the averages measured heavy metal with the maximum permissible limit set by WHO

ELEMENT	AVERAGE CONC. (mg/L)	MAX.PERMISSIBLE CONC. . . . (mg/L) WHO	REMARK
CADMIUM	0.0058	0.0500	BPL
COPPER	0.0526	1.5000	BPL
CHROMIUM	0.0247	0.0500	BPL
IRON	0.1624	1.0000	BPL
LEAD	0.0257	0.0100	APL
MERCURY	0.0267	0.0010	APL

An excess mercury Hg was obtained in all the sample point indicating that it has exceeded the guidelines recommended by united state environmental protection agency. USEPA. World Health Organization WHO and National Agency for Food and Drug Administration and Control. NAFDAC. Also lead exceeded the recommended limit of WHO and NAFDAC. Chromium with average conc. of 0.0247mg/l exceeded the recommended acceptable permissible limit of 0mg/l.

CONCLUSION

Artisanal and small scale gold mining are activity that employs many people in rural area because the barriers to entry are minimal, with low technology, capital; and limited skills needed. From the study of the environmental impact of artisanal and small-scale mining in Borgu local government area Niger state Nigeria the result showed that the activities of artisanal gold miners had increase the level of heavy element by cadmium(21%) copper (15%), chromium (23.5%), iron (30.65%) lead (19.3%) and mercury (20.29%).heavy metal contamination due to gold mining and processing (washing) has become one of the most silent but significant environment side effect.it is an activity associated with many negative social impacts, miners are exposed to chemical contaminants, unsanitary conditions, prostitution, alcoholism and drug addiction. Women and children are generally the most affected by these hazard.it is also associated with a number of environmental impact which are deforestation and land degradation, open pits which pose as animal traps and health hazards and mercury pollution, dust and noise pollution.

However, gold mining operation also have positive impact on the environment if sustainable and modern method are adopted. Considering that gold mining activities in Nigeria are operating below capacity, efforts should be made to review the law and enforce them to minimize casualties.

Artisanal and small scale gold mining (ASGM) activity needs to be encouraged to reduce the rate of youth unemployment in Nigeria but there is also the need to greatly re –organized the trade, educate the miner and provide technical /improved technology on site with adequate security to checkmate all forms of anti-social behavior on mining site.

The environmental impacts of artisanal gold mining in Borgu local government area are still on a small-scale but a potential danger in the nearest future if the practice continues without concise action to mitigate the effect. It is observed that if appropriate action is not taken to control the activities of open mining by artisanal manners, the effects will be on agriculture, fisheries, and public health .

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