Environmental Effect of Quarry Site on the Adjoining Neighborhood in Oluyole Local Government, Oyo State, Nigeria

Jimoh Umar[1*]
Oluwabukola Oriri[1]

Abstract

This study assessed the environmental impact of the quarry site on the adjoining neighbourhood in Oluyole Local Government Area, Ibadan, and Oyo State. The healthy city concept provided an anchor for the research. The mixed-methods and cross-sectional survey research design were used. Primary and secondary data sources were used. Using systematic random technique, three hundred and eleven (311) copies of questionnaires were administered to households in the selected houses within 1km of a purposively selected quarry site. The variables that were investigated include the socio-economic characteristics, challenges associated with quarry sites, quarrying activities effect on human properties and psychological health, the coping mechanisms adopted by the people in the neighbourhood. The study revealed that residents of the neighbourhood close to the quarry site were faced with the following prevalent challenges; ground vibration as a result of blasting (FEI 4.81); noise from heavy machines, hauling and processing vehicles, as well as rock blasting (FEI 4.66); quarrying activities producing noise (FEI 4.23). Therefore, there should be more proactive measure in enforcing the environmental protection laws and regulations guiding the location of quarry sites.

Keywords: Quarrying activities, adverse impact, environment, residential building

[1]Department of Urban and Regional Planning, Faculty of Environmental Design and Management University of Ibadan.

*Corresponding author's email: jimoluadams@gmail.com
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Introduction

In order to achieve rapid development in the economy, many countries rely on various natural resource development activities such as quarrying (Lad and Samant, 2014). Quarrying is a vital economic activity with the prospect to contribute to the development of areas endowed with these resources. The demand for building has tremendously boosted due to an increase in the growth rate of construction to meet the contemporary requirements of population increase and needs for development of housing, thus, encouraging quarrying (Lad and Samant, 2014).

Quarrying and stone crushing has become a universal phenomenon and a cause for concern globally including in advanced countries (Lameed and Ayodele, 2010). According to Ukpong (2012), a form of land use engineering that deals with the extraction of non-fuel and non-metallic minerals from rock is quarrying. This is done often in open pit mining with the use of rock drills, a blast of dynamite, and other methods. The purpose of blasting in quarries is to fragment rock mass with the use of explosives to allow excavation after. It is commonly used for loosening large stone blocks, which get fragmented and broken up into smaller pieces of stone with the use of wedges, the plug and spring method, or crushed by a heavy steel ball weighing several tons. In open-pit mining, boreholes are drilled to the required depth to fracture the rock and partially filled with some explosives that are discharged by blasting (Akanwa et al., 2016).

Significantly, quarrying is a very critical and complex issue. Although quarries provide raw materials to feed the needs of many societies, create employment opportunities, and bolster the local economy; they equally have huge impact on the environment and local communities (Oyinloye and Olofinyo, 2017). This is evident in the negative impacts they have on the environment in different ways, from exploring and blasting to transportation and disposal of the waste rock (Lad and Samant, 2014). Each year, it is estimated that around 4 million people in

developing nations die from acute respiratory diseases, which are largely heightened by pollution from sandblasting, quarrying, and the release of hazardous chemicals (Asante et al., 2014). In addition, the declining environmental conditions are key contributors to ill health and low quality of life that impede sustainable development (Nanor, 2011). Quarry dust is a major source of air pollution with some possible adverse health effects, especially those related to respiratory problems. In addition, explosives are used in blasting large rocks to help in excavating the area where granite is quarried. The blasting process creates vibrations that affect people in surrounding communities, eventually causing cracks or displacements to buildings located close to the quarry sites. The impact could be as severe as the shattering of glasses and other glassware in houses close to the quarry sites. The negative externalities of the phenomenal increase in population of Ibadan without a match for the physical space required to accommodate this growing population has remained a major challenge in the area. In addition, the issue of lack of master plan that could provide a guide for land use development could also be contributory factor to the earlier problem created by quarry activities.

Meanwhile, a lot of research has been carried out on issues relating to quarry activities. For instance, Bamgbose et al. (2014) reviewed the challenges of quarrying activities among rural residents in the Odeda Local Government Area of Ogun and found that the adjacent communities were impacted by the quarrying activities as they experienced a decline in crop yields due to dust cover, bloated leaf surfaces, property damage, constant shaking and consequential damage houses by rock blasting. Oyediran and Omoare (2016) studied the impact of quarrying activities on the housing and water quality of rural households in mining areas of Oyo State and discovered that noise pollution from heavy machines and land shake from blasting affected the living environment. Also, a study carried out by Akinwamide and Bibilari (2018) on the locational effect

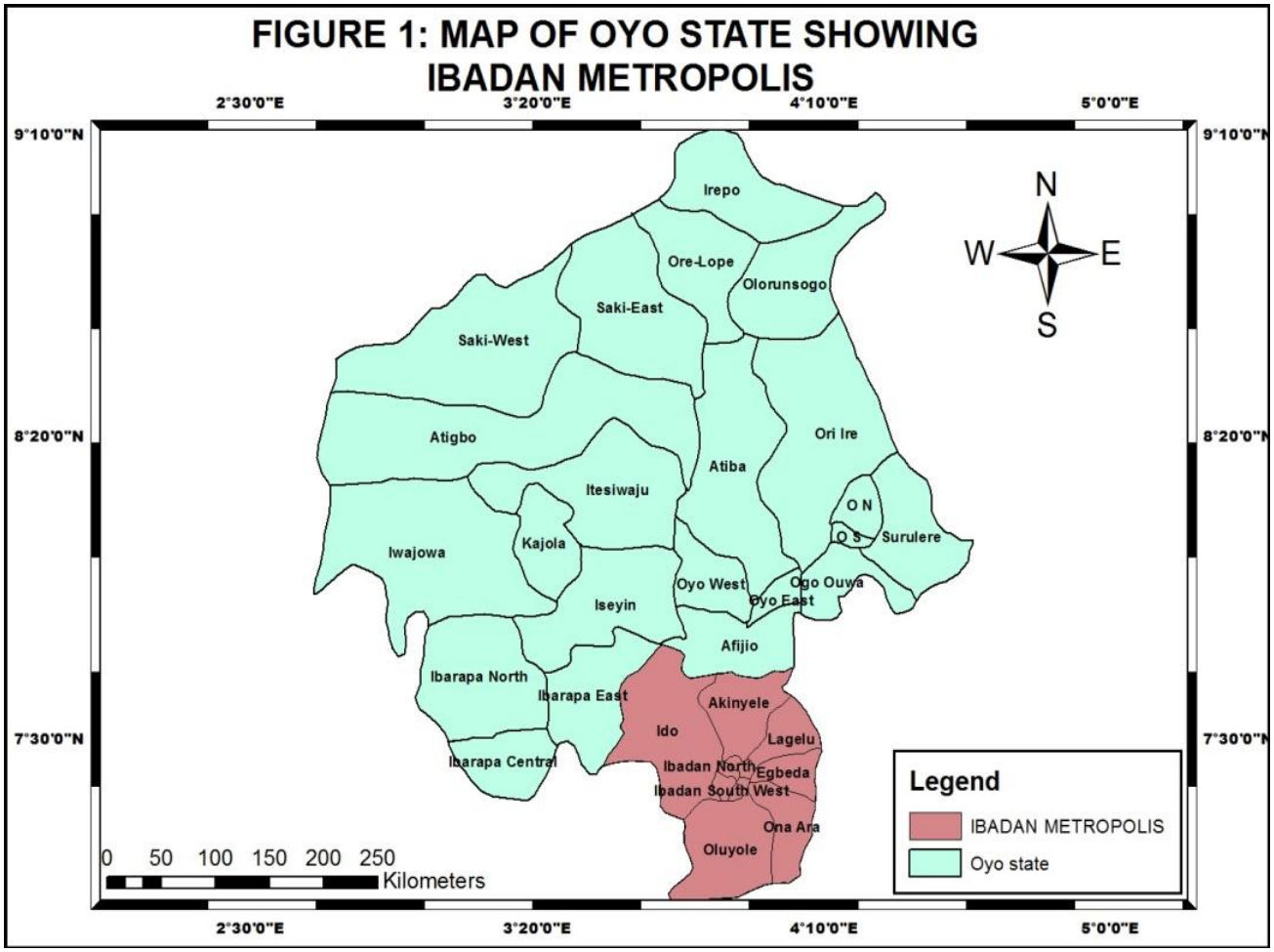
of quarry sites on residents' satisfaction and the environment of proximate residential neighborhood in Akure revealed that the percentage of high levels of environmental pollution increases with the proximity of residential areas to the quarry site. Despite these contributions, the study of the environmental impact with respect to physical planning attributes have not been adequately researched into in the literature. With this in mind, this study, therefore, aims to assess the environmental impact of the quarry site on the adjacent neighborhood in the Oluyole Local Government area with particular focus on the following research questions;

1. What is the resident characteristics and liveability challenges they face due to quarry activities in the study area?
2. What is the impact of and adaptive mechanism to quarrying activities by residents in the study area?

Study Area

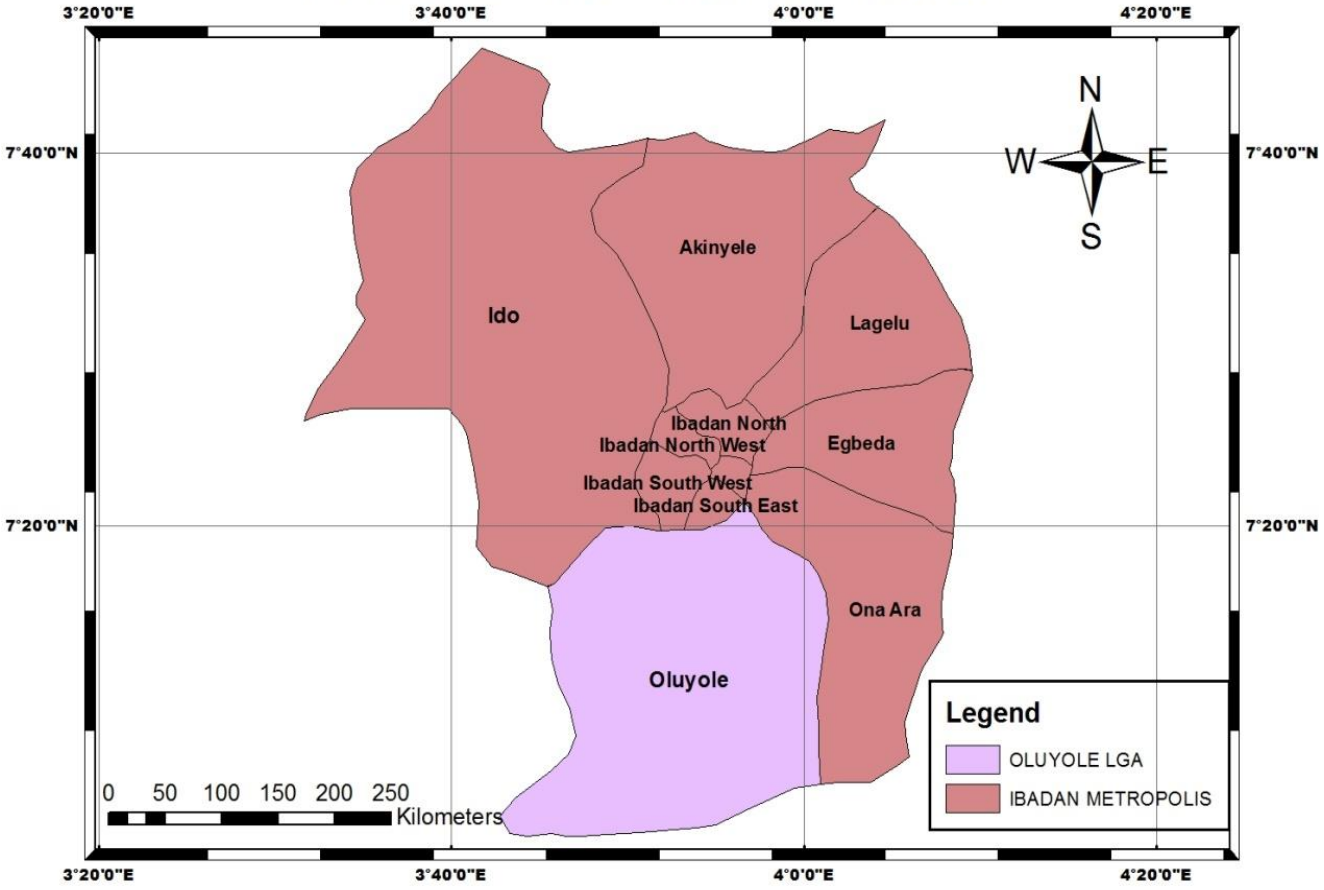
Ratcon Quarry is situated at Sokuro Village and lies between longitude 7'28'14°N and 7'25'83°N; and latitude 3' 84' 36° E and 3'76'24°E in Oluyole Local Governmnt Area, Ibadan, Oyo state. The quarry site is 150 acres in size and has an elevation of range of 151 to 179 meters (see Figure 3). Due to rapid urbanization in Ibadan, demand for housing and different construction projects necessitate the establishment of various quarry activities. While the blasting and escavation is going on, the area where these activities are carried out in the area becomes a serious challenge to people in the area with its attendant negative externalities. Although the activities have also contributed largely to the development or construction of projects by providing materials for the construction industries. In summary, this location was selected purposefully due to the active quarry operations and the rapid expansion residential land-use close to it. Oluyole Local

Government Area has experienced economic development through the establishment and presence of industries. Companies thriving in the area include ROMOil, Oriental foods, Jubaili Agro - Limited, Agrited Company, British America Tobacco (BAT), Black - Horse plastic company, and many others. Quarry companies booming in the area are Takol quarry, Kopek quarry, Ratcon quarry, RCC quarry, CNC quarry, KULUN quarry and Platinum quarry (See figure 1 and 2).



Source: Authors' Field work, 2019.

FIGURE 2: MAP OF IBADAN METROPOLIS SHOWING OLUYOLE LOCAL GOVERNMENT AREA



Source: Authors' Field work, 2019.

Figure 3: Google Imagery of the Selected Quarry Site in Oluyole Local Government Area

Source: Google Earth Image, 2019

Conceptual Framework and Literature Review

Concept of Healthy City

This article is anchored on the healthy city concept which was promoted by the World Health Organization (WHO) in 1986. It was designed primarily to address the challenges posed by the industrial society including environmental, hygienic, and ecological problems. According to Ahmed (1999), Healthy City (HC) is an experiment that approaches health from a non-medical standpoint. It emphasizes on health as a phenomenon that is not susceptible to orthodox scientific research or discussion. In addition, it highlights values of community, relativism, aestheticism,

and private behaviour. World Health Organization (WHO) defines a healthy City as one that is constantly formulating public policies and developing those social and physical environments that allows its residents to cooperatively support one other in carrying out all activities of life and achieving their full potential (Awofeso, 2008). The roots of the Healthy Cities concept can be dated back to when the Health of Towns Association was created in the United Kingdom in the year 1844 to discuss Edwin Chadwick's reports about poor living conditions in cities and towns. According to Sooyeon and Feinberg (2021), WHO started promoting the concept of healthy city with anticipation that densely populated cities should not only have negative impacts such as environmental pollution and nervousness but also the positive impacts which includes Lifestyles of Health and Sustainability (LOHAS). The discovery that numerous problems caused by industrial society including hygienic, ecological and environmental problems will become increasingly severe led to the promotion of this concept. The assumptions of healthy city concept according to WHO (1998b) is to create a health-supportive environment; to achieve a good quality of life; to supply access to health care; and provide basic sanitation and hygiene needs. In order to create a distinct indicator to evaluate if a city is 'healthy' or not, the WHO opines that an ideal healthy city should possess the following functions: provide a clean, safe and high quality living environment, possess a community that is highly participative in policies affecting living standards and welfare, possess a stable and sustainable ecosystem, possess a strong and cohesive community, provide residents with basic needs, diverse, vibrant and creative economic activities, preserve historical monuments and respect local cultures, residents are in good health conditions, provide residents with adequate sanitation and health services. Healthy city concept has been applied in some places for example in Toronto, and Taipei city. Toronto, Canada's largest city has traditionally been known as a "liveable city" with a reliable transit system, a vibrant downtown

and low crime rates. A national Healthy Communities in Canada project was established in Toronto under the supervision of the Canadian Institute of Planners in 1988. The project focused on the inner-city urban area with a population of 600,000. The complete approach of the project included decrease of inequalities in health opportunities, creation of health supportive social and physical environments, and advocating for a community-based health services system. Taipei City Government declared 2002 as the Year One of Taipei Healthy City and used different methods to achieve the goal of "Healthy Taipei" such as endorsing city diplomacy by more international interaction, encouraging citizens to join the healthy city construction, and more investment to the communities (Taipei City Government, 2021). Important city infrastructures were put in place and they gained public recognition and built a good reputation worldwide for example, new healthy food culture, smoke-free Environment, community health care and community health construction, Taipei citizens' weight loss plan and ecological environment.

This concept was also applied by Adekunle (2012) to assess the management of traditional markets in Ibadan, Nigeria. Also, Adeniran, et al. (2018) used this concept to evaluate the issues and challenges of solid waste management and property values in Old Bodija, Ibadan. Meanwhile, there are various concepts that are linked with the concept of healthy city. These are summarized or encapsulated in four urban health paradigm such as, physical environment (like air pollution, noise, housing, indoor air quality), health outcomes (disease and risk factors); socio environments (socio economic factors, socio and cultural conditions, etc.) and interventions (health services and planning, health behaviour change and monitoring, urban planning). In some cases, according to Vlahov and Galea, (2002), urban health is perceived as a sub discipline of international health, where the principal determinants of health were population variables like morbidity and mortality in urban areas focusing on how it has absolutely impacted on human being. Other traditions hang

on the extent to which urban health focuses on the features of urban planning environment and urban living as they affect human health. In this case, the physical and social environments of the cities are considered critical determinants of health in the multilevel or socio-ecological model (Ferdinand et al 2012, Rydin et al 2012). Other perspectives put governance or public health policy as a major focus. In this paradigm, urban health is perceived as a complex of institutional processes that creates healthy or unhealthy conditions (Burris et al 2008, Corbon2017). Other paradigm sees the environment as encompassing social, cultural, ecological and built realms, regarding environment as an integral part of current understanding of cities urban health. It also holds the view that cities or urban spaces are not merely bounded spatial units, according to Brenner (2019), they are seen as dynamically evolving socio-spatial configurations embedded in broader multithread organization and geographical space. It is within these varying school of thought spanning different time in history that Healthy City Concepts is adopted for the study.

Meanwhile, there are several overall requirements for a healthy city. The first is the city response to its developmental needs, its organizations, and how effective it is. The second is that, the city should have the ability to cope with breakdowns of the system and its members. The third, is that the city should have the ability to modify itself and change to meet the always emerging, changing requirements for life. This fourth has to do with the city competence to enable its inhabitants use it to their advantage. The fifth has to do with understanding that this cannot be accomplished unless the city is able to educate its inhabitant. In this study, the concept is utilized to capture the developmental needs of the study area in terms of the ability of the quarrying company to provide materials for the construction company and the residents response to the overall effect of quarrying activities in the study area. This is captured with such variables as; human health, psychology and properties of the residents in the study area. Furthermore, the concept aligns with the question

that deals with the extent to which the people or the residents in the quarrying area able to cope with overall effect of the quarrying activities when there is a breakdown in the system and how he is able to modify the effect to survive the impact. Also, the extent to which the city manager though the local planning authority able to develop planning intervention policies that make the environment save for the residents' living.

Literature Review

Quarrying is a form of mining also known as open pit mining or strip mining. The difference between mining and quarrying is that the latter extracts non-metallic rocks and aggregates while the former excavates the site for metallic mineral deposits (Nanor, 2011). Some of the stones extracted are sandstone, limestone, perlite, marble, ironstone, slate, granite, rock salt and phosphate rock. The suitability of the stone for quarrying depends on its quality, the possibility of cheap and ready conveyance to a large market and its inclination and depth below the surface (Nanor, 2011).

Quarry activity is entrenched in the national environmental regulations on quarrying blasting operations by National Environmental Standards and Regulations Enforcement Agency (NESREA, 2013). This act makes provisions among others for the minimum safe distance from residence as well as post quarrying plans that ensure a perimeter fencing of closed quarry that provides safety for the people around the area where the activities are being undertaken. For instance, on the minimum safe distance, the provision stipulates that no individual shall locate a quarry or engage in blasting within three kilometers (3km) of any existing residential, commercial or industrial area. Subject to the provisions of these regulations, the act of blasting shall be complete, whether or not the alleged act is preceded or accompanied with vibration, noise, air over

pressure, fly rock dust, fumes, or that the impact is felt within, 1,000 meters from the site or epicentre of the blasting.

On the challenges of quarrying activities on its adjoining environment, studies have shown that like many other man-made activities, quarrying causes a significant negative impact on the environment both during the quarrying operations and even years after the quarry is closed (Nanor, 2011). Particularly, during quarrying operations, it is often necessary to blast rocks with explosives in order to extract materials for processing, but this method of extraction gives rise to air pollution, noise pollution, damage to biodiversity and habitat destruction (Eshiwani, 2014). For example, in the cross-river state, the environmental impact of aggregate mining activities of crushed rock industry limited in Akamkpa Local Government Area was assessed and it was revealed that quarrying has significant adverse environmental impacts on the host communities. These include elevated noise level, polluted air and poor water quality (Ukpong, 2012). In addition, Oyediran and Omoare (year?) in the study on the assessment of the effects of quarrying activities on residential and water quality of rural households in mining areas of Oyo State, Nigeria, used descriptive statistics in the survey and found out that the residential environments were affected by noise from heavy machine and land vibration resulting from blasting. They also found that quarrying activities had high effects on the water quality of the study area as dust floated on water surface, decrease in forming foam with soap and heavy settlement at the bottom of water (Oyediran and Omoare, 2016). In the same vein, Oyinloye and Olofinyo (2017) in their research on environmental impact of quarry activities on residents of Akure Region, discovered that quarry activities have resulted in cracks on building walls, ground vibrations, noise, soil erosion, reduction in growth of plants and yellowing of leaf. In Kenya, a study on the assessment of environmental impacts of stone on quarrying activities in Nyambera location, Kisii County

unraveled that stone quarrying was one of the most significant contributors to environmental degradation. This was revealed through respondents' responses where 66% indicated that the quarry site is a threat in the area as most of the quarries are usually filled with water which never drains during rain seasons (Nyakeniga, 2014). Ogbonnaya and Phil–Eze (2020) investigated the challenges of quarrying activities on sustainable quality water resources and the environment in Abakaliki. It was revealed that the methods of quarrying especially crushing of the rock lumps generated dust and acidic waste water pollutants through runoff into the surrounding surface water bodies. Using Principal Components Analysis (PCA), it was discovered that the pollution made water hard, low in oxygen and also contained heavy metals which were above permissible limits. Moreover, parameters like Fe, Pb, Cu, As, Zn, Cd, which contributed in polluting the water were found to affect human health, aquatic plants, animals, and the ecosystem.

Melodi's study on Assessment of Environmental Impacts of Quarry Operation in Ogun State, Nigeria using Ajebo as case study revealed that 91% of the respondents noted that environmental challenges like pollution (including air, water and noise pollution) and land degradation are associated with quarrying activities in their respective communities. Noise pollution and air pollution were discovered to have significant ($p < 0.05$) impact. He also discovered that long period of surface mining was prominent in the study area with its other accompanying impacts like degradation of land and vegetation, water pollution (Melodi, 2017).

Studies have revealed that quarrying activities have adverse impacts on human health and properties. Oyinloye and Olofinyo (2017) in their research on the environmental impact of quarry activities on residents of Akure Region discovered that eye sickness (irritation of the eyes) and respiratory sicknesses (cough, catarrh) are the common health issues experienced among the respondents living close to the quarry area. Bamgbose et. al (2014) in their research discovered

that respondents who are predominantly involved in crop production in Odeda local government area of Ogun state indicated that the damaging effects of the quarry activities recorded were decreasing crop yield. In addition, the damaging effects resulted in reduction in farm income due to dust covering up leaf surfaces and altering photosynthesis, continuous vibration and subsequent damage of houses as a result of rock blasting and damage to ceilings and roofs by flyrocks. Impacts on the health of the residents are ailments like eyes irritation, and cough caused by dust from the quarry sites. Furthermore, in a study carried out on quarrying of stone and the livelihood transformation in peri-urban Kumasi, it was revealed that residents close to quarry sites always feel insecure and under continuous fear from occasional accidents which occur when fast-moving lorries hit residents or when residents get injured from the flying rocks during blasting. The research also showed that nearby residents experience cracks in walls, occasional loss of household valuables including television set, dressing mirrors, other glassware and fragile items when they slide and fall over as a result of vibrations originating from rock blasting (Asante et al., 2014).

Living close to quarry sites has had some damaging effects on the physiological aspect of the peoples' health. For instance, in Akure, findings of the study on perceived environmental impact of quarry activities on residents of Akure Region showed that 15.8% of the respondents at Ijare road suffered skin ailment as a result of quarry operation in the area. About 20.2% of the respondents opined that they experience eye problems, 28.9% of the respondents indicated that they experience respiratory disease while 35.1% indicated no effect option. Correspondingly, at Akure – Owo road, 29.3% of the respondents were of the opinion that quarry activities in the area have caused eye sicknesses while 32.7% of the respondents indicated they experienced respiratory disease. At Akure –Ado, 17.4% of the respondents experienced skin ailment while 35.2% and

23.6% of the respondents opined that they experience respiratory and eye disease respectively. This therefore reveals that irritation of the eyes and respiratory sicknesses (cough, catarrh) are the most common health issues experienced by the respondents staying around the quarry area (Oyinloye and Olofinyo, 2017).

Apart from the direct health consequences of quarry activities on the people living close to it, studies also have revealed that in the rural area where most of these activities are normally located, the quarry activities also have some impacts on the farm produce and consequently on the people. Results of study on the effects of quarry activities on the nutritional composition of edible vegetables in Ishiagu, Ebonyi State revealed a significant ($P<0.05$) reduction in protein, lipid and carbohydrate content of vegetables grown in farmlands close to quarry sites compared to those grown far away from quarry sites. Furthermore, vitamin composition of the selected vegetables significantly decreased ($P<0.05$) in response to environmental stress compared to those farther from quarry sites (Osuocha et al., 2016). These results suggest contamination of farmlands in the study area by quarry waste water and subsequent contamination was also reflected in the vegetables grown in such farmlands.

One of the consequential effects of quarrying activities is the socio-economic impact on the host and neighboring environment and this has been established in the literature. For instance, Chigonda (2010) assessed the benefits and costs of black granite quarrying in Mutoko District, Zimbabwe and discovered that quarrying activities have essential impact on the socio-economic characteristics of the surrounding environment. One of such impact's employment creation. The thirteen quarrying companies had a total workforce of about 3,000 workers out of which about, 80 % are from within the district, while the remaining 20% were from other parts of the country. Seventy percent of the workers lived within a radius of 30-kilometer from the different quarry

sites. This distinctly indicates that most of the employment opportunities were taken up by individuals specifically, those near the quarry sites. Correspondingly, a study carried out in Ewekoro by Afeni and Adeogun (2015) revealed that significant number of the respondents (34.57%) did not have an annual income that is up to ₦90,000 ($600) from the jobs they are engaged in. As recorded by them, these jobs include unskilled laboring in the quarry sites, farming, petty trading, and some local government work that is, the civil service. However, respondents that were earning more than ₦270, 000 ($1800) were business owners whose business centers were situated close to the quarry site and in most cases, these business owners were not permanent residents of the area. They also found out that limestone quarrying and processing in Ewekoro, gave rise to social amenities competition in the surrounding environments, such as Ifo, Arigbajo Itori, and Papalanto, which is due to the increase in population of residents in these communities. Therefore, it has stressed water, food, and other supplies to the limit. Population increase has resulted in inflation due to rise in demand for certain food item which had not been able to meet up with agricultural produce due to withdrawal of residents from farming.

In Oyediran and Omoare (2016) on rural households in mining areas in Ibadan, it was discovered that residents used different coping tactics to overcome the negative impacts of quarrying in order to preserve their livelihoods and living conditions. Some of the coping strategies employed by the respondents include to live with the situation ($\bar{x}$ = 3.00), move away from the house during blasting ($\bar{x}$ = 2.88), cover their food and water with clothes and lids ($\bar{x}$ = 2.84) and use of alum to clean the affected water in the house ($\bar{x}$ = 2.80). The respondents also reported that other measures include change of farm site to a farther distance ($\bar{x}$ = 2.73), use of detergent soaps to wash clothes ($\bar{x}$ = 2.55) and hand-pump borehole water for domestic work ($\bar{x}$ = 2.49). The least ($\bar{x}$ = 1.65) employed coping strategy was to complain to the concern authorities of the quarries about the

situation (Oyediran and Omoare, 2016). As a means of adapting, most of the people living in areas close to quarry site in Nairobi County are mainly low-income earners and for that matter are not able to move to a different area because there is low-cost housing in that area and they are forced to endure in silence (Eshiwani, 2014). In Odeda Local Government Area of Ogun state, residents living close to quarry sites found a way of adapting to the environmental challenges by the use of drugs for their illness, a pair of eye shade to shield the eyes from dust (Bamgbose et al., 2014). In a part of Ikere-Ekiti, Ekiti state, a study carried out by Adetiloye and Nenuwa (2016) on Environmental Challenges of Quarry Activities in Part of Ikere-Ekiti, Ekiti state, Nigeria revealed ways on how residents close to quarry sites deal with the effects of the environmental problems. Of the total respondents, 62.2% preferred to live with the effects of the pollution, 6.7% of the respondents indicated that they would migrate to other areas, 17.8% of the respondents would prefer to complain to health authorities while none of the respondents would want to take to protest and 13.3% of the respondents have decided to take actions that are personal to them. This was indicative that a significant percentage of the respondents preferred to live with the challenges due to various reasons; some due to economic reasons and psychological attachment to the area.

Methodology

Primary data

A cross-sectional survey research design was adopted in this study, relying mainly on primary and secondary sources of data, while a multi stage sampling technique was utilized. The primary data involved the use of questionnaire and Focus Group Discussion (FGD). Using google art, a geospatial analysis was used to purposively select Sokuro quarry site located in Oluyole LGA. The choice of Sokuro was based on the fact that more residential buildings were located close to

it than the others. Afterward, a buffer zone of 1 km radius was mapped out from the quarry site in order to identify the residential buildings and was later ground truthed so as to differentiate the residential buildings from other land uses (see figure 4 and 5). In all, a total number of 622 buildings were identified, and a copy of pretested questionnaire was administered systematically to 311 households' resident within the buffer zone, representing 50% of the sample frame. Issues that were investigated include the socio-economic characteristics of the respondent, the challenges associated with quarrying activities, effect of quarry activities on the health and properties of the neighbouring residents, and the coping mechanism. Thereafter, two sections of FGD with discussants cutting across all the households head and the tenant's residents in the study area regardless of the initial sampled buildings was conducted to complement the questionnaire.

Secondary data

The secondary data involved all the literature relevant to the subject of quarry activities and the environment with particular reference to the question raised in the questionnaire as well as the standard of the choice of 1 km buffer zone. This was meant to show those that are vulnerable to the adverse effect of the environmental pollution caused by the quarry industry as stipulated in Section 37 of the Federal Environmental Protection Agency Act (FEPA) of 1990 and the Code of Practice on Pollution control (NEA Singapore).

Data Analysis

Quantitative (descriptive and inferential (multiple linear regression) and qualitative (Focus Group Discussion) statistical analysis were employed to analyse the data at p value ≤ 0.05 while qualitative data were content analysed.

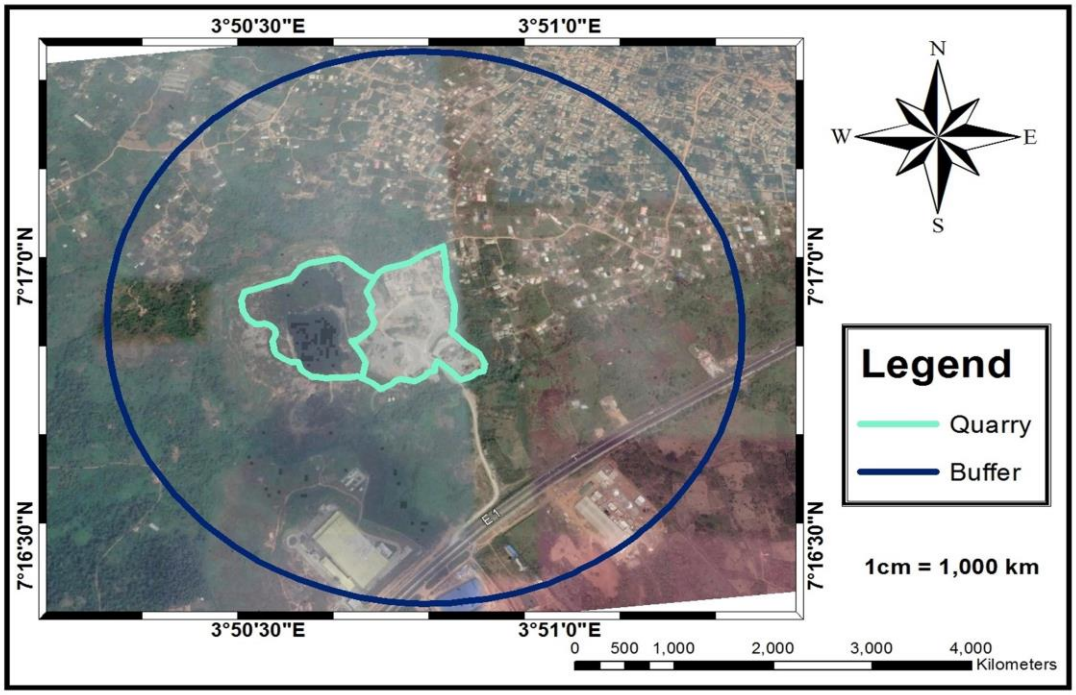


Figure 4: Map showing buffer of 1km distance from the quarry site
Source: Author's fieldwork, 2019

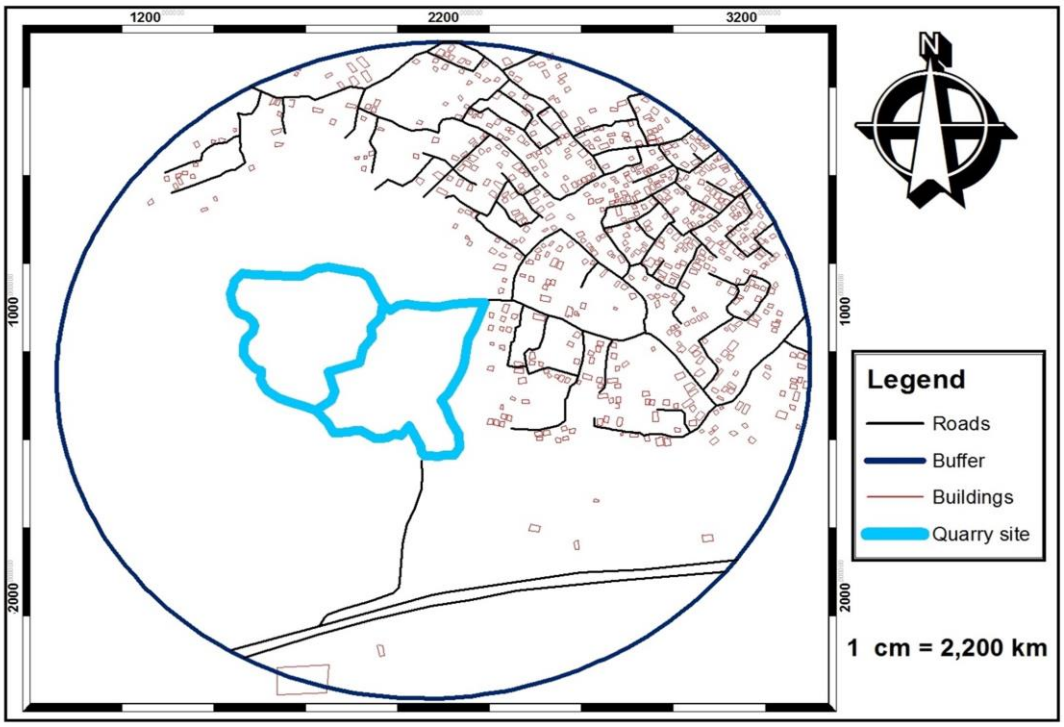


Figure 5: Map showing buffer of 1km distance from the quarry site with adjoining residents
Source: Author's fieldwork, 2019

Results and Discussion

Socio-economic characteristics of the respondents

Investigation was carried out on the socio-economic characteristics of the respondents in the study area. Variables that were considered include gender, age, marital status, educational distribution occupational distribution, and educational distribution of the respondents.

The study revealed that 54.9% of the respondents were female and 45.1% were male. The age distribution of the respondents in the study area showed that those aged between 36-50years accounted for 47.6% followed by those aged between 26-35years accounting for 20.3%. About 19.0% aged above 50years. The least of them were those aged between 18-25years accounting for 13.2%. On the marital status of the respondents, there were more married people accounting for 67.5% than others (singles accounting for 20.9%, widowed accounting for 10.7%) put together. On account of the educational status of the respondents, those who had tertiary education accounted for 48.9%, being the highest. Next in the distribution were respondents with secondary school education accounting for 36.0%, followed by those having only primary school education which accounted for 13.8%. Those with no formal education were the least in the study area accounting for 1.3%. Investigation on the occupational distribution of the respondents revealed that majority 44.1 % were into trading, those who belong to others (students, bankers, retiree, company workers, teachers in private schools, amongst others) accounted for 24.4%, followed by artisans (16.7%), and then civil servants (14.8%) being the least in the distribution (See Table 1). The observed variables suggest that quarrying is common among married residents many of whom are below 50 years. Surprisingly, there is a suggestion that educated persons engage in this occupation.

Table 1. Socio-economic characteristics of the respondents

Variables	Frequency	Percentage (%)
A. Gender		
Male	140	45.1
Female	171	54.9
B. Age		
18-25years	41	13.2
26-35years	63	20.3
36-50 years	148	47.6
Above 50 years	59	19
C. Marital Status		
Married	210	67.5
Single	65	20.9
Widowed	33	10.7
No response	3	0.9
D. Educational Attainment		
Primary Education	43	13.8
Secondary Education	112	36
Tertiary Education	152	48.9
No formal education	4	1.3
E. Occupation		
Trading	137	44.1
Artisans	52	16.7
Civil Servants	46	14.8
Others (students, bankers, retiree, company workers, teachers in private schools)	76	24.4

N = 311

Source: Authors' Field work, 2019

The Perceived Challenges Associated with Quarrying Activities in the Study Area

On the challenges that are associated with quarrying activities in the study area, the perception of the respondents on the prevalent challenges of quarrying activities was determined using a 5 points likert scale. The rating values stands for;

5 ⟶ 4 ⟶ 3 ⟶ 2 ⟶ 1

Strongly agree ⟶ Agree ⟶ Undecided ⟶ Disagree ⟶ Strongly disagree.

The likert scale was eventually subjected to Field Effect Index in order to determine the prevalence of the effect of the activities of quarry in the study area. The Field Effect Index is an index used to determine the effect of various variables on the field. It was used by Adedotun et al. (2018) to determine the architect's perception on awareness and adoption of building envelope technologies (BET) for energy efficient housing in Lagos State. In this study, the Field Effect Index (FEI) was used to determine the field effect of the various challenges associated with quarrying activities. This was done by obtaining FEI of each variable from the division of each summation of weight value (SWV) by the total number of respondents, normally represented as "N" while; Sum of weight value (SWV) of each variable was obtained from the summation of the product of the number of responses of each rating and the weight value of each rating. The mean (x) thereafter, was derived from the division of the summation of the Field Effect Index (FEI) of all the variables by the total no of variables. The Field Effect Index (FEI) is expressed thus:

FEI = SWV/ N

Where FEI - Field Effect Index

SWV- Sum of weight value, that is, Σ a (No of frequency) x rating value

N - Total no of respondents

Mean (x) = Σ of FEI/ no of variables;

$x = \frac{24.96}{8} = 3.12$

$\sigma^2 = \sum \frac{(A-x)^2}{N}$

$\sigma^2 = \frac{11.07}{8} = 1.3838$

Variance = 1.3838

$\sigma = \sqrt{\sigma^2} = \sqrt{1.3838} = 1.1763$

S.D = 1.1763.

Finally, the Field Effect Index (FEI) of each variable compared with the mean was used to determine its prevalence in the study area. From the analysis carried out, the variables observed to be more prevalent in the study area include; ground vibration as a result of blasting (FEI 4.81); heavy machines, blasting of rocks, processing and haulage trucks are the sources of noise (FEI 4.66); quarrying activities produces noise (FEI 4.23). Challenges like quarrying activities generate dust (FEI 2.66), water pollution (FEI 1.67), vehicles transporting quarry products generate air pollutants (FEI 1.86), dry and windy weather facilitates distant movement of quarry dust to the neighbouring environment (FEI 2.44) are not prevalent in the study area (See Table 2).

Table 2: Challenges Experienced as a result of Quarrying Activities

Variables	5	4	3	2	1	SWV	FEI (A)	Mean (x)
Quarrying activities generate dust.	13	77	22	188	11	826	2.66	
Concentration of dust is highest during rocks blasting	4	50	89	152	8	799	2.63	
Vehicles transporting quarry products generate air pollutants	4	6	1	232	68	579	1.86	
Dry and windy weather facilitates distant movement of quarry dust.	12	60	14	202	15	761	2.44	
Quarrying activities produces noise	125	162	5	10	9	1317	4.23	
Heavy machines, blasting of rocks, processing and haulage trucks are the source(s) of noise.	235	61	4	9	2	1451	4.66	3.12
Water pollution	2	9	6	162	132	520	1.67	
Ground vibrations as a result of blasting	270	31	3	7	0	1497	4.81	
Σ							24.96	

Source: Authors' Field work, 2019

Perceived Effect of Quarrying on Human Health, Psychology and Properties on the Residents in the Study Area

We explored the perceived effect of quarrying on the human health, psychology and properties in the study area. On health and psychology, the study revealed that shock was the only prevalent variable and accounted for 74.3%. The proportion of the respondents who experienced both shock and injury from fly rocks accounted for 22.4%, while the respondents who experienced injury from fly rocks accounted for 3.3% being the least prevalent health challenge. Regarding the effect

of quarrying on the properties, investigation revealed that building vibration accounted for 46.8%, this was followed closely by the combination of building crack, building vibration, and partial damage on the properties accounting for 21.8%. Those respondents whose buildings cracked and vibrated accounted for 16.2%, those whose building both vibrated and also had a partial damage on properties accounted for 9.6% while the least effect on properties was building crack accounting for 6.30%. (See Table 3).

Table 3: Impact of Quarrying Activities on Human Health and Properties

Variables	Frequency	Percentage (%)
Health challenges (N = 183)		
Shock	136	74.3
Injury from flyrocks	6	3.3
Both shock and Injury from fly rocks	41	22.4
Property challenges (N = 297)		
Building Crack	18	6.3
Building Vibration	139	46.8
Building Crack and building Vibration	48	16.2
Building crack, building vibration and Partial Damage Of Properties	64	21.8
Building Vibration And Partial Damage of properties	28	9.6

Source: Authors' Field work, 2019

Coping Mechanisms Adopted by Residents in the Study Area

Investigation on the coping strategies adopted for the identified adverse effect of quarrying activities by the respondent revealed that the coping strategy that is predominantly employed was living with the effects, accounting for 54.3%. In addition, about 32.2% of the respondents chose to complain to the concerned authorities, 5.15% chose the combination of living with the effects and migrating to other areas in the future. Next to this was the application of both living with the

effects and complaints to the concerned authorities which accounted for 3.2%. Migration to other areas accounted for 2.3%, while the respondents who chose the combination of migrating to other areas and complaining to concerned authorities accounted for 1.3%. (See Table 4).

Table 4: Coping Strategies Adopted for the Effects of Quarry Activities

Strategies	Frequency	Percentage (%)
Live with the effects	169	54.3
Migrate to other areas	7	2.3
Complain to concerned authorities	100	32.2
Live with the effects and migrate to other areas	16	5.1
Migrate to other areas and complain to concerned authorities	4	1.3
Live with the effects and complain to concerned authorities	10	3.2
No response	5	1.6
Total	311	100

Source: Authors' Field work, 2019

Discussions

One of the most viable and visible impacts of mining/quarry activities on a community is the employment that it generates for the people. The employment opportunities are particularly evident during exploration, mining/ quarrying and closure/rehabilitation phase. The activities have positive and negative impacts on the people involved reflecting on their socioeconomic, environmental and health of the people. The issues tailored around the consequences of these activities provide some significant elements in the consideration of this study.

Regarding the socioeconomic characteristics, the study revealed the tendency of the respondents' ability to tolerate the effect of quarry operations compare with the older counterpart whose quarry activities may have negative health consequences like cardiovascular and pulmonary issue (Sudipta and Nutsolu, 2022), based on their active age advantage. In addition, due to generally poor income couple with relatively cheap land on the statutory setbacks or government acquisition,

it is not impossible for an adult who work and live in the area, and who also want to own their own house to fall victim of the land grabbers who sell land at a cheap price in the study area. In addition, it may not also be impossible therefore, that the respondents may have been enjoying a waiver in the penalty involve in flouting the laws governing the location of quarry sites, or act of share negligence on the part of local planning authority. Furthermore, the reason for the high percentage of respondents with tertiary education can be traced to the early exposure of the respondents to western education coupled with the presence of higher institutions like University of Ibadan, Lead City University, among others. This high literacy level should ordinarily have a bearing on the choice of residential location outside of the planning setbacks of quarry sites. However, their education has no impact whatsoever. This can be traced to lack of awareness and failure of the local planning authority in reaching out to the people through public enlightenment programme on the implication of such generally and on their health in particular.

Furthermore, the high percentage of traders compare with others on occupational structure could be linked to the gender factor where women were always at home involving in one petty trade or the other, with primary responsibility of servicing the site workers (mainly the casual worker) who incidentally were residents in the area. Nevertheless, they are also vulnerable to the negative effect of quarry activities as men this so because their work is as hazardous and precarious as as that of men (ILO,2021). Though their status were not investigated but have high chances of being tenants who took advantage of the quarry site to reside there. This was corroborated by ILO (2010), where it was established that a gender gap in earrings persists across almost all employment categories, including informal wage employment and self-employment where women comprise the majority.

On the perceived challenges associated with quarrying activities in the study area, Field Effect Index (FEI) revealed the outcome of the variables used. The implication of this result is that ground vibrations because of blasting and noise pollution caused by heavy machines, blasting of rocks, processing and haulage trucks and also alarms for blasting notification are the major challenge experienced by the respondents in the study area. This result is supported by a study carried out by Bamgbose et al. (2014), in their research on the Challenges of quarry activities among rural dwellers in Odeda local government area of Ogun state, where it was discovered that the damaging effects of the quarry activities recorded were decreasing crop yield and reduction in farm income due to dust covering up leaf surfaces and altering photosynthesis, continuous vibration and subsequent damage of houses as a result of rock blasting and damage to ceilings and roofs by flyrocks.

On the perceived effect of quarrying on human health, psychology and properties on the residents in the study area. It was discovered that building vibration was the most experienced adverse impact of quarrying activities on the properties of the residents caused by blasting of rocks, which have implication on health, such as stress anxiety contraction of eye pupil and the like, and properties. This result is substantiated by Focus Group Discussion conducted in the study area where a woman said:

> *"Those who are involved in blasting do not notify us early before carrying out their blasting. And most times, the vibration would cause a shock on us especially during siesta by the day".*

This discovery is similar to the findings of Bamgbose et al. (2014) in the Odeda Local Government Area of Ogun state on the challenges of quarrying activities among rural dwellers where they discovered that the rural dwellers experienced continuous vibration and consequent damage of

houses caused by rock blasting and damage to roofs and ceilings by flyrocks; and Eshiwani (2014) in Kenya, Nairobi County, where majority of the residents living close to quarry site complained of shock, that resulted from sudden noise caused by blasting of rocks with explosives.

Going by the coping mechanism adopted by the respondents in the study area, it was revealed that a larger percentage of the respondents decided to live with the adverse effects of quarrying. This may not be unconnected with fear of losing the income which some of them depend on for survival especially in the due to hard economic situation couple with high rate of unemployment that is prevalent in the study area and by large, Nigeria. This is similar to a study carried out by Adetiloye and Nenuwa (2016) on environmental challenges of quarry activities in Part of Ikere-Ekiti, Ekiti state where majority of the residents preferred to live with the effects of the pollution.

Hypothesis Testing

To further test the degree of the effects of quarrying activities on the respondents in the study area, the hypothesis, which states that quarrying effect does not have significant effect on respondents' socio-economic characteristics in the study area was tested. Multiple linear regression was applied to identify the determinants of the effects of quarrying activity such as the socio-economic characteristics (gender, period of stay, tenure status) as the independent variables and the effects of quarrying activity as the dependent variable. The inclusion of gender is premised on the fact that gender divisions constitute an aspect of the wider social division of labour that is rooted in the conditions of production and reproduction. More so, servicing at the quarry site always have the higher percentage of women involvement. This is buttressed by the study carried out by Oke et al (2014) on the role of women in quarry operations in Ekiti state where 24.0% of workers in quarry operations were females. The results of the analysis are shown in Tables 5a, 5b and 5c.

The model summary reveals the strength of the relationship between the independent variables and the variations in the dependent variable. The adjusted R value of 0.046 is far from one and the implication of this is that the model accounts for only 4.6% variations in the dependent variable (effects of quarrying activities) (See Table 5a).

The F - value of 5.530 is significant at 0.05 level of significance. (See Table 5b) Therefore, it can be concluded that the presence of the adverse effects of quarrying activities is a function of the tenure status, gender, and period of stay of respondents in the study area, although the period of stay is the only significant independent variable (0.000) at 0.05 level of significance (See Table 5c). The period of stay of respondents in the environment is a major determinant because the longer people stay in an environment close to the quarry site, the more the discovery of the effects of quarrying activities on them and the environment. This also explains why those who have stayed in the area between 6 to 10 years remain the highest (64.6%) and have been negatively affected by quarrying activities. It could be said therefore that, quarrying effects have significant effect on respondent's socio-economic characteristics in the study area.

Table 5a Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.236a	.056	.046	.189

a. Predictors: (Constant), Tenure status, how long have you been living in this area?, Gender

Table 5b ANOVA[a]

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	.590	3	.197	5.530	.001[b]

a. Dependent Variable: does quarrying activities pose challenges that adversely affect the environment?

b. Predictors: (Constant), Tenure status, how long have you been living in this area, Gender

Table 5c Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.230	.057		21.660	.000
how long have you been living in this area	-.075	.020	-.222	-3.786	.000
Gender	.000	.023	.000	.007	.994
Tenure status	-.032	.026	-.073	-1.247	.213

a. Dependent Variable: does quarrying activities pose challenges that adversely affect the environment?

Conclusion and Recommendations

The authors conclude that quarry activities have significant effects on the residents of the neighborhood of Sokuro quarry sites. This is evident in the challenges such as ground vibration, adverse effect on health and the psychology of the respondents, among others. It is therefore recommended that the government should enforce environmental laws and policies that will protect residents and the communities and ensure the environment is protected. In addition, buffer zone of 1km should be created around industrial layout and a reasonable set back between the quarry sites and residential areas should be maintained so as to keep away developers as provided by the National Environmental Protection (Pollution Abatement in Industrial Facilities Generating Waste) Regulation of 1991 Section 12, Subsections 1b and 2a under Section 37 of the Federal Environmental Protection Agency Act (FEPA) of 1990 should be enforced. Finally, Town Planning Authorities should ensure compliance with this regulation.

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