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THE IMPACT OF ZINC AND LEAD MINING ON AIR QUALITY AT AGALAGU ALIKE IN IKWO LGA OF EBONYI STATE

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ABSTRACT

Atmospheric air consist of mixtures of gases composed mainly of nitrogen and oxygen with small proportion of carbon, noble gases and water vapor essential for the sustenance of life on earth. Anthropogenic activities in diverse ways may threaten the quality of atmospheric air and impairs its quality on life. The introduction of any chemical, physical, or biological agent into the atmosphere, in quantities large enough to produce harmful effect to man and its surrounding environment calls for concern. Therefore, an assessment is needed on air quality and on this basis; air quality test was carried out at the mining site at Agalagu Alike in Ikwo Local Government Area of Ebonyi State, and the results collated indicated lesser air pollution across the mine site, except NO_2 *and* SO_2*. Although the level of* NO_2 *concentration in the study location can be attributed to the activities of mining going on in that area. It was also observed from the results collated that the particulate matter at the study location and immediate environment was very low, which could result from the season of the year (wet season) which the analysis was carried out. Other pollutants like* NH_3*,* H_2S *VOC, and CO were not detected within the coordinates studied in the location. The level of* O_2 *within the location was found to be the same across all the sampling points, with a value of 20.9.*

Key words: Air Pollution, Heavy Metals, Mining, Air Quality and Particulate Matter.

INTRODUCTION

Environmental quality is an imperatively straight and meandering determinant of human health. According to WHO (1997), weakening environmental settings are one of the major factors that contribute to poor healthiness and reduced quality of life, which in turn hinders sustainable development**.** Dust from mining operations if allowed to reach the atmosphere creates an incompatible environment or causes excessive wear on machinery, reduces visibility or increases the rate of accidents and also contributes to winding diseases such as fibrosis, pneumoniasis and scarring of the lungs as a result of repeated inhalation of minerals such as silica, asbestos and coal dust (Health and Safety Council Guidelines, 2018). Mining activities and mining support companies discharge particulate matter into the ambient air. The grievances of the affected communities on air quality have been the airborne particulate matter, emissions of black smoke, noise and vibration. The activities that produce this particulate matter noise pollution include all processes involved in mining, ranging from site clearance and road building, open-pit drilling and blasting, loading and haulage, vehicular movement, ore and waste-rock handling as well as heap leach crushing by companies during heap leach processing. Dust from Zinc-Lead mining operations has a high silica content which may be responsible for silicosis and silico-tuberculosis (Akabzaa and Darimani, 2001).

Unfortunately, the many mining companies have not laid down adequate measures to prevent harmful emissions of dust into the ambient air or measures to reduce air pollution. Measures to reduce dust emission are restricted to occasional spraying of roads within the premises of the mining concessions. This seems to be a misplaced effort because road dust does not appear to be the main source of dust pollution. Airborne emissions occur during each stage of the Zinc-Lead mine cycle, but especially during exploration, blasting, development, construction, and operational activities. Mining operations mobilize large amounts of material, and waste piles containing small size particles which are easily dispersed by the wind. Once pollutants enter the atmosphere, they undergo spontaneous changes before reaching a receptor. These pollutants can cause serious effects to people's health and to the environment at large. Large-scale mining can significantly contribute to air pollution, especially in the operation phase. All activities during ore extraction, processing, handling, and transport depend on equipment, generators, processes, and materials that generate hazardous air pollutants such as particulate matter, heavy metals, carbon-monoxide, sulfur dioxide, and nitrogen oxides.

According to Banez, *et al.* (2010) inhalation of dusts can cause "pneumoconiosis" which is a term that refers to a group of lung diseases. Local communities can potentially be affected by dust up to 1km from the source, although concerns about dust are most likely within 100meters. Deposited dust gives rise to the greatest number of complaints to mines and quarries from local communities, particularly for contrasting colours that are more noticeable on deposition. Settled particles may show up particularly on clean or polished surfaces such as cars, windows and window ledges, or surfaces that are usually expected to remain free from dust. The impacts from mining activities on the health of people are quite significant as blasting vibrations have also resulted in cracks in several buildings exposing the occupants to danger. Other potential mining effects which are of concern to environmentalists include biodiversity loss, land degradation, nuisance effects, reduced plant growth, etc.

Particulates are the tiny solid or liquid particles that are suspended in air and which are usually individually invisible to the naked eyes (Baird, 1997). The particulates include soot, smoke, ash from fuel (mainly coal) combustion, dust released during industrial processes like mining of ores, quarrying and other solids from accidental and deliberate burning of vegetation (Montgomery, 2012). Mining generates a lot of particulate matter (dust) with diameter 1 - 75µm (micron). Particles with aerodynamic diameters of less than 50µm (termed Total Suspended Particulate matter, or TSP) can become suspended in the atmosphere, and those with aerodynamic diameters of less than 10µm termed PM_{10} (inhalable particles) can be transported over long distances (Nickling, 1998) and enter the human respiratory system (Ferris *et al.*, 1979; Miller *et al.*, 1979).

Total Suspended Particulate matter is the concentration of all particles in the atmosphere. Particles with aerodynamic diameters of less than 2.5µm (respirable particles) are most effective at scattering light and have a great effect on visibility or visual intrusion (Malm, 1979), impairment and the earth's radiation balance (Charlson *et al.,* 1992).

Air pollution also causes damage to man-made materials and structures, changes the weather and interferes with comfortable enjoyment of life, property or human activities (Ward *et al.,* 1993). Air pollutants such as dust are unhealthy particles (solids, liquid gas mixtures) that are liable to harm both living and non-living things (Ward *et al.,* 1993). According to Baird (1992), when air quality is monitored, the most common measure of the concentration of suspended particles is the PM index which is the amount of particulate matter that is present in a given volume of air. In spite of the dangers of the dust emission resulting from numerous mining and quarrying activities going on in the study location, there has not been any study on the effects of these activities on the environment and the healthiness of the people living in the study area. The main source of airborne particulate matter include the following activities: site clearing, road construction, top soil stripping and dumping, open pit drilling and blasting, stripping, loading and haulage (Akabzaa, 2000).

In an article contained in one of the National Dailies Newspaper dated April, 2014, residents of Ikwo and Ishiagu LGAs all in Ebonyi State voiced their suffering over dust, noise and tremors caused by blasts where they were particularly apprehensive of their dusty environment, weakened structures and noise pollution generated by blast alerting sirens, transportation trucks and rocks blasting processes which were reported to continue even during the nights causing interference to the proximate residents who wish to sleep. Kilonzo (2014) added that some of the materials that are used in mining activities have the tendency to contaminate the environment.

In consideration of the above, this study therefore evaluated the impact of Zinc and Lead mining activities on ambient air quality in the study area; which was done by studying the impact of Zinc and Lead mining on air quality in the study location, Ikwo LGA in Ebonyi State, determining the level of noise around the mining site with a noise level meter, determining the chemical composition of atmospheric aerosol in the study area, assessing the hazards associated with aerosol to population, and suggesting recommendation towards minimizing air pollution in the study location. These were done with an aim of using the study outcome to provide counteractive recommendations that will redress the observed negative effects. This was necessary with the anticipation that this research would provide information on the extent of air pollution from the mining activities in the study area, that the outcome of this research will assist in determining the extent the mine site is a cause

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for concern on possible health effects towards the local residents and the wider public, that the research will also provide a significant prospect for future work in the field of environmental impact of mining, that the findings of this study will motivate other interested researchers in and outside the study area; thus helping to broaden our knowledge which is a pre-requisite to formulation of effective control strategies in the future, that the outcome of this study may enhance the information with the government to adopt appropriate land-use act and regulations.

2. ENVIRONMENTAL DESCRIPTION OF THE STUDY AREA

Climatic Condition

The environmental characteristics (climate, air quality, vegetation, geology, soil and land use and socio-economic framework) of the facility area are presented below.

Nigeria's climate is characterized by strong latitudinal zones which become progressively drier as one moves northwards from the coast. Rainfall is the key climate variable with a remarkable difference between wet and dry seasons in most areas. By March/April the rainy season is underway in most areas south of the Niger and Benue river valleys. At far North, rain do not commence until about May/June. From December through February of the following year, northwest trade winds, called Harmattan, sweep across the country bringing moderate temperatures and lower humidity across the country. In addition, these winds are often laden with dust particles from the Sahara giving rise to characteristic Harmattan haze that reduces visibility. This general description determines the climatic condition of each location within the country.

The study location like every other area in Ebonyi state is in the warm humid equatorial climatic belt. The weather conditions are influenced by the circulation of two air masses: the cold, dry and dust continental air that originates from the Sahara desert in the north and warm, humid tropical maritime wind which originates from the Atlantic Ocean in the south characterized by two distinct conditions of wet and dry seasons. With the presence of the Inter-Tropical Discontinuity, the area experience two seasons: A short dry season and a long wet season. The dry season commences in November/December to March of the following year, while wet season commences mostly in February/March till late October. The area experience sub equatorial rainfall type with total annual rainfall.

The area is characterized by high relative humidity of about 75% and surface temperature of about 27°C to 30ºC. The mean temperature in the hottest period of February to April is about 30ºC. Average length of rainy season is between 250 to 270 days in a year. The mean annual rainfall varies between 1750mm and 2250mm (FDALR 1985). The least amount of rainfall occurs in December.

Wind Speed and Direction

The prevailing wind direction in the study area is predominantly the South-Westerlies, which account for about 60% of the annual winds.

Geology

Ebonyi State falls within the Asu-River Geologic Group (Lower Cretaceous), Eze-Aku shale

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formation and Nkporo Formations. The State is made up mainly of hydromorphic soils which consist of reddish brown gravely and pale coloured clayey soil, shallow in depth, and of shale parent material. The topography is largely a table land; highest point 162m and lowest 15m above sea level. The area is underlain by Cretaceous Sediments of the Asu River Group, a Tertiary to Recent volcanic intrusion (Basement). The topography of the buffer area can be described as comprising irregular ridges and hills with highlands ranging from 80m to 115m and lowlands with average elevation of 30m. These topographical features are controlled by the bedrock geology. Surface drainage in the area is irregular and consists principally of a number of small ephemeral streams. The streams generally follow a west to east course into the Ebonyi River (Ogbodo, 2013). The study location is referenced geographically on a point location of Latitude $06^{O}10^{'}29.6^{''}$and Longitude $08^{O}08^{'}08.0$".

Hydrogeology

The study location lies within the cross River Drainage Basin. Major rivers in Ebonyi state are the Eastern and Western Ebonyi Rivers which are tributaries of Cross River. All other rivers and streams are tributaries of these two Ebonyi Rivers. At the project location lies the Ozeroko stream and an artificial British Trench, acting as an artificial means for carrying run-off water in monsoon. Both the Trench and Ozeroko stream empties Ebonyi River. Existence of groundwater in parts of the state varies and is seriously influenced by the local geology. While the greater part, which includes the Abakaliki Metropolis, Onueke, some parts of Afikpo north and their environs record reduced groundwater yield to hand dug well and boreholes due to the underlying aquiclude. Other locations have good to fair groundwater yield to hand dug well and boreholes (some parts of Afikpo, Ezzamgbo, Nkalagu and environs).

Ecology

Flora and Fauna

The study area is located within the partially modified lowland tropical rain forest and wooded grassland derived savannah with a large portion of a large portion of cultivated land. The major characteristic of the vegetation of the project area is the abundant combination of varied plant groups whose branches intertwine to form a continuous canopy of leaves within the Area. The predominant vegetation visible along this area is the grasslands, with scattered forests and woodland areas, as well as tropical rainforest which comprise of tall trees with thick undergrowth and less branches.

The area and its surroundings are in the secondary succession Rainforest with a mix of few forest trees. The area is a community of regenerating secondary plants, which has been left to fallow with some pockets of functional and abandoned farmlands, and extensive land being badly eroded. The oil palm (*Elaeis guineesis*) is the most abundant tree. Other species are *Daniella oliveri, Milicia excelsa. Lophira lanceolata, Vitellaria paradoxa, Terminalia spp Naucles spp. Parkia biglobosa, Cola gigantea, Tectona grandis Azadirachta indica, Spondias mombin, Ricinodendron heudelotii, Gmelina Arborea* and *Ceiba pentandra.* The dominant grasses along the route are *Andropogon gayanus, Androprpgon tectorum, Loudetia arundinacea, Hyparrehnia rufa, Panicum Maximum, Chromolaena odorata* and *Schizachyrium sanguineum.*

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Fauna in the study area is dominated by birds, reptiles and mammals. Direct observations in the field and interviews showed that most birds are doves, crow and weaver birds, while the reptiles are mainly various types of snakes and lizards. The mammals occasionally encountered include giant rat (*Cricetaomys gambianus*), ground squirrel (*Xerus erythropus*) and greater cane rat (*Thryonomys swinderianus*), grass cutters, antelopes, monkeys, rodents and wild pigs. The wildlife in the area is said to be greatly reduced because of excessive hunting and farming activities by the people.

Figure 1: Some trees around the study location

Economic Activities

Farming is the major occupation of the people of Agalagu Alike, with the area known for the cultivation of a variety of crops such as rice, yam, cassava and palm-tree in substantially large quantities. The Ikwo LGA is also endowed with a number of mineral resources such as limestone, lead, salt, and laterite. Other important economic enterprises undertaken by residents of Ikwo LGA include mining, trade, and palm wine tapping (Manpower, 2019).

Population

Ikwo had a total population 154,396 people during the 1991 census, but as at 2006 census, Ikwo had an estimated population of 214,969 people, with a projection of 284,400 in 2016.

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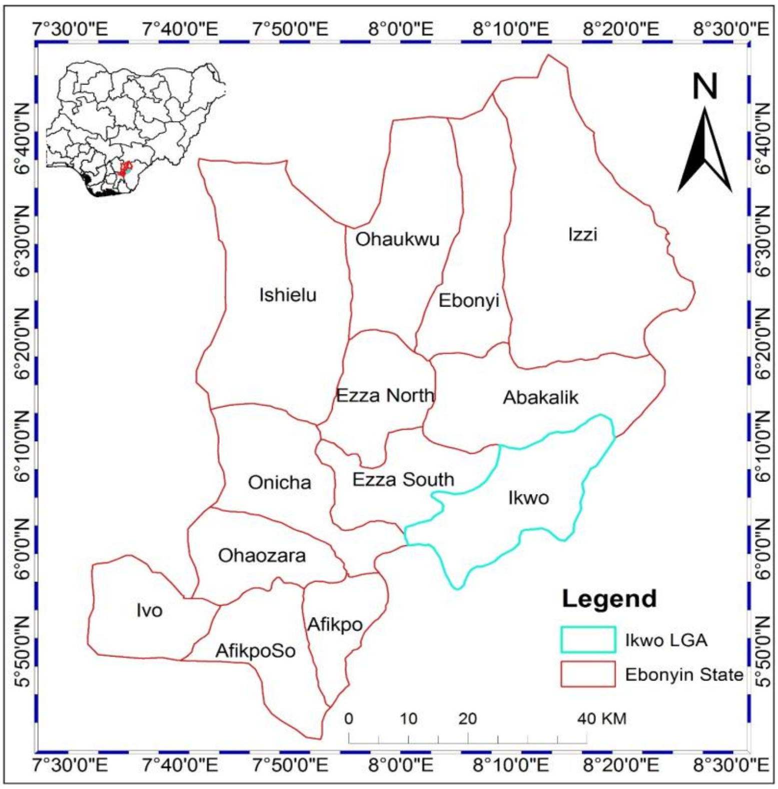

Figure 2: Map of Ebonyi State showing Ikwo LGA

Figure 3: Hauling of mined Ore to a Processing Plant.

3. MATERIALS AND METHOD

Air Quality Data Collection Method

A total of six (6) ambient air quality monitoring stations were identified during the study period. A varying distance of 2 to 3metres height was maintained to avoid obstructions. Particulate matter (PM_{10} and $PM_{2.5}$), Sulphur dioxides (SO_2), Hydrogen Sulphide (H_2S), Anhydrous ammonia (NH_3), Carbon monoxide (CO), Volatile Organic Compounds (VOC), Oxygen (O_2) and Nitrogen oxides (NO_2) were monitored using calibrated Combo Dust sampler. Coordinates readings were taken with the aid of Global Positioning System (GPS) at the various monitoring stations. The basic materials and equipments used in conducting the

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field exercises are: Air quality monitoring meter, Writing pad/pen and GPS 60cx. The field exercise includes the identification of the point's location of the respective monitoring stations. The exercise was aided by three field assistants.

4. RESULTS AND DISCUSSION

The field sampling for air quality at the study location shows lesser air pollution for all elements with the exception of NO_2 in all strategic locations as well as SO_2. The rate of NO_2 pollution can be attributed to the activities of the mining activity.

Table 4.1: Results of Air Quality Monitoring

Points	Northings	Eastings	^{o}C	NH_3	NO_2 (ppm)	SO_2 (ppm)	CO (ppm)	H_2S (ppm)	O_2	VOC	PM (µg/m^3)	
											2.5	**10**
1	$06^{o}10^{'}40.6$	$08^{o}08^{'}08.0$	27.1	0	0.3	0	0	0	20.9	0	22.4	49.9
2	$06^{o}10^{'}40.9$	$08^{o}08^{'}19.5$	27.4	0	0.3	0	0	0	20.9	0	24.7	52.3
3	$06^{o}10^{'}35.2$	$08^{o}08^{'}35.3$	27.6	0	0.3	0.1	0	0	20.9	0	21.0	46.4
4	Indoor	Indoor	28.2	0	0.2	0	0	0	20.9	0	20.2	43.6
5	$06^{o}10^{'}29.6$	$08^{o}08^{'}36.9$	27.6	0	0.3	0	0	0	20.9	0	21.2	46.0
6	$06^{o}10^{'}36.7$	$08^{o}08^{'}29.6$	28.1	0	0.3	0	0	0	20.9	0	20.2	44.0
FMEnv Limits			**-**	**-**	**0.04-0.06**	**0.1**	**10**	**0.07**	**-**	**-**	**250**	

Source: Researchers Fieldwork (2020).

The assessment was conducted towards the ending of the rainy season (October, 2020) thereby making suspended particulate matter at the study location and immediate environment very low. Although dust suppression measure of constant wetting is applied during operation, an average of 90mg/m^3 for particulate matter is expected to increase during dry season even though it is not expected to go beyond 250mg/m^3 if the suppression measures are maintained. Other pollutants like NH_3, H_2S, VOC and CO were not detected at the sampling locations. The level of O_2 within the location was found to be the same across all the sampling points, with a value of 20.9.

5. Health Effects of Primary Pollutant

The presence of the above listed primary pollutants in high concentration could have some adverse effect on the facility's environment and the people most especially if detected consistently above permissible limits.

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The table below shows some primary pollutant and their adverse effect;

POLLUTANTS	**EFFECTS OF EXPOSURE ABOVE PERMISSIBLE LIMIT**
Carbon monoxide	Reduces oxygen carrier leading to damage of the central nervous system
Sulphur IV oxide	Causes irritation of the respiratory tract
Nitrogen IV oxide	Causes inflammation of the lungs
Nitrogen II oxide	Causes inflammation of the lungs but less toxic
Particulate matter	Catarrh and cough, lung infections and other respiratory diseases.
Volatile Organic Compounds	Capable of causing eye, nose and throat irritation, headaches, fatigue, nausea, dizziness and skin problems.

6. CONCLUSION

Mining and smelting of iron ore are important in the growth of economic activities. However, mining related industries are also some of the largest sources of environmental pollution from heavy metals. Conversely, this study shows that the mining activity within the heavy metals mining site does not have any significant effect on the quality of air in the studied vicinity. The collated results shows that most of the analyzed parameters are within the tolerable limits of the regulatory body (FMEnv), with the exception of NO_2 and SO_2 which are minimal; with a concentration range of 0.2 - 0.3 for NO_2 and 0.00 - 0.1 for SO_2 with a tolerable limit of 0.2 - 0.4 for NO_2 and 0.1 for SO_2 respectively. Air pollutants such as PM_{10} and $PM_{2.5}$, H_2S, NH_3, and CO show lesser concentration in air pollution and VOC was undetected.

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