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Vegetation Assessment of Okigwe Limestone Quarry Site at Okpilla in Etsako East Local Government Area, Edo State

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Abstract

The objective of the present study is to assess the impact of limestone quarrying on vegetation and document the flora associated with quarry. Three sites were adopted for this research work which were Site A (4 years quarry site), Site B (1 year and 6months quarry site) and Site C (Surrounding area with no quarry activities). Line transect method was employed and the plant species were identified and quantitative community characteristics were also assessed. The result obtained showed that at site A, B and C there were 49, 36 and 74 plants species, respectively, distributed into 18, 16 and 29 plant families, respectively. The most dominant species rich-families were Fabaceae, Poaceae, Asteraceae and Euphorbiaceae. Herbs were the most dominant plant habit and there were more native plant species in all the studied sites. As the dominance reduced and evenness increased the diversity increased. The Jaccard similarity index revealed that Sites A and B when compared had the highest value of 0.4167 indicating there were more similar in terms of plant species present. It is evident that quarrying activities in the area are detrimental to the vegetation. This finding would be useful while formulating the management plan for the area.

Keywords: Nigeria, limestone, vegetation, families, Jaccard similarity index.

1. Introduction

Limestones are sedimentary rocks primarily of calcium carbonate. Quarrying of different useful minerals, such as limestone, is an old technology that has been in existence since ancient past (Ekmekçi, 1993). The direct negative effects of mining activities can be an unsightly landscape, loss of cultivated land, loss of forest and pasture land, and the overall loss of production. The indirect effects can be multiple, such as soil erosion, air and water pollution, toxicity, geo-environmental disasters, loss of biodiversity, and ultimately loss of economic wealth (Xia and Cai, 2002). Suspended dust, generated from limestone quarries activities, blocks light in the atmosphere from reaching plants through air and also settles on plants and blocks sunlight by covering the stomata of plant leaves that needs to perform photosynthesis. Dust may have physical effects on plants such as blockage and damage to stomata, shading, abrasion of leaf surface or cuticle, and cumulative effects like drought stress on already stressed species (Banez et al., 2010). Limestone mining creates large disturbances that significantly impact soil, vegetation and fauna and result in habitat fragmentation and loss (Sort and Alcañiz 1996). Measures of vegetation structure provide information on habitat suitability, ecosystem productivity, and help predict successional pathways (Silver et al., 2004; Wang et al., 2004).

Information are lacking for the flora associated with limestone quarrying sites at Okigwe Village in Etsako East LGA. The outcome of the present study will therefore provide a source of data on the ecological impact of limestone quarrying in Okigwe village of Etsako East LGA. The data generated will be useful at the post mining phase, when the quarry site is abandoned or the deposit is exhausted. The research objective was to document the flora associated with limestone quarry sites in Edo State and to assess the impact of limestone quarrying on vegetation using phytosociological analysis.

2. Materials and Method

The present study area is bestowed with rich natural vegetation as well as large reserve of mineral resources. Okigwe Village in Okpella plays host to the Edo cement factory and many more solid mineral related factories. The present study area was divided into three sites which was designated as site A, B, and C. Site A represented excavated limestone quarry for a period of four years, Site B represented one and half years while Site C was the control

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where limestone quarrying activities was absence. The use of line transect measuring 50m was employed which was placed 10 times each in the different sites studied. The species found in the line transect were identified with the aid of appropriate literatures, manual, checklist and botanical flora (Keay et al., 1964 ; Gill, 1992; Akobundu and Agyakwa, 1998; Etukudo, 2003 and Aigbokhan, 2014). Quantitative community characteristics, such as frequency, abundance and density, were determined. The data collected were subjected to the following ecological analysis: Importance Value Index (IVI), Importance and diversity indices were determined. Species diversity was computed using PAST Software to analyze different diversity indices. Similarity between communities based on species composition was determined by Jaccard similarity index.

The Shannon diversity index (H') was calculated using the following equation:

$$H' = \sum\left(\frac{ni}{n}\right) in \left(\frac{ni}{n}\right)$$

where, H = Shannon-Weaver index

ni = importance value index

N = total importance value of all species

The values of Shannon diversity index are usually found to fall between 1.5 and 3.5 and only rarely surpass 4.5 (Magurran, 1988).

Evenness (E') was calculated:

$$E' = \frac{\mathrm{H}}{\mathrm{Hmax}}$$

where Hmax is the maximum level of diversity possible within a given population, which equals ln(number of species). Magurran (1988) explained that E ' ranges normally between 0 and 1,

where 1 representing a situation in which all the species are equally abundant.

Simpson Dominance Index= (ni/N)^2

where, ni = importance value index

N = total importance value of all species

Jaccard similarity index = $\frac{A}{\sum(A+B+C)}$

where A = the common species between sites; B= the species of site 1 and C

= species of site 2.

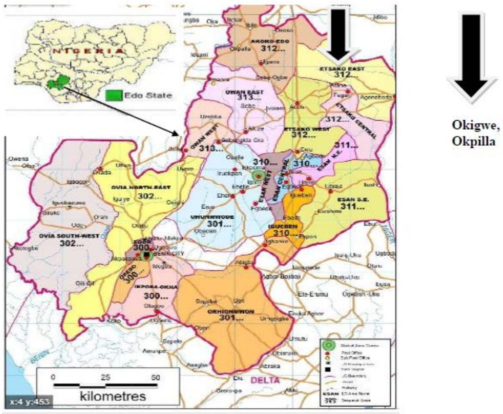

Plate 1: Map of the study area

3. Results

Forty-nine plants species were identified at site A in the studied area (Table 1), distributed in 18 plant families with Poaceae and Asteraceae having the most dominant with a value of 11 and 8 species represented, respectively (Figure 1). The data analyzed for species composition revealed that plants with importance value index (IVI) greater than 10 were Chromolaena odorata (L.) R. King &H. Robinson (13.293), Cyperus sp (32.779), Eurphorbia heterophylla L. (10.337), Sida acuta Burm. f. (56.991) and Syndrella nodiflora (L.) Gaert (11.826). Diplazium sammatii (Kuhn) C. Chr. was the only fern identified in this study. At site B, 36 plant species identified which were distributed into 16 plants families. Fabaceae and Poaceae were represented by 7 species each, followed by Asteraceae with 5 species (Figure 1). The data analyzed for species composition revealed that plants with importance value index (IVI) greater than 10 were Andropogon tectorum Schumach & Thonn (11.04), Aspilia africana (Pers.) C. D. Adams (11.04), Panicum maximum Jacq (14.57) and Spigelia anthelima L.(63.25). Seventy four (74) plants species were identified in site C, which were distributed in the 29 plant families with 1unknown family. The most dominant plant family in the site were Fabaceae (13 spp), Poaceae (11 spp), Asteraceae (7spp) and Euphorbiaceae (5 spp) (Figure 1). Plant with IVI greater than 10 were Manihot esculenta Crantz (10.04), Mimosa diplotricha C. Wright ex Sauvalle (13.25) and the unknown tree (24.85) with the other 70 plants in site C less than 10.

Table 1: Species composition of plants found in the 4 years old limestone quarry site A at Okigwe, Okpella. A=Abundance; D=Density; F= Frequency; RA=Relative abundance; RD= Relative density; RF=Relative frequency; IVI=Importance values index

S/No	Scientific Name	A	F	D	R A	RF	RD	IVI
1	*Acalypha fimbriata* L.	2.33	30	0.7	0.761	2.4	0.74	3.901
2	*Acroceras zizanoides* (Kunth) Dandy	3.33	30	1	1.088	2.4	1.05	4.538
3	*Ageratum conyzoides* L.	3	10	0.3	0.981	0.8	0.32	2.101
4	*Alchornea cordifolia (Schum. & Thonn.) Muell. Arg.*	8.67	30	2.6	2.834	2.4	2.74	7.974
5	*Andropogon tectorum* Schumach & Thonn.	5.33	30	1.6	1.742	2.4	1.68	5.822
6	*Aspilia africana* (Pers.) C. D. Adams	4	30	1.2	1.308	2.4	1.26	4.968
7	*Calopogonium mucunoides* Desv.	1.75	40	0.7	0.572	3.2	0.74	4.512
8	*Carica papaya* L.	1.5	20	0.3	0.49	1.6	0.32	2.41
9	*Centrosema pubscens* Benth	4.25	40	1.7	1.389	3.2	1.79	6.379
10	*Chromolaena odorata* (L.) R. King &H. Robinson)	13.5	40	5.4	4.413	3.2	5.68	13.293
11	*Cissus caesia* Afzel.	2	20	0.4	0.654	1.6	0.42	2.674
12	*Cleome viscosa* L.	3	20	0.6	0.981	1.6	0.63	3.211
13	*Conyza sumaturensis* (Retz.) E. Walker	8.5	20	1.7	2.779	1.6	1.79	6.169
14	*Crotalaria retusa* L.	3.67	40	2	1.199	3.2	2.11	6.509
15	*Cynodon dactylon* (L.) Pers.	1.75	40	0.7	0.572	3.2	0.74	4.512
16	*Cynodon nfuemlensis* Vanderyst	1.67	30	0.5	0.546	2.4	0.53	3.476
17	*Cyperus* sp.	74	10	7.4	24.189	0.8	7.79	32.779
18	*Daniellia oliveri* (Rolfe) Hutch & Dalziel	1	10	0.1	.327	0.8	0.11	1.237
19	*Desmodium triflorum* (L.) DC	4	10	0.4	1.308	0.8	0.42	2.528
20	*Diplazium sammatii* (Kuhn) C. Chr.	6	10	0.6	1.961	0.8	0.63	3.391
21	*Eleusine indica* (L.) Gaetn	5	30	1.5	1.634	2.4	1.58	5.614
22	*Emilia praetermissa* Milne-Redhead	4	10	0.4	1.308	0.8	0.42	2.528
23	*Euphorbia heterophylla* L.	17	20	3.4	5.557	1.6	3.58	10.737
24	*Euphorbia hirta* L.	4	10	0.4	1.308	0.8	0.42	2.528
25	*Euphorbia hyssopifolia* L.	1.5	20	0.3	0.49	1.6	0.32	2.41
26	*Gomphrena celosioides* Mart.	2	10	0.2	0.654	0.8	0.21	1.664
27	*Hibiscus suratensis* L.	2.5	40	1	0.817	3.2	1.05	5.067
28	*Hyptis suaveolens* (L.) Poit.	3.2	50	1.6	1.046	4	1.68	6.726
29	*Ipomoea triloba* L.	1	10	0.1	0.327	0.8	0.11	1.237
30	*Mariscus alternifolius* Vahl	1	10	0.1	0.327	0.8	0.11	1.237
31	*Mimosa pudica* Linn.	1	10	0.1	0.327	0.8	0.11	1.237
32	*Mitracarpus villosus* DC	4	10	0.4	1.308	0.8	0.42	2.528
33	*Nauclea latifolia* Sm.	1	10	0.5	0.327	0.8	0.53	1.657
34	*Oldenlandia corymbosa* L.	4.67	30	1.4	1.527	2.4	1.47	5.397
35	*Panicum maximum* Jacq	12.5	20	2.5	4.086	1.6	2.63	8.316
36	*Paspalum scrobiculatum* L.	4	40	1.6	1.308	3.2	1.68	6.188
37	*Phyllanthus amarus* Schum. & Thonn.	1	10	0.1	0.327	0.8	0.11	1.237
38	*Sacciolepis africana* C. E. Hubb. & Snowden	7.75	40	3.1	2.533	3.2	3.26	8.993
39	*Setaria barbata* (Lam.) Kunth	7	20	1.4	2.288	1.6	1.47	5.358
40	*Setaria pumila* (Poir.) Roem & Schult	7	10	0.7	2.288	0.8	0.74	3.828
41	*Sida acuta* Burm. f.	35.5	10	35.5	11.621	8	37.37	56.991
42	*Spigelia anthelmia* L.	1.75	40	0.7	0.572	3.2	0.74	4.512
43	*Sporobolus pyramidalis* P. Beauv	3.67	30	1.1	1.199	2.4	1.16	4.759
44	*Stachytarpheta jamaicensis* (Linn.) Vahl	2	10	0.2	0.654	0.8	0.21	1.664
45	*Synedrella nodiflora* (L.) Gaert	7.33	60	4.4	2.396	4.8	4.63	11.826
46	*Tridax procumbens* Linn.	2	10	0.2	0.654	0.8	0.21	1.664
47	*Typha domigensis* Pers.	2.8	50	1.4	0.915	4	1.47	6.385
48	*Urena lobata* L.	5	10	0.5	1.634	0.8	0.53	2.964
49	*Vernonia cinerea* (L.) Less	1.5	20	0.3	0.49	1.6	0.32	2.41

Table 2: Species composition of plants found in the 1 ½ yrs old limestone quarry site B at Okigwe, Okpella. A=Abundance; D=Density; F= Frequency; RA=Relative abundance; RD= Relative density; RF=Relative frequency; IVI=Importance values index

S/N	Scientific Name	A	D	F	RA	RF	RD	IVI
1	*Acalypha fimbriata* L	1.75	0.7	40	2.17	3.57	2.19	7.93
2	*Alchornia cordifolia* (Schum & Thonn.) Muell. Arg.	1.33	0.4	30	1.65	2.68	1.25	5.58
3	*Andropogon tectorum* Schumach & Thonn.	3	1.2	40	3.72	3.57	3.75	11.04
4	*Aspilia Africana* (Pers.) C. D. Adams	3	1.2	40	3.72	3.57	3.75	11.04
5	*Calopogonium mucunoides* Desv	2.5	0.5	20	3.1	1.79	1.56	6.45
6	*Chromolaena odorata* (L.) R. King &H. Robinson)	2	0.8	40	2.48	3.57	2.5	8.55
7	*Cissus caesia* Afzel.	1.5	0.3	20	1.86	1.79	0.94	4.59
8	*Crotalaria retusa* L.	2.33	0.7	30	2.89	2.68	2.19	7.76
9	*Cynodon dactylon* (L.) Pers.	2	0.8	40	2.48	3.57	2.5	8.55
10	*Cyperus iria* L.	1.5	0.6	40	1.86	3.57	1.88	7.31
11	*Desmodium triflorum* (L.) DC	3	0.6	20	3.72	1.79	1.88	7.39
12	*Euphorbia hirta* L.	1.33	0.4	30	1.65	2.68	1.25	5.58
13	*Hyptis suaveolens* (L.) Poit.	1.67	0.5	30	2.07	2.68	1.56	6.31
14	*Ipomoea triloba* L.	2	0.6	30	2.48	2.68	1.88	7.04
15	*Laportea aestuans* (Linn.) Chew	1.5	0.6	40	1.86	3.57	1.88	7.31
16	*Ludwigia decurrens* Walter	2.67	0.8	30	3.31	2.68	2.5	8.49
17	*Mimosa pudica* Linn.	2.25	0.9	40	2.79	3.57	2.81	9.17
18	*Mitracarpus villosus* DC	1.5	0.3	20	1.86	1.79	0.94	4.59
19	*Mucuna pruriens* (L.) DC	1.33	0.4	30	1.65	2.68	1.25	5.58
20	*Panicum maximum* Jacq	2.43	1.7	70	3.01	6.25	5.31	14.57
21	*Paspalum scrobiculatum* L.	1.67	0.5	30	2.07	2.68	1.56	6.31
22	*Phyllanthus amarus* Schum. & Thonn.	1	0.2	20	1.24	1.79	0.625	3.655
23	*Sacciolepis africana* C. E. Hubb. & Snowden	2	0.2	10	2.48	0.89	0.625	3.995
24	*Scoparia dulcis* L.	2	0.2	10	2.48	0.89	0.625	3.995
25	*Securinega virosa* (Roxb ex Willd)Baill	1	0.1	10	1.24	0.89	0.625	2.755
26	*Senna siamea* (Lam) Irwin & Barbeby	2	0.4	20	2.48	1.79	1.25	5.52
27	*Setaria barbata* (Lam.) Kunth	1.67	0.5	30	2.07	2.68	1.56	6.31
28	*Solenostemon monostachyus* (P. Beau.) Brig.	2	0.8	40	2.48	3.57	2.5	8.55
29	*Spigelia anthelmia* L.	15	12	80	18.61	7.14	37.5	63.25
30	*Sporobolus pyramidalis* P. Beauv	2	0.6	30	2.48	2.68	1.88	7.04
31	*Synedrella nodiflora* (L.) Gaert	1.33	0.4	30	1.65	2.68	1.25	5.58
32	*Talinum triangulare* (Jacq.) Willd.	1	0.3	30	1.24	2.68	0.94	4.86
33	*Tephrosia bracteolata* Guill. & Perr.	2	0.2	10	2.48	0.89	0.625	3.995
34	*Tridax procumbens* Linn.	1	0.3	30	1.24	2.68	0.94	4.86
35	*Urena lobata* L.	1.67	0.5	30	2.07	2.68	1.56	6.31
36	*Vernonia cinerea* (L.) Less	2.67	0.8	30	3.31	2.68	2.5	8.49

Table 3: Species composition of plants found in the control site. A=Abundance; D=Density; F= Frequency; RA=Relative abundance; RD= Relative density; RF=Relative frequency; IVI=Importance values index

S/No	Scientific Name	A	D	F	RF	RA	RD	IVI
1	*Acalypha fimbriata* L.	3	0.6	30	1.96	1.39	1.36	4.71
2	*Acroceras zizanoides* (Kunth) Dandy.	2	0.2	10	0.65	0.93	0.45	2.03
3	*Ageratum conyzoides* L.	4	2.4	40	2.61	1.86	5.45	9.92
4	*Albizia adianthifolia* (Schumach.) W. Wight.	1	0.1	10	0.65	0.46	0.23	1.34
5	*Alchornea cordifolia* (Schum & Thonn.) Muell. Arg.	1.33	0.4	30	1.96	0.62	0.91	3.49
6	*Andropogon tectorum* Schumach & Thonn.	1	0.1	10	0.65	0.46	0.23	1.34
7	*Anthocleista djaloensis* A.Chev.	1	0.3	30	1.96	0.46	0.68	3.1
8	*Anthocleista vogelli* Planch.	2	0.2	10	0.65	0.93	0.45	2.03

9	*Aspilia africana* (Pers.) C. D. Adams	2	0.2	10	0.65	0.93	0.45	2.03
10	*Calopogonium mucunoides* Desv.	1	0.1	10	0.65	0.46	0.23	1.34
11	*Calotropis procera* (Aiton) R.Br.	2.33	0.7	30	1.96	1.08	1.59	4.63
12	*Carica papaya* L.	2	0.4	20	1.31	0.93	0.91	3.15
13	*Celosia argentea* L.	1.5	0.3	20	1.31	0.69	0.68	2.68
14	*Chromolaena odorata* (L.) R. King &H. Robinson)	4	1.2	30	1.96	1.86	2.73	6.55
15	*Citrus sinensis* (L.) Osbeck.	1	0.2	20	1.31	0.46	0.45	2.22
16	*Cleome viscosa* L.	1	0.1	10	0.65	0.46	0.23	1.34
17	*Cocos nucifera* L.	1	0.1	10	0.65	0.46	0.23	1.34
18	*Commelina erecta* L.	3	0.6	20	1.31	1.39	1.36	4.06
19	*Corchorus olitorius* L.	2	0.2	10	0.65	0.93	0.45	2.03
20	*Crotalaria retusa* L.	3	0.3	10	0.65	1.39	0.68	2.72
21	*Cynodon dactylon* (L.) Pers.	1	0.1	10	0.65	0.46	0.23	1.34
22	*Daniellia oliveri* (Rolfe) Hutch & Dalziel	1.25	0.5	40	2.61	0.58	1.14	4.33
23	*Desmodium scorpiurus* (Sw.)Desv.	3.33	1	30	1.96	1.54	2.27	5.77
24	*Desmodium triflorum* (L.) DC.	3	0.6	20	1.31	1.39	1.36	4.06
25	*Elaeis guineensis* Jacq.	2.5	0.5	20	1.31	1.16	2.27	4.74
26	*Eleusine indica* (L.) Gaetn	2.5	0.5	20	1.31	1.16	2.27	4.74
27	*Emilia praetermissa* Milne-Redhead	2.33	0.7	30	1.96	1.08	1.59	4.63
28	*Euphorbia hirta* L.	1	0.2	20	1.31	0.46	0.45	2.22
29	*Ficus sur* Forssk.	2.25	0.9	40	2.61	1.04	2.05	5.7
30	*Gomphrena celosioides* Mart.	2	0.4	20	1.31	0.93	0.91	3.15
31	*Havea brasiliensis* (A. Juss) Mull.Arg	12	1.2	10	0.65	5.57	2.73	8.95
32	*Hewittia sublobata* Linn.	2.5	0.5	20	1.31	1.16	2.27	4.74
33	*Hyptis suaveolens* (L.) Poit.	1.25	0.5	40	2.61	0.58	2.27	5.46
34	*Ludwigia decurrens* Walter	3	0.3	10	0.65	1.39	0.68	2.72
35	*Mangifera indica* L.	2	0.4	30	1.96	0.93	0.91	3.8
36	*Manihot esculenta* Crantz	9.5	1.9	20	1.31	4.41	4.32	10.04
37	*Mariscus alternifolius* Vahl	1	0.1	10	0.65	0.46	0.23	1.34
38	*Mimosa diplotricha* C. Wright ex Sauvalle	7.75	3.1	40	2.61	3.59	7.05	13.25
39	*Mimosa pigra* L.	2	0.4	30	1.96	0.93	0.91	3.8
40	*Mitracarpus villosus* DC	1	0.1	10	0.65	0.46	0.23	1.34
41	*Morinda lucida* Benth	1	0.1	10	0.65	0.46	0.23	1.34
42	*Mucuna pruriens* (L.) DC	3.75	1.5	40	2.61	1.19	3.41	7.21
43	*Musa paradisiaca* L.	2.5	1	40	2.61	1.16	2.27	6.04
44	*Musa sapientum* L.	1.67	0.5	30	1.96	0.77	0.91	3.64
45	*Mussaenda erythrophylla* Schum. & Thonn.	1.5	0.3	20	1.31	0.69	0.68	2.68
46	*Nauclea latifolia* Sm.	2.75	1.1	40	2.61	1.28	2.5	6.39
47	*Ocimum gratissimum* L	2	0.6	30	1.96	0.93	1.36	4.25
48	*Panicum maximum* Jacq	4	0.8	20	1.31	1.86	1.82	4.99
49	*Paspalum scrobiculatum* L.	2	0.2	10	0.65	0.93	0.45	2.03
50	*Psidium guajava* L.	2.25	0.9	40	2.61	1.04	2.05	5.7
51	*Sacciolepis africana* C. E. Hubb. & Snowden	2	0.2	10	0.65	0.93	0.45	2.03
52	*Scoparia dulcis* L.	1	0.1	10	0.65	0.46	0.23	1.34
53	*Securinega virosa* (Roxb ex Willd)Baill	1	0.1	10	0.65	0.46	0.23	1.34
54	*Senna siamea* (Lam) Irwin & Barbeby	2	0.2	10	0.65	0.93	0.45	2.03
55	*Setaria barbata* (Lam.) Kunth	2	0.6	30	1.96	0.93	1.36	4.25
56	*Setaria pumila* (Poir.) Roem & Schult	3	0.9	30	1.96	1.39	2.05	5.4
57	*Sida acuta* Burm. f.	2	0.2	10	0.65	0.93	0.45	2.03
58	*Solenostemon monostachyus* (P. Beau.) Brig.	5	2	40	2.61	2.32	4.55	9.48
59	*Spigelia anthelmia* L.	4	2	40	2.61	1.86	4.55	9.02
60	*Sporobolus pyramidalis* P. Beauv	2	0.2	10	0.65	0.93	0.45	2.03
61	*Sterculia tragacantha* Lindl.	1.5	0.6	40	2.61	0.69	1.36	4.66

62	*Synedrella nodiflora* (L.) Gaert	1	0.1	10	0.65	0.46	0.23	1.34
63	*Talinum triangulare* (Jacq.) Willd.	2	0.2	10	0.65	0.93	0.45	2.03
64	*Tephrosia bracteolata* Guill. & Perr.	2	0.1	10	0.65	0.93	0.23	1.81
65	*Tephrosia pedicelata* Baker	2	0.1	10	0.65	0.63	0.23	1.51
66	*Trema orientalis* (L.) Blume	2	0.4	20	1.31	0.93	0.91	3.15
67	*Tridax procumbens* Linn.	3.33	1	30	1.96	1.54	2.27	5.77
68	*Typha domigensis* Pers.	2	0.4	20	1.31	0.93	0.91	3.15
69	*UNKNOWN- TREE*	35	3.5	10	0.65	16.24	7.96	24.85
70	*Urena lobata* L.	1	0.1	10	0.65	0.46	0.23	1.34
71	*Vernonia cinerea* (L.) Less	1	0.1	10	0.65	0.46	0.23	1.34
72	*Vitex doniana* Sweet	1	0.1	10	0.65	0.46	0.23	1.34
73	*Zea mays* L.	11	1.1	10	0.65	5.1	2.5	8.25
74	*Zornia latifolia* Sm.	1	0.1	10	0.65	0.46	0.23	1.34

in all the studied sites, for liana it was only in site A and B while for fern it was only in site A. The phytogeographical status or profile shows that there were more native plant species than the cosmopolitan, exotic, pantropical and unknown species in all the studied sites (Figure 3). Pantropical species were not seen in site B.

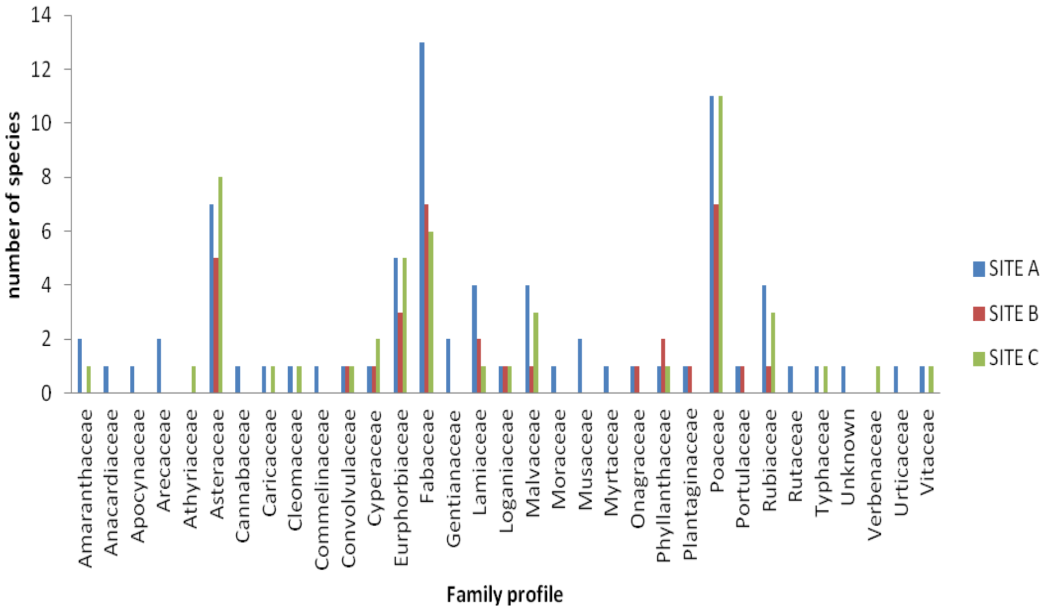

Figure 1: Family profile of plants at site A, B and C

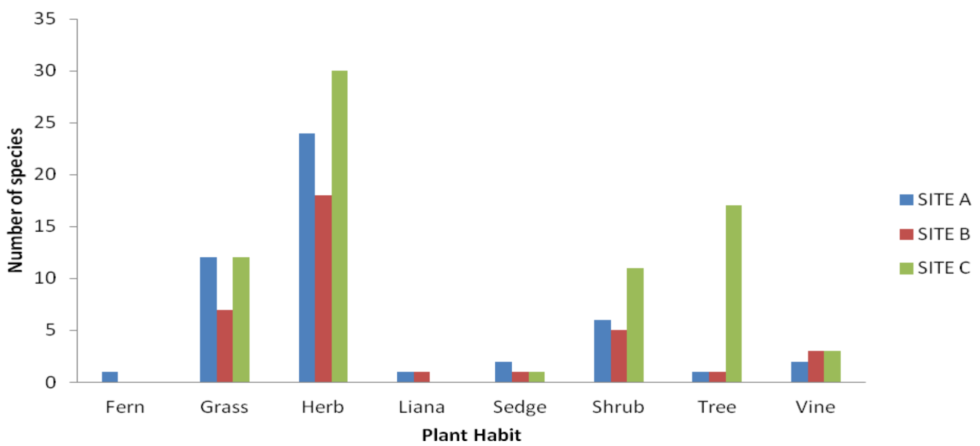

Figure 2: The abundance of plant types in limestone quarry sites at Okigwe

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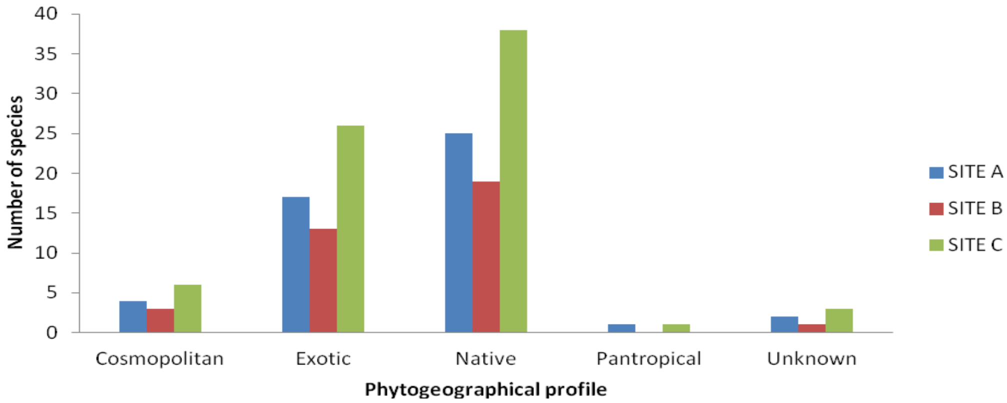

Figure 3: Phytogeographical profile of the different sites studied

The Simpson_1-D, Shannon-H, and Evenness were highest in site C with a value of 0.9703, 3.841, and 0.6291, respectively, Simpson_1-D, Shannon_H, Evenness, were lowest at Site A with values of 0.8413, 2.775, respectively. It was observed that as the dominance reduce and evenness increased the diversity increased as shown in Table 4 below. Presented below in Figure 4 is the Jaccard Similarity Index (JSI) for the different sites. It was observed that Site AB had more similar species than site AC and BC as evident in the high JSI value of 0.4167.

Table 4: Summary of some diversity indices

Diversity index	Site A	Site B	Site C
Taxa_S	49	36	74
Dominance_D	0.1587	0.1544	0.02974
Simpson_1-D	0.8413	0.8456	0.9703
Shannon_H	2.775	2.799	3.841
Evenness_e^H/S	0.3274	0.4562	0.6291

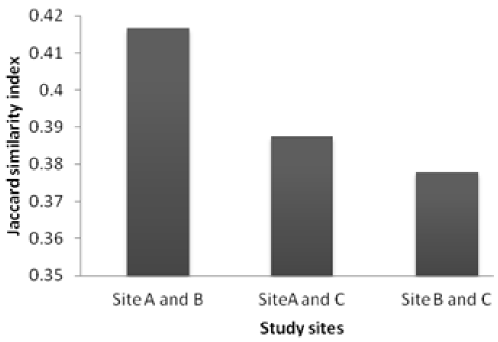

Figure 4: Jaccard similarity index for the three different sites

4. Discussion

Ecosystem disturbance are event or series of events that alters the relationship of organisms and their habitat in time and space. Many species of plants are disappearing at an unprecedented rate due to the direct or indirect effects of anthropogenic activities (Achard et al., 2002; Alford et al., 2007). Ecosystem disturbance by quarrying is an evitable fall out of industrialization and modern civilization which causes damage to the vegetation, hydrological relations and soil biological systems.

Result obtained from the present study sites indicates that a total of 90 plants species distributed into 33 plants families were identified. Xin-Sheng et al. (2012) reported a total vascular flora of 88 species belonging to 44 families and 76 genera was recorded from a limestone area in Cat Dua Island while Kumarasinghe et al. (2013) reported a total of 41 floral species in a commercial limestone quarrying site in Sri Lanka. In Site A, 49 plants species belonging to 44 genera and 18 families was identified. Site B had fewer species compared to that of sites A and C which had 36 plants species distributed into 36 genera and 16 families while site C had 74 species belonging to 29 families and 68 genera. The plant species composition in sites A and B were low when compared with site A. This is in line with the studies of Lyngdoh et al. (1992) and Sarma (2002)., while studying the impact of coal mining on the vegetation characteristics of the Nokrek Biosphere Reserve of Meghalaya outlined that the composition of vegetation reduces in the mined areas with that of the adjacent unmined areas. Lyngdoh et al. (1992) reported less number of species in the mine spoils of different ages to that the unmind sites. The differences in species composition could be attributed to the varying degree of quarrying activities. This is in agreement with the findings of Jha and Singh (1990), Das Gupta (1999), and Sarma (2002).

The most species rich families in the present study were Asteraceae, Eurphorbiaceae, Fabaceae and Poaceae but in contrast to these findings Xin-Sheng et al. (2012) reported that the dominant families of the flora were Euphorbiaceae, Papilionaceae, Moraceae, Rutaceae and Rubiaceae. Excavation of the ground for limestone minerals resulted in the reduction of tree richness in sites A and B. The most dominant plant types in the present study were the herbaceous species which was followed by grass in all the studied sites. This is in agreement with the findings of Sarma (2005) who reported that there was an increase in the number of herbaceous species and apparent decrease of tree species in the mined areas when compared with the surrounding area. Other plant life form, identified in the present study, was a fern, climbers (liana, vine), sedges and shrubs.

It is suggested that the predominance of herbs and grasses compared to the trees and shrubs species in the quarry sites (A and B) imply that large disturbances contribute to habitat fragmentation and environmental degradation.

The study of the geographical distribution of plants is a very important aspect in vegetation science and based on this, the phytogeographical distribution of the plants in the present study was considered in the three sites studied, there were more native species, followed by exotic species. The native plant species contributed a high level of plant richness and diversity in the limestone quarrying sites. Also the high number of exotic species indicated their ability to survive in such a harsh environment.

The concept of 'Important Value Index (IVI)' has been developed for expressing the dominance and ecological success of any species, with a single value (Mishra, 1968). The IVI of plant species in site A as depicted in Table 1 shows that there were some plant with high values and some with very low IVI values. Some plants with high IVI in site A includes *Alchornia cordifolia* (7.974), *Chromolaena odorata* (13.293), *Cyperus* sp (32.779), *Euphorbia heterophylla* (10.737), *Panicum maximum* (8.316), *Sacciolepis africana* (8.993), *Sida acuta* (56.991) and *Synedrella nodiflora* (11.826). The data analyzed for species composition in Site B as depicted in Table 2 shows that the following plants *Andropogon tectorum Aspilia africana*, *Chromolaena odorata*, *Cynodon dactylon*, *Mimosa pudica*, *Panicum maximum* and *Spigelia anthelima* had high IVI values of 11.04, 11.04, 8.55, 8.55, 9.17, 14.57 and 63.25, respectively. In Site C, *Ageratum conyzoides* (9.92), *Solenostemon monostachyus* (9.48), *Spigelia anthelmia* (9.02) *Manihot esculenta* (10.04), *Mimosa diplotricha* (13.25) and the unknown tree (24.85) were the plants with high IVI values. When the IVI of all the plant species in the different sites was compared the *Spigella anthelmia* in Site B had the highest value of 63.25 followed by *Sida acuta* in Site A with a value of 56.991. The high importance value of *Spigella anthelmia* and *Sida acuta* in quarrying areas suggests their ability to grow and multiply in the disturbed environments and their dominance in the harsh conditions. Dominant species utilize their resources and have an extensive effect on the environmental conditions and when they are removed from the habitat, biotic and abiotic components of the habitat will change (Razavi et al., 2012).

Furthermore, in Site A plants species with low IVI values were *Daniellia oliveri* (1.237), *Ipomoea triloba* (1.237), *Mariscus alternifolius* (1.237), *Mimosa pudica* (1.237), *Tridax procumbens* (1.664). For Site B, they were *Scoparia dulcis* (3.995), *Securinega virosa* (3.995), *Senna siamea* (2.755) and *Tephrosia bracteolata* (3.995). While for Site C, they had relatively low IVI values (Table 3). The Simpson_1-D, Shannon-H, and Evenness were highest in site C with a value of 0.9703, 3.841 and 0.6291, respectively. As dominance_D reduced from Site A (0.1587) to Site B (0.1544) and then to Site C (0.9703), there was a gradual increase in the Simpson_1-D, Shannon_H, and Evenness_e^H/S indices. Shannon-Weaver index of diversity was much lower in the quarrying sites compared to control. This suggests dominance of one or two species in the quarrying sites. For example, in Site A and Site B *Sida acuta* (IVI: 56.991) and *Spigelia anthelmia* (IVI: 63.25) were the most dominant species, respectively. The Jacard similarity index obtained in this work revealed that Site A and B had the most similar plant species as seen by their high value of 0.4167. The Jacard similarity index for Site A and C was higher than that of Site B and C. It is suggested in the present study that the low similarity index of Site B and C is probably due to the fact that Site C was recently excavated, thus plants are trying to colonize the new harsh environment. Therefore, it indicates that as the excavated ground is left abandoned the plants growing in this area will gradual resemble that of the surrounding area. This was observed when Site A (4years) and C was compared for their similarity index.

5. Conclusion

It was found that the number of tree and shrub species decreased due to quarrying sites but the number of herbaceous species colonizing the quarrying areas increased. The present study led to the conclusions that phytosociological analysis can be used as important tools for predicting the impact of quarrying activities on vegetation. The information gathered on various aspects of vegetation and colonization of plants in quarrying areas would be helpful in revegetating the areas.

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