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ENVIRONMENTAL EVALUATION OF QUARRY OPERATION IN AKURE METROPOLIS, ONDO STATE, NIGERIA

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Abstract
The study investigated the encroachment of settlements, noise level and prevalent health challenges of quarry operations near Shasha market in Akure North Local Government of Ondo State. The footprint of buildings was digitised from the georeferenced Google earth image in ArcGIS environment and extracted as polygon map. Sound recording system at 250 Hz was employed to measure noise levels at multiple buffered ring interval: 0 – 0.5 km, 0.5 – 1 km, 1 – 1.5 km and 1.5 – 2.0 km relative to Stone Work Quarry Company as the reference location. Other quarry companies that also exist in the study area are Johnson and FCC. Data on the prevalent health problems was obtained from residents and staff of the companies. Structured questionnaire was administered on 100 randomly chosen residents and staff of the quarry companies in order to gather data on the prevalent health problems in the study area. Percentage was used to analyse the respondents. The study revealed that the encroachment of buildings between 0 and 0.5 km is very small, from 0.5 to 1 km is small, between 1 and 1.5 km is moderate, and from 1.5 to 2.0 km is high. While very high clustering of buildings outside the buffered rings between 0 and 2 km was noticed at the northwestern, southeastern and southern zones of the study area. The noise level, 80 – 90 dB was measured between 0 and 0.5 km, 70 – 80 dB for distance from 0.5 to 1 km, 60 – 70 dB for distance between 1 and 1.5 km, 50 – 60 dB for distance from 1.5 to 2.0 km and 40 – 50 dB was recorded outside the fringe of 1.5 – 2 km ring. Responses from interviews showed that within 0.5 – 1 km, 90% of the residents suffered from shock, catarrh 45%, and cough 30%; and within 1.5 – 2 km, shock is 40%, catarrh 20% and cough 15 %. The study concluded that cracks on some building walls were noticed within 0 – 0.5 km range. Residents living within 0 – 0.5 km and 0.5 – 1 km will suffer severe hearing loss. Moderately severe hearing loss for within the ring 1 – 1.5 km. Moderate hearing loss / moderately severe hearing loss for within 1.5 – 2 km ring. Mild hearing loss / moderate hearing loss at the fringe greater than 2 km distance. Residents living close to the quarries would be exposed to varying health issues such as shock, catarrh and cough.

Key Word: *Granite quarrying, Settlement, Noise pollution, Health impact, GIS*

Introduction

The rapid growth of cities, a direct implication of urbanization is attributed to spatial growth of towns and cities or in other words growth in urban areas that is commonly referred to as urban growth (Bhatta, 2010). Since 1950´s, the number of city dwellers worldwide shows no sign

of stopping as the influx of people moving into cities soars and more new townships are being developed (Farah *et al.* ,2013). The ever increasing population in urban centres in the third world countries like Nigeria cannot be over emphasized; as it is closely linked with modernization, industrialization, and migration, which has resulted in both positive and negative effects on the environment and man.

Akure metropolis, is a city in South Western Nigeria housing the capital of Ondo State. Between 1976 and the present time, the city has experienced enormous growth and has developed independently of any spatial urban planning. This rapid growth became prominently noticed in the last two to three decades (Owoeye and Akinluyi, 2018). As urbanized features extended farther from the central areas, lands populated by development are altered in significant ways. Since 1976 when the town became the state capital, there have been remarkable changes in its growth and development. Several developmental projects that brought transformation to the physical landscape of the city are very prominent (Owoeye and Ibitoye, 2016).

Rock quarrying and stone crushing activities have been the cause of concern everywhere in the world, including the advanced countries. Quarrying activity is a necessity that provides much of the materials used in traditional hard flooring, such as granite, limestone, marble, sandstone, slate and even just clay to make ceramic tiles (Lameed and Ayodele, 2010).

Therefore, quarry is an open-pit mine from which rocks or rock minerals are extracted through various processes that may comprise removal of the topsoil (overburden), drilling, blasting with explosives and use of machinery to crush and grade rock materials and for transportation. Quarrying, like every mining operation, is a destructive development activity whose socio-economic benefits may be unable to compensate for the overall detrimental effects on natural ecosystems (Olufemi *et al*., 2014). Blasting and crushing of rocks and use of explosives and heat to produce granite chips release particulate matter, noise and dust of different metallic constituents from the machineries and blasting processes. Hence, compaction by heavy machinery produces various impacts on the air, water, soil, earth surface, flora and fauna, and human beings (Enger and Smith, 2002).

Solid materials in the form of smoke, dust and also vapour generated during quarrying operations are usually suspended over a long period in the air. Moreover, particulate matters in the air are capable of being transported from the point of generation to areas far beyond (UNEP, 1991). Once particles of varying chemical compositions are inhaled, they lodge in human lungs; thereby causing lung damages and respiratory problems (Last, 1998). According to Deborah (1996) and National Industrial Sand Association (1997), dusts generated from granite quarrying contain 71 percent silica. Inhaling such dust results in silicosis which is capable of disabling an exposed person and subsequently, may lead to death. Apart from silicosis, sandblasters, miners and quarry workers are known to suffer from pneumoconiosis (www.gulflink.osd.ml). Suspended particulate matter may be affecting more people globally than any other pollutant on a continuous basis (Richard *et al*., 2002).

Therefore, this study mapped the encroachment of settlements, noise level

and prevalent health challenges among the dwellers around granite quarries bordering Shasha market. This was with a view to providing sustainable solution to the negative impact of quarry activities in an emerging economy like Nigeria.

Study Area

The study area (Figure 1) is a subset of Akure North local government area and is located between latitudes 7° 15′ N and 7°20′ N and longitudes 5°12′ E and 5° 16′ E. The topography of the area is an undulating plain with scattered inserbergs that may rise up to about 370 m above sea level. The rock type found in the area is porphyritic granite. It is crystalline and coarse grained (porphyritic) in texture. The phenocrysts are cubical to rectangular shapes possibly microcline feldspars due to the pinkish colourations. Some of the phenocrysts are so large measuring up to 2 by 3cm in size (Olarewaju, 1988). There are three quarry companies in the study area. They are: Stone work, FCC and Johnson; however, Stone work is the most active among the three quarries and hence it is the focus of this study (Figure 1). These companies have contributed greatly to the socio-economic activities of Akure North Local Government through the exploitation of this rock by large-scale quarrying operation. This area is well known to the resident of Akure city due to the presence of Shasha market, where agricultural products like tomato, pepper, onions, potatoes and other agricultural products are brought from the northern parts of the country for sale to the residents.

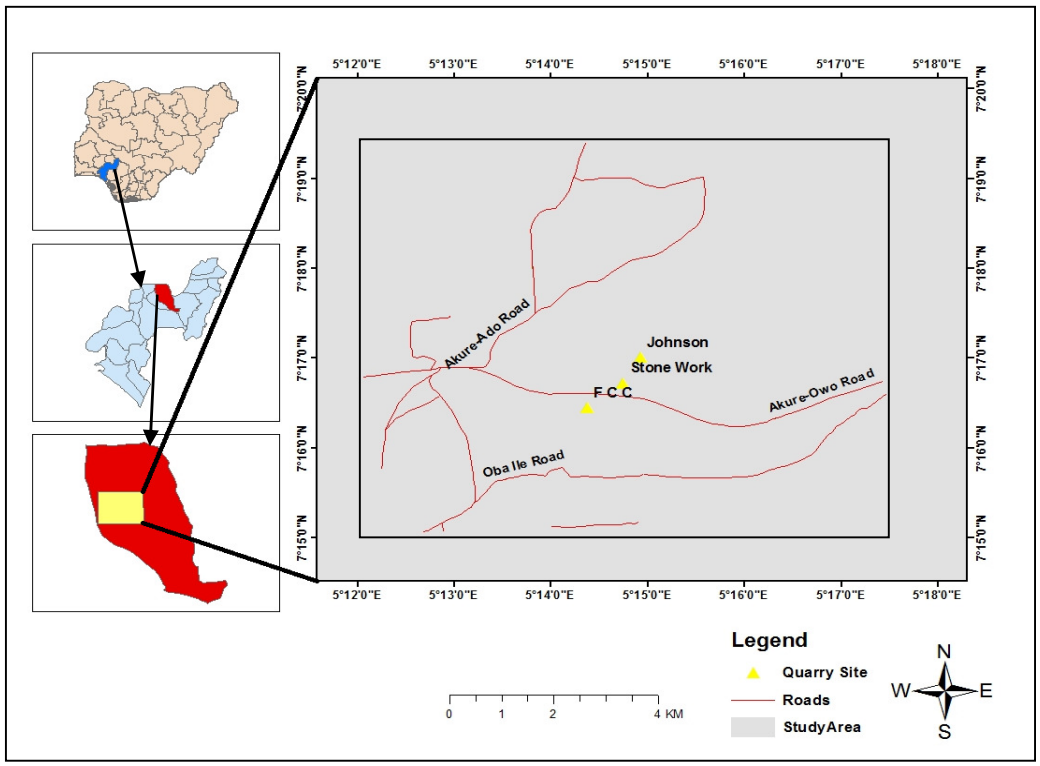

Fig 1: Map of the study area

Materials and Methods

The sources of data used for this study were acquired from field mapping, questionnaire administration, and Google earth image. The georeferenced high resolution google earth image was used to extract settlements by digitization process around the quarry companies (Stone Work, Johnson and FCC). The digitization of buildings was done in ArcGIS 10.5 to examine the level of encroachment to the quarries by using Stone work as the reference quarry. The other quarries are Johnson and FCC. The geometry of the study area was also extracted from the Google earth image of the area. A sound level meter in decibel (dB) at 250 Hz was used to measure the sound pressure level at distances 500 m, 1 km, 1.5 km, and 2 km from the Stone work quarry designed 0 m. These intervals were used to create a multiple buffering ring so as to quantify the loudness of sound overlapping buildings around the study area. The footprint of the quarries were captured by Global Positioning System (GPS). Oral interview was conducted with the aid of fifty (50) structured questionnaires were administered on the residents using a systematic random sampling technique at 500 m from Stone work quarry to 2 km. The heads of households within this interval (500 – 2km) of one out of ten houses were randomly selected. The questionnaire was targeted at knowing the prevalent health issues as a result of the quarry activities. The responses were subjected to statistical frequency analysis so as to deduce frequency of occurrence of health problems.

Results and Discussion

Figure 2 depicts the spatial footprints of buildings across the study area. Although buildings are permitted 2 km away from quarrying sites (NESREA, 2007), analysis (Figure 2) shows that encroachment of buildings on the site between 0 and 0.5 km relative to Stone Work Quarry (SWQ) Company is very small. For the buffered distances: 0.5 – 1 km, 1 – 1.5 km and 1.5 – 2 km, reveal small, moderate and high encroachment density respectively (Figure 2). While the peri-building outside the buferred rings (0 – 500 m, 500 m – 1 km, 1 – 1.5 km and 1.5 – 2.0 km) at the northwestern, southeastern and southern zones of the study area depict very high clustering of buildings over the years due to increasing urbanization along Akure – Ado road, Akure – Oba-Ile road and Akure – Owo express road. The presence of Shasha market intensified the economic activities in the area which also contribute to the encroachment of buildings to the SWQ, the reference quarry. Reconnaissance survey conducted during the course of this study showed cracks on some building walls within 0 – 500 m range. This corroborated the work of Oyinloye and Olofinyo (2017) who reported that majority of the respondents living within 2 km radius to a quarry site experience cracks on the walls of their buildings.

Table 1 and Figure 3 present the measured sound levels between 0 and 2 km at 500 m interval and outside the ring. 80 – 90 dB was measured within 0 – 0.5 km ring. 70 – 80 dB was recorded for 0.5 – 1 km ring. For rings at distances 1 – 1.5 km and 1.5 – 2 km, 60 – 70 dB and 50 – 60dB sound levels were measured respectively. While 40 – 50 dB noise level was recorded for settlements outside the fringe of 1.5 – 2 km ring. Table 2 presents the threshold scale for hearing loss level (Bance, 2007) and it was used as the reference scale to determine the degrees of hearing loss damages the residents are

exposed to. Therefore, Table 3 shows the effects of hearing loss encountered by the residents as a result of the proximity of the buildings to the quarries by comparing Tables 1 and 2. From Table 3, it shows that residents living within 0 – 0.5 km and 0.5 – 1 km will suffer severe hearing loss. Moderately severe hearing loss will be encountered by residents living within the ring 1 – 1.5 km. Within 1.5 – 2 km ring, residents are going to experience moderate hearing loss / moderately severe hearing loss. While the residents living at the fringe greater than 2 km ring will be exposed to mild hearing loss / moderate hearing loss.

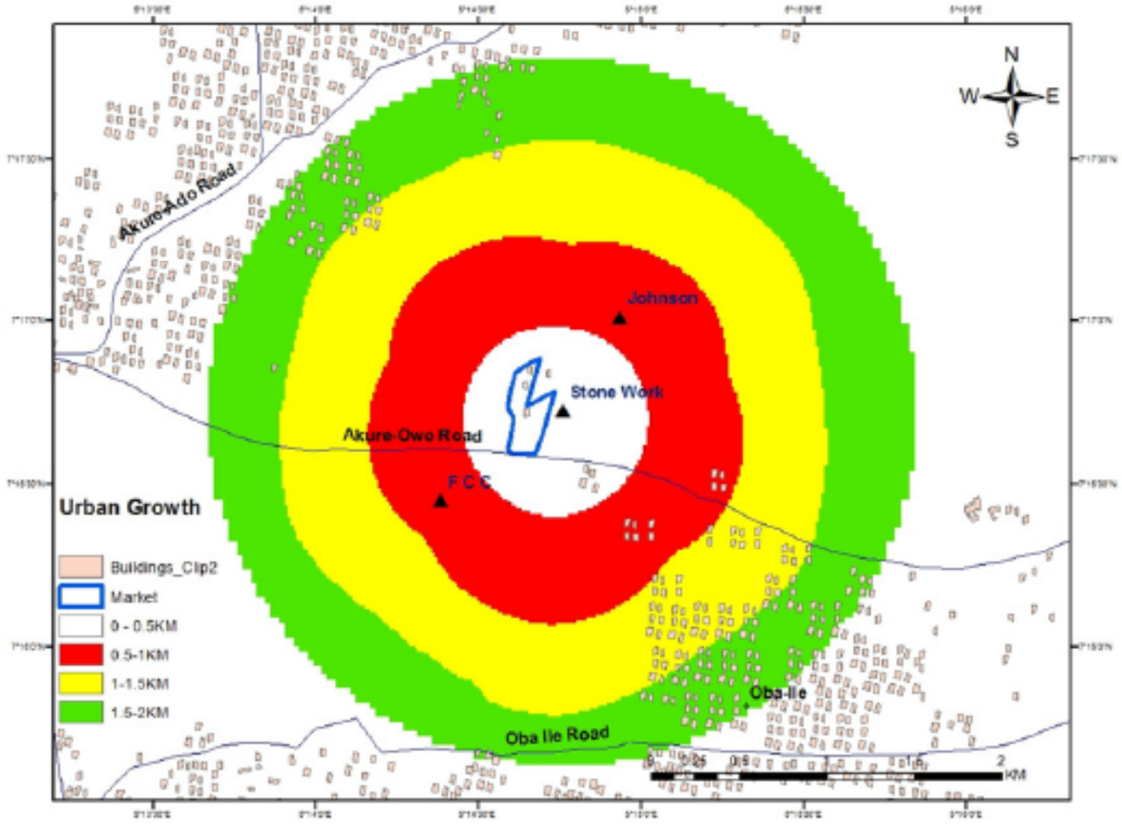

Fig. 2: Map showing footprints of buildings

Table 1: Measured noise level

Buffered distance (km)	Measured noise level (dB)
0 – 0.5	80 - 90
0.5 – 1	70 - 80
1 – 1.5	60 – 70
1.5 – 2	50 – 60
> 2	40 – 50

(Reference Location: Stone Work Quarry)

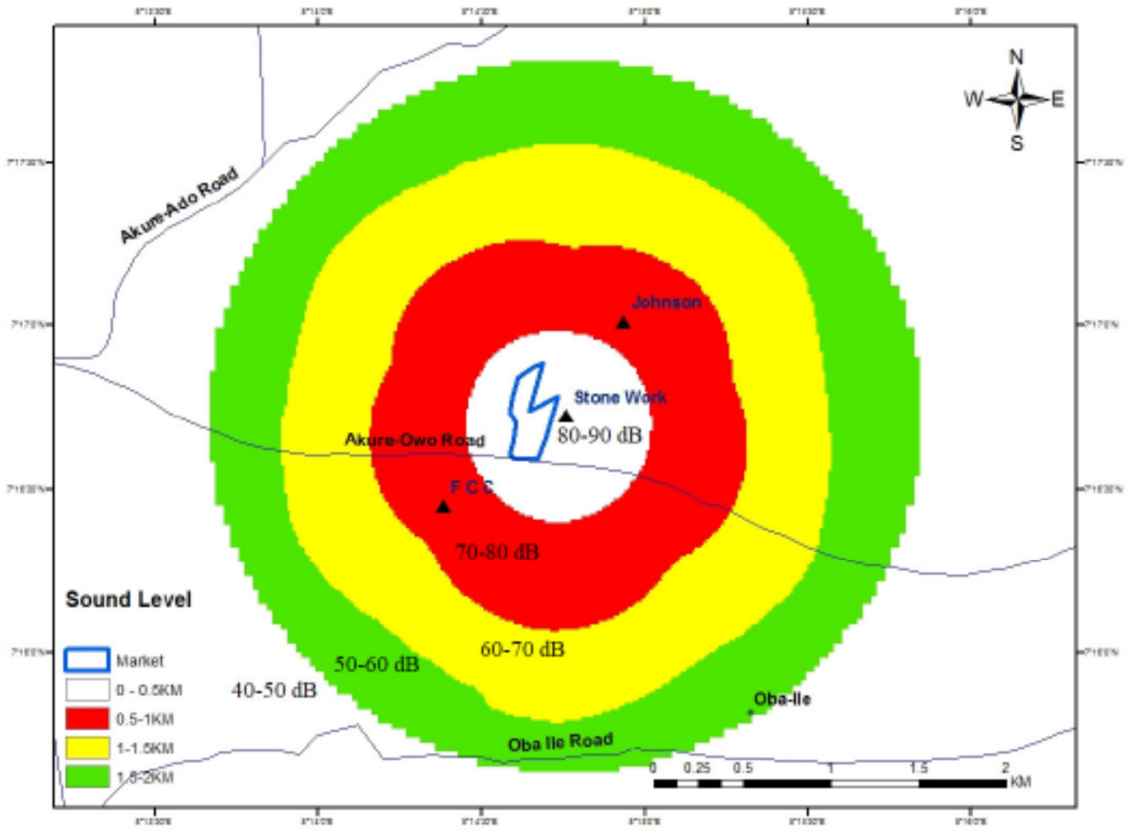

Fig. 3: Map showing the sound level at multiple buffered distances

Table 2: Threshold scale of hearing loss

Hearing threshold (dB)	Degree of hearing loss
-10 to 15	Normal hearing ability
16 to 25	Minimal hearing loss
26 to 40	Mild hearing loss
41 to 55	Moderate hearing loss
56 to 70	Moderately severe hearing loss
70 to 90	Severe hearing loss
> 90	Profound hearing loss

(Source: Bance, 2007)

Table 3: Degrees of residents hearing loss

Buffered distance (km)	Measured noise level (dB)	Level of expose to hearing loss
0 – 0.5	80 - 90	Severe hearing loss
0.5 – 1	70 - 80	Severe hearing loss
1 – 1.5	60 – 70	Moderately severe hearing loss
1.5 – 2	50 – 60	Moderate hearing loss / Moderately severe hearing loss
> 2	40 – 50	Mild hearing loss / Moderate hearing loss

From the analysis of responses from interviews (Figure 4), the health problems suffered by the residents within 0.5 – 1 km ring include shock 90%, catarrh 45%, and cough 30%; within 1.5 – 2 km ring, shock 40%, catarrh 20% and cough 15 %. Although the residents affirmed that cough and catarrh is very prominent during the dry season. Related studies on the impact of granite quarrying by Oguntoke *et al*. (2009), Oyinloye and Olofinyo (2017), Mbuyi, 2017) revealed similar observation. The high percentage of shock (90%) and moderate percentages for catarrh (45%) and cough (30%) experienced by residents and staff of the quarries at 0.5 – 1 km were due to noise and dust emanating from the use of explosives creating ground vibration that result from rock blasting. Conversely, the percentages for shock (40%), catarrh (20%) and cough (15 %) at 1.5 – 2 km showed that the characteristics of prevalent health issues by the residents and staff of the quarry companies depend largely on proximity to the quarry companies. Because percentage of shock at at 1.5 – 2 km is moderate compare to high percentage at 0.5 – 1 km. Likewise for catarrh (20%) and cough (15 %) that were low at 1.5 – 2 km, they were moderate at 0.5 – 1 km. The health problems experienced by residents and quarry workers are identical, and are similar to those reported by Murray and Lopez (1996), Dockery and Pope (1994), Pope *et al*. (1995) and Peters (1996).

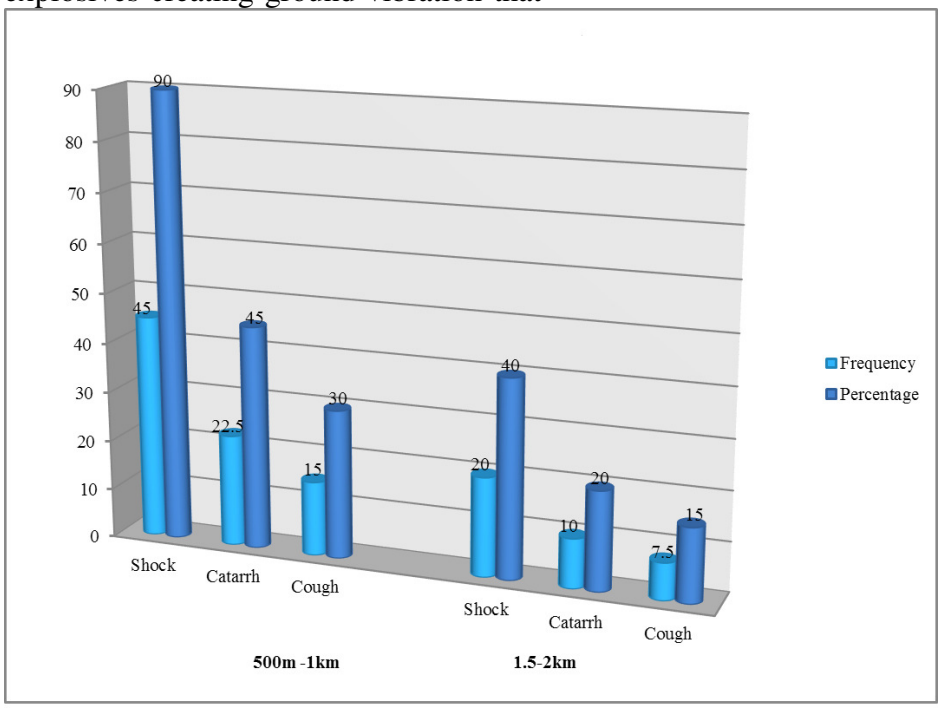

Fig. 4: Analysis of exposure to health hazards

Conclusion and Recommendations

Regardless the enormous socio-economic benefits of quarry operations to the owners and staff of such ventures, the hosting community and acruable taxes to government, there is need to identify environmental and health hazards that come with it so as to find ways of mitigating them. This study only focuses on the enroachment of buildings, degree

of exposure to hearing loss and common health problems emanating from such activities on the staff and the host community. It was discovered that granite quarrying have various effects on the environment and human health which include unregulated expansion of settlements to the quarries, noise pollution and residents exposure to shock, catarrh and cough. However, the use of toxic materials and long period of mining were identified causes of both human and environmental pollution. Though quarrying affects the sustainability of host community, the operators should be encouraged to use technologies that are user and environmental friendly, and to comply with health and safety measures stipulated by national environmental standards and regulations enforcement agency authority (NESREA, 2007). Environment evaluation report (EER) survey should be made mandatory by NESREA for inclusion in its environmental management policy so that impact of mining activities are reduced to the barest minimum.

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