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Full Length Research Paper

Ecological impact of artisanal and small scale mining in parts of Taraba state, Nigeria

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Abstract

Artisanal and small scale mining (ASM) refers to informal mining activities undertaken by individuals and groups who rely heavily on manual labour, using simple implements and methods. However, because of the large number of people involved in ASM operation, significant ecological impact could be created within a very short period of time. The research was carried out in 12 selected mining sites in five mining communities namely; Maisamari, Yelwa, Gurgu, Didango and Jukun in Sardauna and Karim Lamido LGAs. Detailed field observation and measurements with vivid picture description and laboratory determination of the geochemical characteristics of soil and water of the affected areas were employed in this study. The findings of the results revealed the prevalence of abandoned mine pits ‘‘lottos’’ trenches and ponds that pose serious danger to grazing animals and human beings in the area. A total of 335,259.96m^2 (33.525 hectares) of grazing land, farmland and forest reserve have been degraded in all the 12 mining sites in the two LGAs. Also, in Didango, a total of 560,990m^3 of materials have been removed and dumped as mining heaps in the 3 mining sites. Other ecological impacts of the ASM include landslide, alteration of water courses, loss of biodiversity and wildlife habitats and pollution in surface and groundwater. This study recommend the need for the government to commence the process of remediation, reclamation or mitigation of the abandoned mine pits by undertaking inventory of such sites in the State and enforcing mining regulation to forestall future occurrences.

Keywords: Artisanal, Didango, Ecological, Small scale, Maisamari, Mining.

INTRODUCTION

It is usually impossible to extract any mineral from the earth surface without changing the natural environment in one way or the other (Mulligan, 1996). A mine usually requires access road, power, water, shade or houses that may impact on the ecosystem. The geological setting of a mineral deposit and type of mining basically determine the kind of ecological impact on the operational area. In Nigeria, most of the mining operations are carried out by artisanal and small scale miners which are usually surface mining carried out with little or no advanced technology to manage the ecological damages of the mining operations (Oladipo, 2006). Increasing ecological impact witness over the years is as a result of the fact that most of the miners undertake the operations illegally with no required government license or permit. Oftentimes, their area of operations are not known to the government officials. This makes it difficult for the government to monitor their operations in order to impose/enforce environmental regulations on them. Again, the government may/does not have adequate records of land degraded during these operations in parts of the State and country where this type of mining takes place. This makes future planning of policies of reclaiming, restoring and managing the mining environment difficult.

Mining operations often times leave the affected environment severely degraded, physically and socially. Degradation commonly occurs at all stages of mining activities from exploration to mine closure, resulting from both large and small scale artisanal mining operations (Walde, 1992). Until the 1970's environmental issues were not given serious/adequate consideration in mining policies by mining companies, government and the host communities. Environmental degradation was generally accepted as the price that had to be paid for the production of essential mineral commodities.

In Nigeria, prior to the coming into existence/the passing of the Mineral Act of 1946, there was no restoration clause in our mining law (Ahmed, 2008). Thus, the mines that were worked on in the 19th and early 20th centuries were left un-reclaimed and unrestored. More importantly/seriously, there was no strict enforcement of the environmental clauses in the 1946 mineral law. As a result, Nigeria has a legacy of derelictions from past mining activities. These derelictions are widespread across the country. The major environmental problems that are evident in these places include open pits, open mine entries, abandoned tailings and mine dumps, some toxic materials and unstable grounds associated with shallow underground working (Alex, 2007).

The recent wide spread upsurge in artisanal and small scale mining operations in various parts of the country, which were mostly un-regulated, has increased several folds the ecologically degraded sites in various parts of Nigeria. These degraded sites require to be investigated now.

Although, colonial mining operations were mostly confined to the present Plateau and Enugu States, mining operations have been going on vigorously in many other States of the federation without any record of their activities or their impacts on the ecosystem. These mining operations are undertaking mainly by artisanal and small scale miners. In most cases because their operations are illegal, government does not know their area of activities. Therefore, mining methods, minerals mined and their impacts on the ecosystem remained unknown.

The States where illegal or artisanal or small scale mining operations have been taking place for decades now include Kaduna, Niger, Kogi, Kwara, Oyo, Osun, Zamfara, Bauchi, Gombe, Taraba, Benue and Cross River (Ahmed, 2008). Available records indicate that industrial metals: precious metal, precious and semi-precious stones are mined in different parts of these States and in varying quantities. There are no records of the mining operations in these other States as in Plateau and Enugu States. There is also little or no literature on the illegal mining operations (Bugaji, 2006). It is therefore important that mining operations in these States should be investigated, recorded and brought to the attention of the public and government for information and policy planning.

Taraba State recorded a boom in gemstones mining in Sardauna LGA in 1996/97 and 2014/15. Mainly artisanal miners carried out the mining of these gemstones. The unconventional methods of operation of these miners resulted in landslide of a portion of the village killing over fifty people (Ahmed, 2008). Sardauna and Karim Lamido are two LGAs where gemstones and industrial minerals exist in commercial quantities and mining operations have been going on in several communities in these LGAs for so many years ago. Unfortunately, the operations of the artisanal and small scale miners (ASMs) are unregulated. As a result, the operations have impacted negatively on the ecosystem. This study therefore, examine the ecological impact of ASM operations in two LGAs (Sardauna and Karim Lamido) in Taraba State. The study focus on how much ASM operations have taken place in this area and what are the extent of damage done to the ecosystem.

MATERIALS AND METHODS

Desk review of existing data sources, including literatures, data bases and topographic maps prior to the initiation of field activities was employed. Field reconnaissance of the identified areas was carried out. This involved a field visit to all the identified mining sites. It involved field observation and measurements of abandoned mine pits and related features. These features include ''lotto'' pits, degraded lands from direct mining activities or erosion, destruction of conserved forest reserve, pollution of stream channels and contamination of soil and water bodies. Measuring tape was used to measure the extent of degraded areas as a result of artisanal mining operations. For very large areas where measuring tape was not adequate, the Garmin 12 X GPS was used. The ''Go – To'' and ''Sun and Distance'' menu was used to measure distances. A Garmin 12 X GPS (Global Positioning System) was used to determine the coordinates of the areas affected by the mining activities. The ''Go – To'' and ''Sun and Distance'' menu of the same Garmin 12 X GPS was used to measure distance and depths measured using steel tape. The volume of the areas of physical damage was calculated in the field. The Simpson's Rule of estimation of irregularly shaped land or ponds was used to determine the total area disturbed by artisanal mining operations of the past. The Simpson's Rule states that the area of an irregular shaped surface is a product of the mean of the maximum and minimum length and the mean of the maximum and minimum width measured (Ahmed, 2008). The choice of this method was because of its precision and ease of application. Only the GPS, measuring tape, ropes and pegs was required. Analytical samples of some selected soil and water were taken and analyzed for possible chemical impact of mining on the ecosystem.

RESULTS AND DISCUSSION

Minerals mined and Mining Methods

The most common minerals mined at Sardauna and Karim Lamido LGAs are gemstones, mainly blue sapphire, topaz and occasionally amethyst and garnet. The minerals occur as placer deposits in ancient river bed. The minerals were initially weathered from the host rock, eroded, transported, sorted and then deposited in the present environment. They were later covered by very thick overburden.

In the mining sites, ASMs operation include clearances of vegetation to create footpath and in mining area, manual digging and excavation, transportation, washing and sorting of minerals. All these operations are manually carried out. Three mining methods were identified in the area;

i. Traditional ‘‘loto’’ underground mining,
ii. Ground sluicing and
iii. Panning

The traditional ‘‘loto’’ underground mining method accounts for over 98% of the ASM operation in the area. In ‘‘loto’’ mining, vertical shafts (pits) of 2-3m in diameter are dug until the mineralized area (the wash) is reached. When the wash is reached, horizontal shafts are dug in four different directions to excavate the wash. The excavated wash is brought to the surface by manual haulage using pale and rob or bucket-wheel. The wash is then taken to the river for washing in sags. The remaining gravels are sorted out manually for the gemstone.

The vertical shafts are closely spaced, 1-5m apart and have varying depths ranging from 2-13m deep. All the vertical shafts (pits) are linked to one another underground.

Ground sluicing is another method of mining in the area. In this method, a trench is dug and material excavated from the river banks, river bed or even from the ‘‘loto’’ pits is placed in it. Water is directed to flow gently over it. Clay and fine materials are washed away leaving behind gravels from which the gemstones are sorted out.

The third method employed by the ASM operation is panning; sand gravels on the river bed or wash exposed at the stream banks are excavated using shovel and placed into head pan or calabashes. Using water and gravity separation, lighter and smaller fragments are discarded leaving behind heavier fragments, and gemstones are then sorted out from the residual fragments.

Extent of Degradation by ASM Operation

Findings from the study shows that one of the most visible signs of the ecological impact of artisanal and small scale mining activity in the State is the proliferation of abandoned mine pits. Decades of mining mostly artisanal and small scale miners had left behind numerous abandoned mine pits scattered throughout the State. Most of the mines or affected mining pits were abandoned or left in an inadequate reclamation status. These abandoned mine pits and their associated mine features constitute significant safety and environmental hazards to local communities and the natural ecosystem. The estimates of the number of abandoned mine pits in two LGAs (study area) in the State and their characteristics based on the existing data sources are presented in Table 1.

The Table 1 revealed that about 340,7432.82m^2 of grazing land, farmland and forest reserve have been degraded in 12 mining sites of 2 LGAs. The findings of the study shows that the nature of the degradation includes proliferation of numerous closely spaced ‘‘lottos’’/pits as well as mining dumps. This study further shows that at Didango, an estimated 560,990m^3 of materials has been excavated and dumped as mining heaps in 3 mining sites. These are baryte mining sites which involved the use of semi-mechanized bulldozers to remove the over burden and heaped at the mining sites as shown in Table 2.

Land Disturbances

ASM operation has caused significant land disturbance in the mining areas of the two LGAs. The indiscriminate sitting of ‘‘loto’’ pits has degraded the land of the affected area. The subsequent dumping of over burden and ‘‘after wash’’ (mainly gravels) has increased the surface area of the disturbed land. The area disturbed is irregular in shape (Plate 1); therefore, Simpson’s Rule of estimation of volume of irregularly shape or ponds was partly applied to determine the total surface area of the land disturbed in this area. In this method, the maximum length and the minimum length determined the interval of width measurement and the maximum width determine the interval of length measurement. For example if the maximum length is between 81-90m, then width measurement are taken at intervals of 9m and vice versa.

In the field four cardinal points of the area were first determined and pegged using wooden pegs to give the area a rectangular shape. The intervals of measurement were determined and pegged and then all the length and

Table 1. Surface Estimate of Degraded Mine Land in Taraba State

Location	Mining Site Area	Length (m)	Width (m)	Surface (m^2)
Maisamari	1	469.33	254	119,209.82
	2	200	118	23,600
	3	324	207	67,068
	4	267	68	18,156
Yelwa	5	150	80	12,000
	6	200	30	6,000
Gurgu	7	250	63	15,750
Didango	8	382	95	36,290
	9	238	35	8,330
	10	420	32	13,440
Jukun	11	128	59	7,552
	12	142	94	13,348
Total				304,743.82

Source: Fieldwork 2013.

Table 2. Estimation of Materials Removed and Dumped at Mining Sites at Didango

Location	Mining Sites	Length (m)	Width (m)	Depth (m)	Volume (m^3)
Didango	8	382	95	12	435,480
	9	238	35	7	58,310
	10	420	32	5	67,200
Total Volume					560,990

Fieldwork, 2013.

Plate 1. Regular - Shaped Trench of Abandoned Baryte Mining Site at Didango

the width measurements were taken and tabulated. The measurements were all taken using the ‘‘GO-TO’’ and ‘‘SUN-AND-DISTANCE’’ Menu of GPS and steel measuring tape.

Table 3. Length and Width Measurement of Degraded Mine Site at Maisamari

S/No	**Length Measurement (m)**	**Width Measurement (m)**
1	L_1 =355	W_1 = 270
2	L_2 = 360	W_2 = 178
3	L_3 = 374	W_3 = 289
4	L_4 = 458	W_4 = 284
5	L_5 = 520	W_5 = 268
6	L_6 = 538	W_6 = 242
7	L_7 = 547	W_7 = 238
	L_8 = 542	W_8 = 230
	L_9 = 520	W_9 = 187
	4,214	2,186
	Average = 468.22m	**Average = 242.89m**

Fieldwork, 2013

Plate 2. Examining Mining Impacts on Stream Channel in Yelwa town

The maximum length was measured to be 547m. So, width measurement were taken at intervals of 55m while the maximum width was measured to be 289m and the length measurement were taken at interval of 29m and the result is presented in Table 3. The average length and width were calculated and the total surface area determined using simple arithmetic multiplication of average length and average width.

The average length calculated was 468.22m and the average width was 242.89m giving a total surface of area of the disturbed land to be 113,725.96m^2.

Erosion, Subsidence and Instability

Stripping the land of the mining sites of its vegetation cover has aided erosion in the area. Topsoil and overburden, which are loosely dumped on the surface, were observed to be easily washed away by surface run-off. Also, areas of ground sluicing to pre-concentrate gravels to recover gemstones in some areas resulted in gully erosion. Subsidence was evidenced in areas of old underground ''loto'' excavations. About 50% of the pits enumerated in the area has lost its smooth topography because of this active subsidence (Plates 3 and 4).

The surface area of the Mambilla plateau is predominantly made up of lateralized volcanic rocks overlying the basement complex. The area is characterized by undulating topography with very steep slope. During the reconnaissance and preliminary visits of this study in 2007, it was observed that 3 landslide sites in Maisamari and environs resulted in the loss of over fifty (50) lives. The southern part of the Maisamari mining site which consist of lateralized basalts overlying the basement complex at the foot of a steep hill and with the presence of ''lotto'' underground excavations is potential landslide zone. This study described the area as a landslide disaster zone. The area should be avoided especially during the pick of the rainy season.

Plate 3. Land degradation as a result of Collapse of Mining Walls at Yelwa Mining site

Plate 4. Collapse of Walls in a Baryte Mining Pit in Didango, Karim Lamido LGA

Alteration of Water Courses

ASM operation like underground sluicing has resulted in re-direction of water courses thereby obstructing the natural surface water flow. However, this impact is not very severe compared to others as ground sluicing is minimally practiced in the area. Few areas of minor gully erosion were observed resulting from this mining by ASMs.

Effects of ASM on Availability, and Quality of Surface and Groundwater

ASM operation especially of alluvial deposits relies heavily on water for washing and pre-concentration. In fact, field observations have revealed that lack of availability of surface water slows down ASM operations. In the study area, two main activities; exploitation and processing have affected both the surface and ground water quality and quantity. The discharging and or dumping of overburden into streams as well as washing, panning and ground sluicing to pre-concentrate gravels have seriously polluted the available surface water in the area (Plate 5). This agrees with Ojo (2006) that ASM operations constitute serious pollution to surrounding water. The pollution is further revealed by the excessive total dissolved solutes in the water of the area from laboratory chemical analysis. ‘‘Lotto’’ pits and open cast

Plate 5. Polluted Stream Channel as a result of Mining Activities at Yelwa Mining Site

excavation (Didango) in most area have created artificial reservoir that have definitely affected the ground water system of the area.

Heavy Metal Contamination

Concentration of placer deposits by natural processes of erosion, transportation, sorting and deposition is also associated with accumulation of heavy metals. These mineral deposits and the heavy metals which were initially buried in the area by overburden have been exposed by ASM operation and in some places discharged into available surface water sources like ponds and streams that are really used by man and animals. Dumping of mining waste in water does not only affect the physical quality of water but also its chemical quality. Also, exposure of minerals to the atmosphere in the presence of weak carbonic acid induced chemical reaction that affect the water quality. The mining pits contain water that is reacting with the mineralized environment. The mining pit water in turn recharges the ground water system.

Direct Impact on Vegetation

Vegetation/forest is one of the major resources that is susceptible to mining activity. The main ASM operations that have affected vegetation in the mining area is the clearance of vegetation to create access road to the mine, to construct wooden bridges that lead to the area, and also the clearance of vegetation prior to commencement of exploitation. About 60% of the mining sites was initially a forest. The entire area affected by ASM operations is estimated at 119,209.82m^2. Therefore, 60% of this area will give 71,525.89m^2 (60% of 119,209.82m^2 = total surface area). The findings also revealed that 5km (5,000m) of the road that lead from Maisamari town to the mining site was cleared of its vegetation prior to mining operations in the area. The average width of the road was estimated at 2m giving a total surface area of 1000m^2(2m x 5,000m). The total surface area cleared of vegetation in Maisamari site 1 (both mining site and road) is summed at 81,525.89m$^{2.}$

Loss of Habitat

Habitat loss in the area refers to physical disturbance of habitat through clearance of vegetation. The mining site is one of the thick forested areas in Maisamari and the surrounding settlements. Findings from oral interview revealed that the mining area was where major wildlife were found. The clearance of vegetation as well as other activities have destroyed wildlife habitats and driven most of the wildlife further away. In addition to clearance of vegetation, some of the factors that have led to loss of habitat include noise and disturbances from the miners, motor cycles and blasting.

Displacement of Fauna

The loss of habitat describe above has resulted in displacement of certain faunal species (animals driven away) and the consequence is disequilibrium of the ecosystem. Some animal species are scavengers and their displacement from their habitat may lead to food shortage with adverse effect on mortality.

Loss of Biodiversity

Every ecosystem is inhabited by certain faunal and floral species. Mining activities that normally and significantly change the shape and face of the earth will certainly result in loss of biodiversity. In Maisamari mining site 1, the clearance of vegetation to create access road and prior to mining has resulted in the loss of a lot of trees, shrubs and grasses of different species. The dumping of overburden has also destroyed some plant species. This agrees with the report of Ashawa (2007) that vegetation clearance lead to loss of biodiversity. During the reconnaissance survey some non-aquatic faunal species like rats, rabbits and reptiles were seen to have lost their lives in some of the ‘‘loto’’ pits filled with water. Also, the presence of these numerous pits has endangered the lives of human beings and animals. Few cases of livestock falling inside the ‘‘loto’’ pits have been reported.

Creation of New Habitat

The clearance of the forest, which has driven predators had created new habitat for non-predator. Also, the availability of numerous pits that hold water year round has created new habitat for aquatic lives. During the field observations some of the shallow pits that hold no water have been habited by mammals such as rats and reptiles like snakes and lizards. This is the only positive impact of ecological disturbances of ASM operation in Maisamari mining site.

CONCLUSION

This study has examined the ecological impact of ASM operation in Taraba State. The study findings revealed that the large number of people involved in ASM operation contribute to the ecological impact observed in the mining sites. The ecological impacts include prevalence of abandoned mine pits ‘‘lottos’’ trenches and ponds that pose serious danger to grazing animals and human beings in the area. A total of 335,259.96m^2 (33.525 hectares) of grazing land, farmland and forest reserve have been degraded in all the 12 mining sites in the two LGAs. Also, in Didango, a total of 560,990m^3 of materials have been removed and dumped as mining heaps in the 3 mining sites. Other ecological impacts of the ASM include landslide, alteration of water courses, loss of biodiversity and wildlife habitats and pollution in surface and groundwater. This study recommend the need for the government to commence the process of remediation, reclamation or mitigation of the abandoned mine pits by undertaking inventory of such sites in the State and enforcing mining regulation to forestall future occurrences.

REFERENCES

Ahmed YM (2013). Characterization of Artisanal and Small Scale Mining in Parts of Taraba State Nigeria. An Unpublished Ph.D Thesis submitted to the Department of Geography, University of Jos in Fulfilment of the Requirement for the award of the Degree of Doctor of Philosophy of the University of Jos, Nigeria.

Ashawa Consult Ltd (2007). ‘‘Health, Safety and Environmental Plan, Remediation/ Rehabilitation/Reclamation of Abandoned Mines and Quarry Sites in Nigeria. Ashawa Technical Report Submitted to MMSD, Abuja, Nigeria.

Alex CC (2007). ‘‘The Ecological Impact of Mining Industry’’ being a paper presented at MMSD Sponsored Workshop, Abuja, Nigeria.

Bugaji BM (2006). Final Report on Action Plan for Artisanal and Small Scale Gypsum Mining Pilot Project, Nafada, Gombe State. Unpublished Technical Report Presented to Ministry of Solid Mineral Development, Abuja, Nigeria.

Mulligan D (1996). Environmental Management in Australian Minerals and Energy Industries. Principles and Practice, Sydney, Australia.

Ojo OM (2006). ‘‘Mining and Communities’’. Unpublished Report Presented at the Launching of Sustainable Management of Mineral Resource Project (SMMRP), Abuja, Nigeria.

Oladipo SO (2006). Status of Nigerian Mineral Resource Industries (ASSM Perspectives). Being a presentation atthe Nigerian Mining and Geosciences International Conference, Kaduna.

Walde T (1992). ‘‘Environmental Policies Towards Mining in Developing Countries’’. *Journal of Energy and Natural Resources,* 10(4): 327 – 357.