



Environmental Impact of Quarry Activities on Resident of Akure Region, Nigeria

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ABSTRACT

The quarrying industry is of vital importance to all aspects of modern day life and development. However, searching, locating and extracting materials used for construction activities pose some problems to the environment which normally result in the damaging of the immediate environment and atmosphere. The aim of study is to assess the environmental impact of quarry activities in Akure region and identify the hazards associated it. Structured questionnaire and field observations was administered to elucidate data on socio-economic characteristics of the residents; vibration effects; building damages; health effects and impact of quarry activities on the environment. There were 2900 buildings in the study area which constitute the research population. The sample size of 10% was adopted, hence 290 copies of questionnaires was administered in the study area. The study also employed ArcGIS software to determine the extent of land area that is affected by pollution as a result of the quarry activities in the study area. The research also made use of IKONOS imagery for Geographical Information Systems GIS) to buffer and extract buildings that are within 3km radius. Results obtained show that most buildings that fall within buffer zone to quarry site

have high risk such as air pollution, noise pollution and health effects. The Study recommended total relocation for the residents that falls buffer zones to reduce health risk problems and monitoring visits to quarry sites should be undertaken routinely so as to minimize the negative effects of quarrying operations on humans and the environment

Keywords: ArcGIS, Buffer zones, Construction activities, Extracting materials, IKONOS imagery, Pollution

1. INTRODUCTION

A quarry is a surface mining operated area, which produces enormous quantities of gravel, limestone, and other materials for industrial and construction applications Duan *et al.* (2008). Usually where quarrying takes place, the land is cleared of all vegetation, the landscape is drastically altered and the ecosystem totally disrupted Bradshaw and Chadwick (1980) and Roberts and Marrs (1981). Surface hydrology and groundwater levels and flow paths are also altered. Quarries normally operate for about 30 years and during that time a variety of quarry equipment may be used. Although in general a quarry is a type of open surface working from which virgin rock or minerals are extracted, each quarry is very different and will use different types of quarry equipment. The design and general running operation of a quarry depends on the type of rock being extracted, the general environment surrounding the quarry, the size of the quarry and the geography and geology of the general area Osterkamp and Joseph (2000) and Nicolau and Asenso (2000).

Generally, the effects of dust emission from quarries have both micro-spatial and regional dimension. Air pollution and ground vibration arising from blasting, crushing and emission of noxious gases have negative impacts on human health and well-being Andrew and (Bauder 1968).

Several studies have been conducted on the negative impact associated with environmental effects of quarry activities. One of the biggest negative impacts of quarrying on the environment is the damage to biodiversity Anand (2006). Biodiversity essentially refers to the range of living species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms. The damage caused to plants by pollution include necrosis (dead areas on leaf structure) chlorosis (loss or reduction of chlorophyll leading to

yellowing of leaf), epinasty (downward curvature of the leaf due to higher rate of growth on the upper surface), and abscission of leaves (premature fall). Also Adekoya (2003) and Aigbedion (2005) discovered a trend of declining crop output on farms within a close radius to quarries. They concluded that the phenomenon is most probably associated with dust pollution on crop leaves and flower, disrupting photosynthesis and reducing yield. The attendant adverse effect of quarrying activities on crop health and yield, and on human health is likely to be inversely proportional to rural livelihood. In addition, Brogard and Seaquist (2005) stated that livestock growth, development and productivity of livestock could be affected by shocks they feel as a result of blast noise and vibration.

Without doubt, the most contentious environmental impact experienced by residents living adjacent to quarries and surface mines are those produced by blasting. This has been confirmed not only anecdotally but also by surveys carried out by mineral planning authorities William and Hugh (2006). When an explosive charge is detonated in a short hole, there is a sudden release of stored energy in the form of an explosion of gas at high temperature and pressure. The effect of this sudden release of energy is to produce a high pressure pulse to the rock surface and generate a compressive strain pulse in the surrounding rock. According to Andrews and Bauder (1968), due to constant traffic of heavy dumpers and Lorries to and from quarry sites, people who live near are likely to develop asthma or other respiratory diseases while their lungs development may also be stunted. Quarry activities have also produced an ever growing number of abandoned quarry pits that are quickly filled up with water and become suitable habitats for freshwater snails that in turn acts as intermediate host for *Schistosoma haematibium* that eventually contributes to the prevalence of urinary problems in people Hilson (2002). The stagnant water bodies also breeds other disease carrying organisms, increasing the susceptibility of rural populace to various health challenges. Apart from these, land degradation, other negative impacts of quarrying includes swamp creation, deterioration of ground water, erosion of soil, noise and percussions from rock blasting, generation of dust, smoke and fumes; production of noxious gases and ground vibration. Suspended particulate matter is quite outstanding among all pollutants emanating from quarrying operations USEPA (2008).

Quarrying is a sensitive and complex issue. On the one hand quarries supply raw materials to meet many of society's needs, create employment and contribute to the local economy, but on the other hand they can have a significant impact upon the environment and local communities Odunnaike (2008).

However, quarries can cause significant impact to the environment, but with the right planning and management; many of the negative effects can be minimized or controlled if strictly the operators and community adhere to the policy and regulations governing the location of a structure in an environment. Therefore, this paper seeks to assess the environmental impact of quarry activities on residents of Akure regions. The objectives are therefore to:

- i map out quarry industrial zones in the study area using IKONOS imagery
- ii examine the impact of quarry industries on the physical and socio-economic aspects of residents in the study area;
- iii assess the environmental impact of quarry in the study area using buffer zone of 3 km radius; and
- iv examine the effect of quarry industrial pollution on the health of residents in the study area

3. MATERIALS AND METHODS

Akure became the capital of Ondo State in 1976. It lies on latitude $7^{\circ}.15^{\circ}\text{N}$ on the Equator and longitude $5^{\circ}.15^{\circ}\text{E}$ of the Greenwich Meridian. It is about 370m above the sea level, is situated within a 48kilometer radius to major towns in Ondo State, viz Ondo to the South, Owo to the East and Iju/Itaogbolu to the North. Easy access and geographical centrality of Akure to these towns have enhanced the growth prospects of the city (figure 1) Federal Ministry Lands and Survey, Abuja (2015)

Akure is a nodal town which is located nearly at the centre of the state, being about 32km from Ado Ekiti, Owo, and Ondo and about 60km from ilesa, Ikare and Ore. It is also surrounded by some neighbouring towns like Ilara, Igbara Oke, Ijare e.t.c. thus; it really justifies its position as the state capital. Figure 2 and 3 shows the maps of Ondo State and Akure Showing the Quarry Industrial Site respectively Olofinyo (2015)

The population of Akure in 1963 was put at 71,006 and by 1999; the total population has risen to 239,124 according to the 1991 census. By the year 2006, the total population has increased to 340,021 inhabitants NPC (2006). At 2014, using a growth rate of 3.18 percent,

the city is estimated to have 453,731 people using a formula for projection, $P_t = P_o (1+r)^n$ Gabriel (2014).

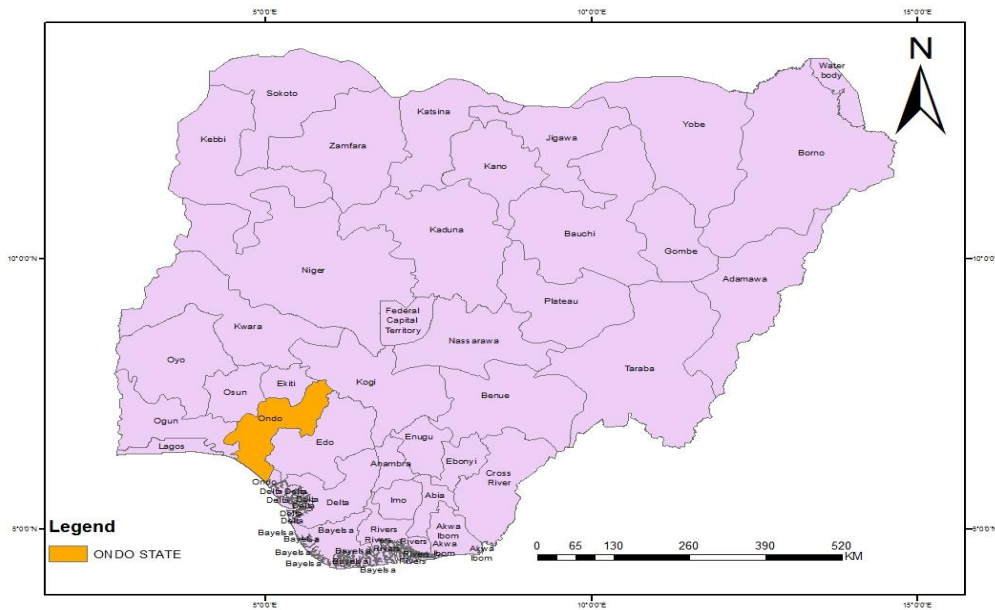


Fig 1: Map of Nigeria showing Ondo State.

Source: Federal Ministry of lands and survey, Abuja (2015).

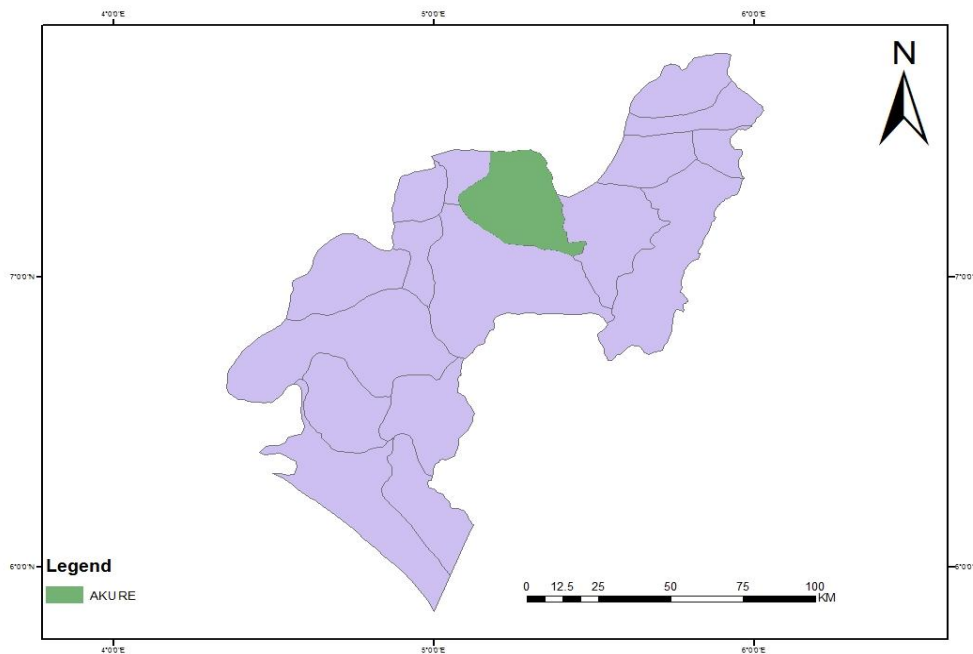


Fig 2: Map of Ondo State showing the Study Area.

Source: Author's Field Survey, 2015

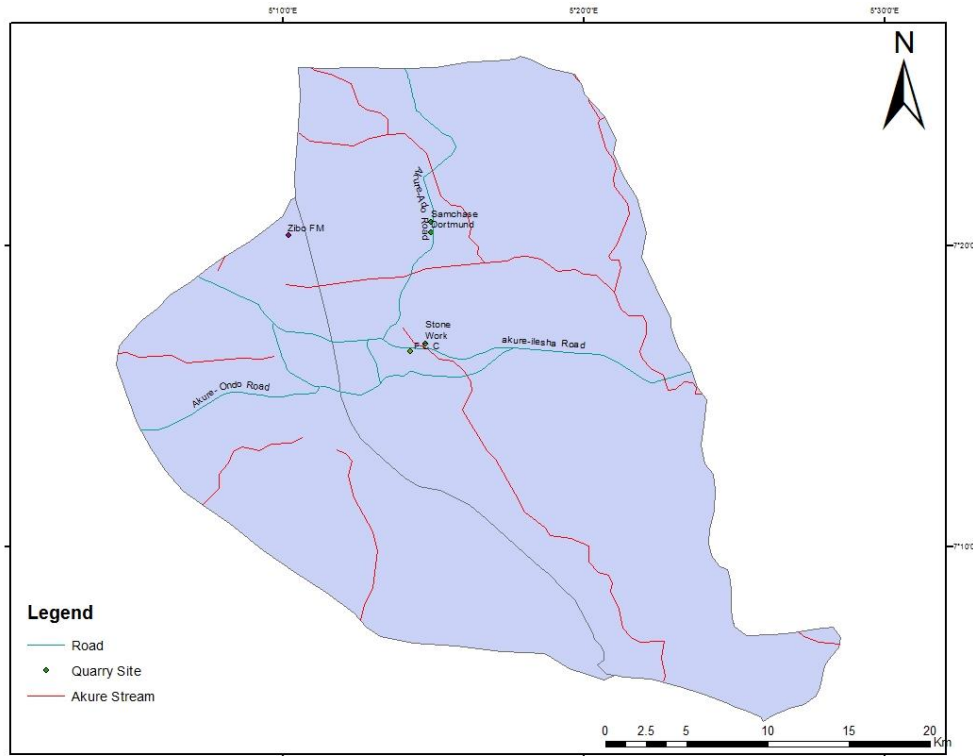


Fig 3: Map of Akure Showing the Quarry Industrial Site

Source: Author's Field Survey, 2015.

Systematic random sampling technique was employed to administer questionnaire to the residents, this techniques was in selecting buildings in which the household-heads were interviewed at an interval of 5th, 10th, 15th 20th -----, nth buildings. In order to determine the total number of questionnaires to be administered to residents, 10 percent of total number of households living within 3km radius around the three quarry sites were selected based on their similarity in their socio economic characteristics Neuman (1991). The questionnaire addresses income of respondent, distance of building from quarry site, effect of dust on health and building, environmental impact of quarry among others. Table I shows the quarry sites and the number of questionnaires administered per site. The research made use of IKONOS imagery for Geographical Information System (GIS) to buffer and extract buildings that are less than 1km and within 1.1km to 3km to the quarry site. All the questions were carefully analysed and considered in addition to spatial information from GIS analysis to arrive at our conclusion.

Table 1: Sample size for the Residents in the study area

S/N o	Name of Industries	Road s	No of Quarr y	Coordinate s Easting	Northin g	Total number of Building s within 3km radius	(Total number of questionnaire s) 10% of Buildings within 3km radius
1.	Zibo-fm quarry	Akure -Ijare Road	1	7.33789	5.16997	444	44
2	FCC Quarry	Akure -Owo Road	2	7.27683	5.24673	1830	183
3	Stonework Quarry			7.27626	5.23808		
4	Samchase Quarry	Akure -Ado Road	2	7.34647	5.24981	626	63
5	Dortmund & Company Ltd Quarry			7.3423	5.25002		
Total		5		290			2900

Source: Author's Field survey, 2015

4 RESULTS AND DISCUSSIONS

4.1: Occupational Status of the Respondents

Table 2 shows the occupational status of the respondents. Table 2 shows that at Ijare road, 6.8% of the respondents were farmers and 15.9% were artisans. While trader and civil servant were 54.5% and 22.7% respectively. Similarly at Akure – Owo road, 10.4% of the respondents were farmers and 21.9% were artisans. While traders and civil servants were 48.1% and 19.7% respectively. While at Akure –Ado road, 9.5% of the respondents were farmers and 47.6% were artisans. Traders and civil servants were 23.8% and 19.0% respectively. The table below reveals that most of the respondents are engaged in one form of occupation or the other.

Table 2: Occupational Status of the Respondents

Location	Ijare		Akure – Owo		Akure – Ado	
Occupation	Freq	%	Freq	%	Freq	%
Farming	3	6.8	19.0	10.4	6	9.5
Trading	24	54.5	88.0	48.1	15	23.8
Civil servant	10	22.7	36.0	19.7	12	19.0
Artisans	7	15.9	40.0	21.9	30	47.6
Total	44	100.0	183	100.0	63	100.0

Source: Author’s field survey, 2015

4.2 Environmental Impact of quarry operation on the environment

The environmental impact of quarrying operation on the environment as shown on Table 3 indicates that at Ijare road, 20.0% of the respondents were of the view that the impact has resulted to cracks on wall of buildings while 38.3% and 4.5% complained of ground vibration and soil erosion. 15.8% of the respondents were of the opinion that the impact has resulted to Noise and 21.4% choose no option. Similarly at Akure – Owo road 22.4% of the respondents were of the view that the impact has resulted to cracks on wall of buildings while 25.1% and 23% confirmed ground vibration and erosion of soil respectively. 14.2% of the respondents are of the opinion that the impact has resulted to noise and 15.3% choose no option while at Akure –Ado 28.6% of the respondents were of the view that the impact has resulted to cracks on wall of buildings. 42.9% and 4.8% complained of ground vibration and erosion of soil respectively. While 19.0% of the respondents are of the opinion that the impact has resulted to noise and 4.8% showed no opinion. Table 10 reveals that majority of the respondents living within 2km radius to the quarry site experience Cracks on wall of their buildings or total collapsed on their buildings (see figure 4). However, respondents living 2km radius away from the quarry site reported slight Ground vibration and Noise Pollution which had left many of their building/walls cracking and roofing perforated and deafness in the long run.

Table 3: Environmental Impact of quarry operation on the environment

Location	Ijare		Akure – Owo		Akure – Ado	
	Freq	%	Freq	%	Freq	%
Crack on wall of building	9	20.0	41	22.4	18	28.6
Ground vibration	17	38.3	47	25.1	27	42.9
Erosion on soil	2	4.5	42	23.0	3	4.8
Noise	7	15.8	26	14.2	12	19.0
None	10	21.4	27	15.3	3	4.8
Total	44	100.0	183	100.0	63	100.0

Source: Author’s field survey, 2015



Figure 4: Building that fall with 1km radius damaged by the effects of stone blasting in Akure-Ado axis

Source: Author’s Field Survey, 2015

4.3 Environmental impact on vegetation

The impact of quarrying activities on the vegetation as shown on table 4 revealed that at Ijare road, 9.1% of the respondents were of the view that the impact has resulted to great damage on plants while 29.5% and 20.5% confirmed reduction in growth and yellowing of leaf. While 25.3% and 15.6% of the respondents didn’t specify and showed no opinion respectively. Similarly at Akure – Owo road, 12.5% of the respondents were of the view that the impact resulted to damage on plants while 9.5% confirmed reduction in growth and

yellowing of leaf as well. 38.6% and 29.9% of the respondents ticked no specific option and none respectively. While at Akure –Ado, 21.9% of the respondents were of the view that the impact has resulted to damage on plants while 37.7% confirmed reduction in growth. 23.0% of the respondents were of the opinion that the impact has resulted to yellowing of the leaf, 17.5% ticked none effect option. It is quite obvious that air pollution and toxic waste pollution from the site affects plants and farm produce (See figure 5).

Air-borne pollution especially dust from the quarry sites are known to be responsible for vegetation damage and crop yield loss and thus becomes a threat to the survival of plants in industrial areas Iqbal and Shafiq (2001). Such dusts reduce plant cover, height and number of leaves. Apart from the dust emitted, toxic compounds such as fluoride, magnesium, lead, zinc, copper, beryllium, tetraoxosulphate VI acid (H₂SO₄) and hydrochloric acid are dangerous to the vegetation. All these negative impacts on vegetation and plants will affect crop yield thereby result to food shortage in Akure regions.

Table 4 Environmental Impact on Vegetation

Location	Ijare		Akure-Owo		Akure-Ado	
Impact on Vegetation	4	9.1	23	12.5	13	21.9
Reducing in growth	13	29.5	17	9.5	24	37.7
Yellowing of the leaf	9	20.5	17	9.5	14	23.0
Others specify	11	25.3	70	38.6	-	-
None	7	15.6	56	29.9	12	17.5
Total	44	100.0	183	100.0	63	100.0

Source: Author's field survey, 2015



Figure 5: Dust produced during the Quarrying work has contributed hugely to Air Pollution; dusts can be seen on vegetation some distances away from the Quarry

Source: Author's Field Survey 2015

4.4 Health Challenges of the resident due to Pollution of Quarry activities

Table 5 shows that 15.8% of the respondents at Ijare road experienced skin disease as a result of the operation of quarry in the area. 20.2% opined that they experience eye disease. While 28.9% of the respondents experience respiratory disease and 35.1% ticked none effect option. Similarly at Akure – Owo road, 29.3% of the respondents were of the view that the impact of quarry activities has resulted to eye disease. While 32.7% of the respondents experience respiratory disease and 38.0% choose none effect option. 17.4% of the respondents at Akure –Ado experience skin disease while 23.6% and 35.2% opined that they experience eye and respiratory disease respectively. Similarly 26.8% of the respondents ticked none option to any of the diseases. It also reveals that eye disease (eye irritation) and Respiratory disease (cough, catarrh) is most common among the respondents living around the quarry area. It was observed that most of the workers are protected; the residents in the community are exposed to the dust during quarry activities. The pollution produced from quarry activities affect the health of people living very close to the site thereby making live difficult to the residents. Diseases associated with pollution include silica containing dust, chronic airways obstruction and bronchitis, tuberculosis and lung cancer.

Table 5: Health Challenges of the resident due to Pollution of Quarry activities

Location	Ijare		Akure – Owo		Akure – Ado	
	Freq	%	Freq	%	Freq	%
Skin disease	7	15.8	-	-	11	17.4
Eye disease	9	20.2	54	29.3	15	23.6
Respiratory disease	13	28.9	60	32.7	22	35.2
None	15	35.1	69	38.0	17	26.8
Total	44	100.0	183	100.0	63	100.0

Source: Author's field survey, 2015

4.5 GIS Analysis

Figures 6, 8 and 10 show the buffering of the quarry between 500m to 3 km radius using ArcGIS. The choice of 3 kilometer buffer is to show those that are vulnerable to the adverse effect of the Environmental Pollution caused by the Quarry in industry as stated by the Code of Pollution control (NEA Singapore) that the nearest building to a Quarry industry or any other light or heavy industries should fall after 3km buffer. One of the major activities carried out in a quarry firm is the blasting of rock which results to noise pollution. However, the study identified the level of noise pollution affecting in the residents. Figure 7 revealed the impact of quarrying activities varies relative to distance of residents living within 500m radius along Ijare quarry site experience 94.7% noise pollution while residents living within 501-1km radius experienced 75.7% noise level. Similarly, the residents living within 1.1km-2km radius experience 51.7% noise level. However, residents living 2km radius away experience 39% noise level. The implication of is that, the closer your resident to the quarry site, the higher the noise value while the far away you are to the quarry site, the lower the noise pollution.

Furthermore, figure 9 shows Akure-Ado quarry site of residents living within 500m radius to the quarry site experienced 90.6% noise level while residents living within 501m -1km radius experienced 72% noise level. Moreover, residents living within 1.1km -2km radius experienced 53.7% noise level. Similarly, residents living 2km radius away from Akure-Ado quarry site experienced 37.7% noise pollution.

Figure 11 shows Akure-Owo quarry site of residents living within 500m radius to the quarry site experienced 95% noise level while residents living within 501m- 1km radius experience 73.7% noise pollution. However, residents living within 1.1km-2km radius experienced 55% noise level while residents living 2kms radius away from the quarry site experienced 39% noise.

However, the residents living around all the quarry sites are mostly vulnerable to noise-borne pollution because of their proximity to the site.

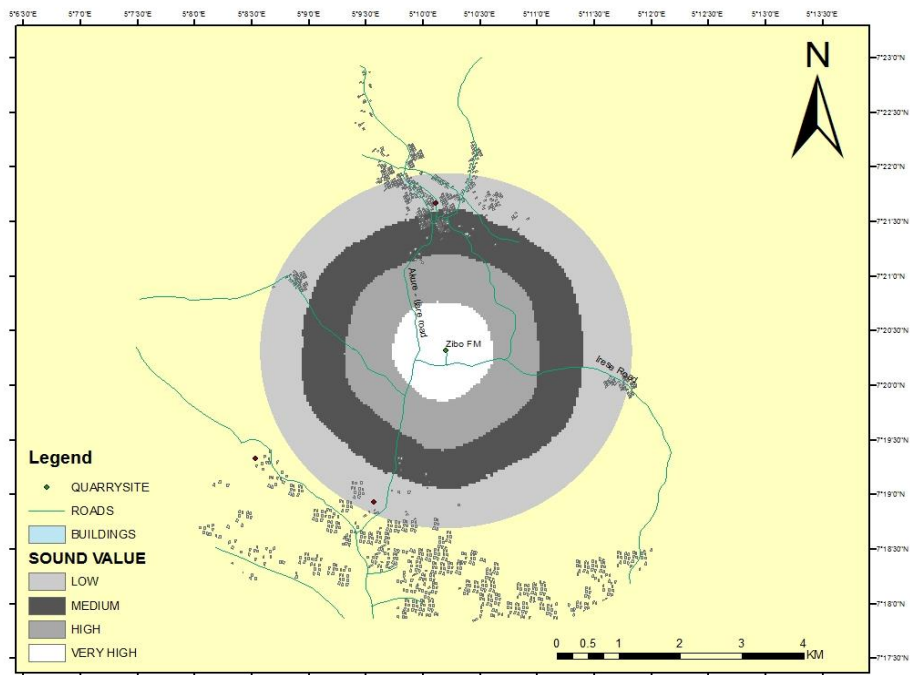


Fig. 6: Map showing the Level of Noise Pollution in Quarry Environs within 3km radius along Ijare axis.

Source: Author’s Field Survey, 2015

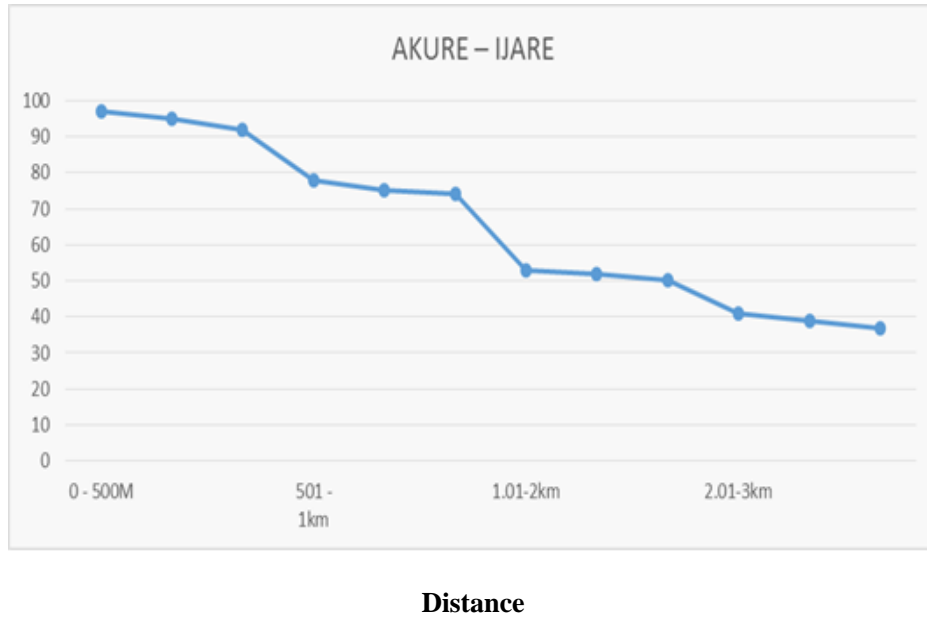


Fig 8: Chart showing the impact of noise pollution around the quarry environs along Ijare axis

Source: Author’s Field Survey, 2015

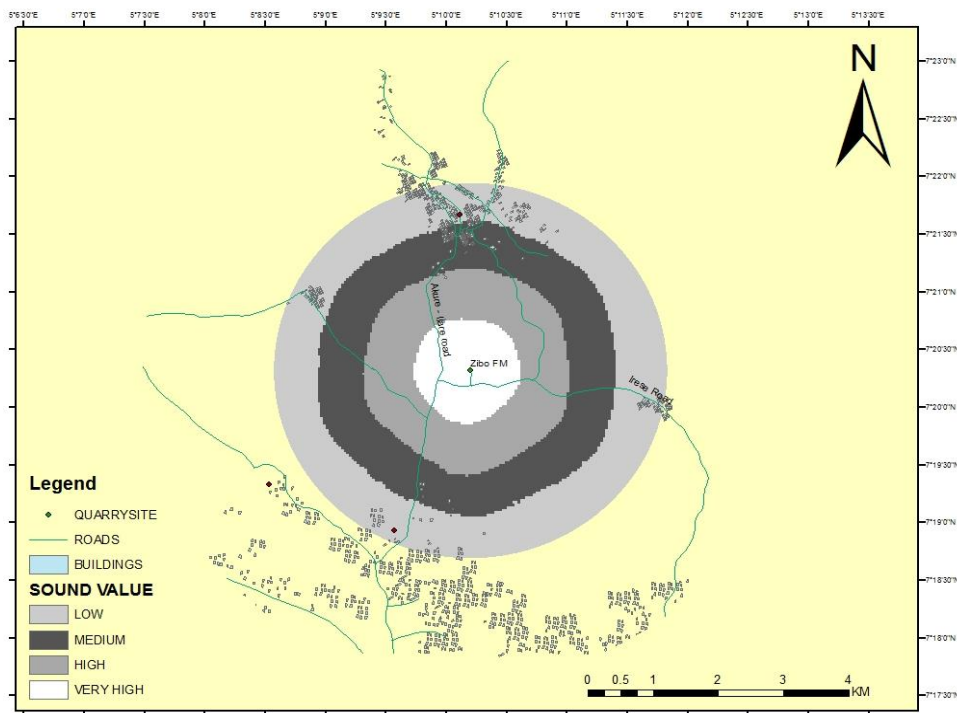


Fig. 8: Map showing the Level of Noise Pollution in Quarry Environs within 3km radius along Akure-Ado axis.

Source: Author’s Field Survey, 2015.

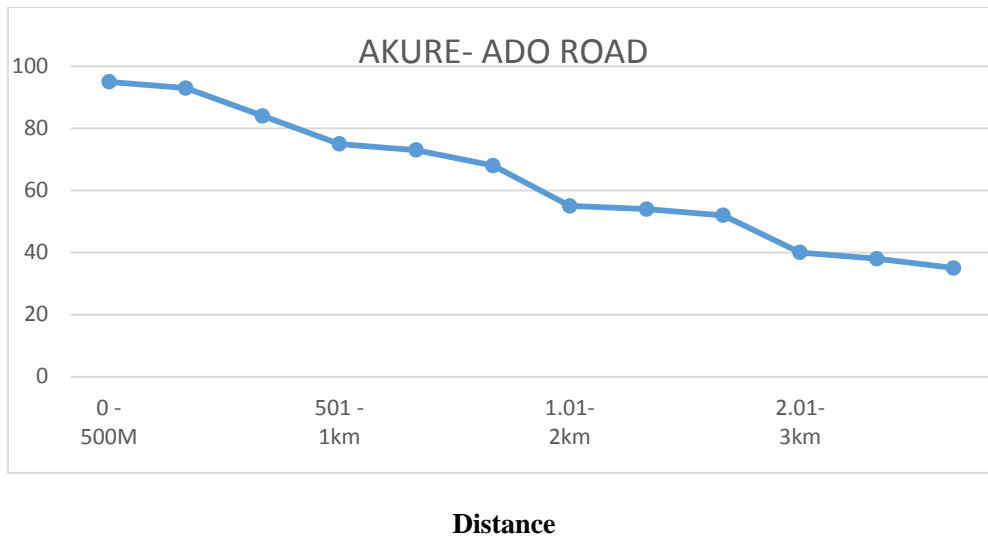


Fig 10: Chart showing the impact of noise pollution around the quarry environs along Akure-Ado axis

Source: Author’s Field Survey, 2015

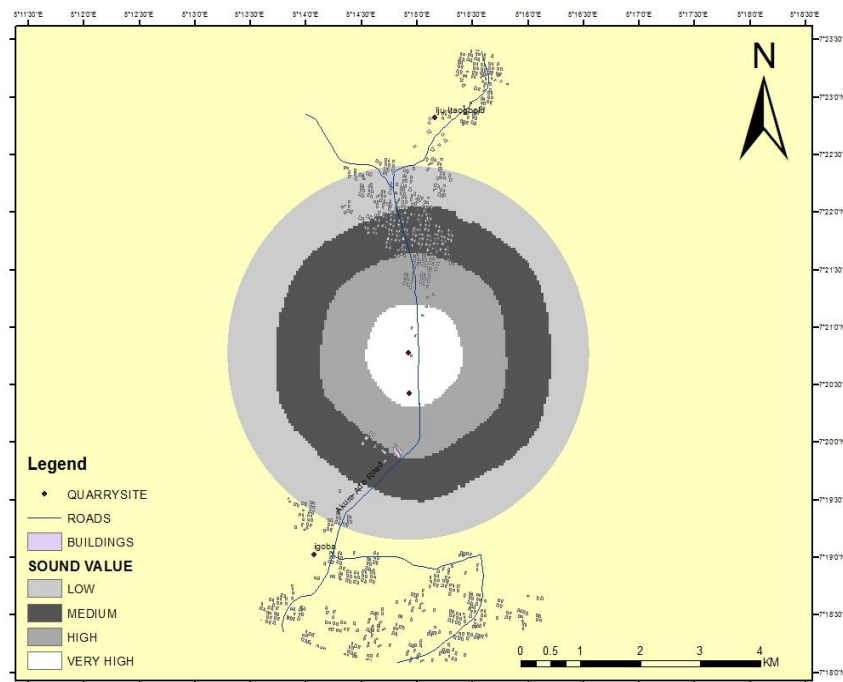


Fig. 10: Map showing the Level of Noise Pollution in Quarry Environs within 3km radius along Akure-Ado axis.

Source: Author’s Field Survey, 2015

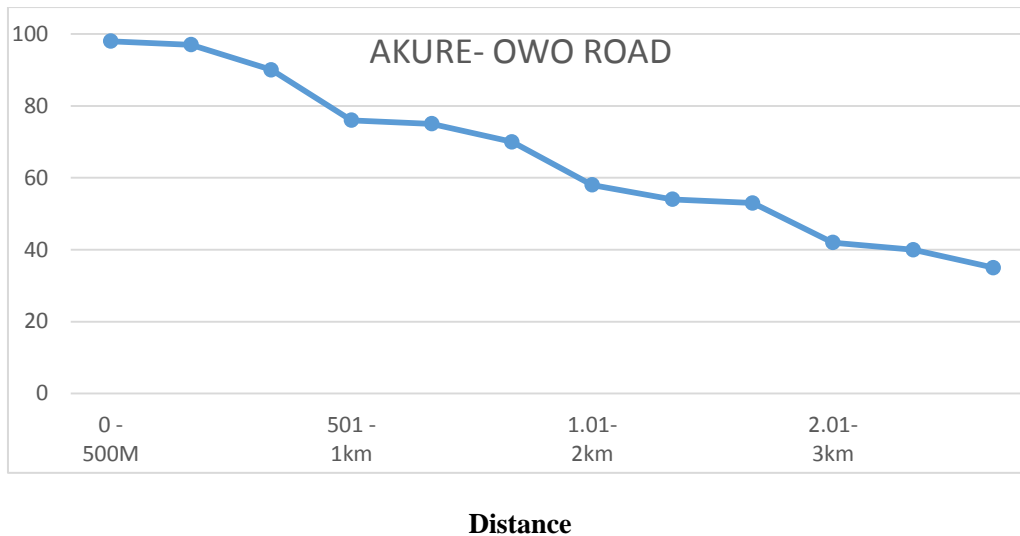


Fig 12: Chart showing the impact of noise pollution around the quarry environs along Akure-Owo axis

Source: Author's Field Survey, 2015

5. CONCLUSION

This study highlighted the impact of quarry activities on the environment and health risks of residents living near quarry industrial zones in Akure, Nigeria. Air (dust) pollution is the major type of pollutions generated in the study area. The pollutions affect the health of the people living very close to the site thereby making live difficult to the residents.

Plants and vegetation around the local environment were seen covered with whitish dust emanating from the quarrying sites, and this may eventually affect/disturb the processes of photosynthesis leading to low plant production or eventual death of these vegetations.

However, the quarry site along Akure-Owo road is in the middle of residential area, with some houses barely 100 metres away from its perimeter wall. The residents have expressed fears about the quarry's effects on their lives but no concrete action has been taken.

Noise as a pollutant produces contaminated environment which becomes a nuisance and affects the health of a person, his activities and mental abilities Chatwal (1999). The noise pollution in the study area is mainly resulting from blasting, drilling, crushing, loading, unloading, machineries and transportation. Therefore quarrying and crushing activities will continue as long as man is concerned about the comforts and standards of living. The major

beneficial impact of stone quarrying is employment, community development, income opportunity etc

6. RECOMMENDATIONS

Quarries play a significant impact to the environment, with right planning and management, many of the negative effects can be minimized or controlled. Therefore, the following measures should be taken into consideration in order to reduce or eliminate the negative effects of quarries in our local environments.

1. Quarry operators should replace their machine from noisy ones to quiet machines.
2. National Environmental management Authority should ensure that quarry operators and the community adhere to the rules and regulations against locating structures 2kms away from quarry sites.
3. The government should implement land use proposal not to plant trees around quarry sites.
4. Necessary legislation should be put in place by the government to regulate quarry activities.

Moreover, the government, the industry and the community should be encouraged to be partners in progress. They can jointly be involved in monitoring environmental resources depletion, especially the compliance level of the plant to minimum standards for sustainable and pollution free society.

Effort geared toward reclaiming the quarry site should be extended further by actually transforming quarry site into parks and garden for recreational purpose via such projects like afforestation, Scarification and final conversion into animal zoos and garden where people can visit and pay a token that will be used in maintaining such projects Olofinyo (2015).

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