International Journal of Social Sciences and Management Review

Volume: 04, Issue: 04 "July - August 2021"

ISSN 2582-0176

ANALYSIS OF RCC GRANITE QUARRY SITE ON AIR QUALITY OF YANGOJI, KWALI, AREA COUNCIL, ABUJA, NIGERIA

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https://doi.org/10.37602/IJSSMR.2021.4408

ABSTRACT

This study analyzed granite quarry site on air quality of Yangoji, in Kwali Area Council, Federal Capital Territory, Abuja, Nigeria. Using measurement, the study used an industrial scientific ibrid Mx6 gas analyzer to measure NO2, CO and CO2, pm2.5 and pm10 with a handheld laser particle counter, Model 3887 and So2 with Crowcon gas man EN50014. The study revealed that particulate matter (pm2.5 and pm10), NO2, CO and SO2 were all above the limits of Nigerian Ambient Air Quality Standards of 150 µg/M3 for a 24-hourly average time for pm10 and 35 µg/M3 for pm2.5, 0.06ppm for No2 and 10ppm for CO at the quarry site, granite mill, stockpiling area and packing house except the village upwind. The study also discovered that pm10 and nitrogen oxide have the highest coefficient of variation of 51 and 67 respectively. The study further revealed a positive significant ($p < 0.05$) relationship between particulate matter (2.5), nitrogen oxide (NO2) and carbon monoxide (CO). The study concludes that quarry activities released air pollutants into the environment and pollutants such as particulate matter (pm2.5 and pm10) and greenhouses gases such as CO, CO2, NO2 and SO2 were all detected. The study, therefore, recommends that for sustainable quarry activities, the quarry site should be located in the interior surrounded by adequate vegetation which would act as sinks and block for various emissions emanating from the quarry site.

Keywords: Air Quality, Quarry Site, Yangoji, Kwali, Abuja, Nigeria.

1.1 INTRODUCTION

The process of getting useful stone from a quarry is known as quarrying. The methods and equipment used in the quarry depend on the purpose for which the stone is extracted (Babatunde, Kofoworola & Oluwafunmilayo, 2013). Different quarrying activities have different impacts on air quality, the process of making holes in rock overburden with the aid of a drilling machine may be treated as a point source of pollutant emission (Babatunde et al, 2013). Shattering the drilled granite or overburden in a bid to loosen the mass in smaller fragments may be treated as an instantaneous point source for suspended particulate. Also, the loading and movement of dumper trucks on haul routes would generate suspended particulates while the crushing of granite and transferring it to a belt conveyor would be a potential source of dust generation (Babatunde et al, 2013). Dust is the main source of air pollution in the quarry industry, the extent of pollution by dust depends on the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the

dust particles and their chemistry (Hsin-Yi, 2012). The dust has an effect both on human health and the natural environment, it can lead to chronic health effects, for instance, decreased lung capacity and lung cancer resulting from long-term exposure to toxic air pollutants (Sunyer, 2011). However, it blocks and damages the internal structure and abrasion of leaves and cuticles (Hsin-Yi, 2012). Quarrying of granite has a considerable impact on land, water, air and biological resources if the operation and post-operation issues are not handled properly. In Yangoji in Kwali Area Council, Federal Capital Territory, Abuja, quarry activity by RCC company is believed to have distorted the natural air quality of Yangoji due to the release of pollutants into the environment leading to visual impairments and respiratory tract infections. Studies have been done on the levels of heavy metals in soil and vegetation of a quarry site (Bada & Fagbayibgo, 2009) and on the level of suspended particulates in the ambient air and around selected quarry sites (Oguntoke, et al, 2009) but much work has not been done on the effect of quarry activities in relation to air quality. The objectives of this study are to determine the various air pollutants associated with RCC quarry activities and determine the variations and relationship of the pollutants with respect to the distance from the drilling station.

2.0 MATERIALS AND METHODS

2.1 Location of the Company

This was carried out in the vicinity of the RCC Quarry site located at km 39, Lokoja Abuja Road, near Yangoji village, Kwali Area Council of the Federal Capital Territory FCT, Nigeria. Figure 1 shows the location of the company in Kwali Area Council, FCT, Abuja, Nigeria. The quarry company engages in the production of granite for sale to construction companies and registered agents. The climate of Kwali follows a tropical pattern with the rainy season lasting between seven months between April and October with cessation in August and the dry season running through November till February. The geology of Yangoji is basically a pre-Cambrian basement complex comprising order granites and metasediments which have been transformed into analectic migmatites and granites.

2.2 Sample Collection and Analysis

Ambient air samples were taken in the major activities areas according to the procedures stipulated by Adoki (2012) such as quarry site, granite mill, packing house and Yangoji village upwind of the factory. The average time for sampling was 30 minutes, sampling was carried out in the afternoon. The parameters measured in the sampled air were Sulphur dioxide (So2), oxides of nitrogen (Nox), carbon monoxide (Co), carbon dioxide (Co2), respirable and inhalable particulates (Pm2.5 and Pm10) were also measured.

2.3 Statistical Analysis

The data obtained were subjected to descriptive statistics, analysis of variance and correlation analysis.

International Journal of Social Sciences and Management Review

Volume: 04, Issue: 04 "July - August 2021"

ISSN 2582-0176

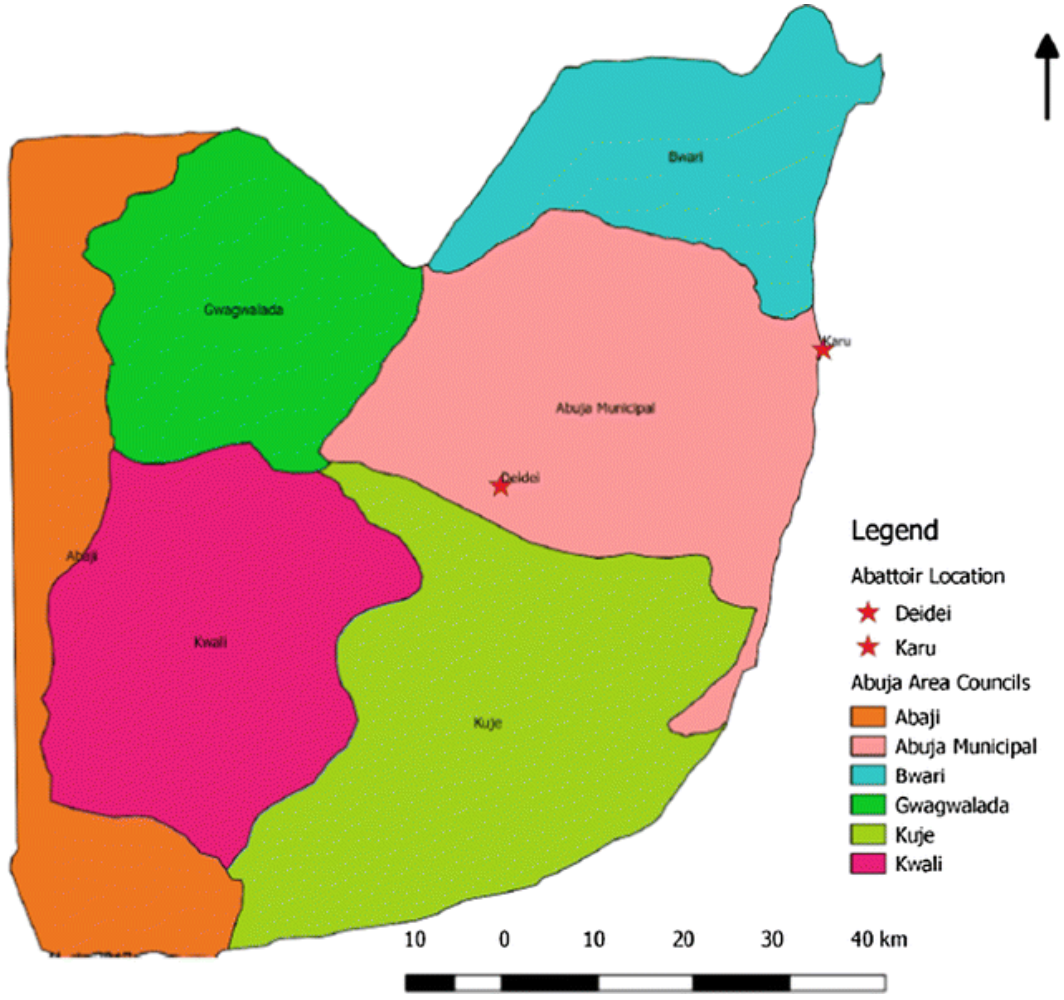

Fig. 1: Map of Kwali Area Council Showing RCC Quarry Site Yangoji

Table 1. Air Parameters Analysed and Instruments used

Parameters	**Instruments**
So_2	**Crowcon Gas Analyser EN50014**
Co, Co_2, Nox	**Ibrid Mx6 gas analyser**
$Pm_{2.5}$	**Hand held laser particle counter**
Pm_{10}	**Hand held laser particle counter**

3.0 RESULTS

Table 2: Examination of pollutants' Value of RCC Quarry Site in Yangoji.

		Parameters							
S/N	**Pm10 ($Nglm^3$)**	**Pm2.5 ($Nglm^3$)**	**No^2 (ppm)**	**10 (ppm)**	**Co (ppm)**	**Co_2 (ppm)**	**So_2 (ppm)**		
1.	Quarry site	156	81	1.01	10.62	35.4	28.5		
2.	Granite mill	290	86	1.51	11.2	39.7	32.4		
3.	Stock pilling Area.	103	96	2.20	13.31	49.5	38.3		
4.	Parking house	274	94	1.31	10.51	75.42	53.6		
5.	Village up wind	89	24	0.04	2.00	26.5	26.2		
	FMEnu. Limit	150**	35**	0.06	10				
	WHO					5000			

Source: Author's Fieldwork, 2017.
***National Ambient Air Quality Standard, 2006.**

The results obtained for the concentration of particulate matter (pm10) measured in all the sampling stations were between the range of 89 µg/m3-290 Ng/ m3. This implies that particulate matter (pm10) at the quarry site, granite mill, stockpiling area, parking house were all above the Nigerian Ambient Air Quality Standards (NAAQS, 2006), which stipulates a range of 150 µg/ m3 for a 24-hourly average time except for the village upwind that has a value below the standard with 89 µg/ m3 for a 24 hourly average time which can be attributed to the distance of the village and present of vegetation cover surrounding the village. Table 2, also shows that particulate matter (pm2.5) in all the sampling stations has value above the standard of Nigerian Ambient Air quality standards (NAAQS, 2006) of 35 µg/ m3 except for the village upwind of the quarry site which was between the range of 24 µg/ m3 -96 µg/ m3. Nitrogen dioxide (No2) has a value between 0.04-2.20 ppm which was above the standard of Federal Ministry of Environment Standard of 0.06ppm (FMEnu Limit, 2006) except for the village upwind. The results obtained for the concentration of carbon monoxide (Co) revealed that the concentration of carbon monoxide (Co) measured in all the sampling stations were between the ranges of 2.00 pm-13.31ppm. This implies that the concentration of Co measured in all the sampling stations was above the (FMEnu Limit, 2006) except for the village upwind, which stipulates a range of 10 ppm-20ppm for an 8-hourly average time. The highest concentration of 13.31ppm was at the stockpiling area while the lowest concentration of 2.00ppm was recorded at Yangoji Village. This low concentration is due to the fact that CO is naturally oxidized by oxygen in the atmosphere to carbon dioxide, therefore CO gets to Yangoji village, it must have been oxidized to CO2.

Table 2 also shows that the concentrations of Carbon dioxide (CO2) in all the sampling stations at Reynold quarry site and its community were between the range of 26.5ppm and 75.42ppm which falls below the maximum standard natural concentration (600ppm) of carbon dioxide in the fresh air and the recommended World Health Organization threshold

limit value of 5000ppm which is safe for healthy adults for an 8-hour work per day (WHO 1990). The concentration of 75.42ppm recorded at the parking house was the highest compare to other stations. This could be due to released gases from the combustion of fuel. Concentrations of 35.4ppm, 39.7ppm, 49.5ppm, 75.42ppm and 26.5ppm were recorded at the quarry site, granite mill, stockpiling area, parking house and village upwind respectively. Also, concentrations of sulphur dioxide (SO2) of 26.2ppm, 32.4ppm, 38.3ppm, 53.6ppm and 28.5ppm were recorded at the quarry site, granite mill, stockpiling area, parking house and village upwind. The concentration of 53.6ppm recorded at the parking house was highest compared to other sampling units which could be due to gas released from the combustion of kiln fuel.

Table 3: Variation of Pollutants in the Study Area.

Pollutants	Mean	Standard Deviation	Co-efficient of Variation
Pm10	182.4	94.5	51.8
Pm2.5	76.2	29.8	39.1
No_2	1.21	0.78	67.0
Co	9.5	4.35	46.3
Co_2	43.3	18.75	43.3
So_2	35.8	10.90	30.4

Source: Author's Fieldwork, 2017.

Table 3 revealed that particulate matter (pm10) with a standard deviation of 94.5 and Nitrogen oxide (NO2) with S.D. 0.78 variation of 51.8 and 67 which is an indication of a high concentration of this pollutant within the sampling units of the study area. This high concentration of pm10 which can be attributed to quarry activities and vehicular movement to and fro within the sampling stations is also discernable from the table that particulate matter 2.5, with a standard deviation of 2.98, Carbon monoxide (CO) with a standard deviation of 4.35, Carbon dioxide with standard deviation 18.75 and Sulphur dioxide (So2) with standard deviation 10.90, all have a low relative coefficient of variation with pm2.5(39.1), CO (46.3), CO2 (43.3) and SO2 (30.4) in all the sampling stations which can be attributed to vegetation cover around the sampling units. This is in agreement with Chaulya (2005) that emissions of SO2, CO2 are negligible. This is also in agreement with the prediction of the United States Environmental Protection Agency (USEPA) that suspended particulate matter is quite outstanding among the pollutants emanating from quarry operations (USEPA, 2008).

Table 4: Correlation Coefficient of Air Pollutants in the Study Area.

Variables	Pm10	Pm2.5	No2	Co	Co2	So2
Pm10	1.00					
Pm2.5	0.428	1.00				
No_2	0.260	0.908*	1.00			
Co	0.391	0.947*	0.941	1.00		
Co_2	0.542	0.750	0.498	0.510	1.00	
So_2	0.483	0.615	0.396	0.344	0.971	1.00

N = 5

*** Correlation is significant at 0.05 level (2-tailed)**

*** Correlation is significant at 0.01 level (2-tailed).**

Using Pearson correlation coefficient indicated that there is a significant ($p<0.05$) positive relationship between particulate matter (pm2.5) nitrogen oxide and carbon monoxide at 0.05 level (2 tailed) as Pearson correlation co-efficient was 0.908 for NO2 and 0.947 for CO. The coefficient of determination r2 for pm2.5 and NO2 is 0.908*x 0.908* which is 0.8244x1.00 or 82.4%. Hence, 82.4% is a high coefficient of determination. This means there is a high relationship between particulate matter (pm2.5) and nitrogen oxide (NO2). Also, the coefficient of determination r2 for pm2.5 and Co is 0.947x0.947 which is 0.8968x100 or 90%. 90% is a high coefficient of determination. This means there is a high relationship between particulate matter (pm2.5) and carbon monoxide (CO). This might be an indication that the pollutants were emitted from the same source. This study was in agreement with the study carried out by Babatunde, Kofoworola and Oluwafunmilayo (2013) when the assessed air quality in the vicinity of quarry site in Abeokuta. Their study revealed a positive significant ($p<0.05$) relationship between particulate matters (pm10, pm2.5) and CO, in the study area. There is a positive significant ($P<0.05$) relationship between carbon monoxide (CO2) and Nitrogen oxide (NO2) is 0.498*, 0.498* which is 0.2480x100 or 25%. Hence 25% is a low coefficient of determination which indicated a low relationship between carbon monoxide (CO2) and Nitrogen oxide using Pearson correlation coefficient indicate that there is a positive significant ($P<0.01$) relationship between carbon dioxide (CO2) and Sulphur oxide (SO2) at 0.01 level (2-tailed as Pearson correlation coefficient was 0.971. The coefficient of determination r2 for CO2 and SO2 is 0.971x0.971 which s 0.9428x100 or 94.3%. Hence, 94.3% is a high coefficient of determination which means a high relationship exists between carbon monoxide and Sulphur oxide. This high relationship can be attributed to the fact that these pollutants were associated and released from the same source (USEPA, 2008).

4.0 CONCLUSION

Quarry activities released air pollutants into the environment. Air pollutants such as particulate matter (pm2.5 and pm10) and greenhouse gases like CO, CO2, NO2 and SO2 were detected. All these pollutants have high value in quarry site, granite mill, stockpiling area, parking house but recorded low values in the village upwind which can be attributed to the presence of vegetal cover in the village.

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