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Effects of Quarrying Activities on Local Vegetation Cover in Ebonyi State, Nigeria



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ABSTRACT

The study was aimed at the application of a precise method to ascertain the role of quarrying activities on vegetation cover in Ebonyi State, Nigeria. Quarrying activities affect vegetation cover by hindering it from performing its biological roles among which is the photosynthesis process by means of which the environmental pollutant, carbon dioxide is converted to life sustaining oxygen. Methods employed in the study include field measurements carried out with the assistance of a qualified surveyor, who obtained the area extent of degraded land. Garmin eTrex GPS receiver was used to obtain the coordinates of locations in the quarry sites. Remote sensing was used to obtain the maps of various sections of the study area. Discriminant analysis was used to differentiate and isolate effects on vegetation cover by quarrying activities in quarrying and non-quarrying areas from such other effects as farming, bush burning, the road, as well as other construction, works a is distinct from results which are not normally isolated by remote sensing and Google map. The discriminant analysis showed that local vegetation cover in 6 communities gave positive test result based on their positive discriminant analysis scores. The other 21 communities had negative test results based on their negative discriminant analysis scores. In effect, whereas quarrying activates were found significant in 6 communities, they were not found significant in the other 21 communities. The analysis yielded a canonical correlation value of 0.94, indicating that there was a very strong effect of the quarrying activities in the affected areas. The resulting Wilks's Lambda and Chi-square values respectively of 0.120 and <0.01 showed that there was a satisfactory classification of the intensities or level of quarrying activities. Hence, precise determination of the effects of quarrying activities on local vegetation cover will constantly enhance efforts towards reduction of local carbon dioxide surplus and oxygen deficiency through photosynthesis process, as well as gully erosion restraint. Initiation and enforcement of policies towards achieving best sustainable quarrying practice are recommended.



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INTRODUCTION

Increased demand for quarried products has stimulated investment surge in stone quarrying/mineral exploration and production in developed and developing nations including Nigeria (Okeke, 2008 and Mahtani, 2008). It is estimated that over 13 million people in about 30 countries across the world are engaged in quarrying, with about 80 million to 100 million people depending on the extractive activities for their livelihood (World Bank Report, 2012). Nigeria has a proven economic reserve of 33 types of minerals in over 400 locations in the country. Solid minerals and aggregates cut across the entire South-East geo-political zone made up of Abia, Anambra, Imo, Enugu and the Ebonyi States and the South-western States (Akpokodje, 1992 and Lawal, 2010). The Nigerian Bureau of Statistics (2008) recorded about 1,800 registered quarries in 1996. These supply the raw materials for construction industries as well as metallic and non-metallic industries around the country (Murtala, 2011).

Ebonyi State has had a vibrant quarrying industry that dates back to the 1950s (Chima *et al.*, 2010). Over time it has experienced a considerable increase in quarrying operations with about 400 private operators producing over 100,000 metric tons of stone materials per annum (Ministry of Solid Minerals, 2007). There is a surplus supply of these natural resources in the State due to its geologic formation (Edet *et al.* 2011). It has triggered the excavation and exploitation of quarry resources. It has also brought about economic benefits as employment, direct contracts, purchase of locally-produced goods, foreign exchange earnings and development projects in the host communities where the stones are quarried (Sosa *et al.*, 2001, Bradshaw, 2005 and Bridge, 2008).

Notwithstanding the socio-economic benefits of quarrying operations, when quarrying operations become unregulated without the best sustainable practice in view; adverse effects on the environmental resources becomes unavoidable. In particular, it is the effects on vegetation cover that this study seeks to specifically determine.

Bloodworth *et al.* (2009) reported that the past quarrying activities in the North of England, especially in the districts of Cornwall remain, influence on the natural vegetation and landscape of the area. These had considerable biological and physical effects, especially on the landscape. Also, in the United Kingdom, Yorkshire Dales, around 4.5million tons of rock are quarried each year. The quarrying activities have had a substantial effect on the natural environment (BBC, 2014). Greenpeace International (2010) reported that in the United

States, between 1930 and 2000, quarrying activities have altered about 2.4 million hectares (5.9 million acres) of vegetation, most of it originally forest.

Attempts to re-seed land destroyed by quarrying activities have been difficult because the process has so much damaged the soil surface. In Montana, for example, replanting projects had a success rate of only 20-30 percent, while in some places in Colorado only 10 percent of oak aspen seedlings that were planted survived (Greenpeace International 2010). In China, quarrying has degraded the quality of land of an estimated 3.2 million hectares, according to 2004 estimate. The overall restoration rate in relation to the total land area of wasteland was only about 10–12 percent (Greenpeace International, 2010). In Nigeria, currently, there has not been many attempts at re-seeding/restoring areas degraded by quarrying activities.

Ako *et al*, (2014), Musa and Jiya (2011) and Oke *et al* (2010) investigated the impact of limestone quarrying on the vegetation and landform in Ogun State, Nigeria. Although their findings concluded that quarrying operations destroyed the landscapes and caused losses of vegetation, the effects by construction works, bush burning and farming were not isolated. Similar studies by Mathada *et al* (2012) in South Africa, George *et al*. (2008) in Greece, as well as by Lad and Samant (2012) in Kolhapur District, India did not isolate quarrying activity effects from farming, bush burning and construction work. Such other studies by Knowles *et al*. (1999) in Cornwall, United Kingdom and Strahler and Strahler (1997) in the United States showed the same shortcomings.

Clearly, the past studies on the effect of quarrying on vegetation cover have not properly isolated its negative effects on vegetation cover from the effects of bush burning, construction works and farming. They had relied on remote sensing and Google maps. Upon this; this study employed the discriminant analysis to effectively isolate the negative effects of quarrying from other likely factors. Discriminant analysis is a powerful classification technique to discriminate the assigned observations to pre-defined groups (George C. J. F, 2014). Khattree R *et al* (1995) indicated that the common objectives of DA are i) to investigate differences between groups ii) to discriminate groups effectively; iii) to identify important discriminating variables; iv) to perform hypothesis testing on the differences between the expected groupings; and v) to classify new observations into pre-existing groups.

MATERIALS AND METHODS

The study area is situated between longitudes 7° 30' and 8° 30'E and latitudes 5 ° 40' and 6 °54'N (see Fig. 1 and 2). It has a land area of 5,935 sqm. Km and a population of 2,176, 947. It has an annual growth rate of 3.5% (National Population Commission, 2006, National Bureau of Statistics, 2010). Ebonyi's population is largely rural, it has an average rurality index with an estimated 75 percent of the population (over 1.2 million people) living in rural areas.

In order, to achieve the objective of this research, which is to determine the role of quarrying activities in affecting vegetation cover in the study area. The data for the study was collected through direct field observations, oral interviews, photographs and measurements. Several field visits were made to obtain ground control points and other field reconnaissance site familiarization tasks. Measurements were made with the assistance of a qualified professional surveyor who, the area extents of both degraded and non-degraded areas. These measurements were restricted to only areas degraded by quarrying and did not include areas degraded by farming, bush burning and construction works. It was recognized that remote sensing alone is incapable of differentiating between areas degraded by quarry activities and those degraded by farming, bush burning and construction works. The coordinates of the quarry pits and other locations were obtained using Garmin eTrex GPS receiver. Remote sensing equipment was used to provide maps for the entire study area. Data were analyzed using multivariate discriminant analysis. Discriminant Analysis (DA) as a multivariate statistical technique was used to build a predictive/descriptive model of group discrimination based on observed predictor variables and to classify each observation into one of the groups either high or low quarrying effects. The multiple quantitative attributes are used to discriminate single classification variable because of a prior knowledge of the sample (quarry sites) from each class was required. The dependent variable of the study was the frequency of quarrying activities indicating the levels of quarrying intensity being classified, while the independent variables were the areas of quarried land and areas of the vegetated, non-quarried land.



Fig. 1: The Map of Nigeria showing the location of Ebonyi State.

Source: Google Map (2016)

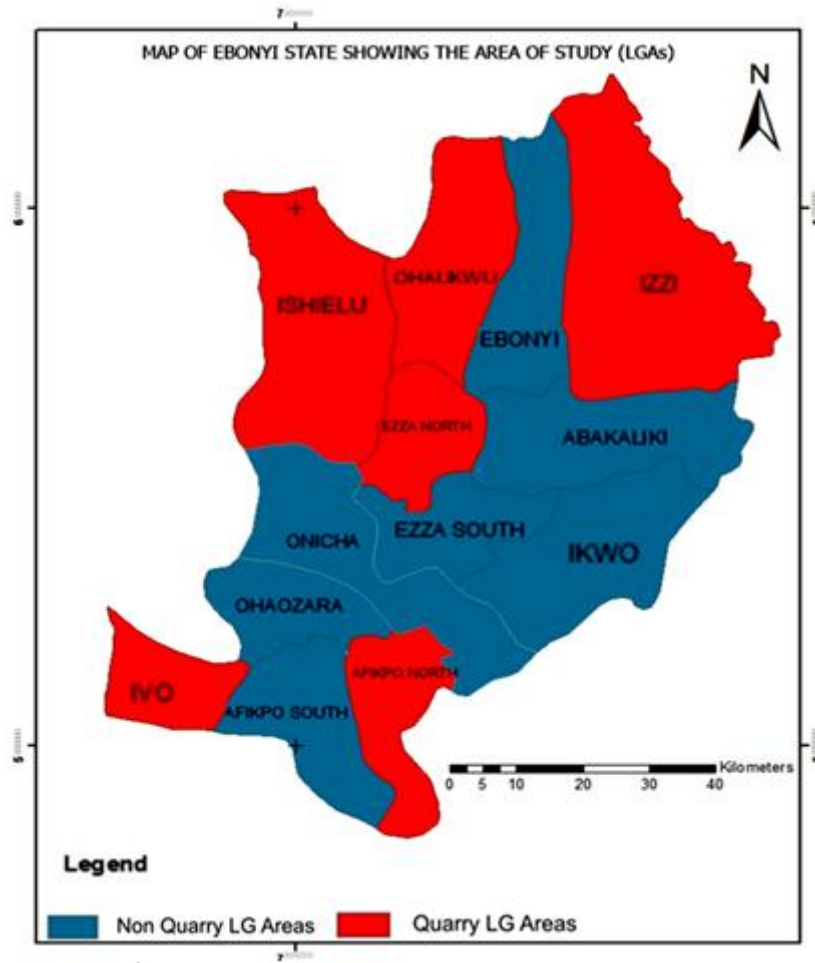


Fig 2. Showing map of the study area

Source: Infographic Consultants Limited, Nigeria (2016)

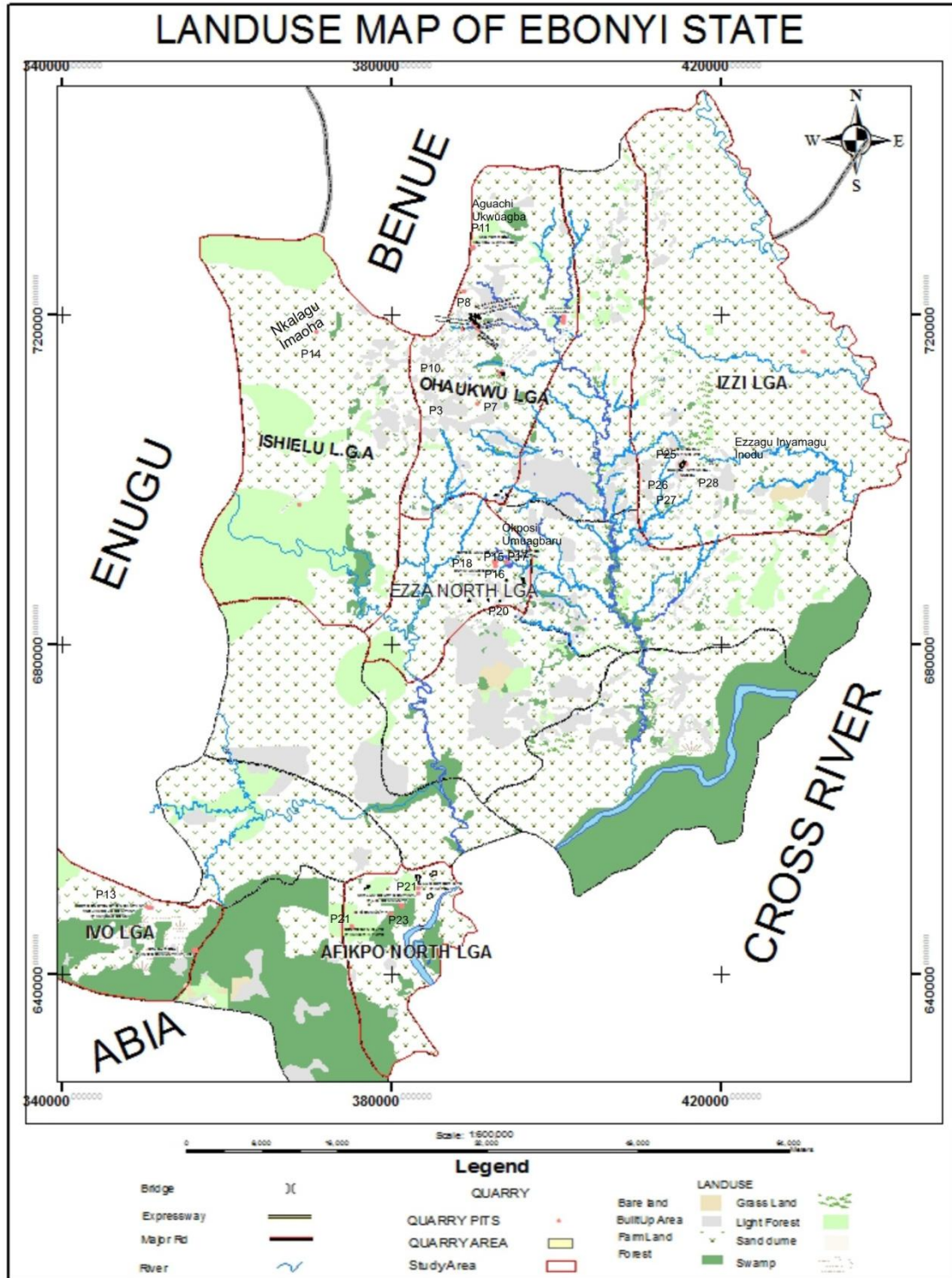


Fig. 3: The Land use Map of the Ebonyi State showing the Quarry Sites

Source: Info graph Consultant Nigeria, Limited, (2016).

RESULTS

Table 1.1 shows the output results of the analysis including the local communities, the grouping of quarrying in each locality, the pit areas, vegetation cover in non-quarrying areas, the resulting discriminant scores, and the interpretation of the discriminant scores. Areas with positive scores were classified as experiencing the significant effect. These are Umuaguma in Ohaukwu Local Government Area (LGA), Akpoha in Afikpo North LGA, Ezzagu in Izzi LGA, Amaeze and Amokwe in Ivo LGAs, Nkalagu in Ishielu LGA, while those with negative scores were classified as experiencing no significant effect. These include Akpeagu, Umuaguma, Ndiagu, Idaka, Aguaehi all in Ohaukwu LGA, Okposi, Enyim, and Omega in Ezza North LGA. Others are in Akpoha and Ezzagu in Afikpo North and Izzi LGAs respectively. This result is in perfect agreement with the field measurements and the photo plates.

Table 1.1: Discriminant Analysis for Classifying Vegetation Cover affected by Quarrying Activities in the Study Area.

Villages/LGAs	Group	Pit Area	Vegetation Area	Discriminant score	Interpretation of the score
Akpeagu, Ohaukwu LGA	1	0.19	5969.92	-.69019	No significant effect
Akpeagu,II Ohaukwu LGA	1	0.54	5969.57	-.47162	No significant effect
Umuaguma, Ohaukwu LGA	1	0.54	5969.57	-.47445	No significant effect
Umuaguma, Ohaukwu LGA	1	3.96	5966.15	1.65772	Significant effect
Ndiagu Idaka, Ohaukwu LGA	1	0.54	5969.56	-.46885	No significant effect
Ndiagu Idaka, Ohaukwu LGA	1	0.10	5970.70	-.74560	No significant effect
Ndiagu Idaka, Ohaukwu LGA	1	0.49	5969.62	-.50527	No significant effect
Ndiagu Idaka,	1	0.40	5966.15	1.65768	No significant

Ohaukwu LGA					effect
Ndiagu Idaka, Ohaukwu LGA	1	0.72	5970.04	-.76303	No significant effect
Ndiagu Idaka, Ohaukwu LGA	1	0.65	5969.46	-.40469	No significant effect
Aguaehi Ugwuachi, Ohaukwu LGA	1	0.54	5969.57	-.47445	No significant effect
Okposi, Ezza North LGA	2	0.94	3279.26	-.37783	No significant effect
Okposi, Ezza North LGA	2	0.50	3279.70	-.65240	No significant effect
Enyim, Ezza North LGA	2	0.13	3280.07	-.88214	No significant effect
Omega, Ezza North LGA	2	0.31	3279.89	-.76540	No significant effect
Omega Ezza North LGA	2	0.08	3280.12	-.91032	No significant effect
Akpoha, Afikpo North LGA	3	5.40	5525.51	2.52930	Significant effect
Akpoha, Afikpo North LGA	3	0.22	5530.70	-.69832	No significant effect
Akpoha, Afikpo North LGA	3	0.02	5530.90	-.82159	No significant effect
Afipko North LGA Amasiri	3	0.32	5530.60	-.63388	No significant effect
Ezzagu, Izzi LGA	4	0.04	1156.26	-1.05877	No significant effect
Ezzagu, Izzi LGA	4	0.05	1156.26	-1,04756	No significant effect
Ezzagu, Izzi LGA	4	1.39	1156.12	1.21818	Significant effect)
Ezzagu, Izzi LGA	4	0.19	1156.24	-.96360	No significant effect
Amaeze, Ivo LGA	5	9.45	3132.62	4.91524	Significant effect
Amokwe, Ivo LGA	5	4.77	3222.00	2.00625	Significant effect
Imaoha, Ishielu LGA	6	3.78	1042.97	1.26186	Significant effect

Source: Researcher’s SPSS Computation, 2016

The analysis also had a canonical correlation value of 0.94 indicating that there was very strong effect of the quarrying activities on the affected areas. Moreover, the resulting significant Wilks's Lambda and chi-square values respectively of 120 and < 0.01 (see Table 1.2 and 1.3) show that there was the satisfactory classification of the intensity or levels of quarrying activities in the study area. The result of the discriminant analysis was corroborated by the responses from the communities on their perception on the socio-economic effects of the quarrying activities in the area.

Table 1.2 Summary of Canonical Discriminant Function

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	7.092 ^a	99.5	99.5	.936
2	.033 ^a	.5	100.0	.178

a. First 2 canonical discriminant functions were used in the analysis.

Table 1.3: Wilks’s Lambda

Test of Function(s)	Wilks's' Lambda	Chi-square	df	Sig.
1 through 2	.120	49.891	4	.000
2	.968	.755	1	.385

Source: Researcher’s SPSS, Computation, 2016.

Table 1.4 shows the percentage of excavated vegetation due to quarry activities. The first column shows the local government areas. The second column shows the total area of vegetation cover lost to quarrying activities. The third column contains the percentage of area occupied by quarrying pits. A total of 400,441 hectares of vegetation cover has been lost in Ebonyi State due to quarrying operations.

Table 1.4: Percentages of Excavated Vegetation due to Quarrying Activities.

Active Quarry L.G.A Areas	Total Area of vegetation lost by Quarry pits	% of area occupied by the quarry pits	Total Area of L.G.As in (ha)
Ohaukwu	1,157050m ²	28.7	59,701
Ishielu	377325m ²	9.3	104,335
Ivo	1,422000m ²	35.2	32,271
Afikpo north	595350m ²	14.7	5,530.9
Ezza North	323825m ²	8.0	32,802
Izzi	153000m ²	3.7	115,626
Total	4,028,550m²	100	400,441

Source: Author’s Fieldwork, 2016.

These findings were also confirmed by the photo plates. The results from the field measurements further validate these findings. Ivo LGA (the location of the site) happens to occupy the largest percentage of 35% and a total vegetation loss area of 32,271ha. This is clearly observed in Table 1.4

The second highest area is the pit located at Akpoha in Afikpo North LGA. It also occupies 15% of destroyed vegetation cover. The third is the quarry site located at Amaeze in Ishiagu area of Ivo LGA. It is followed by the quarry site located at Ndiagu Idaka at Ohaukwu LGA while the quarry sites located at Nkalagu, Ishelu LGA and Ezzagu area of Izzi LGA also are classified as areas of large effect of quarry activities in this study area.

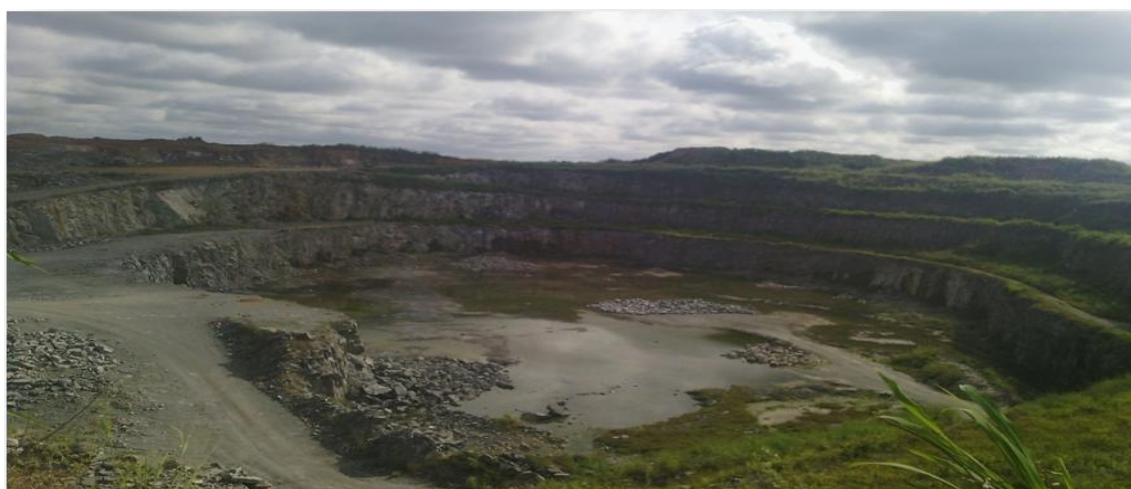


Plate 1.1: Quarry with the largest effect of vegetation loss at Ishiagu.

Source: Photographed by Author, 2015

DISCUSSION

The results showed that quarrying operations have destroyed landscape, caused loss of vegetation, deforestation, loss of farmlands and grazing lands. The increase in demand for aggregates for construction purposes has placed immense pressure on the geological resources. Therefore, increased demand for aggregates is bound to have considerable negative environmental effects on the place where they occur. Field observations showed that in the areas where quarrying operation are active, the lands are heavily degraded. Removal of the top soils, trees and vegetation with heavy machines deprives the land of its nutrients and renders the land infertile for agricultural purposes. For instance, at Amaeze in Ishiagu area located at Ivo LGA, there were areas where the land had been covered by rocks and other debris from quarrying activities. This has not only impeded plant growth on the land but has also rendered the surface rugged, making it impossible for productive farming activities to take place.



Plate 1.2: Quarry with large de-vegetated area at Ezzagu in Izzi LGA

Source: Photographed by Author, 2016

In addition, oral interviews indicated that respondents complained that pits and heavy holes/trenches were created as a result of these activities. Such areas eventually become inaccessible to the people because they become fatal zones. Field observations also confirmed this as such pits were observed at Akpeagu Ukwuagba and Afikpo North with

depths ranging from about 50-75m deep. They are either covered with rocks or water (which render the land infertile) or are converted into waste pits and other toxic materials are deposited. There were scenes of rock piles close to villages such as Okposi, Ibii, and others. Scenes of death-trap pits and rugged surfaces has at a location close to the Company at Ivo LGA.

It is quite unfortunate that even though many residents are aware of the negative effects of quarrying, no serious intervention measures have been put in place on a sustainable basis to arrest the menace. Findings from the field measurements indicated that there has been large-scale exploitation of limestone and granite in Ebonyi state. A total of 400,441 hectares of prime lands has been destroyed due to an excavation of rocks. This research undoubtedly inferred that the continuous quarrying of rock resources in the area has had a resultant negative effect on the arable lands and vegetation. However, the unregulated quarrying practices have adversely affected the farmlands and forest areas leaving large pits and trenches in the area.

Furthermore, oral interviews from the residents of the communities and youth leaders indicated that majority of the quarry companies operate on illegal terms with little compensation for the loss of their lands and vegetation. They hardly provide social amenities and infrastructure like clinics, schools and scholarships which they had promised during their initial meetings with the communities' leaders before quarry activities commenced. It is apparent that the people are in dire need of basic facilities.

Again, oral interviews showed that the companies mainly provide access routes to aid them in the transportation of raw materials from the sites. The boreholes and culverts were also provided not just to serve the villagers but also the resident company workers. These issues have resulted in conflicts between the residents and the companies' staff. They argued that the indigenes of Ebonyi State who were employed by the companies were not well paid because they lack professional expertise and skills. This was also the case when the youths, the chiefs' and leaders were orally interviewed at Ndiagu Idaka in Ezzamgbo, Ohaukwu LGA.

Also, a similar situation was also highlighted by the youth leaders interviewed at Ohaechara, Opi in Amasiri who complained bitterly. It was observed that three quarry companies namely SG mineral, Global Lopet and Santoko Rock were shut by the villagers due to their loss of

farmlands and forests, pollution of their rivers and disappearance of wild animals used for hunting and livelihood without considerable compensation.

Obviously, lack of enforcement of bye-laws and guidelines for quarrying operations gave the companies and contractors the freedom to open and abandon quarries haphazardly without considering the proximity of the quarries to communities and their lands. This implies that there is need to enforce the laws on quarrying operations mostly on the issue of restoration of depleted lands and vegetative areas. The present events point up problems. These are aggravated by the fact that the quarry operators neither comply with the existing environmental laws nor fulfill their custodial obligations to protect their traditional lands.

CONCLUSION AND RECOMMENDATION

The literature review indicated that the effects of quarrying on vegetation and landscape had been investigated both in Nigeria and other parts of the world. The shortcomings of these studies were highlighted as non-isolation of effects of quarrying from the effects of a bushing, construction work and farming. However, the various findings corroborate with the findings of this study. The major contribution is that the proper effect due to quarrying activities has been determined. The areas actually affected by quarrying alone are less.

Previous studies on the effect of quarrying activities on vegetation cover did not isolate effects due to quarrying and effects due to such other sources as bush burning, construction works and farming. They had relied on remote sensing and Google mapping.

The study has developed a model (canonical correlation of 0.94) that showed a strong correlation between the intensity of quarrying activities on the vegetated land and quarried areas of Ebonyi State. The resulting Wilks's Lambda and Chi-square values respectively of 0.120 and <0.01 showed that there was a satisfactory classification of the intensities or level of quarrying activities. The multivariate discriminant analysis was used to determine the relationship between categorical variable quarrying intensity and the continuous variable, quarried and unquarried area extents. The advantage of discriminant analysis is the development of scores of the intensity of degradation for each community. Regression analysis does not have this provision. The study also showed a very satisfactory classification of the land intensities of the quarrying activities. Hence, precise determination of the effects of quarrying activities on local vegetation cover will constantly enhance efforts towards reduction of local carbon dioxide surplus and oxygen deficiency through

photosynthesis process, as well as gully erosion restraint. This will be useful to government authorities and related environmental bodies with required information and mitigation measures in arresting the present situation.

Also, there is a need for intensive and participative information dissemination campaigns, involving the Local Government Organizations (LGOs), Non-Government Organizations (NGOs) and religious organizations to arouse the awareness of residents regarding the environmental effects of quarrying on the local vegetation cover.

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