Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Asian Journal of Plant Science and Research, 2013, 3(3):14-23

ISSN : 2249-7412
CODEN (USA): AJPSKY

Eco-taxonomic assessment of plant species regeneration status in a post-remediated crude oil impacted site in parts of Ibibio-I-Oil field in Ikot-Ada Udo, Ikot-Abasi local government area of Akwa Ibom State, Nigeria

[*1]Edwin-Wosu N. L. and [2]E. A. B. Edu

[1]Department of Plant Science and Biotechnology, Faculty of Biological Science, College of Natural and Applied Sciences, University of Port Harcourt, Choba, Port Harcourt, Nigeria
[2]Department of Botany, University of Calabar, Cross River State, Nigeria

---

ABSTRACT

This research paper describes the floristic structure, composition and status of plant species natural regeneration in a post-remediated crude oil impacted site in Ikot-Ada-Udo, Ibibio -1- oil field in Ikot Abasi LGA of Akwa Ibom State, Nigeria, with special attention to the scope of biodiversity sustainability. A simple random sampling method based on a standard procedure for ecological assessment along specific transect was adopted for the study. Result shows that the regenerating vegetation is a complex of heterogeneous life-forms following the trend of both biotic and abiotic influence. A total of 52 representative plant species under 21 families were recorded with mosaic heterogeneity. The species were establishing through coppicing, seedling, rhizome and sapling. Few species exhibited a single mode of regeneration while many others exhibited multiplier mode of regeneration. By the quantitative structure a total density of 782 regenerating species was recorded in the study area with the highest density record (d= rd) of 50 = 6.40 by Manihot esculenta among other species. Manihot esculenta also had the highest species abundance of 200 = 9.45, highest IVI of 17.3 while C. odorata had the highest frequency of occurrence (100 = 4.71) among other species. There was increase in herbaceous habit dominated by the seedlings/saplings indicting a primary regenerative succession which seems to be progressive toward trees and shrubby habits. Ratio of abundance to frequency (A/F) indicates a contiguous distribution pattern of species regeneration in the study site with Manihot esculenta having the highest contiguous distribution pattern. Generally, there is complete view of successive regeneration status in the study area, rich in regenerating species capable of bringing the depleted site under complete forest cover and establishing diverse heterogeneous natural forest again if protected to conserve the seedlings or saplings of the regenerating species.

Key words: regeneration, biodiversity conservation, abundance, density, frequency, species diversity

---

INTRODUCTION

The natural forest of Ibibio in Ikot – Ada –Udo, in Ikot-Abasi L.G.A of Akwa Ibom State has faced a serious alteration that large portions of it have already been lost, due to hydrocarbon (crude oil) exploration and exploitation activities leaving the area with only a small percentage of vegetation cover. Though it has been reported that only 27 plant species are categorized threatened or endangered [1] and also 2,464 species, subspecies, varieties, stocks and sub-populations in the plantae kingdom have been categorized as threatened or endangered species [2] there could be many more. Also it is estimated that the disappearance of one plant species could results in the loss of other plant species and indirectly the loss of 10 to 13 dependent species of insects and higher animals [3]. This possibly could

be imminent in this part of Akwa Ibom State as a result of hydrocarbon exploration and extraction resulting to continues loss of it biodiversity.

The rational use and management of biodiversity, the habitats, species and genes prevalent in an area are of paramount importance for sustainable use of biodiversity. To develop biodiversity sustainably one must know the plant species present in an ecosystem. For conserving biodiversity it is fundamental to arrest the loss of natural plant resources by adopting proper conservation strategies and protection of natural regeneration of plant species. The Ibibio-1-oil field is a marginal oil field in Akwa Ibom State. The area was a natural forest not until the commencement of petroleum exploration and human interferences during which the natural forest of the area became subject to ecological succession from its pioneer climax stage to a retrogressive secondary mosaic nature. The secondary vegetation which as a result of the remediation activity carried out, now has plant species growing naturally and from the coppice of both harvest and oil impacted species, which are still in the seedling and sapling stages due to the enactment of some protection.

Micro environmental factors vary with seasonal changes which affect the growth stage (seedling, sapling and young trees) of plant communities that maintain population structure of any forest [4]. Thus, it becomes an important issue to understand the species diversity, population structure and regeneration status of any forest communities for the maintenance of both natural and control (protected) forest. Therefore, information on the regeneration status of plant is important to determine the potential of an area for biodiversity conservation and sustainability.

Though various report on population structure and regeneration status have been documented by many workers in different forest ecosystems [5, 6, 7, 8], but neither scanty nor any information on this aspect under the Local conditions of Ikot-Ada-Udo in Akwa-Ibom State has been generated. The information on tropical plant diversity is needed because of its potential usefulness and implication for conservation and environmental management across the protected area. The aim of this study was to determine the current natural regeneration status of the study area with special attention to the scope of biodiversity conservation and estimating the population of key species and distribution in terms of their diversity and frequency of abundance.

MATERIALS AND METHODS

i) *Geomorphological Description of the Project Location*

The study area is a post-remediated parts of Ibibio-1-oil field in Ikot Ada Udo, with its situate between latitude 4^{o} 41^{1} 30" N and 4o 36^{1} 0"N and longitude 7^{o} 38^{1} 30"E and 7^{o} 44^{1} 0"E of Ikot-Abasi Local Government Area in Akwa Ibom State (FIG. 1). The study area is located in the rain forest belt in Akwa Ibom State of Nigeria within the equatorial climate region, characterized by high rainfall, high relative humidity and maximum temperature. The area is in the centre of one of the agricultural zones of the State. The vegetation is of a typical secondary nature with its prevalent species of ecological succession regenerating from the effect of a seriously impacted oil spillage and post-remediation process. The area has been enacted as a protected area in order to protect and rehabilitate the fauna and flora diversity of the post-spilled remediated area.

The successive vegetation of the area is characterized by prevalent species of shrubby trees, herbs, climbers', lianers, and dominantly members of *Poaceae, Malvaceae, Fabaceae, Asteraceae, Cyperaceae, Arecaceae, Apocynaceae* and *Rubiaceae*. Others include *Euphorbiaceae, Commelinaceae, Melastomataceae* and *Convolvulaceae* plant families, typical of secondary succession fallowed bush. The environment has also witnessed some of human activities such as farming far and near residential areas by the local communities, leaving fields of plantations such as *Xanthosoma maffafa, Anana comosus, Musa* spp., *Dacryodes edulis, Mangifera indica, Coccus nocifera*. Though primarily a climax vegetation of various strata, the effects of these human activities and the serious impact of post-spillage and post-remediation have consequently left it with some form of irregular vegetation features. This can therefore be categorized as a low land secondary mosaic forest as described by Hopkin [9]. However, the vegetation is yet described as rainforest vegetation in relation to similar view of vegetation analysis by SAF [10] and Edwin-Wosu, [11, 12, 13].

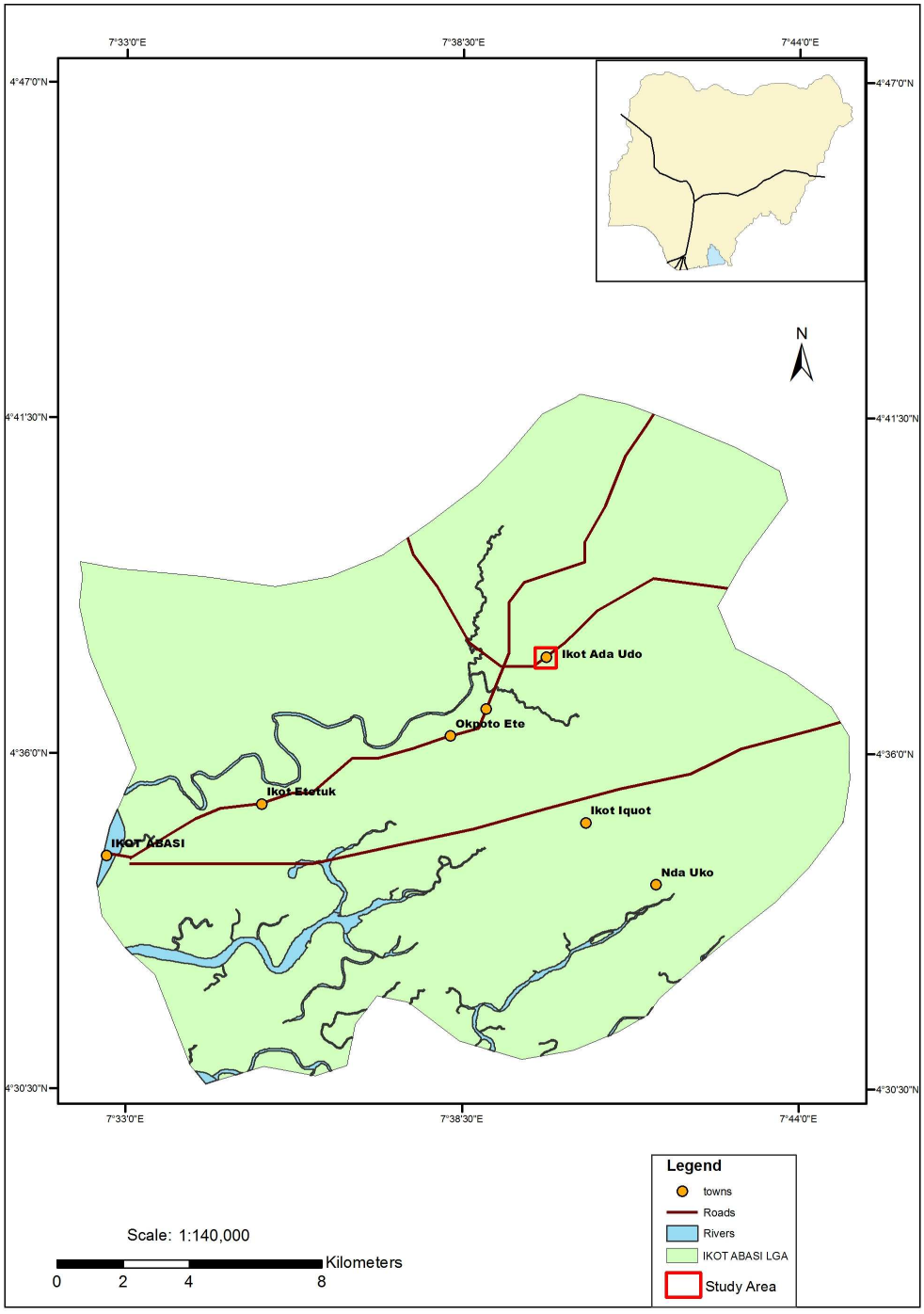

FIG. 1: Ikot-Abasi map showing study area.

ii) Vegetation Assessment

Quantitative and Qualitative floral Analysis

It was carried out by adopting the simple random sampling based on standard procedures for ecological assessment studies [14] along specific transect to determine the regeneration status of the post-remediated oil spilled site. A total of two (2) station transact directions (code named vegetation 1 and 2) with four (4) sampling plots per station and a total eight (8) sampling plots for the two (2) stations were systematically sampled in randomized design, each plot covering 20 x 20m area . Specimens were collected from the study transect using shears. All the important representative plant species sampled were identified in the field as far as possible and were properly identified using Floras such as Burkill, [15, 16, 17, 18, 19]; Hutchinson and Dalziel, [20, 21, 22, 23, 24]; Ivens *et al*.[25]; Joyce and Stanfield [26]; Joyce [27]; Keay [28]. All the seedlings, saplings, coppice and Rhizome were recorded.

The frequency of distribution, abundance, and density of the most representative species of the area were estimated using the methods of Austin and Greig-Smith [29]; Kershaw [30] and Shukla and Chadel's [31] approach as modified in Bonham [32]. The species diversity over the study area was evaluated using the Shannon-Wiener [33] index as modified in Kinako's [34] diversity index. Vegetation was described in semi-quantitative terms [35], and in accordance, species with a wide frequency of distribution with many stands are described as *very abundant (++++)*. Some species with similarly wide frequency of distribution but with few stands are said to be *less frequent, abundant, or restricted species (+++)*. The species of limited geographical distribution and with a few stands are termed *scarce or occasional (++)* and *very scarce or rare (+) species*. The species designated *(++)* and *(+)* are often envisaged as being vulnerable for elimination because of their limited extent alone beside any other factors.

Relative density, relative abundance and relative frequency were estimated following Misra [36] method. While the Importance Value Index (IVI) was estimated by adding the values of RD, RA and RF using the Shukla and Chandel [31] method.

The ratio of abundance to frequency for different species was determined for distribution patterns. Thus with the "*thumb of rule*" designated as follows: *Regular (<0.03), random (0.03 – 0.05),* and *contiguous (>0.05)* distribution as adopted by Curtis and Cottam [37].

RESULTS

The project study area is secondary mosaic vegetation with spatial and vertical structure arrangement, heterogeneous in nature. The heterogeneity is a complex of various lifeforms involving shrubs and herbs. Despite the heterogeneous mosaic nature of the secondary vegetation, the project area contains plant species in various diversity and abundance with representative species recorded in Table 1.

The heterogeneous secondary mosaic vegetation is being characterized with both biotic and abiotic influences. This is being attributed to a number of retrogressive processes such as the influence of the post oil spill incident, human activities (farming), post-remediation processes, the regeneration and floristic succession of the project site coupled with seasonal variation under local environmental condition. This caused totality of changes in vegetation array in terms of abundance and species diversity.

In the present study, a total of 52 representative plant species under 21 families with mosaic heterogeneity were recorded in which seven families (*Poaceae, Asteraceae, Cyperaceae Euphorbiaceae, Malvaceae, Fabaceae* and *Rubiaceae*) of different species were prevalently dominant with five species being abundant and one species very abundant. Among the dominant families *Poaceae* and *Cyperaceae* had the highest species diversity in terms of richness with seven species respectively. *Asteraceae* and *Fabaceae* (5 species) respectively, *Malvaceae* (4 species), while *Euphorbiaceae* and *Rubiaceae* (3 species) respectively (Table-1).

Species diversity is one of the major criteria in recognizing the importance of an area for conservation. The species diversity within the study area has also recorded some level of variations in terms of richness and evenness. Within study site only *Chromolaena odorata* recorded maximum evenness and richness in terms of diversity.

There was increase in herbaceous status in terms of habit and life form with a representative total of 40 species recorded as herbs, eleven (11) as shrubby, and one as tree (Table 1a) and (FIG 2). The herbaceous increase within the study area is an indication of a primary regenerative succession which seems to be progressive toward a climax

vegetation with trees and shrubby habits. Result has shown that the species in their diverse capabilities have re-established through various mode of regeneration status with few species exhibiting multiplier mode of regeneration. The species were establishing through coppicing, seedling, rhizome, and sapling. However, 16 species exhibited a single mode of regeneration by seedling, three species by rhizome while the rest exhibited multiplier mode of regeneration (Table 1a). The study has shown that open canopy may favour germination and seedling establishment through increased solar radiation incident on the forest floor. The species – *Alchornea cordifolia, funtumia elastica, Rauvolfia vomitoria, Alchornea laxiflora, Anthonotha macrophylla, Anthocleista djalonesis,* and *Barteria nigritiana* at the study site were not present as trees. New species were found regenerating, which were absent as adults. Result has also shown that many of the species exhibited multiplier mode in terms of regeneration status. They were establishing through coppicing along side seedlings /saplings and rhizomatous modes of regeneration.

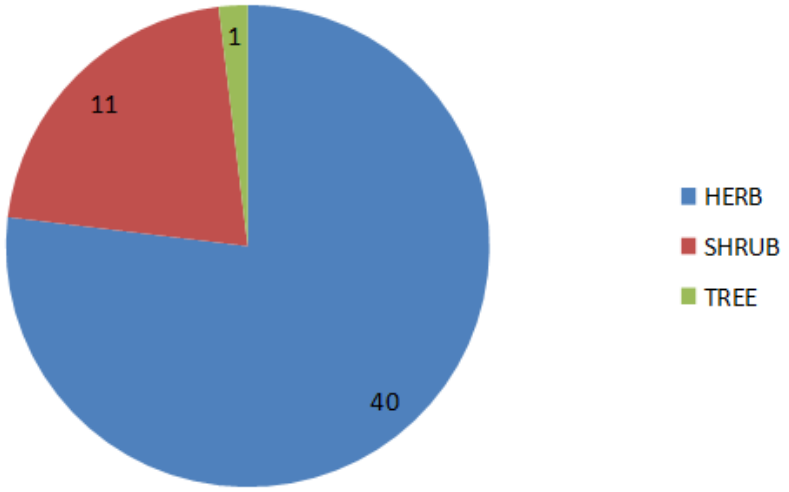

FIG. 2: Life-form and Habit of Representative Species in the Site

Table 1b show the quantitative structure of regeneration in the study site. The total density of regenerating species in the study site was recorded as 782. Within the study site the highest density (d ≡ rd) of 50 ≡ 6.40 was recorded for *Manihot esculenta,* three species has 30 ≡ 3.84 while the rest species had values range of 5-25 ≡ 0.64 – 3.20 (Table 1b). The highest frequency of occurrence was recorded as 100≡ 4.71% with *Chromolaena odorata*. The highest species abundance was recorded with *Manihot esculenta* Crantz having 200≡9.45 followed by *Eragrostis tenella* 120≡5.66. *Manihot esculenta* had the highest Importance Value Index (IVI) of 17.03 followed by *Eragrostis tenella* and *Chloris pilosa* with equal IVI of 10.68 respectively (Table 1b). The study area was found to be dominated by the seedlings/saplings of herbaceous species. However, the dominant herbaceous species are not only important for biodiversity conservation but also of local and commercial importance in ethno-botany and ethno-medicine.

It is an oil impacted and post – remediated site, but regeneration of many indigenous species was evident and this is very important for biodiversity conservation. The Ratio of abundance to frequency (A/F) indicates that the distribution of all the regenerated species was contiguous though with *Manihot esculenta* recording the highest contiguous distribution pattern. The findings of the present study provide a complete view of regeneration status in the study area. From these research findings it is evident that the degraded forests of the Ibibio-I-Oil Field are turning into diverse heterogeneous natural forests again. The area is rich in regenerating species that could result in the establishment of a diverse natural forest, hence with contiguous distribution pattern and if protected to conserve the seedlings or saplings of the regenerating species.

Table- 1a: Present status of species regeneration and their reproductive strategies in parts of study area in Ibibio -1- oil field in Ikot Ada - Udo, Akwa Ibom State

Species	%f	S.D	Family	Common Name	Habit	Mode of regeneration	Remark
Panicum maximum Jacq.	75	3.82	*Poaceae*	Grass	Herb	S /R	+++
Ipomoea involucrata P. Beauv.	75	3.82	*Convolvulaceae*	NA	Herb-Climber	S / R	+++
Chromolaena odarata (L.) R.M. King & Robinson	100	4.71	*Asteraceae*	Siam weed	Herb	S / C/R	++++
Digitaria horizontalis Willd.	50	3.00	*Poaceae*	Grass	Herb	S	++
Scoparia dulcis Linn.	75	3.82	*Scrophulariaceae*	NA	Herb	S	+++
Urena lobata Linn.	50	3.00	*Malvaceae*	Hibiscubur Congo jute	Herb	S / C	++
Malvastrum coromandelianum (Linn.) Garcke	50	3.00	*Malvaceae*	Paddy's Lucerne	Herb	S / C	++
Mariscus alternifolious Vahl.	50	3.00	*Cyperaceae*	Sedge	Herb	S	++
Commelina erecta Linn.	25	2.41	*Commelinaceae*	White mouth day flower	Herb	R	+
Panicum laxum Sw.	50	3.00	*Poaceae*	grass	Herb	S / R	++
Alchonea cordifolia (Schum & Thonn.) Mull –Arg	25	2.41	*Euphorbiaceae*	Chrstmas bush	Shrub	S / Sa/C	+
Cynodon dactylon (Linn.) Pers	25	2.41	*Poaceae*	Bermuda grass	Herb	R	+
Elaeis guineensis Jacq.	50	3.00	*Arecaceae*	Oilpalm tree	Tree	S	++
Funtumia elastica (Prenss Stapf.)	50	3.00	*Apocynaceae*	Bush rubber	Shrub	S / Sa/C	++
Rauvolfia vomitoria Afzel.	50	3.00	*Apocynaceae*	Swizzle stick	Shrub	S / Sa/C	++
Heterotis rotundifolia (Sm.) Jac.	75	3.82	*Melastomataceae*	Rock rose	Herb	S / R	+++
Stachytarpheta cayennensis (L.C. Rich) Schau.	50	3.00	*Verbenaceae*	Blue rat's tail	Herb	S / Sa/C	++
Alchornea laxiflora (Benth. Pax & K. Hoffm.	25	2.41	*Euphorbiaceae*	Chrismasbush	Shrub	S / Sa/C	+
Melochia melissifolia Mollis K. Schum.	50	3.00	*Sterculiaceae*	NA	Herb	R/C	++
Kyllinga squamulata Thonn. *ex*. Vahl.	50	3.00	*Cyperaceae*	Sedge	Herb	S	++
Kyllinga pumlia Michx.	50	3.00	*Cyperaceae*	Sedge	Herb	S	++
Fimbristylis littoralis Gaudet.	50	3.00	*Cyperaceae*	Sedge	Herb	S	++
Diodia scandens Sw.	25	2.41	*Rubiaceae*	NA	Herb	S / R	+
Eragrostis tenella (Linn.) P. Beauv. *ex* Poem & Schult.	25	2.41	*Poaceae*	grass	Herb	S	+
Spermacoce ocymoides Burm.f.	50	3.00	*Rubiaceae*	NA	Herb	S	++
Conyza sumatrensis (Retz.) Walker	25	2.41	*Asteraceae*	Fleabane	Herb	S	+
Cnetis ferruginea DC.	25	2.41	*Connaraceae*	NA	Shrub	S / Sa	+
Commelina benghalensis Linn.	50	3.00	*Commelinaceae*	NA	Herb	R	++
Emilia practermissa Milne- Redhead	25	2.41	*Asteraceae*	Lilac tassel flower	Herb	S/C	+
Desmoduim triflorum (Linn.) DC.	50	3.00	*Fabaceae-papilio.*	Three flower ticktrefoil	Herb	S / R	++
Desmoduim ramosissimum G. Don.	25	2.41	*Fabaceae-papilio.*	NA	Herb	S / Sa / C	+
Axonopus compressus (Sw.) P. Beauv.	75	3.82	*Poaceae*	Carpet grass	Herb	S / R	+++
Oldenlandia affinis (Roem & Schult) DC.	50	3.00	*Rubiaceae*	NA	Herb	S	++
Aspilla africana (Pers.) CD Adams.	50	3.00	*Asteraceae*	Haermorhage plant	Herb	S	++
Chloris pilosa Schumach.	25	2.41	*Poaceae*	Grass	Herb	S / R	+
Mariscus flabelliforms kunth.	50	3.00	*Cyperaceae*	Sedge	Herb	S	++
Manihot esculenta Crantz.	25	2.41	*Euphorbiaceae*	Cassaya	Shrub	Sa/C	+
Milletia arboensis (Hook.f) Bak.	25	2.41	*Fabaceae -papilio.*	Fermentation plant	Shrub	S/C/Sa	+
Anthonotha macrophylla P. Beauv.	25	2.41	*Fabaceae-caesal*	West African rosewood	Shrub	S/C/Sa	+
Anthocleista djalonesis A. Chev.	25	2.41	*Loganiaceae*	Cabbage tree	Shrub	S/C/Sa	+
Sida corymbosa R.E. Fries	50	3.00	*Malvaceae*	Wire weed	Herb	S/C/Sa	++
Indigofera spicata Forssk.	25	2.41	*Fabaceae-papilio.*	Eleven-leaved Guinea indigo	Herb	S/R	+
Sida cordifolia Linn.	25	2.41	*Malvaceae*	Lima	Herb	S/C/Sa	+
Marattia fraxinea Sm.	50	3.00	*Maratiaceae*	Pteridophyte	Herb	S/R	++
Melastomastrum capitatum (Vahl.) A & R. Fern.	50	3.00	*Melastomataceae*	-	Herb	S/Sa	++
Harrungana madagascariensis Lam *ex*. Poir	25	2.41	*Guttifarea*	Dragon's blood	Shrub	Sa/C	+
Emilia sonchifolia (L.) DC.	25	2.41	*Asteraceae*	Lilactassel flower	Herb	S	+
Melochia pyramidata Linn.	25	2.41	*Sterculiaceae*	NA	Herb	R/C	+
Barteria nigritiana Hook. F	25	2.41	*Passifloraceae*	NA	Shrub	Sa/C	+
Microsorum pteropus (L) Copel	25	2.41	*Polypodiaceae*	Epiphyte	Herb	S/R	+
Cyperus haspan Linn.	50	3.00	*Cyperaceae*	Sedge	Herb	S	++
Cyperus diffornis Linn	25	2.41	*Cyperaceae*	Sedge	Herb	S	+

Note: + (15 – 19) Very scarce. ++ (20 – 49) Scarce. +++ (50 – 79) Abundant. ++++> (80 – α) Very abundant. NA – Not available. SD – Species Diversity %F – Percentage Frequency. S – Seedling. Sa – Sapling. C- Coppice. R- Rhizome.

Table 1b: Quantitative structure of regenerating species in parts of study area in Ibibio -1- oil field in Ikot Ada - Udo, Akwa Ibom State

Species	%F	D	A	%RF	%RD	%RA	IVI	A/F
Panicum maximum Jacq.	75	17	23.00	3.53	2.17	1.09	6.79	0.31
Ipomoea involucrata P. Beauv.	75	10	13.33	3.53	1.28	0.63	5.44	0.18
Chromolaena odarata (L.) R.M. King & Robinson	100	20	20.00	4.71	2.56	0.94	8.21	0.20
Digitaria horizontalis Willd.	50	25	50.00	2.35	3.20	2.36	7.91	1.00
Scoparia dulcis Linn.	75	17	23.00	3.53	2.17	1.09	6.79	0.31
Urena lobata Linn.	50	10	20.00	2.35	1.28	0.94	4.57	0.40
Malvastrum coromandelianum (Linn.) Garcke	50	15	30.00	2.35	1.92	1.42	5.69	0.60
Mariscus alternifolious Vahl.	50	17	34	2.35	2.17	1.61	6.13	0.68
Commelina erecta Linn.	25	12	48	1.18	1.54	2.27	4.99	1.92
Panicum laxum Sw.	50	20	40	2.35	2.56	1.89	6.80	0.8
Alchonea cordifolia (Schum & Thonn.) Mull –Arg	25	7	28	1.18	0.90	1.32	3.40	1.12
Cynodon dactylon (Linn.) Pers	25	7	28	1.18	0.90	1.32	3.40	1.12
Elaeis guineensis Jacq.	50	6	12	2.35	0.77	0.57	3.69	0.24
Funtumia elastica (Prenss Stapf.)	50	8	16	2.35	1.02	0.76	4.13	0.32
Rauvolfia vomitoria Afzel.	50	5	10	2.35	0.64	0.47	3.46	0.2
Heterotis rotundifolia (Sm.) Jac.	75	10	13.33	3.53	1.28	1.28	6.09	0.18
Stachytarpheta cayennensis (L.C. Rich) Schau.	50	9	18	2.35	1.15	0.85	4.35	0.36
Alchornea laxiflora (Benth. Pax & K. Hoffm.	25	5	20	1.18	0.64	0.94	2.76	0.8
Melochia melissifolia Mollis K. Schum.	50	15	30	2.35	1.92	1.42	5.69	0.6
Kyllinga squamulata Thonn. *ex*. Vahl.	50	20	40	2.35	2.56	1.89	6.80	0.8
Kyllinga pumlia Michx.	50	25	50	2.35	3.20	2.36	7.91	1.00
Fimbristylis littoralis Gaudet.	50	15	30	2.35	1.92	1.42	5.69	0.6
Diodia scandens Sw.	25	20	80	1.18	2.56	3.78	7.52	3.2
Eragrostis tenella (Linn.) P. Beauv. *ex* Poem & Schult.	25	30	120	1.18	3.84	5.66	10.68	4.8
Spermacoce ocymoides Burm.f.	50	20	40	2.35	2.56	1.89	6.80	0.8
Conyza sumatrensis (Retz.) Walker	25	20	80	1.18	2.56	3.78	7.52	3.2
Cnetis ferruginea DC.	25	5	20	1.18	0.64	0.94	2.76	0.8
Commelina benghalensis Linn.	50	15	30	2.35	1.92	1.42	5.69	0.60
Emilia practermissa Milne- Redhead	25	15	60	1.18	1.92	2.83	5.93	2.40
Desmoduim triflorum (Linn.) DC.	50	8	16	2.35	1.02	0.76	4.13	0.32
Desmoduim ramosissimum G. Don.	25	10	40	1.18	1.28	1.89	4.35	1.60
Axonopus compressus (Sw.) P. Beauv.	75	30	40	3.53	3.84	1.89	9.26	0.53
Oldenlandia affinis (Roem & Schult) DC.	50	20	40	2.35	2.56	1.89	6.80	0.80
Aspilla africana (Pers.) CD Adams.	50	25	50	2.35	3.20	2.36	7.91	1.00
Chloris pilosa Schumach.	25	30	120	1.18	3.84	5.66	10.68	4.8
Mariscus flabelliformis kunth.	50	20	40	2.35	2.56	1.89	6.80	0.8
Manihot esculenta Crantz.	25	50	200	1.18	6.40	9.45	17.03	8
Milletia arboensis (Hook.f) Bak.	25	5	20	1.18	0.64	0.94	2.76	0.8
Anthonotha macrophylla P. Beauv.	25	6	24	1.18	0.77	1.13	3.08	0.96
Anthocleista djalonesis A. Chev.	25	5	20	1.18	0.64	0.94	2.76	0.8
Sida corymbosa R.E. Fries	50	15	30	2.35	1.92	1.42	5.69	0.6
Indigofera spicata Forssk.	25	10	40	1.18	1.28	1.89	4.35	1.6
Sida cordifolia Linn.	25	10	40	1.18	1.28	1.89	4.35	1.6
Marattia fraxinea Sm.	50	20	40	2.35	2.56	1.89	6.80	0.8
Melastomastrum capitatum (Vahl.) A & R. Fern.	50	10	20	2.35	1.28	0.94	4.57	0.4
Harrungana madagascariensis Lam *ex*. Poir	25	10	40	1.18	1.28	1.89	4.35	1.6
Emilia sonchifolia (L.) DC.	25	7	28	1.18	0.90	1.32	3.40	1.12
Melochia pyramidata Linn.	25	10	40	1.18	1.28	1.89	4.35	1.6
Barteria nigritiana Hook. F	25	6	24	1.18	0.77	1.13	3.08	0.96
Microsorum pteropus (L) Copel	25	10	40	1.18	1.28	1.89	4.35	1.6
Cyperus haspan Linn.	50	30	60	2.35	3.84	2.83	9.02	1.2
Cyperus diffornis Linn	25	20	80	1.18	2.56	3.78	7.52	3.2
TOTAL	**2125**	**782**	**2118.66**	**103.55**	**100.73**	**100.70**	**304.98**	**66.23**

%F – Percentage frequency.; D – Density.; A – Abundance.; %RF – Percentage relative frequency.
%RD – Percentage relative density.; %RA – Percentage relative abundance.; IVI – Importance value index.
A/F – Ratio of abundance to frequency.

DISCUSSION

The nature of forest communities largely depends on the ecological characteristics in sites, species diversity and regeneration status of species [38]. Habitat alteration (including habitat loss, degradation and fragmentation) is now among the major risks of ecosystem degradation by human activities [39]. The heterogeneity of the study area vegetation is being attributed to a number of retrogressive processes such as the influence of the post-oil spill incident, human activities (farming), post-remediation process, the regeneration and floristic succession of study site. This has resulted to changes in vegetation structure in terms of abundance and species diversity. This corroborates the assertion by Cubizolle *et al*. [40] who observed human activity as an important agent influencing plant species biodiversity.

Environmental pollution (particularly of hydrocarbon nature) however do have direct losses to the people themselves by way of displacement and indirectly by way of serious threat to the biodiversity despite some form of resistance and resilience by some flora. The existence of species in the community largely depends also on its regeneration under varied local environmental conditions. Upon such condition open canopy might favour the vegetation establishment through increased solar radiation incident on the forest floor. Consequently this could also influence the growth stages in seedling, sapling and young shrubs, herbs and trees of plant communities that

maintain the population structure of any forest. This corroborates the assertion that open canopy may favour germination and seedling establishment through increased solar radiation on forest floor [41, 42].

Regeneration is a critical phase of forest management, because it maintains the desired species composition and stocking after disturbance [43]. This may also be true for the present research. Many species at the study site which supposedly under natural habit are trees or shrubs were not present as trees in the study area. New species were found regenerating, which were absent as adults, with many exhibiting multiplier capability through coppicing, seedling/sapling and rhizomes in their mode of regeneration status. The study has shown that the area is richly endowed with floras of various strata and categories (trees, shrubs, herbs, lianers and climbers). The greater abundance of lower vascular species among the families is an indication of a secondary vegetation structure heterogeneous in nature as a result of the regeneration process with new species that were absent as adult. However, there were still differences in the ranks of species frequency in different transect.

There was a tremendous change in the floristic composition of the study area with regard to differences in species time-lag adaptation associated with post-remediation regeneration. This also corroborates the observation that vegetation in an anthropogenic influenced habitat is linked to ever increasing synanthropisation [44]. This was attributed to a number of direct or indirect human activities resulting to total changes in plant species biodiversity cover and loss of habitat connectivity [45, 46, 47].

The post–remediated Ibibio-I-Oil field site can be brought under complete forest cover by natural regeneration of forest establishment. The present study shows that though the study area was oil impacted, then post-remediated forest, the species richness of the establishing forest is approximately similar to natural forests of Ikot-Ada-Udo, Akwa Ibom State. Complete absence of seedlings and saplings of tree species in a forest indicates poor regeneration, while presence population indicates successful regeneration [48]. So through proper protection of recruiting regeneration, the area could become a natural forest, which could corroborate Hopkin [9] as been categorized as a low land and secondary mosaic forest, but can still be described as rain forest vegetation in relation to similar view of vegetation analysis [10].

The density, frequency, abundance, species diversity, RD, RF and RA considered as indices of success in reforestation [49] suggests that it is possible to re-establish a complete forest cover for the degraded deforested Ibibio area by natural regeneration. The recorded indices are considered quite adequate to establishing complete forest cover, a very important step for biodiversity conservation. Ratio of abundance to frequency (A/F) indicates that the distribution of all the regenerated species was contagious. In a similar assertion contagious distribution pattern is the prevalent pattern in nature unlike random distribution found in very uniform environments. Contiguous distribution in natural vegetation has been reported by several workers [50, 51, 30, 52]. From the research findings it is evident that the oil impacted post-remediated forests of Ikot-Ada-Udo, are turning into diverse heterogeneous natural forest again.

CONCLUSION

The findings of present study provide a complete view of regeneration trend in the study area, which is rich in regenerating species that could result in the establishment of a diverse natural forest if protected to conserve the seedlings or saplings of the regenerating species. The result shows that it is possible to bring the depleted area under complete forest cover through the protection of natural regeneration.

REFERENCES

[1] Anon. *Forestry sector review:* Forestry Master Plan, Project 372001/23, Bangladesh (TA No.1355-BAN), Appendix 2. **1992**.
[2] IUCN 2009. IUCN Red List of Threatened Species. www.iucnredlist.org, retrieved on 31st January, 2010
[3] Manilal, K.S. National Parks and Conservation: A case study of Silent valley. In: *Conservation and economic evaluation of Biodiversity*. Eds. Pushpangadan P.; Ravi, K.; Santosh, V., Vol. **1,** Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. **1997**.
[4] Khumbongmayun, A.D.; Khan M.L. and Tripathi, R.S. Biodiversity conservation in sacred groves of Manipur, northeast India: population structure and regeneration status of woody species, *Biodiversity and Conservation* **15**:2439-2456. **2006**.

[5] Ashton, P.S.; Hall, P. *J.Ecol*. **1992**. 80: 459-481.
[6] Cao, M.; Zhang J.H.; Feng, Z.; Deng J.; Deng, X. *Trop. Ecol*. **1996**. 37(2): 183-192.
[7] Gunatilleke, C.V.S.; Weerasekera, N.; Gunatilake, I.A.U.N.; Kathriarachchi, H.S. The role of dipterocarps, their population structures and spatial distributions in the forest dynamics plot of Sinharaja, Sri Lanka. In: *Tropical Ecosystem: Structure, Diversity; and Human Welfare*. Eds. Ganeshaiah, K.N., Uma Shaanker, R.; Bawa, K.S. *Proceedings of the International Conference on Tropical Ecosystems*. Oxford & IBH Publishing, New Delhi, pp. 591-594. **2001**.
[8] Uma S. *Curr. Sci*. **2001**. 81: 776 -786.
[9] Hopkin, B. *Nigeria J. Eco.* **1968**. 56:97-115
[10] SAF, *Forest Cover types of North America*. Washington D.C. Society of American Foresters. **1954**.
[11] Edwin-Wosu, N. L. Eco-taxonomic Baseline Assessment of vegetation of Pirigbene – Obama – Agip oil field further development project in Southern Ijaw Local Government Area, Bayelsa State. Final Draft Report, NAOC / Sydney Gate-way (Nig) Limited. October, **2010**.
[12] Edwin-Wosu, N. L. Eco-taxonomic Post-impact Assessment of vegetation of GOI lake oil spillage (EIA SHEWING) – Vegetation survey claim of Goi Community against Shell Petroleum Development Company (SPDC) in Gokana Local Govt. Area. **2011**.
[13] Edwin-Wosu, N. L. Environmental Evaluation Study of Vegetation of the Disused Imo River, Nkpoku, Obigbo North, Ebubu Pipeline (ROW) in Rivers State / and Abia State, February, 2012. MACPHED / SPDC. Wet Season Draft Report. **2012**.
[14] Kinako, P.D.S. *Fundamental of Quantitative and Applied Plant Ecology*. Belk Publishers Port Harcourt. **1988**.
[15] Burkill, H.M. *Useful Plant of West Tropical Africa*, Vol. **1** (2ed.). Royal Botanic Garden, Kew. **1985**.
[16] Burkill, H.M. *Useful Plant of West Tropical Africa*, Vol. **2** (2ed.). Royal Botanic Garden, Kew. **1994**.
[17] Burkill, H.M. *Useful Plant of West Tropical Africa*, Vol. **3** (2ed.). Royal Botanic Garden, Kew. **1995**.
[18] Burkill, H.M. *Useful Plant of West Tropical Africa*, Vol. **4** (2ed.). Royal Botanic Garden, Kew. **1997**.
[19] Burkill, H.M. *Useful Plant of West Tropical Africa*, Vol. **5** (2ed.). Royal Botanic Garden, Kew. **2000**.
[20] Hutchinson, J.; Dalziel, J.M. *Flora of West Tropical Africa*, Vol. **1**. (Part 1.) Crown Agents for oversea government and administrations, Millbank London. **1954**.
[21] Hutchinson, J.; Dalziel, J.M. *Flora of West Tropical Africa*, Vol. **1**. (Part 2.) Crown Agents for oversea government and administrations, Millbank London. **1958**.
[22] Hutchinson, J.; Dalziel, J.M. *Flora of West Tropical Africa*, Vol. **2**. Crown Agents for oversea government and administrations, Millbank London. **1963**.
[23] Hutchinson, J.; Dalziel, J.M. *Flora of West Tropical Africa*, Vol. **3**. (Part 1) Crown Agents for oversea government and administrations, Millbank London. **1968**.
[24] Hutchinson, J.; Dalziel, J.M. *Flora of West Tropical Africa*, Vol.**3**. (Part 2.) Crown Agents for oversea government and administrations, Millbank London. **1972**.
[25] Ivens, G.W.; Moody, K.; Egunjobi, J.K. *West African Weeds*. Oxford University Press. Nigeria. **1972**.
[26] Joyce, L.; Stanfield, D.P. *The Flora of Nigeria Sedges (Cyperaceae)*. Ibadan University Press, Ibadan Nigeria. **1974**.
[27] Joyce, L. *Flora of Nigeria grasses*. Ibadan University Press. Ibadan Nigeria. **1989**.
[28] Keay, R.W.J. *Trees of Nigeria*. Clarendon Press. **1989**.
[29] Austin, M.P.; Greg-smith, P. *J.Ecol.* **1968**. 56:851-884
[30] Kershaw, K.A. *Quantitative and Dynamic Plant Ecology*. 2nd Edition, Edward Arnold, London pp 305. **1975**
[31] Shukla, S.R.; Chandel, S.P. *Plant Ecology*. 4th Edn. S. Chandel and Co. Ramnagar, New Delhi – 110055.197pp. **1980**.
[32] Bonham, C.D. *Frequency: Measurement of Terrestrial vegetation*, John Wiley and Sons Inc New York, NY pp 90-96. **1989**.
[33] Shannon, C.E.; Wiener, W. *The mathematical theory of communications*. Urbana, Illinois: University of Illinois Press. **1949**.
[34] Kinako, P.D.S. *Bull. Sci. Assoc. Nigeria* **1981**.7 (1): 42.
[35] Pryor, L.D. Australian endangered species. *Eucalyptus Australian National Parks and Wildlife Services Special Publication (5) Canberra* 139 pp. **1981**.
[36] Misra, R. *Ecology Workbook.* Oxford & IBH Publishing Co. Pvt Ltd., New Delhi. 244 pp. **1968**.
[37] Curtis, J.T.; Cottam, G. *Plant Ecology Work Book: Laboratory field reference manual.* Bugess Publishing Co., Minnesota. 193 pp. **1956**.
[38] Mohammed, A.; Al-Amin, M. *Proc Pakistan Acad. Sci*: **2007**.44(3):165-172

[39] Whitfield, D.P.; McLeod, D.R.A.; Fielding, A.H.; Broad, R.A.; Evans, R.J.; Haworth, P.F. *J. Applied Ecol.* **2007**.38: 1208-1220.
[40] Cubizolle, H., Tourman, A., Argant, J.; Porteret, J.; Oberlin, C.; Serieyssol, K. *Landscape Ecol*. **2003**.7:211-227.
[41] Khan, M.L.; Rai, J.P.N.; Tripathi, R.S. *Acta Oecol-Oec. Appl*. **1987**. 8(3): 247-255.
[42] Srinivas, C. *Plant Biomass, Net Primary Productivity and Nutrient Cycling in Oak (Quercus serrata* Thumb.) *Forests of Manipur*. Ph.D. Thesis, Manipur University, Manipur, India. **1992**.
[43] Duchok, R.; Kent, K.; Khumbongmayun, A.D.; Paul, A.; Khan, M.L. *Current Science*, **2005**. 89 (4): 673-676.
[44] Ahmed, S.S.; Ahmed, T.; Akbar, K.F. Baseline study of roadside vegetation of Lahore Islamabad motorway (m^{-2}) and its fertility status. *Journ. of App. Sci.* **2004**. 4(2): 266 – 270.
[45] Koran, J. Man's impact upon the flora and vegetation in Central Europe. In: Holzer, W.; Werger, M.J.A.; Ikusina, I. (Eds.). *Man's impact on vegetation* Hague, Dr. W. Junk pp 277 286. **1983**.
[46] Luoto, M.; Rekolianen, S.; Aakkula, J.; Pykala, J. *Anibio*, **2003**. 32(7): 447 – 452.
[47] Paciencia, M.L.B.; Prado, J. *Plant Ecol*. **2005**. 18(1): 87 – 104.
[48] Saxena, A.K.; Singh, J.S. *Vegetation* **1984**. 58:61-69.
[49] Rajivar, G.S.; Dhaulakhandi, M.; Kumar, P. *Indian Forester*, **1999**. 125:623-630.
[50] Greig Smith, P. *Quantitative Plant Ecology*. London, ButtterWorth. **1957**.
[51] Odum, E.P. *Fundamentals of Ecology*. W.B. Saunders Co. Philadelphia, USA. **1971**.
[52] Verma, R.K.; Shadangi, D.K.; Totey, N.G. *The Malaysian Forester* **1999**. 62:95-106.