

# AN ASSESSMENT OF GRANITE QUARRYING IMPACT ON ENVIRONMENT IN EDO NORTH NIGERIA: USING GIS APPROACH

BY

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## ABSTRACT

Granite quarrying for many years has served as an important source of construction materials supply, employment and revenue especially in developing countries like Nigeria which are endowed with it abundant deposit. The various impact produced by quarrying operations varies in both magnitude and location and has cause significant impact on the environment in the various host communities. Therefore, this study explores and assesses granite quarrying and its impacts on communities within which granite quarrying activities takes place. The focus is on granite quarrying in Edo North Nigeria where Granite quarrying is vigorously carried out in Iyuku, Imeke and Uluokhe communities. The methodology involved, review of related literature, and GIS and remote sensing approach was adopted for the study. Google satellite image for 2009 and 2019 were acquired for the study of the quarry expansion and location. Landsat 7 and 8 were acquired from United State Geological Survey archives to study vegetation depletion for the period of 10 years. All analysis was executed with Arcgissoftware. The study revealed that from 2009 to 2019 the poorly vegetated areas with falls majorly within the quarry sites increase from 12.453% to 17.241% indicating a 4.788% increase in depleted vegetation cover. Similarly, sites have expanded over time (within a period of 10years) to encroach into natural water sources causing water pollution as shown in figure 4(a&b). The study recommends among others that regular environmental

audit and monitoring of quarrying activities should be enforced in order to ensure adherence to the standards and limits of the impacts generated from the different stages of their operation

## INTRODUCTION

The construction of infrastructure and the development of the built environment such as roads, airports, buildings and many other facilities is vital to the growth of any nation (Enatfenta, 2007). Over the years, the construction of these facilities has increased and also become very complex. Complex in the sense that new technologies and modern design are emerging almost on a daily basis resulting in adoption of new technical solutions. However, the reliance on the major construction materials like aggregate both fine and coarse, and cement has remained unchanged. In fact, the demand for these materials has increased so as to satisfy the needs of the rapidly growing population. In order to meet up with this demand old quarries are being expanded and new ones established. This is because granite quarrying is a necessity that provides most of the materials used in construction. (Lameed & Ayodele 2010).

Mineral exploitation in Nigeria dates back to the geological expeditions by colonial masters in the early part of the 20<sup>th</sup> century, Ajakaiye (1985), Chuku (1988) in (Ndinwa and Ohwona 2014). It has resulted in revenue accruing earning and economic development. In Edo State Nigeria, granite quarry is an everyday activity which is currently going on. The industry in Edo State has great potentials, with capacity to contribute to local and foreign exchange earnings, as well as the attraction of direct foreign investment thereby boosting the nation's economy (Ndinwa & Ohwona 2014).

Quarrying is the process of obtaining quarry resources usually rocks found on or below the earth surface. (Vincent, Joseph, & Rapheal 2012). Oguntoke, Aboade and Gbadebo (2009) opined that quarrying operation generally involves removal of overburden, drilling, blasting and crushing of rock materials. The various impact produced by these operations varies in both magnitude and location. Like any other man-made activities (anthropogenic factors), quarrying activities cause significant impact on the environment. (Okafor 2006) as cited by (Lameed and Ayodele 2010).

Afeni and Adeogun, (2015) opine that though the exploitation of natural resource, has traditionally been seen as a vital part of economic growth, it is now well recognised that concern for environmental and socioeconomic consequences which must be included as a key component of the development activities. Therefore, according to Taylor in Daudu, Abdulazeez and Mauwiyya (2012), the question increasingly being asked is whether the current state of exploitation of resources can be sustained without serious implication for the future. This explains the reason why many experts have done a lot of work on various issues relating to the impact of quarrying on the environment.

These include; Saroglu et. al (nd), on environmental impact analysis of quarries located on the Asian side of Istanbul, Oguntoke et. al (2009), wrote on the impact of Granite quarrying on the health of workers and nearby residents in Abeokuta Ogun State, Nigeria. Arigbigbola et. al (2012) have undertaken work on Assessment of Health and Environmental Challenges of Cement factory on Ewekoro Community Resident Ogun State Nigeria. Omosanya and Ajibade (2011) has done work on Environmental impact of quarrying on Otere village Odeda Southwestern Nigeria, while Musa Jiya (2011) studied An assessment of mining activities impact on vegetation in Bukuru Jos Plateau State using Normalized Differential Vegetation Index (NDVI). Vincent et. al (2012) studied effect worked on environmental and Health impact of solid mineral exploration and exploitation in south-Northern Nigeria: A case study of Igarra in Edo State. etc. In all of these studies non effectively addressed the case of Edo North. Also, the use of remotely sensed data for evaluating the impact of quarrying on the environment of quarry activities on some selected communities in the lower Many Krobo District of Eastern Region of Ghana. Also Lameed and Ayodele 2010 researched on effect of quarrying activity on biodiversity: Case study of Ogere site, Ogun state Nigeria. Other researches by Oborien (nd) looked at impact of granite quarry on the environment: Case study of Iyuku community, Edo State and Ndinwa and Ohwona (2014) has not been adopted in the study area.

However, summary of the impacts of quarrying from these studies includes, dust which is a major sources of air pollution, increase in noise level as a result of crushing machine and trucks hauling granites, Destruction of the natural habitats and the spices they support; generation of a significant amount of waste; damage to biodiversity, defacement of the landscape, increased rate of soil erosion, impact on buildings, impact on vegetation and wide life, impact on agriculture, impact on water and other social impacts like health and conflicts among others.

To this end, the environment which provides the foundation upon which the society exists, develop and survive is traumatized. Consequently, the need to achieve equilibrium between the environment, and the adverse impact associated with quarrying activities cannot be over emphasized.

Although measures for mitigating these impacts of quarrying on the environment are already employed in the study area, the effects are not felt. Some of these measures adopted according to Oguntoke et al, (2009), Lameed & Ayodele (2010) include introduction of controlled blasting operations to minimize hazards from missiles, establishment of dust control mechanism at the unit level, mandatory EIA report for all quarries with compliance monitoring visit to quarry sites to be done routinely so as to minimize negative effects of quarrying operation on the environment. Etc.

From the fore going this study is concerned with the assessment of environmental impact of quarrying on host communities in Edo North Nigeria.

## **STUDY AREA**

Commented [U1]:

Edo north lies within Latitudes 6500'N-7030'N and Longitudes 5400'E-6050'E at the northern fringe of Edo State, Nigeria (see fig1.2 & 1.3). It is underlain in the north by Precambrian Basement Complex and in the south by Cretaceous and Tertiary sediments. The northern part is rich in industrial and metallic minerals which are currently at various stages of exploitation (Ndinwa & Ohwona, 2014)

The national population commission census of 2011 projected the population density of Edo north to about 1,093,980 people. The main activities indulged in by the populace is agriculture which is practiced at both the subsistence and commercial scale. Food crops are mainly yams, cassava and plantain while cash crops include cocoa and palm produce. The local people are also gainfully employed in the quarrying of rocks in the area.

The climate is tropical, that is, warm and humid climatic condition during the wet and dry seasons is noticed prominently in the area. The dry season is between November and February, while the rainy seasons are mostly between April and October. Average rainfall is between 1000mm and 1500mm with temperature as high as 36.7<sup>0</sup>c (Edo central Office of Research and Statistics, 2013). Vegetation is the guinea savanna, with denser forest fringing some of the rivers and steeper slopes formed by the ancient sedimentary rocks in areas where they overlie the basement. There are variable species of animals, which inhabit this environment. They include mammals, reptiles, birds, rodents, crickets and insects. Grazing of cattle such as cows, sheep and goats are carried out mostly by the nomadic Fulani's. The area is drained by many rivers and the prominent ones include River Ose and its tributaries as well as River Ojio, Oirle, Edion and Obe and Ubo with the tributaries. The drainage density of Edo north can be described as light as the drainage channels are sparsely separated.

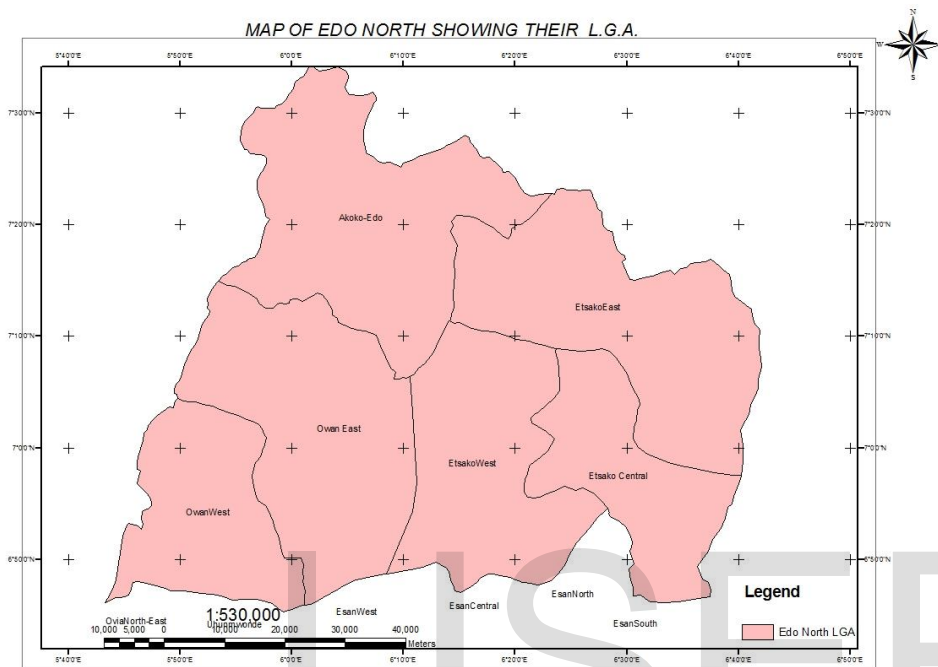


Fig 1: Map of Edo North Showing the Local Government Areas.

Source: Adapted from Ndinwa & Ohwona (2014)

## REVIEW OF RELATED LITERATURE

### Overview of Granite Quarrying Industry

As at the last count, the Ministry of Mines and Steel Development (MMSD) have discovered over 30 commercially available industrial mineral in Nigeria and granite is one of such industrial minerals. The granite deposit in Nigeria is estimated to be in billions of metric tons.

Granite has been reported as the material of choice for making durable roads of good quality as early as in the 19th century and also for Building and other forms of constructions (bridges, drainages etc) (Halwenge 2015). The industry grew as a result of high demand for granite as a construction material (Langer, 2001). As a result, the granite quarrying industry in Nigeria is dominated by indigenized multinational construction firms who own most of the well established and mechanized large quarry sites. (Mbamali, 2005). There are also quite a large number of medium and small-scale sites scattered all over the country, which are purely indigenous

In Malaysia, for example it is estimated that the quarry industry employs about 30 per cent of the construction work force. As a result, Quarry operators have been identified as a key contributor to Malaysian economy providing job opportunities to the lower class. (Ibrahim, 2007) in (Halwenge 2015).

In 2010, the granite industry in Pakistan was estimated to have an annual turnover of around US\$ 1 billion and provided direct employment to over 0.5 million people (Ilyas & Rasheed, 2010) as cited by (Halwenge 2015).

Granite quarrying is helping in meeting the demand for infrastructural expansion in Nigeria. The material is the most common, available, affordable and reliable building material in terms of compressive ability (force). As a result, granite quarrying as an extractive economy provides over 60 percent of the raw material used in building and other construction work. As Nigeria is developing new structures and expanding existing infrastructure like roads and buildings of all shapes and sizes. There is a need for a corresponding increase in the number of granite quarries to conveniently take care of the granite needs of the construction industry. For example, according to (ASPASA, 2011) in (Mutarla, 2011) by estimate a kilometer by 10 metres wide stretch of road could use about 500 trucks load of crushed granite stone.

Apart from the fact that granite serves as a common construction material, granite quarrying contributes significantly to the economic development of a nation in different ways namely; contributing to government revenue through royalties, explosive permits levies, blasting certificate fees etc. In the same vein, granite quarrying is a labour-intensive operation, therefore serves as a means for employment opportunities and further development of other infrastructure.

In 1996 about 1800 quarries were recorded in Nigeria (NBS,2008) as cited by (Mutarla, 2011). This number went down over the years due to the embargo on Nigeria by the commonwealth in 1996. However with the reform of the sector in 2005 coupled with the rising crude oil prices and exclusion of duties on mining equipments and machines, the granite quarrying industry has again began to recover. Subsequently about 1003 registered quarrying sites are located throughout the country as at 2011 this figure would have increased over the years.

Quarry distribution in Nigeria has followed the pattern of infrastructural development and growth rate of a particular area and the availability of granite producing rock deposit. Consequently, the nation's capital city Abuja has a high concentration of quarries to supply material like stone dust aggregate of various sizes for building and construction work. In the same way, quarries are located near city capitals in various state; in south west Nigeria the concentration of quarries in Ogun and Oyo compared to other states is because of the availability of granite producing rock deposit and proximity to Lagos where there is aggressive construction work on a regular basis. This is coupled with the non availability of granite rock aggregate in Lagos state.

In Edo state, quarries in Ofosu and part of Ondo state service the granite aggregates needs for construction in southern part of Edo while quarries in Edo north supply granite material in the region and also to Edo central senatorial district and neighbouring states like Delta, Anambra etc. With an estimated figure of about 16million housing deficit in Nigeria (Ezekiel, 2010) as quoted in (Mutarla, 2011) and a need to develop associated infrastructure, the demand for granite quarry products/materials will keep experiencing an upsurge.

### **Environmental Impacts of Granite Quarrying on Host Communities**

Over the years mineral extractive industry has provided the needs of humanity which include transfer of technology, increasing productivity, the generation of employment and skills, generation of income and has also enhance industrialization (Bradshaw, 2005; Bridge 2004). Like the saying goes "*No Pain No Gain*" the industry is also destroying the livelihoods and environments of their host communities (Fonseca, 2004) in (Mutarlar, 2011). These impacts depend largely on the mining operation type, the size and complexity of the project, type of mineral being extracted, type of exploitation method and the life span, the nature of the surrounding environment and the effectiveness of planning, pollution prevention, mitigation and control measures employed. As a result, Noronha (2001), see the impacts as being inherently detrimental to the communities that are in close proximity to it. The impacts can vary significantly, depending on the management of the quarries and the implementation of the legal and regulatory policies put in place. Kemp (2009) is of the view that the communities become more vulnerable when governments fail to adequately protect them. The size and intensity of the mining project is another important determinant of its impact. Research has shown that the most useful approach in assessing the impact of mining is to consider the various stages of development-from conceptualization to remediation (Eggert, 2010; Elliot, 2003). Before mineral resources are harnessed, they have to pass through certain phases (Adekoya, 2003), but each stage gives rise to particular impacts in terms of scale and intensity.

Mining can directly impact the environment through the value chain activities - exploration and feasibility; construction and development; ore extraction, separation and dressing; refining; transportation; closure and reclamation (Twerefou, 2009). Until recently, the most commonly shared opinion of research on the environmental impact of mining has been that environmental impacts are localized as mines occupy a small area of land when compared to the scale of other land uses, such as forestry and agriculture, (Hodge, 1995). However, a growing number of research studies on the environmental impacts of mining challenge this view of mining as a localized activity with isolated environmental impacts (Bridge, 2004; McAllister et al., 2001; Miranda et al., 2003). cited by (Murtala, 2011).

The geology and chemical characteristics of the mineral extraction techniques and the size of the mine are critical to the level of environmental impact, the larger the mine the greater and more widespread the impacts. Proximity of the mine to habitation and economic activities such as agriculture, fisheries and sources of water also determines the extent of the impact (Miranda et al., 2003; MMSD, 2002) cited by (Murtala, 2011).

## **RESEARCH METHOD**

### **GIS and remote sensing approach**

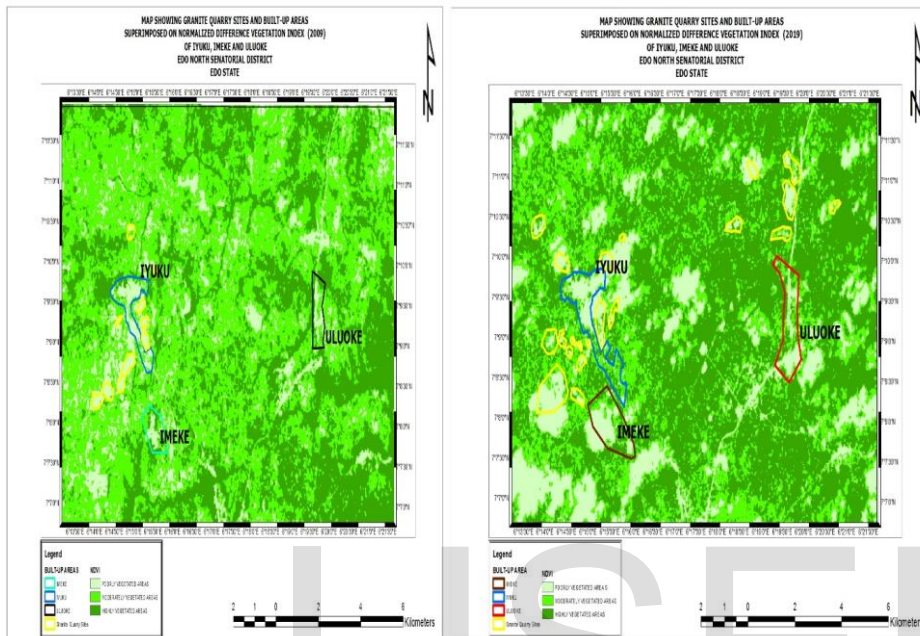
GIS and remote sensing approach was adopted for the study. Google satellite image for 2009 and 2019 were acquired for the study of the quarry expansion and location. Landsat 7 and 8 were acquired from United State Geological Survey archives to study vegetation depletion encroachments on natural water bodies and built-up areas for the period of 10 years. All analysis were executed with Arcgissoftware

### **PRESENTATION OF GIS ANALYSIS/REPORT.**

GIS is an organized collection of computer, hardware, software, geographic data and personnel to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information (Clarke, 2002). Geographic Information Systems is not only a medium for combining spatial data but it is also a powerful technology for the quantitative analysis of land use changes and map updating (Treitz et.al., 1992). Therefore, its ability to manipulate and analyzes spatial information make GIS an indispensable vector-based solution for assessing environmental problems. Also, the presentation tools, which are used for communication of the information obtained from analysis in GIS, add another dimension to this technology for being so popular.

### **Observed Vegetation Cover Changes from 2009 – 2019 (10years difference) in Imeke, Iyuku and Uluoke (NDVI)**





NDVI (2009) NDVI (2019)  
Fig2: Observed Vegetation Cover Changes from 2009 – 2019  
Source : Field survey 2019

**Table 1 : percentage of vegetative cover changes for a 10 years Period**

2019			2009		
S/N	Count	Percentage	Count	Percentage	Condition
1	21743	12.453%	30103	17.241%	Poorly Vegetated Areas
2	94547	54.150%	54751	31.358%	Moderately Vegetated Areas
3	58312	33.397%	89746	51.401%	Highly Vegetated Areas

NDVI PIE CHART FOR 2009

NDVI PIE CHART FOR 2019

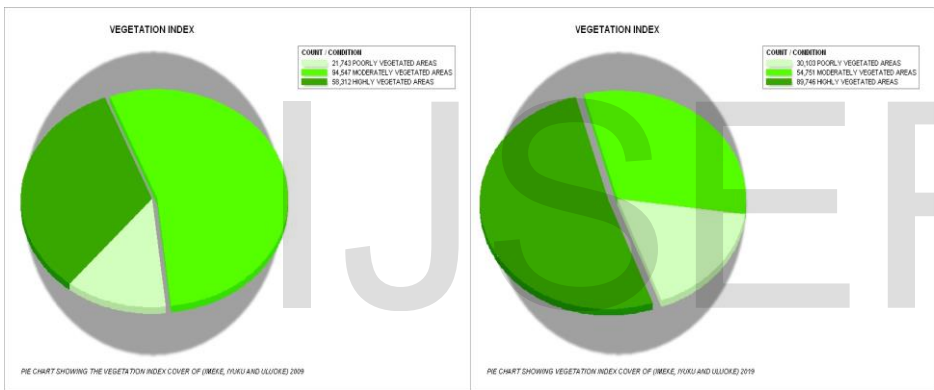


Fig 3: Pie chart showing. Observed Vegetation Cover Changes from 2009 – 2019

Source : Field survey 2019

The table1 above summaries the vegetation cover with in the study extent (Imeke Iyuku and Uluoke) as indicated by the normalized difference vegetation index (NDVI) analysis in both 2009 and 2019. From the analysis as shown on the above table, it was observed that from 2009 to 2019 the poorly vegetated areas with falls majorly within these quarry sites increase from 12.453% to 17.241% indicating a 4.788% increase in depleted vegetation cover. This change in vegetation cover can strongly be attributed to increased quarry activities with these regions.

### Observed Relative Distance from Quarry site to Built up Area Changes from 2009 – 2019 (10years difference) in, Iyuku

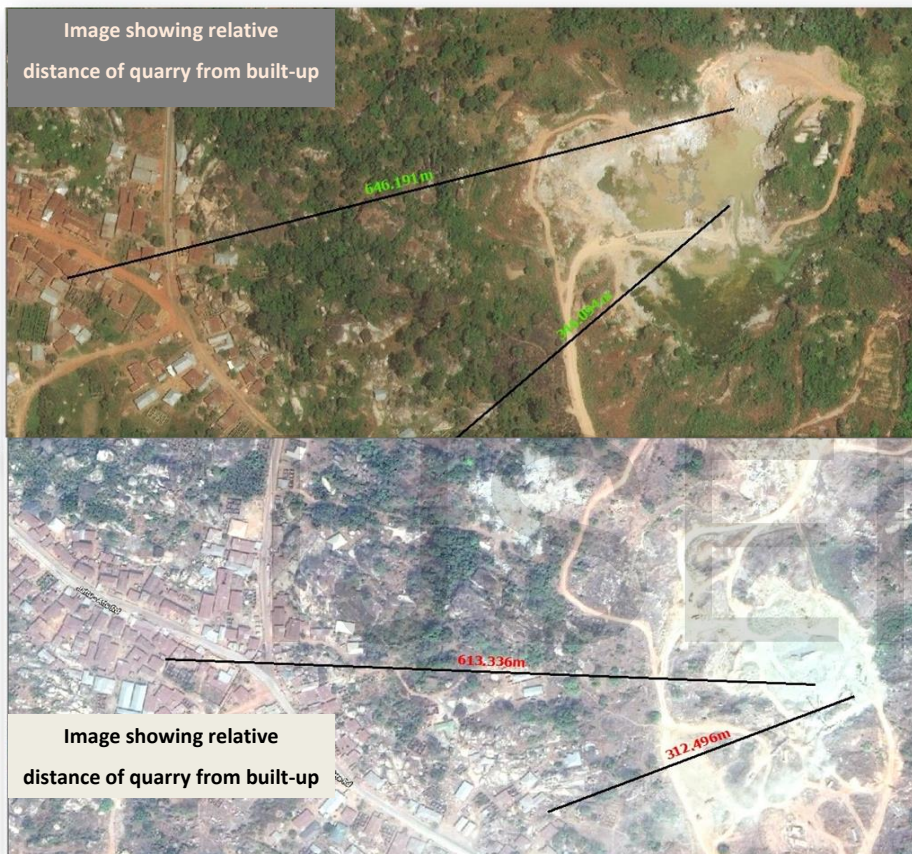


Fig 4(a&b): Relative Distance of Quarry Sites and Built Up Extent in 2009 and 2019 Respectively

The image above shows the distance from a quarry site in Imeke to its built-up areas. In 2009 it was estimated that the distance of this site to built-up areas was 646.191m and 346.094m (as shown on the above image). Due to expansion in land mass of this quarry and built-up areas, this distance reduced to 613.336m and 312.496m.

### Proximity to Water Bodies with 500m Buffer changes from 2009-2019 in case study

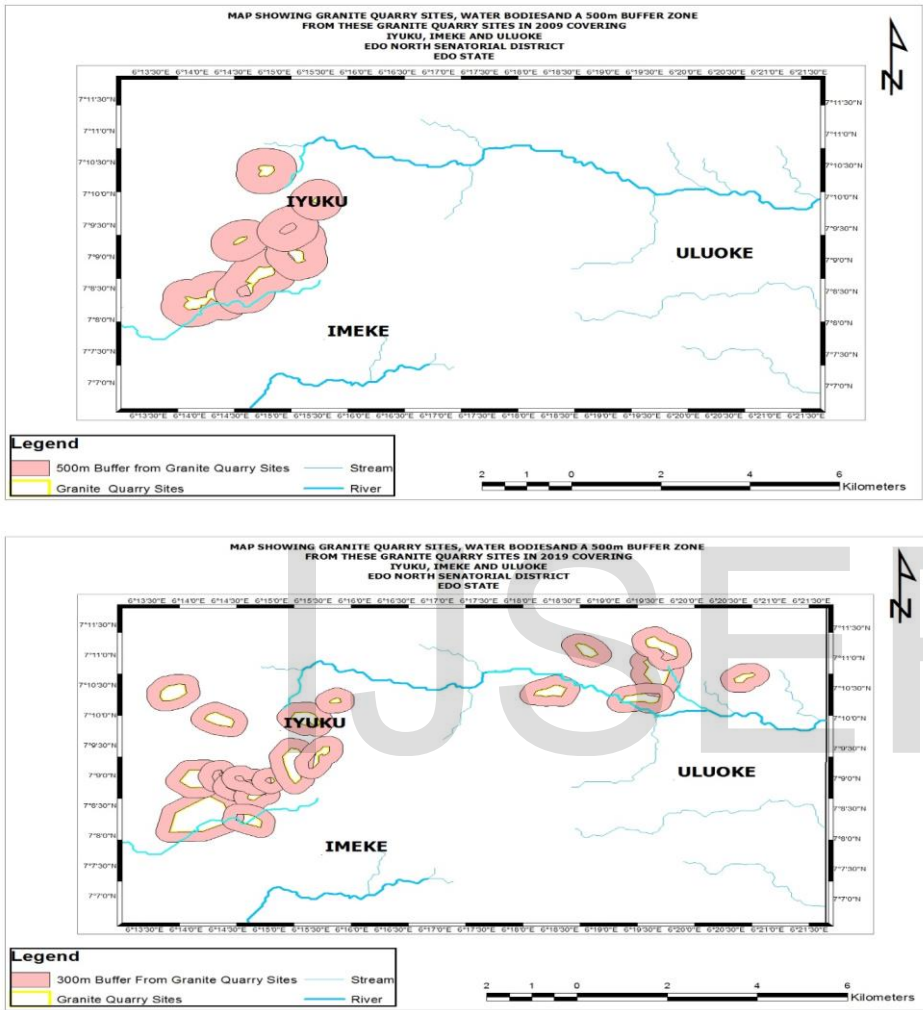


Fig 5.(a&b): Proximity to Water Bodies at Imeke Iyuku and Uluokhe.

The above maps show how quarry sites have expanded over time (within a period of 10years) to encroach into natural water sources. This proximity of these quarry sites to these water bodies may have led to run-off from these quarry sites to finding their way into these water bodies making it unhealthy for human consumption and aquatic activities.

## DISCUSSION OF FINDINGS

From the vegetative cover analysis, findings reveal that within the 10 years' period, the areas covered by heavy vegetation (highly vegetated areas) depleted from 43.935% in 2009 to 29.105% in 2019 measuring about 14.83% depletion in vegetation. From the NDVI, it is seen that as the quarry sites increase or expand, the vegetation around the quarries depreciates. Similarly quarry sites have expanded over time (within a period of 10 years) to encroach on natural water sources. This proximity of these quarry sites to these water bodies may have led to run-off from these quarry sites to finding their way into these water bodies making it unhealthy for human consumption and aquatic activities in the study area.

In 2009 it was estimated that the distance of quarry site to built-up areas in iyuku was 646.191m and 346.094m (as shown on fig.4 a&b.). Due to expansion in land mass of the quarry and built-up areas, this distance reduced to 613.336m and 312.496m in 2019 there by aggravating the environmental problems pollution, cracking of building, noise, resulting from the operation of the quarry industry in the Edo North. These negative effects arising from quarrying activities affect the residents as they suffer directly the consequences of pollution property damage and others as a result of the fact that the quarries are in close proximity with the residential areas

## CONCLUSION AND RECOMMENDATION

As the world climate changes with every passing day, environmental impacts caused by granite quarrying actions are on the increase. This reinforces the need to protect the environment from disasters through the adoption of appropriate mitigation measure for environmental safety. To this end, this study was conceived to study how granite Quarrying impact on the environment. Based on the findings, the study makes the following recommendation.

- Regular environmental audit and monitoring of quarrying activities should be enforced in order to ensure adherence to the standards and limits of the impacts generated from the different stages of their operations.
- In order to achieve sustainable quarrying certain changes need to take place: This includes both institutional changes by the *authorities* as well as application of novel exploitation techniques by the *operator*, which should be consistent with the future as well as the present needs. There should be commitment by the government and operators towards continuous environmental and socioeconomic improvement, from granite exploration, through operation, to closure.
- Impacts of granite quarrying on the environment should be fully considered during the design and set up process of quarries.
- Granite impact mitigating measure should be incorporated in all ramifications in granite quarrying operation in the study area.

- Relevant government agency should look into the pollution control policy and put into consideration that no residential building be erected within 1km to 3km to any quarry site in order to reduce the rate of impact on the people.

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