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ENVIRONMENTAL AND HEALTH IMPACT OF SOLID MINERAL EXPLORATION AND EXPLOITATION IN SOUTH-NORTHERN NIGERIA: A CASE STUDY OF IGARRA IN EDO STATE

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ABSTRACT

The act of quarrying/mining and the subsequent processing and transporting of these raw materials are greatly hampered by high environmental and health costs. This is observable at the quarry sites, processing factories and the surrounding environments. It is important to state that the environment of the northern part of Edo State has suffered in many areas where exploitation of earth resources by quarrying method and the subsequent processing are carried out. This was revealed from the fieldwork. The importance of these minerals to the nation's economy cannot be undermined. There is no wisdom therefore to suggest that mining activities be eliminated in order to sustain the quality of the environment. What should be done is for the government, industrial prospectors and environmentalists to take precautionary and remedial measures that can minimize the ill-effects of mineral development. Emphasis should shift to sustainable exploitation of the resources, while the enforcement agency should ensure that quarrying and mining of rocks by the industrial prospectors are in line with the Quarry Act of Nigeria 1979.

Keywords: Environment, Degradation, Quarry, Mining and Exploitation.

Contribution/ Originality

The study contributes to knowledge on the environmental impacts and processes of solid minerals exploration and exploitation in Nigeria. It also makes available materials for further research work on the subject matter.

1. INTRODUCTION

The environment is dynamic. It undergoes modification by several natural processes such as climatic and tectonic processes, and thus imposed physical constraints on human activities. However, artificial modifications of the environment do occur and it has become noticeable in recent times, and man has proved to be the main actor in this regard [1]. Exploitation of mineral resources has assumed prime importance in several developing countries including Nigeria [2].

Nigeria is endowed with abundant mineral resources, which have contributed immensely to the nation's wealth with associated socio-economic benefits. Mineral resources are an important source of wealth for a nation, but before they are harnessed, they have to pass through the stages of exploration, mining and processing [3].

Mineral exploitation in Nigeria dates back to the geological expeditions by the colonial master in the early part of the 20th century [4], [5]. It has resulted in revenue accruing earnings and economic development. In the southern part of Nigeria, especially the northern part of Edo State, solid mineral exploitation is an everyday activity that is currently going on. The mining industry in Edo State is of great potential which has the capacity to contribute to local and foreign exchange earnings as well as the attraction of foreign direct investment thereby boosting the country's economy. These economic raw materials that are exploited from these areas have some environmental impact associated to it. This impact is observable at the quarry sites, processing factories and the surrounding environments. The degradation of the environment have in turn affected agriculture, vegetation, wild life and even pose a threat to the health conditions of the mine or quarry workers and every other persons living within the surrounding environment. It is the objective of this paper to present in a nutshell the environmental impacts of the activities involved in harnessing solid minerals in Edo State, using Igarra as a case study.

2. STUDY LOCATION

Igarra is derived from IGALA, the original ancestor who inhabited the union of IGALA/OKPOTO and eventually migrated to the present Kogi State between the 13th and 16th centuries. Igarra area lies within Latitudes 7°00'N-7°30'N and Longitudes 6°00'E-6°30'E at the northern fringe of Edo State, Nigeria (see figure 1). It is underlain in the north by Precambrian Basement Complex and in the south by Cretaceous and Tertiary sediments. The northern part is rich in industrial and metallic minerals which are currently at various stages of exploitation (see Table 1). The area has been sufficiently studied by Odeyemi [6], Rahaman [7] due to the relatively unweathered and well-exposed outcrops.



Figure 1: Location Map of Study Area (Northern part of Edo State, Nigeria)

Table-1. Some of the mineral deposits in the study area

Mineral deposit	State of exploration	Mining company	Lateral extent of deposit
Egbigele marble	Fairly exploited	Unknown	0.42km ²
Egbigele-Ate marble	Unexploited	Unexploited	2 km ²
Ekpedo marble	Unexploited	Unexploited	5.27 km ²
Eruru/Ojirami marble	Fairly exploited	Unknown	0.42 km ²
Igarra marble	Moderately exploited	Geoworks Nig Ltd	9.0 km ²
Igwe marble	Fairly exploited	Freedom, Hussler	16 km ²
Ikpeshi marble	Moderately exploited	Freedom Group of Companies	4.5 km ²
Ikepi marble	Unexploited	Unexploited	3.9 km ²
Imekebu feldspar	Fairly exploited	Freedom Group of Companies	1.2 km ²
Isikwi kaolin	Fairly exploited	Freedom Group of Companies	3.2 km ²
Oguda marble	Highly exploited	Gamblers Nigeria Limited	0.8 km ²
Sasaro marble	Fairly exploited	Eshevesho Nigeria Limited	1.1 km ²
Ubo marble	Fairly exploited	Freedom Group of Companies	24 km ²
Ukpella marble	Highly exploited	Unknown	4 km ²

Source: Tsekpo [8]

The national population commission census of 2006 projected the population density of Igarra to about 700,000 people. The main activities indulge in by the populace is agriculture which is practiced at both the subsistence and commercial scale. Food crops are mainly yams,

cassava and plantain while cash crops include cocoa and palm produce. The local people are also gainfully employed in the quarrying of rocks in the area.

The climate is tropical, that is, warm and humid climatic condition. Vegetation is the guinea savanna, with denser forest fringing some of the rivers and steeper slopes formed by the ancient sedimentary rocks in areas where they overlie the basement. There are variable species of animals, which inhabit this environment. They include mammals, reptiles, birds, rodents, crickets and insects. Grazing of cattle such as cows, sheep and goats are carried out mostly by the nomadic Fulanis. The area is drained by many rivers and the prominent ones include River Onyami and its tributaries as well as River Ojo, Orle, Edion and Obe and Ubo with the tributaries. The drainage density of Igarra can be described as light as the drainage channels are sparsely separated.

Rahaman [7] grouped the rocks of the basement complex into six:

- Migmatite-gneiss-quartzite complex;
- Younger metasediments, commonly referred to as the schist belts;
- Charnockitic, gabbroic and dioritic rocks;
- Older Granites;
- Volcanics and hypabyssal rocks; and
- Unmetamorphosed dolerite dykes, basic dykes and syenite dykes.

The Precambrian Basement Complex in Igarra area is made up of a metasupracrustal suite comprising of quartzites, quartz-schists, metaconglomerates, marble and calc-silicate rocks. Within this area is the Igarra schist belt. A detailed study [6] shows that the said schist belt can be classified into four groups:

- Quartz-biotite schist with intercalated quartz-pebble conglomerate;
- Calc-silicate gneiss and marble;
- Polymict metaconglomerate; and
- Phyllites and muscovite schists

All the above groups of rocks have undergone various degrees of deformation with the adjacent migmatite-gneiss-quartzite complex. There have also been a lot of migmatization and granitization in some places as a result of emplacement of Pan African granite plutons which marks the last of the Precambrian activities to affect the Igarra area [6]. The dominant structural trend in the study area is approximately N-S, and this is defined by mineralogy, lithology, axial planes and cleavages. The geological complexity of the study area is therefore not in doubt. This probably has been responsible for the existence of diverse rock and mineral types, particularly industrial minerals that are being exploited by several industries providing employment for hundreds of people.

3. IMPACT ON THE ENVIRONMENT

Mining of solid mineral provides a variety of socio-economic benefits; its environmental and social costs, if not well handled, can be massive in terms of land conversion and degradation, habitat alteration, water and air pollution. In Nigeria, the mining sector is generally thought to be the second largest source of pollution after crude oil production [9]. The sector is resource intensive and generates high concentrations of waste and effluents. Environmental impact arising from the mining and processing of industrial rocks and other minerals in this part of Edo State, results in the pollution of air, water or soil materials which interferes with human health, the quality of life and the natural functioning of the ecosystem [4], [10]. It also results in the defacement of the landscape, increased rate of soil erosion and deforestation. The noise and vibration caused by blasting of rocks with explosives (dynamite) have caused adverse effect on buildings and people leaving within the surrounding communities. These impacts caused by mining activities in this area are further discussed.

(a) Defacement of the Landscape

This is easily noticed in the quarry sites where, the aesthetic value of the environment is totally reduced. The presence of several mine pits makes the area unsightly. The common wastes generated by the open pit method of mining are overburden materials and waste rocks. These wastes are dumped as heaps by the side of the pits, which generally have steep slopes and are unstable, so sliding frequently occurs. Common sites are observed at granite quarries at Imeke and marble quarries at Ikpeshi and Igarra. Some of the pits are filled up with water to create ponds or artificial lakes. Observation also shows that most of these ponds are being used as breeding grounds for mosquitoes, algae and reptiles. In some cases, they are used by the inhabitants as source of drinking water as well as swimming pools (see plate 1).

Plate-1. Abandoned mine pits filled with water in Igarra and Ikpeshi



(B) Increased Rate of Soil Erosion

The unprecedented demands from the rapidly expanding human population and advancement in technology are causing a continuing decline in the quality of the environment and its ability to

sustain life [11]. The excavation of sand in particular for building purposes in the area underlain by sedimentary rocks such as Afowa, Ayoguri, Fugar and Apana have caused considerable damage to the land. This activity has opened up all the landscape to severe erosion. However, the rate of erosion is highest where the action of water removes debris from the land and flow down slope. Erosion of the landscape is also prevalent in area underlain by crystalline rocks where quarrying activities occur on daily basis. These are found in the highly vegetated and grassland areas. Once a prospector identifies a suitable mineral deposit, the land surface is stripped of their vegetation. This action exposes the fertile topsoil to erosive work of water as it washes away loose soil, leaving behind materials, which cannot support plant growth. A good example is an abandoned granite quarry at Igarra and the sand burrow pit at Afowa (see plate 2). Some of the burrow pits are up to 2.0sq km in area. In the sand quarries, this forms temporary base level for the erosive action of water as it incises gullies on the surrounding landscape as well as sediment deposition problems downstream. Spawning grounds for fish and other wild life habitat are often destroyed. During rainy season, prolonged high flood interfere with the drainage and the economic use of land.

Plate-2. Destruction caused by erosion in Ayoguri and Afowa



(c) Air Pollution

In the course of drilling into the hard rocks, blasting by explosives and crushing processes, large amounts of very fine dust particles are released and dispersed by wind over wide areas. Visits to quarry sites at Igarra and the marble quarries in the hinterlands as well as the factories where these rocks are processed, particularly Auchi-Igarra road reveals high concentration of dust in the air and surrounding vegetation (see plate 3). The dust is mainly made up of fine particles of marbles, granite dusts or clayey materials. [10] observed that the inhalation of these fine solid-particles dispersed in air has resulted in respiratory disorder among some quarry workers and those living around. He stated that crushing of the granite (a siliceous rock) to stone dust exposed the operators and other quarry workers using the heavy-duty machines to some kinds of environmental and occupational disease known as silicosis, a lung disease of miners.

These he said are more intense in work settings than in the general environment. [10] attributed the diseases to be caused by chemical agents, radiation and physical hazard to water pollution and air pollution.

Plate-3.Gaseous particles emitted into the atmosphere from mine sites



The burning of the fuels used by generator and heavy-duty vehicles in quarries and processing sites has contributed tremendously to the increase in carbon dioxide in the environment. The significance of this increase in carbon dioxide production is its potential for raising the temperature of the earth through the process known as the “*green house effect*” [12]. Carbon dioxide in the atmosphere prevents the escape of outgoing long-wave radiation from the earth to outer space; as more heat is produced and less escape, the temperature of the earth increases [13]. The contribution of the activities of quarry and mining is a significant of global warming of the atmosphere, which invariable would have serious environmental effects. Global warming of the atmosphere could result in:

- Climatic changes both regionally and globally
- Alternation in the natural vegetation, which affect crop production
- Rise in sea level

All these changes would in turn have great impact on human life. In addition to the burning of fuel is the deposition of acid. This is caused by the emission of sulfur dioxide and nitrous oxide into the air by heavy-duty motor vehicles used in the quarries on daily basis. It has been remarked [14] that interaction of climates with sunlight, moisture and oxidants, lead to the production of sulfuric acid and nitric acids. These are carried with the atmospheric circulation and eventually come to the earth during rainfall as acid rain, and as dry deposits in the form of dry particles and atmospheric gases. The consequence of this is its ability to corrode metals and monuments built of marble, destruction of vegetation and acidify streams and soils [15].

(d) Impact of Noise Level

Noise is one of the major environmental hazards arising from the quarrying of rocks in this part of Edo State. Noise is generated during the processes of excavation, drilling into the hard

rock with jackhammer and blasting of the crystalline rocks with explosives. Noise is also generated through the movement of heavy-duty trucks, as well as mineral processing machines and power generated by diesel generators. All these operate for several hours in a day. The noise emanating from these activities constitute a nuisance not only to the mine workers, but also to the inhabitants living around the quarry sites.

According to [World Health Organization \[16\]](#), noise in the workplace is responsible for the most prevalent occupational impairment, hearing loss or permanent deafness. The International Coordination of Environmental and Occupational Control activities, which is guided by WHO carried out studies in several parts of the world with similar problems. Their findings showed that exposures of mine workers and the inhabitants of the mining areas to high noise levels enhance the development of psychological problems among few people, increased irritability among many and resulted in slow reaction time and general fatigue among most inhabitants of the area.

(e) Impact on Buildings

The shock waves generated by the explosion of the dynamites travel considerable distance away from the quarry sites and are also accompanied with very loud noise, which have devastating effect on persons, buildings and the surrounding communities. This action is very much pronounced where granite quarries are not too far from residential buildings. Cracked and dilapidated buildings caused by these activities are common sight at Ikeshi and Igarra (see plate 4).

Plate-4. dilapidated buildings residing by indigents of the mine and quarried communities



(f) Impact on Vegetation and Wild Life

One of the environmental problems from quarrying of rocks in this part of Edo State is deforestation. Evidently, majority of the rural poor in northern part of Edo State earn their livelihood directly from the rich natural resources—land and forests - through farming, hunting and related activities. Large areas of land in square kilometers have been cleared, thus destroying the forest that many animal species depends on for food and habitation (see plate 5). This disrupts the balance in the ecosystem and many species known to inhabit this environment may have

migrated away or are exterminated. Hunting is seldom practiced as compared with southern part of the state where no such mining is done, and is very rich in avian (cattle egrets, kites, vultures and sparrows) reptilian (Iguana, snakes and crocodiles) and mammalian (monkey, antelopes and deer).

Plate-5. Bulldozer bringing down forest trees and removal of topsoil for quarry site



(g) Impact on Agriculture

Arable land for farming are getting depleted in these mining district and farmers are forced to cultivate less fertile lands, thus, reducing productivity. In many areas, this overburden materials excavated are deposited as tailing heaps, and in some cases are leveled and spread over large areas using bulldozers. After the lush vegetation of the land in which mining operation is carried out has been removed, the area rarely recovers (see plate 6). This is because there is no longer good root system to anchor the topsoil or decaying plant matter to replenish the nutrients. If this is allowed to continue over a long period of time, the area may eventually transits to a desert land. The consequence of this environmental impact on the life of the people is low food production and this leads to hunger and starvation. In other cases, some mineral deposits such as marble are found within agricultural areas such as cocoa plantations. An attempt to mine these deposits results in the destruction of so many of the economic trees, which are destroyed during surface mining of marble. Such farmlands have been destroyed at some marble quarried at Igarra.

Plate-6. Degraded arable lands caused by the quarrying and mining of rock materials



(h) Impact on Water

The wastes generated as a result of mining is mainly overburden materials and waste rocks. The materials are mainly soils and gravels which are chemically inert. When transported to the stream channels, they do not interfere with the chemistry of the water. However, because of their massive influx into the stream channels, they increased the turbidity and bed loads of the streams. Studies were conducted by Tsekpo [8] on some prominent rivers and stream located within the Basement terrain where the mining of marble are actively being carried out. The other test was carried out on a river devoid of marble occurrence. The aim was to determine the effect of quarrying and processing of this solid mineral on the surface water as the inhabitants depends much on the water for domestic purposes. There was significant difference between the two areas with respect to two of the parameter tested for hardness and calcium content. It was shown that the rivers which drained the marble outcrops has more calcium content as well as hardness value than the rivers which drain areas devoid of marble occurrence. The source of the calcium is undoubtedly the marbles being quarried within the drainage basin of the stream. The high amount of calcium in the form of carbonate has resulted in the hardness of the water from those rivers and streams. The consequences of hard water, is its inability to lather with soap. The temporary hardness of the water is removed by boiling the water. This will impact economically on the users of the surface water for laundry purposes, as much money will be spent on soap and boiling to soften the water.

(i) Social Impact

Mineral extraction does not only directly affect the biophysical environment of the rural communities in Edo State, but also indirectly affects the socio-economic and socio-cultural environment of the communities as well. Such social impacts range from health, conflicts, problems related to drug use and alcoholism and other social vices like robbery and divorce.

- **Impact on Health**

The flow of liquid and gaseous pollutants into the environment poses health and safety risks for those living in and near it Tuffour [15]. These pollutants include air pollution due to emissions such as sulphur dioxide from processing plants, run-offs from mine processes and leakages from rock and tailing dumps that contain various elements and chemicals detrimental to human health [8]. Inhaling large amounts of siliceous dust and sharing poor air quality in the mines are some of the major causes of health hazards among miners. Rock mining activities usually produce silica-rich respirable dust particles that can cause silicosis and tuberculosis as well as aggravate the situation of people with respiratory diseases such as asthma. In this part of Edo State where surface mining and small-scale mining are practiced, vector-borne diseases such as malaria and schistosomiasis are common. This is largely due to the stagnant ponds which are breeding grounds for mosquitoes.

- **Conflict**

One result of openness in the mining sector is the rampant social conflict that exists in mining communities [17]. The widespread discontent in those communities is the result of their total or partial alienation from actively taking part in decisions affecting them believing falsely that planners or policymakers know best. The people of Igarra and other communities where solid minerals are mined feel cheated by not taking part in decisions affecting their livelihood or not benefiting adequately from their “*God given*” natural resource on which their livelihoods depend (see plate 7). As a result, some of the people in the mine communities resort to legal and non-legal actions in their bid for self-determination and the control of their own resources [17]. These conflicts have resulted in the destruction of property, death and have seriously affected livelihoods in Ikeshi, Igarra and other smaller mining communities.

Plate-7.Community indigents protesting against the quarrying and mining of rock materials



4. REMEDIAL PROCEDURE ON MINERAL EXPLOITATION

An acceptable degree of rehabilitation of mined over area is possible, but at considerable cost. The surplus waste left on the surface such as the dumps and heaps of overburden materials can be leveled out and landscape to blend with the general surrounding environment. The fill should be compacted mechanically to the natural soil density of the surroundings. Because of the danger of soil erosion, rapid replanting is essential. This will involve covering the site with soil, as the fill material on its own cannot support vegetation because it is infertile, soil can be imported from elsewhere.

Vegetation helps to stabilize the ground as it reduces percolation of water and prevent erosion by water. Active mine sites could be screened, landscaped and beautifies to improve their aesthetic values. Alternative to landscaping of dug pits and ponds is to convert them to fish ponds if the right condition exists. Dust pollution can largely be eliminated by adoption of technologies that will release less dust or water could be sprayed into the air to dissolve the dust particles. The working area should be well ventilated so that there is rapid dilution of dust particles by air. Noise produced by blasting operations could be reduced by minimizing the use of explosives especially in sites close to settlements. Only those explosives approved for quarrying by the Quarries Act of Nigeria should be used and the regulation for their use strictly adhered to.

5. CONCLUSION

Solid mineral exploration and exploitation investments in Nigeria and indeed the African continent are greatly hampered by high environmental and health costs associated with its mineral investigation, processing and transporting amongst others. The prevailing methods and technology used for exploitation contributes to the striving of the available fertile lands, forest and sources of ground and surface water. This is noticeable through great danger posed by mineral exploitation such as abandoned sites, biodiversity damage, use of hazardous chemicals with potential health risk to mine workers and neighbouring communities. This was revealed from the fieldwork were majority of the respondents interviewed agreed that there have been outbreaks of waterborne diseases resulting from mining, reported cases of acid rain, respiratory ill-health, hearing loss, high blood pressure, intensive noise, land defacement resulting to loss of soil fertility, accelerate soil erosion, vibration affecting building structures, disturbance to wildlife as well as decline in agricultural productivity of the immediate bearing communities.

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