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# EVALUATION OF CONCENTRATION OF GASES AT DIFFERENT DISTANCES IN MPAPE QUARRY SITES, FCT-ABUJA, NIGERIA

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## Abstract
*Man might survive weeks without food and days without water, but he can only last a few seconds without clean air, It has become clear that air quality in the study area need to be examined, since air pollution in the study area has affected the health of human beings and animals, damaged vegetation, soils and deteriorates materials and generally affects not only the large metropolitan areas but also the medium sized urban areas. This study assessed the effects of Quarry on Air Quality in Mpape, Bwari Area Council, FCT Abuja, Nigeria. A total of 218 Air samples were collected from six points around the quarries sites and recorded insitu for analysis. The samples were collected three times in a day (Morning, Afternoon and Evening) for three days. Absolute Instrument System (AIS) model Aerocet 5315 was used to collect the parameters according to WHO, USEPA and NESREA guideline. The following parameters were investigated; Particulate Matter (PM), Carbon monoxide (Co), Sulphur dioxide ($S0_2$), Nitrogen dioxide ($NO_2$), Ammonia ($NH_3$), Chlorine ($CL_2$) and Hydrogen Cyanide. 2 active and 2 dormant quarries were considered by the study, land was measured to determine the impact of quarry in the study area. The statistical test employed was Analysis of Variance and student t-test. Based on the data collected and the analysis made, it was observed that the mean values of the parameters varied from points to points and at different time of the day. Also, the mean values of the parameters were compared with the NESREA recommended limits, and it was observed that Julius Berger have used about 50% of the area granted to her by Nigerian Mining Cadastre Office, while*

*Galaxy quarry have used 33.33% of the area granted, it was observed that Sulphur dioxide has a concentration of 0.45ppm, $NO_2$, 0.17ppm and $NH_3$ 0.38ppm, were above the NESREA recommended limit. While C0, 6.11ppm, HCN, 0.16ppm, SPM mg/$m^3$ and $Cl_2$, 0.03ppm are still below the standard limit. Air quality Index shows that Sulphur dioxide, and Nitrogen dioxide has a very poor quality index. The study therefore recommends that, all activities that lead to the release of air pollutants should be liable to environmental tax law; the quarries companies should upgrade their plants to more efficient technologies and by switching to lower carbon content fuels which will reduce emission of pollutants in the study area.*

***Keywords:*** *gases, distances, sites, quarry, exploration, concentration*

## Introduction

Quarrying activities have led to the development of infrastructure, created employment opportunities, growth of towns and establishment of various industries; have also led to environmental damage (Siachoono, 2009). There are two reasons why land degradation generally results from mineral extraction: first is industrial development and secondly short-term economic benefits such as reaching production goals and employment. Thus, quarry activity has affected the environment in both negative and positive ways. Scholars in different parts of the world have carried out researches to identify how this activity has impacted the environment ((Adekoya, 2003; Ajakaiye, 1985; Kibet, 2014)

Human activities pose the highest threat to the conservation of biodiversity and fragile ecosystems thereby promoting environmental degradation in mining of mineral resources such as crude oil and gas, iron ore, limestone, gypsum, amongst many others. Mining activities represent human action that cut through landscape, scarring, and interfering with the natural habitat conditions as well as micro-climate conditions (Busuyi *et al*., 2008). Therefore, the problems are. Quarry activities in Nigeria have caused significant impact on the environment, the blasting rocks with explosives to extract material for processing gives rise to noise pollution, air pollution, damage to biodiversity and habitat destruction which affect the human environment of a particular area (Okafor, 2016).

Studies have been carried out by different scholars in relation to quarrying, such as that by Kibet, (2014) and its impact on the environmental such as dust pollution, cracks in building, noise pollution, reduced photosynthesis by flora, nuisance dust, biodiversity loss and others are usually associated with quarrying. The need for construction materials like sand, gravel or rocks and paint production constitutes the basis of the effects of quarrying. Particulate matter, noise, vibrations, and run-offs are impacting negatively on the health and property of the people living around the cluster sites. These are most likely to generate environmental problems such as cracks in buildings which may collapse and destroy life, outbreak of malaria infection and other water-borne or water- related diseases, loss of fauna and flora (biodiversity), land degradation and decline in crop yield.

It has become clear that the effects of quarrying in the study area need to be examined, since environmental degradation in the study area has affected the health of human beings and animals, damaged vegetation, soils and deteriorates materials and generally affects not only the large metropolitan areas but also the medium sized urban areas. Pollution has a great impact on human health, climate change, agriculture, and natural ecosystem. (Syed, 2012)

Quarry in the study area has resulted in environmental degradation, in terms of loss of biodiversity, soil contamination, water, and air pollution.

Quarry in the study area have resulted to the recent earth tremors experienced around August and September 2018. (Nigerian Geological Survey Agency 2018)

Quarry has resulted in deforestation, disruption of soil texture, soil erosion, dispersion of quarry dust in the study area, and deterioration of the ecosystem amongst others. (Mines Environmental Compliance Department 2011)

Environmental effects of quarrying in general are known to impoverish the flora and fauna of the host environment, result in sediments deposition in riverine systems, create large mining spoil mounds and deep mining lakes, result in loss of timber resources and other vegetal cover, toxification and pollution due to chemical wastes or weathering of mining spoils, changes in micro-climate, and several others. These degradations of the ecosystem are not only on site but downstream and off-site as well. These, in turn, significantly alter the socioenvironmental spheres of the affected areas. Despite these negative impacts, mining of various mineral resources has still flagrantly been carried out.

Many studies have been conducted on the effects of quarry activities in Mpape and environs but none have looked at the effects on air quality in the study area, therefore is need to further investigate the environmental effects of quarry in the study area, to highlight present and likely consequences to avoid further deterioration of the ecosystem, and the environment at large.

## The Study Area

### *Location and size*

Federal Capital Territory (FCT) is the home of Abuja, the capital of Nigeria. The territory was created in 1976 from parts of former Nasarawa, Niger, and Kogi States and it is in the central region of Nigeria, bordered to the north by Kaduna State, to the east by Nassarawa State, to the south-west by Kogi State and to the west by Niger State. It lies between longitudes $6^0$ 20'E and $7^0$ 33'E of the Greenwich Meridian and with latitudes $8^0$ 30'N and $9^0$ 20'N of the equator. It occupies an area of about 8000km$^2$. The FCT is in the centre of the country. Mabogunje (1977) describes the FCT as being in the middle belt of Nigeria with a size equivalent to 0.87% of Nigeria.

The FCT has six area councils namely, Kuje, Gwagwalada, Abaji, AMAC, Kwali and Bwari where the Lower Usuma Dam is located. The federal Capital Territory is central to Nigeria in administrative, geographical, and lying just above the hot and humid lowlands of the Niger/Benue trough but below the drier parts of the country lying to the north. It lies north of the wide alluvial plains formed by the confluence of the Niger and the Benue rivers. The Jema'a platform, a continuation of the Jos plateau extends well into the middle of the territory. The city is in a scenic valley of rolling grasslands.

The area Mpape which means "rock" in the local Gwari language, supplies much of the stone used to transform Abuja from a small village in the 1980s into the fasters growing capital in the world. Mpape is located about 2kms away from Maitama district and has about 10 active quarry industries and 4 inactive quarry.

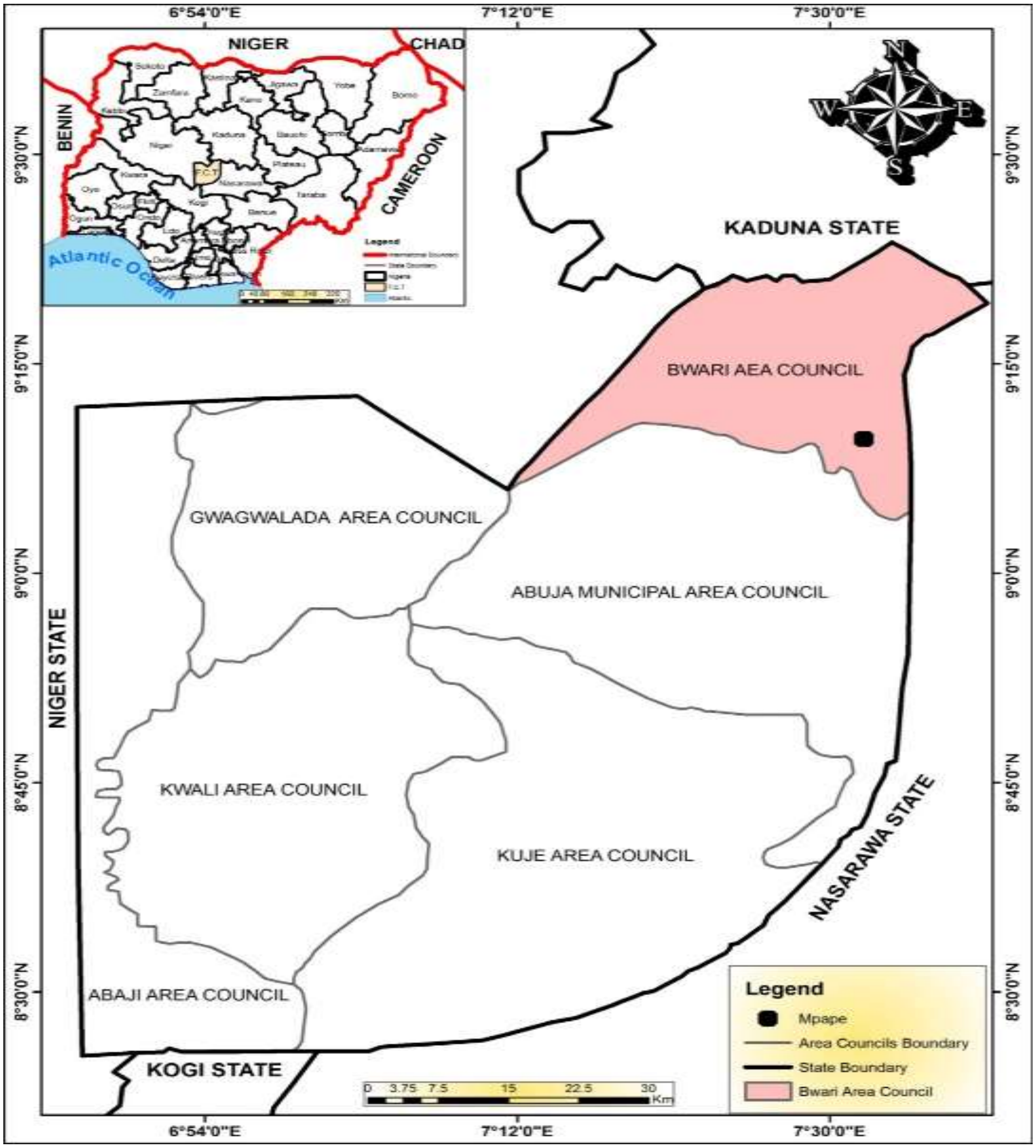


**Figure 1: Abuja showing Bwari Area Council.**
**Source: Department Geography, NSUK, 2018**

## Materials and Methods

### Analysis

A major part of the air analysis was carried out at the sample site. A standard laboratory procedure was followed in the analysis of the selected air quality parameters that was considered in the study were recorded in situ.

## Statistical Analysis

The statistical analysis employed were descriptive statistics such as mean, standard deviation and coefficient of variation. The data were subjected to analysis of variance (ANOVA) and student t test for the comparison of the mean differences between the survey values and the NESREA limit.

## Result and Discussion

### Air Concentration at Gases at Different Distances in the Study Area

The mean values of concentration of air quality parameters of different distances of the study area derived from the investigation are presented in table 4.5.

### Sulphur dioxide ($SO_2$)

The result in table 1: revealed the value of $SO_2$ in the study area, it varies from 0.43ppm to 0.47 Ppm, with a mean of 0.45ppm, SD value of 0.01 and COV value of 0.00.

**Table 1: Concentration of gases at different distances in the study area in Raining Season.**

| Parameters/ Sampling points | $So_2$ ppm | $NO_2$ ppm | $Cl_2$ ppm | $Co_2$ ppm | $H_2S$ ppm | VOC ppm | $NH_3$ ppm | SPM ug/m$^3$ | HCN ppm | NOISE dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Point 1** | 0.46 | 0.21 | 0.31 | 6.00 | 0.27 | 0.19 | 0.36 | 30.41 | 0.16 | 33.08 |
| **Point 2** | 0.44 | 0.16 | 0.30 | 5.66 | 0.26 | 0.19 | 0.36 | 31.45 | 0.16 | 33.15 |
| **Point 3** | 0.47 | 0.17 | 0.37 | 6.58 | 0.31 | 0.21 | 0.50 | 35.01 | 0.19 | 38.46 |
| **Point 4** | 0.44 | 0.15 | 0.30 | 6.12 | 0.26 | 0.19 | 0.35 | 32.98 | 0.15 | 33.00 |
| **Point 5** | 0.43 | 0.18 | 0.28 | 6.20 | 0.25 | 0.19 | 0.37 | 32.96 | 0.16 | 31.00 |
| **MEAN** | 0.45 | 0.17 | 0.03 | 6.11 | 0.27 | 0.19 | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0.38 | 32.56 | 0.16 | 33.74 |
| **MINIMUM** | 0.43 | 0.15 | 0.02 | 5.66 | 0.25 | 0.19 | 0.35 | 30.41 | 0.15 | 31.00 |
| **MAXIMUM** | 0.47 | 0.21 | 0.03 | 6.58 | 0.31 | 0.21 | 0.50 | 35.01 | 0.19 | 38.46 |
| **SD** | 0.01 | 0.02 | 0.01 | 0.33 | 0.02 | 0.00 | 0.06 | 1.74 | 0.01 | 2.79 |
| **COV** | 0.00 | 0.00 | 0.00 | 0.11 | 0.01 | 0.00 | 0.00 | 3.04 | 0.00 | 7.79 |
| **Control Point** | 0.30 | 0.06 | 0.02 | 6.00 | 0.18 | 0.01 | 0.02 | 20.00 | 0.10 | 34.00 |
| **REMARK** | N | N | S | S | S | S | S | | | |

**NOTE: N= no significant variation; S = significant variation**
**Source: Field survey, 2020**

The variation in $SO_2$ in the study area can be attributed to the anthropogenic sulphur oxides ($SO_2$) emissions and the bulk of these emissions are generally attributed to fossil-fuel-.red power plants and base-metals smelters. Locally (particularly in humid areas), major point sources of $SO_2$ can generate acidic mists that can engender potential health concerns. Peter et al, (2018) attributed the high values of $S0_2$ have been also reported by other researchers working on similar activities. The $SO_2$ was high because the in the operations blasting the rocks and grinding them further into various sizes generated dust constantly.
Sulphur oxide refers to all oxides of sulphur, the two major ones being sulphur dioxide ($SO_2$) and sulphur trioxide ($SO_3$). Sulphur dioxide is a colourless gas with a pungent, irritating odour and taste; it combines with oxygen to for sulphur trioxide. It is also released from volcanic eruptions, blasting of granite, oceans, biological decay, burning of fossil fuel and forest fires. Upon dissolution or during precipitation, it returns to the earth as acid rain, causing soil and water acidification. Inhaling sulphur dioxide is associated with increased respiratory symptoms and diseases. Sulphur oxide combines with other substances in the air to produce a haze that reduces visibility.

In quarrying, $SO_2$ emissions mainly derive from the combustion of sulphur bearing compounds in the fuels (e.g., from pyrite [FeS2] in coal and various sulphur compounds in oil and petroleum coke) but can, to a lesser extent, also come from pyrite, sulphate minerals, and kerogens in the nonfuel raw materials. Some of the $SO_2$ formed during preheating is scrubbed by limestone or lime in the raw material feed and forms anhydrite (CaSO4), but, although much of it can become part of the granite deposit, at least part of the anhydrite tends to decompose and rerelease $SO_2$ as the feed enters the (much hotter) calcination zone or apparatus in the kiln line Hendrik *et al* 2003 collaborated the findings that the emissions of $SO_2$ during granite mining and aggregates production can be attributed to sulphate minerals, sulphur compounds in oil and petroleum coke.

Sulphur dioxide ($SO_2$) is one major air pollutant. It is usually formed from the oxidation of sulphur containing fuels and biomass. Hydrogen sulphide ($H_2S$) gas is extremely toxic, odorous, and corrosive. It can be present in natural gas in certain areas and can be released by sulphate reducing bacteria in certain marine environments. Exposure to $SO_2$, at concentration above 5.00ppm could stimulate broncho-constriction (as in asthma) and mucus secretion as well as irritate the eyes in man. Long term exposure to lower concentration may result in death form cardiac and/or respiratory diseases and increased prevalence of related symptoms.

Sustained exposure to $H_2S$ gas above 0.06ppm could result in death.

**Nitrogen dioxide ($NO_2$)**

The result in table 1: shows that $NO_2$ ranges 0.15ppm and 0.21ppm, with a mean concentration of 0.17ppm, SD value of 0.02 and COV of 0.00. The concentration of NO2 in the study area can be attributed to High-temperature combustion of fuels in the granite deposit releases nitrogen oxides ($NO_2$), with the nitrogen being mainly derived from the atmosphere but also to some degree from the fuels themselves; a minor contribution also comes from some types of raw materials. The formation of $NO_2$ in granite is complex and yet incompletely understood. Haspel, (2002) attribute $NO_2$ in quarrying industries due to high temperature combustion of fuels in the quarrying. Lanier and Hanson, (2010), also attribute the presence of $NO_2$ quarry industries to fuel $NO_2$ is formed from the burning of nitrogen compounds in the fuels; most fuels contain at least some

nitrogen. Of the major fuels, coal, the most common fuel, contains the most nitrogen and natural gas the least.
The oxides of nitrogen are usually formed at higher temperature combustions e.g., industrial combustion and vehicle engines. NO2 is readily formed by partial oxidation of nitrogen and is usually emitted in exhaust pipe or motor vehicles and the manifold of power generating equipment where rapid oxidation to $NO_2$ takes place. $NO_2$ may also be generated by oxidizing nitro- gen at high temperatures. Long term exposure to $NO_2$ concentrations above 563ppm may cause pulmonary disease and increase susceptibility to bacterial infection in man.
Nitrogen oxides refer to the binary compound of oxygen and nitrogen. It consists mainly of nitrogen dioxide ($NO_2$) and nitrogen monoxide (NO). Nitrogen oxides are produced in most combustion processes from nitrogen compound in fuel. The most important sources of nitrogen dioxides are thermal power stations, combustions engine and generators. The amount of nitrogen oxides released directly into the atmosphere is relatively small and non- toxic, but at high concentrations, the health effects include changes in lung function and aggravate existing heart disease.

**Plate 1: Quarry face in the study area.**

**Chlorine ($Cl_2$)**

The result in Table 4.3 A: shows the concentration of $Cl_2$ in the study area, it ranges from 0.02ppm to 0.03ppm, with a mean concentration of 0.03ppm, SD value of 0.01 and COV of 0.00. The highest concentration was found in point 3 and the lowest in point 5, $Cl_2$ it is a very toxic gas to human. The variation of $Cl_2$ can be attributed to the mining and production stone aggregate since all the processes involved in aggregates production emit pollution to the atmosphere. Bhat, (2012), started that almost all the manufacturing units of a quarry industry e.g., raw mill, kiln, coal mill, explosive is point sources of pollution emission. In addition, some other activities associated with post-manufacturing stages like open air handling,

**Carbon monoxide (CO)**

The result in Table 2 shows the concentration of carbon monoxide at different distance in the study area, it has a range of 1.67ppm to 2.30ppm, it has a mean concentration of 1.99ppm, SD value of 0.28 and COV of 14.07. the highest concentration occurs at point 3 and point 4 respectively due to incomplete combustion of fuel in the crusher plant and from the trailer park in the study area, Hassan, and Mohammed, (2012) collaborated the findings that high amount of carbon monoxide in an area is due to incomplete combustion of fuel and explosive addictive's like $Fe_3O_3$in the process of aggregates manufacturing which precipitate carbon monoxide into the atmosphere.

This level is above the maximum discharge range of 10.0-20.0ppm for daily average of 8 hourly values in Nigeria (NESREA, 2011). Carbon monoxide (CO) is generated from the incomplete oxidation of fossils fuels (hydrocarbon). Sources of CO in the study area are giant diesel-powered generating plant, processing plant, vehicular emissions, diesel and petrol engines such as heavy-duty equipment, welding machines, trucks etc. Prolonged and excessive exposure to ambient accumulation of CO values greater than 877ppm could bring about formation of carboxyhaemoglobin and prevent oxygenation of the blood leading to suffocation and consequent death. Young and elderly persons as well as individuals with cardio-vascular diseases and respiratory problems are most at risk from exposure to this gas.

Carbon monoxide is an oxide of carbon. It is a colourless, odourless, poisonous gas which is released by the combustion of many natural and synthetic products.

It is also the major oxide of carbon produced by the complete combustion of hydrocarbon fuels. Carbon Monoxide is a focus of public concern due to its increasing concentration in the atmosphere. Prolonged exposure to moderate concentrations of this gas can cause acidosis and adverse effects on calcium–phosphorus metabolism in humans. This results in increased calcium deposits in soft tissues. Carbon monoxide is also toxic to the heart and causes diminished contractile force.

Carbon dioxide is a colourless and odourless gas vital to life on earth. There are natural sources: aerobic respiration, fermentation, volcanoes, and hot springs. Man-made sources of $CO_2$ include combustion of fossil fuel and bush burning. It is a greenhouse gas and the amount in the atmosphere must be monitored.

**Hydrogen Sulfide ($H_2S$)**

The result in Table 1: shows that the minimum concentration of $H_2S$ was 0.25ppm and the maximum concentration of 0.31ppm with a mean of 0.27ppm, SD of 0.02 and COV of 0.01. Hydrogen Sulfide ($H_2S$) is a gas commonly found during the drilling and production granite, crude oil and natural gas, plus in wastewater treatment and utility facilities and sewers. The gas is produced because of the microbial breakdown of organic materials in the absence of oxygen. Colorless, flammable, poisonous and corrosive, H2S gas is noticeable by its rotten egg smell. With toxicity like carbon monoxide, which prevents cellular respiration, monitoring and early detection of $H_2S$ could mean the difference between life and death.

**Volatile Organic Compounds (VOC)**

VOCs are chemicals that easily enter the air as gases from some solids or liquids. They are ingredients in many commonly used products and are in the air of just about every indoor and outdoor setting. Sources include BTEX (benzene, toluene, ethyl benzene, xylene), hexane, cyclohexane, 1,2,4-trimethylbenzene. High levels of VOCs have been documented to cause cancer and affects liver, kidney, and nervous system**.**

The result in table 4.3 A: shows that minimum concentration of VOC in the study area with a value of 0.19ppm and maximum concentration of 0.21ppm, with a mean of 0.19ppm, SD of 0.00 and COV of 0.00.

**Ammonia ($NH_3$)**

The result in table 1: shows that NH3 varies from 0.35ppm to 0.50ppm in the study area, with a mean of 0.38ppm, SD value of 0.06 and COV value of 0.00. The variation in $NH_3$ in the study area can be attributed to the material use in explosives, Granite, fuel and $FeS_2$which when they are heated during pre-calcination, they release $NH_3$. (Haspel, 2002). Started that trace amounts of $NH_3$ and similar compounds (hereafter collectively labeled "dioxins") can be formed from the combustion of organic compounds in fuels and dust from crushing of granite aggregates, especially because of the combustion of certain waste fuels. The potential to increase emissions of dioxins may inhibit a plant's use of the offending fuel where emissions cannot be controlled by varying the combustion conditions in the kiln, where this control precludes efficient kiln operations, or were obtaining permits to burn the fuel would be too time consuming or costly.

**Suspended Particulate Matter**

The result in table 1: shows the concentration of particulate matter at different distance in the study area, it ranges from 30.41Mg/$m_3$ to 35.01Mg/$m_{3,}$ with a mean of 32.56Mg/$m_3$, it has a SD of 1.74 and COV of 3.04. Suspended particulate matter is highest in the mining area with a concentration of 35.01Mg/$m_3$ due to blasting and crushing of granite in the study area, followed by the loading area due to exit of clinker from the chiming, this can be attributed to the law of diffusion of gases, Magaji and Hassan (2015) collaborated with the findings that the movement of pollutants are influenced by the law of diffusion of gases, which states that "gases tend to move from areas of high concentration to areas of low concentration". Therefore, following the direction of the wind, the gases tend to have moved farther away from the starting point which is the where the pollution is generated.

Particulates are tiny solid or liquid particles suspended in the air. These may consist of smoke, dust, and vapour. Particulates could pose a health risk as they contribute to allergies, infections, asthma, and other respiratory tract infections. Seasonal variability and weight of the particulates can affect the speed of particulate matter and thus influence their dispersion in the atmosphere.

**Hydrogen Cyanide**

The result in Table 1: shows that Hydrogen cyanide ranges from 0.15ppm to 0.19ppm, with a mean concentration of 0.16ppm, SD of 0.01 and COV of 0.00.

**Noise level**

The result in table 1: shows that Noise ranges from 31.00 dB(A) and 38.46 dB(A), with a mean concentration of 33.74 dB(A), SD of 2.79 dB(A) and COV of 7.79 dB(A). The main sources of noise in the study area included noise from rock blasting site, crush rock processing plants, haulage trucks, diesel power generating plant, heavy duty trucks, welding machines, heavy trucks on the highway hooting, human activities in the neighbourhood etc. The noise level at the sampling stations (including control) varied slightly. The highest noise level was recorded at SP5 inside the premises of the company followed by SP3 recorded at the plant. Other sampling points recorded noise level consistent with what is to be expected from such environment. The noise levels were all within the NESREA and FMEnv limits of 114 dB(A) and 90 dB(A) respectively.

**Sulphur dioxide ($SO_2$)**

The result in table 2: revealed the value of $SO_2$ in the study area, it varies from 0.42ppm to 0.49 Ppm, with a mean of 0.45ppm, SD value of 0.01 and COV value of 0.00. The variation in $SO_2$ in the study area can be attributed to the anthropogenic sulphur oxides ($SO_2$) emissions and the bulk of these emissions are generally attributed to fossil-fuel-.red power plants and base-metals smelters. Locally (particularly in humid areas), major point sources of $SO_2$ can generate acidic mists that can engender potential health concerns. Peter et al, (2018) attributed the high values of $S0_2$ have been also reported by other researchers working on similar activities. The $SO_2$ was high because the in the operations blasting the rocks and grinding them further into various sizes generated dust constantly.

**Table 2: Mean values of concentration of parameters at different distances in the study area.**

| Parameters/ Sampling points | $SO_2$ ppm | $NO_2$ ppm | $Cl_2$ ppm | CO ppm | $H_2S$ ppm | VOC ppm | $NH_3$ ppm | SPM ug/m$^3$ | HCN ppm | NOISE dB(A) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Point 1** | 0.46 | 0.22 | 0.31 | 6.12 | 0.27 | 0.19 | 0.36 | 30.11 | 0.16 | 33.08 |
| **Point 2** | 0.44 | 0.16 | 0.30 | 5.69 | 0.26 | 0.19 | 0.36 | 31.45 | 0.16 | 33.15 |
| **Point 3** | 0.49 | 0.17 | 0.37 | 6.78 | 0.32 | 0.22 | 0.60 | 36.01 | 0.19 | 38.90 |
| **Point 4** | 0.44 | 0.18 | 0.30 | 6.12 | 0.26 | 0.19 | 0.34 | 32.98 | 0.15 | 33.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Point 5 | 0.42 | 0.18 | 0.28 | 6.20 | 0.25 | 0.19 | 0.37 | 32.96 | 0.16 | 31.00 |
| MEAN | 0.45 | 0.17 | 0.31 | 6.11 | 0.27 | 0.19 | 0.38 | 32.56 | 0.16 | 33.74 |
| MINIMUM | 0.42 | 0.16 | 0.28 | 5.69 | 0.25 | 0.19 | 0.34 | 30.11 | 0.15 | 31.00 |
| MAXIMUM | 0.49 | 0.22 | 0.37 | 6.78 | 0.32 | 0.22 | 0.60 | 36.01 | 0.19 | 38.90 |
| SD | 0.01 | 0.02 | 0.01 | 0.33 | 0.02 | 0.00 | 0.06 | 1.74 | 0.01 | 2.79 |
| COV | 0.00 | 0.00 | 0.00 | 0.11 | 0.01 | 0.00 | 0.00 | 3.04 | 0.00 | 7.79 |
| Control Point | 0.30 | 0.06 | 0.02 | 6.00 | 0.18 | 0.01 | 0.02 | 20.00 | 0.10 | 34.00 |
| REMARK | N | N | S | S | S | S | S | S | S | S |

**NOTE: N= no significant variation; S = significant variation**
**Source: Field survey, 2020**

Sulphur oxide refers to all oxides of sulphur, the two major ones being sulphur dioxide ($SO_2$) and sulphur trioxide ($SO_3$). Sulphur dioxide is a colourless gas with a pungent, irritating odour and taste; it combines with oxygen to for sulphur trioxide. It is also released from volcanic eruptions, blasting of granite, oceans, biological decay, burning of fossil fuel and forest fires. Upon dissolution or during precipitation, it returns to the earth as acid rain, causing soil and water acidification. Inhaling sulphur dioxide is associated with increased respiratory symptoms and diseases. Sulphur oxide combines with other substances in the air to produce a haze that reduces visibility.

In quarrying, $SO_2$ emissions mainly derive from the combustion of sulphur bearing compounds in the fuels (e.g., from pyrite [$FeS_2$] in coal and various sulphur compounds in oil and petroleum coke) but can, to a lesser extent, also come from pyrite, sulphate minerals, and kerogens in the nonfuel raw materials. Some of the $SO_2$ formed during preheating is scrubbed by limestone or lime in the raw material feed and forms anhydrite ($CaSO_4$), but, although much of it can become part of the granite deposit, at least part of the anhydrite tends to decompose and rerelease $SO_2$ as the feed enters the (much hotter) calcination zone or apparatus in the kiln line Hendrik *et al* 2003 collaborated the findings that the emissions of $SO_2$ during granite mining and aggregates production can be attributed to sulphate minerals, sulphur compounds in oil and petroleum coke.

Sulphur dioxide ($SO_2$) is one major air pollutant. It is usually formed from the oxidation of sulphur containing fuels and biomass. Hydrogen sulphide (H2S) gas is extremely toxic, odorous, and corrosive. It can be present in natural gas in certain areas and can be released by sulphate reducing bacteria in certain marine environments. Exposure to $SO_2$, at concentration above 5.00ppm could stimulate broncho-constriction (as in asthma) and mucus secretion as well as irritate the eyes in man. Long term exposure to lower concentration may result in death form cardiac and/or respiratory diseases and increased prevalence of related symptoms. Sustained exposure to $H_2S$ gas above 0.06ppm could result in death.

**Nitrogen dioxide ($NO_2$)**

The result in table 2: shows that $NO^2$ ranges 0.16ppm and 0.22ppm, with a mean concentration of 0.17ppm, SD value of 0.02 and COV of 0.00. The concentration of $NO_2$ in the study area can be attributed to High-temperature combustion of fuels in the granite deposit releases nitrogen oxides ($NO_2$), with the nitrogen being mainly derived from the atmosphere but also to some degree from the fuels themselves; a minor contribution also comes from some types of raw materials. The formation of $NO_2$ in granite is complex and yet incompletely understood. Haspel, (2002) attribute $NO_2$ in quarry industries due to high temperature combustion of fuels in the quarrying. Lanier and Hanson, (2010), also attribute the presence of $NO_2$ quarry industries to fuel $NO_2$ is formed from the burning of nitrogen compounds in the fuels; most fuels contain at least some nitrogen. Of the major fuels, coal, the most common fuel, contains the most nitrogen and natural gas the least.

The oxides of nitrogen are usually formed at higher temperature combustions e.g., industrial combustion and vehicle engines. $NO_2$ is readily formed by partial oxidation of nitrogen and is usually emitted in exhaust pipe or motor vehicles and the manifold of power generating equipment where rapid oxidation to $NO_2$ takes place. $NO_2$ may also be generated by oxidizing nitro- gen at high temperatures. Long term exposure to $NO_2$ concentrations above 563ppm may cause pulmonary disease and increase susceptibility to bacterial infection in man.

Nitrogen oxides refer to the binary compound of oxygen and nitrogen. It consists mainly of nitrogen dioxide ($NO_2$) and nitrogen monoxide (NO). Nitrogen oxides are produced in most combustion processes from nitrogen compound in fuel. The most important sources of nitrogen dioxides are thermal power stations, combustions engine and generators. The amount of nitrogen oxides released directly into the atmosphere is relatively small and non- toxic, but at high concentrations, the health effects include changes in lung function and aggravate existing heart disease.

**Chlorine ($Cl_2$)**

The result in table 2: shows the concentration of $Cl_2$ in the study area, it ranges from 0.28ppm to 0.37ppm, with a mean concentration of 0.31ppm, SD value of 0.01 and COV of 0.00. The highest concentration was found in point 3 and the lowest in point 5, $Cl_2$ it is a very toxic gas to human. The variation of $Cl_2$ can be attributed to the mining and production stone aggregate since all the processes involved in aggregates production emit pollution to the atmosphere. Bhat, (2012), started that almost all the manufacturing units of a quarry industry e.g., raw mill, kiln, coal mill, quarry plant is point sources of pollution emission. In addition, some other activities associated with post-manufacturing stages like open air handling.

**Carbon monoxide (CO)**

The result in table 2: shows the concentration of carbon monoxide at different distance in the study area, it has a range of 5.69ppm to 6.78ppm, it has a mean concentration of 6.11ppm, SD value of 0.33 and COV of 0.11. the highest concentration occurs at point 3 and point 4 respectively due to incomplete combustion of fuel in the crushing plants and from the mining pits in the study area, Hassan, and Mohammed, (2012) collaborated the findings that high amount of carbon monoxide in an area is due to incomplete combustion of fuel and explosive addictive's like $Fe_3O_3$in the process of aggregates manufacturing which precipitate carbon monoxide into the atmosphere.

This level is above the maximum discharge range of 10.0-20.0ppm for daily average of 8 hourly values in Nigeria (NESREA 2011). Carbon monoxide (CO) is generated from the incomplete oxidation of fossils fuels (hydrocarbon). Sources of CO in the study area are giant diesel-powered generating plant, processing plant, vehicular emissions, diesel, and petrol engines such as heavy-duty equipment, welding machines, trucks etc. Prolonged and excessive exposure to ambient accumulation of CO values greater than 877ppm could bring about formation of carboxyhaemoglobin and prevent oxygenation of the blood leading to suffocation and consequent death. Young and elderly persons as well as individuals with cardio-vascular diseases and respiratory problems are most at risk from exposure to this gas.

Carbon monoxide is an oxide of carbon. It is a colourless, odourless, poisonous gas which is released by the combustion of many natural and synthetic products. It is also the major oxide of carbon produced by the complete combustion of hydrocarbon fuels. Carbon Monoxide is a focus of public concern due to its increasing concentration in the atmosphere. Prolonged exposure to moderate concentrations of this gas can cause acidosis and adverse effects on calcium–phosphorus metabolism in humans. This results in increased calcium deposits in soft tissues. Carbon monoxide is also toxic to the heart and causes diminished contractile force.

Carbon dioxide is a colourless and odourless gas vital to life on earth. There are natural sources: aerobic respiration, fermentation, volcanoes, and hot springs. Man-made sources of $CO_2$ include combustion of fossil fuel and bush burning. It is a greenhouse gas and the amount in the atmosphere must be monitored.

**Hydrogen Sulfide ($H_2S$)**

The result in table 2: shows that the minimum concentration of $H_2S$ was 0.25ppm and the maximum concentration of 0.32ppm with a mean of 0.27ppm, SD of 0.02 and COV of 0.01. Hydrogen Sulfide ($H_2S$) is a gas commonly found during the drilling and production granite, crude oil, and natural gas, plus in wastewater treatment and utility facilities and sewers. The gas is produced because of the microbial breakdown of organic materials in the absence of oxygen. Colorless, flammable, poisonous and corrosive, $H_2S$ gas is noticeable by its rotten egg smell. With toxicity like carbon monoxide, which prevents cellular respiration, monitoring and early detection of $H_2S$ could mean the difference between life and death.

**Volatile Organic Compounds (VOC)**

VOCs are chemicals that easily enter the air as gases from some solids or liquids. They are ingredients in many commonly used products and are in the air of just about every indoor and outdoor setting. Sources include BTEX (benzene, toluene, ethyl benzene, xylene), hexane, cyclohexane, 1,2,4-trimethylbenzene. High levels of VOCs have been documented to cause cancer and affects liver, kidney, and nervous system.

The result in table 2: shows that minimum concentration of VOC in the study area with a value of 0.19ppm and maximum concentration of 0.22ppm, with a mean of 0.19ppm, SD of 0.00 and COV of 0.00. and the control point recorded 0.01ppm.

**Plate 2: Showing air pollution during drilling.**

**Ammonia ($NH_3$)**

The result in table 2: shows that $NH_3$ varies from 0.34ppm to 0.60ppm in the study area, with a mean of 0.38ppm, SD value of 0.06 and COV value of 0.00. The variation in $NH_3$ in the study area can be attributed to the material use in blasting, fuel and $FeS_2$which when they are heated during pre-calcination, they release $NH_3$. (Haspel, 2002). Started that trace amounts of $NH_3$ and similar compounds (hereafter collectively labeled “dioxins”) can be formed from the combustion of organic compounds in fuels and dust from crushing of granite aggregates, especially because of the combustion of certain waste fuels. The potential to increase emissions of dioxins may inhibit a plant’s use of the offending fuel where emissions cannot be controlled by varying the combustion conditions in the kiln, where this control precludes efficient kiln operations, or were obtaining permits to burn the fuel would be too time consuming or costly.

**Plate 3: Mined granite surface in Galaxy Quarry**

## Suspended Particulate Matter (SPM)

The result in table 3 B: shows the concentration of particulate matter at different distance in the study area, it ranges from 30.11ug/$m_3$ to 36.01ug/$m_{3,}$ with a mean of 32.56ug/$m_3$, it has a SD of 1.74 and COV of 3.04. Suspended particulate matter is highest in the mining area with a concentration of 36.01ug/$m_3$ due to blasting and crushing of granite in the study area, followed by the loading area due to exit of dust, this can be attributed to the law of diffusion of gases, Magaji and Hassan (2015) collaborated with the findings that the movement of pollutants are influenced by the law of diffusion of gases, which states that "gases tend to move from areas of high concentration to areas of low concentration". Therefore, following the direction of the wind, the gases tend to have moved farther away from the starting point which is the where the pollution is generated.

Particulates are tiny solid or liquid particles suspended in the air. These may consist of smoke, dust, and vapour. Particulates could pose a health risk as they contribute to allergies, infections, asthma, and other respiratory tract infections. Seasonal variability and weight of the particulates can affect the speed of particulate matter and thus influence their dispersion in the atmosphere.

**Plate 4: Crushing Activities in Julius Berger Quarry**

**Hydrogen Cyanide (HCN)**

The result in table 3 B: shows that Hydrogen cyanide ranges from 0.15ppm to 0.19ppm, with a mean concentration of 0.16ppm, SD of 0.01 and COV of 0.00. and the control point has a concentration of 0.01ppm.

**Noise level**

The result in table 3 : shows that Noise ranges from 31.00 dB(A) and 38.90 dB(A), with a mean concentration of 33.74 dB(A), SD of 2.79 dB(A) and COV of 7.79 dB(A), the control point has a concentration of 34.00 dB(A). The main sources of noise in the study area included noise from rock blasting site, crush rock processing plants, haulage trucks, diesel power generating plant, heavy duty trucks, welding machines, heavy trucks on the highway hooting, human activities in the neighbourhood etc. The noise level at the sampling stations (including control) varied slightly. The highest noise level was recorded at SP5 inside the premises of the company followed by SP3 recorded at the plant. Other sampling points recorded noise level consistent with what is to be expected from such environment. The noise levels were all within the NESREA and FMEnv limits of 114 dB(A) and 90 dB(A) respectively.

## Conclusion

The result of the analysis shows that about 30% of the mining land allotted to the quarry companies in the study area have been degraded in one form or the other, result of the analysis of the gaseous pollutants, CO, NOx, and SO2 which were released into the atmosphere from the activities of quarrying revealed that the environment has been greatly polluted and the fact that the values obtained are much higher than the limits stipulated by the NESREA, implies that the lives of people living and working in this environment are seriously threatened. Moreover, the smoke emanating from the chiming causes impairment of respiratory organs, reduction in visibility for both pedestrians and motorists along the factory and the settlement, which could lead to accident. Emission of the stone dust also causes discoloration and weakening of the pillars of the houses around the settlement due to acid rain. It is therefore recommended that the mining of granite should be discontinued while alternative method of blasting and crushing processing should be enacted. All activities that lead to the release air pollutants should be liable to an Environmental Tax Law. Moreover, the Federal Government and all stakeholders as well as other relevant bodies should as a matter of urgency curtail the activities of the sawmill industries to abate the magnitude of environmental pollution in the area. Despite the low level of contamination, it can be concluded that all things being equal, if this situation is not checked, it will lead to environmental disaster as nobody selects the air, he/she breaths.

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