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EVALUATION OF FLORA SPECIES DIVERSITY IN URBAN FORMATIONS OF CALABAR, CROSS RIVER STATE, NIGERIA

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ABSTRACT*: Species diversity represents the species richness or number of species found in an ecological community, including the abundance (number of individuals per species), and the distribution or evenness of species. It has contributed to the awareness of the loss of natural vegetation which is an on-going global issue. Therefore, the research work aimed at examining the flora diversity of Calabar Metropolis Cross River State, Nigeria. However, the objectives for these studies are to identify and delineate areas of species abundant in urban formation of Calabar Metropolis. The methodology of Atu, & Bisong (2013) was adopted in delineating the urban area for the study. A four kilometer buffer zone was delineated from the CBD (Watt market) and labeled as highly built area, a second 3 kilometer was created from the limit of the first buffer zone as the moderately built up area and a two kilometer zone was taken from the edge of the second as the sparsely built up area. Furthermore, a buffer of 2 kilometers from the edge of the sparsely built up area was classified as non-built-up zone to another 3 kilometers. Thereafter the purposive sampling technique was used to select samples zones in each of the delineated areas (highly built up, moderately built up, sparsely built up and non- built up areas). Based on this classification Ekorinim, Satellite Town, Johnathan by-pass, Ikot Omin and Abayong community where the sampled zones. At each of the zones two sample plots were randomly selected. The trees were enumerated via transect walk lane of 1000m x 50m interval on site identification by the researcher. The analysis of the research findings shows a total of 72 species in the built and non built-up area of the study, 36 Trees, 17 shrubs and 19 herbs as shown in table 1.1 and 1.2 respectively. Some of the species of trees enumerated were: Alstonia conggensis, Mittragyna stepolusa, Musanga cecropioides. Mussaenda erythrophylla Anacardium occidentalis, Ipomoza Involucrata are some examples of the shrubs identified and Clerodendrum splendens, Calopogonium mucunoides, Aspilic africana. In the same vein, the result of hypothesis which states that: there is no significant difference in flora species diversity among the various built-up areas was rejected while the alternate upheld. It was concluded based on the results that there is a significant difference in flora species diversity of the study area. Therefore, it is recommended that the ecological flora survey should be carried out periodically in the study area to ascertain the affected flora species.*

KEYWORD*:* flora vegetation, species diversity and urban formations.

INTRODUCTION

Diversity of species represents the species richness or number of species found in an ecological community, including the abundance (number of individuals per species), and the distribution or evenness of species. It is one of the most important indices used for evaluating the sustainability of forest communities which can be determine through patterns and processes. It has contributed to the awareness of the loss of natural vegetation which is an on-going global issue. Most of these issues has not only results in the extinction of flora species but had also threatens the ecosystem services. Flora are plant life occurring in a particular region or time, they constitute varieties of plant species in which the variation is expressed among trees, shrubs and herbs within a given ecosystem. They can be native or exotic species or a combination of both depending on the nature of the ecosystem (natural or man managed ecosystem). Flora are significant to man in providing habitat for fauna species, thus contributing to wildlife sustainability, absorbing of pollutants and dust through shading and evaporative cooling. Other benefits include the provision of profitable by-products to man such as, firewood, compost, timbers and also the adding of nutrient to the soil. The change in vegetation not only brings about changes in vegetation composition and structure, but also has implications on the soil (Offiong, Iwara & Ekpe 2016).

Globally, the adoption of various measures such as legal protection of economic trees, the use of protected areas, and agro-environmental schemes have been used to safeguard species and habitats. Currently the global disappearance and declined in flora species presents the entire world with one of its greatest conservation challenges. For instance in Europe, native plants have been declining on daily. A decline in the extent and condition of flora may precede the loss of its species and provide an indicator of the health of other elements of the environment. Flora species are therefore of great significance to man and nature. In spite of the roles played by flora species, evidence still suggests that severe threat from diverse sources such as deforestation, inadequate farming practices, invasive alien species, urbanization, oil and gas exploration and developmental activities affect flora species diversity (Phil-Eze and Okoro, 2008).

However, inventory to investigate plant diversity and floristic composition in an ecosystem is important to the level of adaptation to the environment and their ecological significance, and is absolutely essential understanding the natural ecosystem dynamics ((Reddy, Shilpa, Amarnath & Pattanik 2008 & 2011). This plays an important role in the management of biodiversity as essential bio-resources and in the management of conservation of species and natural ecosystem (Malouin, Larocque , Doyle, Bell, Dacosta & Liss K. 2015; Lukácz, Sramkó , Molnár 2013; Meng , Lu & Liu 2011; Nurfadilah 2015; You et al. 2016; Huang et al. 2016).

In Nigeria, the flora vegetation varies from humid tropical forests in the south to savannah, while to the north is occupied by grasslands. But today a great percentage of this luxurious vegetation has been removed in the course of various human activities such as residential development, road transportation network and building of markets. At present Cross River State has lost about 19% of its tropical high forests due to human activities like agriculture, settlement (e.g., construction of buildings, fences), resource extraction (e.g., mining, timber harvesting), and industrial development (e.g. the construction of roads), others causes include natural Causes like geological

forces such as climate change (e.g., changes in rainfall, sea level rise),high level of poverty among the urban dwellers, increase in population and immigration of people into urban settlement (REDD+ status, 2012). In the same vein, the city of Calabar enjoys an agglomeration of economic, industrial and educational activities, plus commercial ventures such as markets, eateries and shopping malls.

However, the concentration of these activities attracts people from the rural communities and other parts of Nigeria and the world to the cities which have necessitated the expansion of the city to its peripheries involving natural vegetation degradation and loss. Therefore, adequate management and restoration of degraded ecosystems, biodiversity and forest conservation, analysis of the flora diversity and composition, and combined understanding of ecology and environmental factors that influence the diversity flora species is important. Based on the aforementioned, the research paper seeks to evaluate flora species diversity in built-up and non built-up areas of Calabar urban Cross River State, Nigeria.Further, it was hypothesized that:

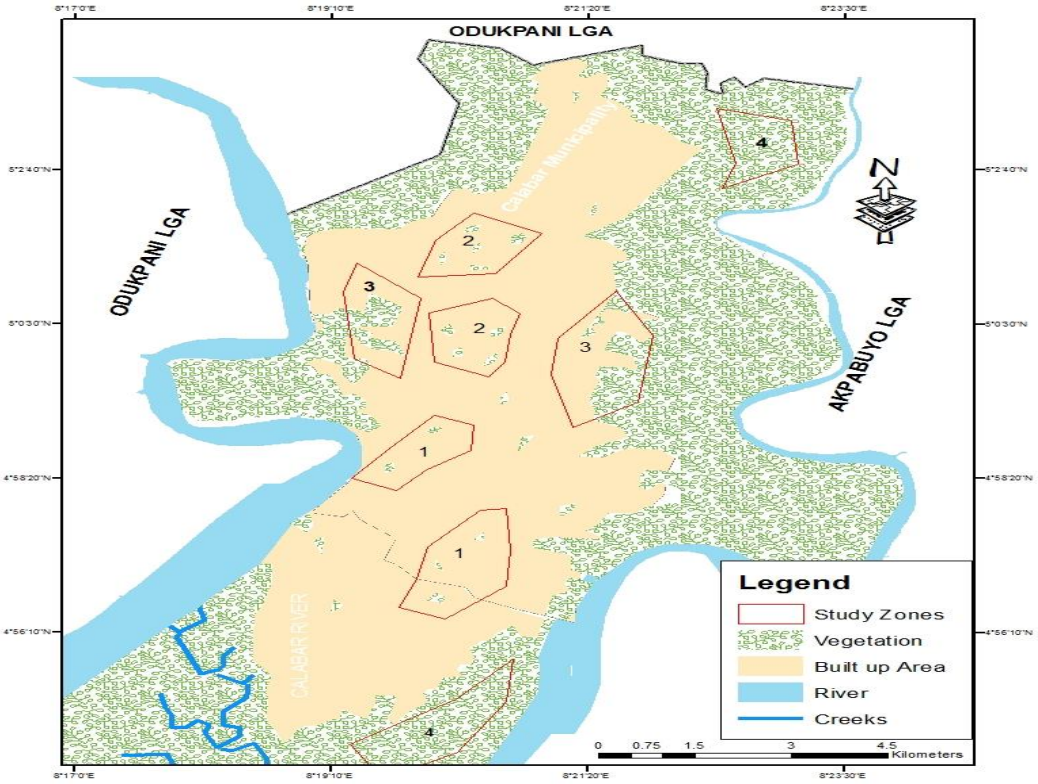
$H0_{1:}$ There is no significant variation in flora species diversity between the zones built-up and non-built-up areas of Calabar.

MATERIALS AND METHODS

Study area: Calabar lies between latitude, 4°28'N and 5º15'N of equator and longitude, 8°13'E and 8º37'E Greenwich meridian. Calabar is bounded by Odukpani Local Government Area in the north, Akpabuyo Local Government Area to the south by Calabar South and west by Calabar River. It has an area of 98.712 square kilometers. Under the Koppen's climate classification, the metropolis features a tropical monsoon climate with a lengthy wet season spanning 8-9 months and a short dry season covering the remaining 3-4 months with an average annual rainfall of 2750mm (Climate-ata.org, 2016).The harmattan which significantly influences weather in West Africa is noticeably less pronounced in the city. Temperatures are relatively constant throughout the year, with average high temperatures usually ranging from 25 to 28 degrees Celsius. The predominant vegetation type within the study area is mangrove. The mangrove flora consists of trees and shrubs of varying species. The common genus is Rhizophora with three species, R Eaemos, R. Harisonii and R. Managle. There are also plants, prodococcus, bateri, ancistrophyllum, and the gregarious and aggressive Nypa Fruituzan. The vegetation is known to be part of the most complex vegetation which is of the mangrove growth in the Cross River estuary. The complex plant community of wetland origin formed an ecological niche for reptile.

Method: the methodology of Atu, & Bisong (2013) was adopted in delimiting the urban area for the study. A four kilometer buffer zone was delineated from the CBD (Watt market) and labeled as highly built area, a second 3 kilometer was created from the limit of the first buffer zone as the moderately built up area and a two kilometer zone was taken from the edge of the second as the sparsely built up area. Furthermore, a buffer of 2 kilometers from the edge of the sparsely built up area was classified as non-built-up zone to another 3 kilometers.

Sampling technique: purposive sampling technique was used to select samples zones in each of the delineated area (highly built up, moderately built up, sparsely built up and non- built up areas). Based on this classification Ekorinim, Satellite Town, Johnathan by-pass, Ikot Omin and Abayong community where the sampled zones. At each of the zones two sample plots were randomly selected. Where the random sample plot does not contain vegetation the next sample plot was adopted. The trees were enumerated via transect walk lane of 1000m X 50m interval on site identification by the researcher, a botanist from the Department of Botany in the University of Calabar and a forest guide from the CRS Ministry of Forestry. Where a tree could not be identified onsite, a scrap of the back of the tree & the leaf were collected, preserved & transported to the Department of Botany in the University of Calabar for proper identification.



Delineated areas of flora diversity in Calabar
FIG. 1: Calabar showing the study location
Source: Cross River Geographic Information System (CRGIS)

RESULT

TABLE 1.1
Identify Flora species diversity in built-up area of Calabar

S/N	Common Name	Botanical Name	Family Name	Occurrence	Specie Type	Ecological Status			
				Total	Life form	A	C	O	R
1.	Neem tree	*Azadirachta indica*	*Meliaceae*	8	Tree		x		
2.	flame of the forest	*Delonie regia*	*Caesalpinaceae*	9	Tree			x	
3.	Fan palm	*Borassus flabellifer*	*Palmae*	18	Tree	x			
4.	Managasta almond	*Terminalia montalv*	*Combretaceae*	17	Tree	x			
5.	Custard apple	*Greenwayodendroh synonmys*	*Annonaceae*	8	Tree			x	
6.	Indian almond	*Terminalia catapa*	*Combretaceae*	2	Tree				x
7.	Odan tree	*Ficus thoningii*	*Moraceae*	5	Tree				x
8.	Avocado pear	*Persea amercana*	*Lauraceae*	5	Tree				x
9.	Mango tree	*Mangifera indica*	*A nacardiaceae*	10	Tree			x	
10.	Palm tree	*Elaeis guinensis*	*Palmae*	3	Tree				x
11.	Thunder tree	*Croton zambesicus*	*Euphorbiaceae*	4	Tree				x
12.	Drumstick northern b	*Moringa oleifera*	*Moringaceae*	4	Tree				x
13.	Comb teak	*Gmelina arborea*	*Verbanaceae*	5	Tree				x
14.	Stool wood	*Alstona boonci*	*Apocynaceae*	3	Tree				x
15.	Cashew nut tree	*Anacardium occidentalis*	*Anacardiaceae*	11	Tree			x	
16.	Native pear	*Dacryodes edulis*	*Bursaraceae*	5	Tree				x
17.	cassod tree	*Cassia siamea*	*Caesalpinaceae*	5	Tree				x
18.	Spanish shawl	*Dissolis roiundifolia*	*Melastomataceae*	5	Herb				x
19	Arabica seed	*Urena cobata*	*Malvaceae*	3	Herb				x
20	Burkil	*Pandiaka involucrate*	*Amaranthaceae*	5	Herb				x
21	Morning glory	*Ipomoza*	*Convolvucea*	17	Herbs				
22	Broom weed	*Sida acuta*	*Malvacea*	32	Herbs				
23	Common ginger liliy	*Costa afer*	*Zingiberacea*	20	Herbs				
24.	Teak	*Teclona grundis*	*Verbenceae*	4	Tree				x
25.	Guava	*Psidium guajava*	*Mvrtaceae*	5	Tree				x
26.	Asthma weed	*Erigeron floribunda*	*Asteraceae*	2	Herb				x
27	Camwood	*Baphia nitida*	*Fabaceae*	16	Tree			x	

28	Ringworm plant	*Cassia alata*	*Caesalpiniaceae*	10	Shrub		x	
29	Cattle stick	*Carpolobia lutea*	*Polygalaceae*	5	Shrub			x
30	Water lily	*Nymphaea lotus (L)*	*Nymphaceceae*	15	Herb	x		
Total				248				

Source: authors Field analysis (2019)

TABLE 1.2
Flora species in non built-up of Calabar

S/N	Common Name	Botanical Name	Family Name	Occurrence	Specie Type	Ecological Status			
				Total	Life form	A	C	O	R
1.	Stool wood	*Alstonia conggensis*	*Apocyanceae*	18	Tree	x			
2.	Abura	*Mittragyna stepolusa*	*Rubiaceae*	9	Tree		x		
3.	Umbrella tree	*Musanga cecropioides*	*Moracaea*	25	Tree	x			
4.	Blood tree	*Harimgana madagariensis*	*Hypericacaea*	19	Tree	x			
5.	Forest bamboo	*Bambusa vulgaris*	*Bambusae*	14	Tree		x		
6.	Christmas bush	*Alchohea cordifolia*	*Euphorbiacaea*	23	Shrub	x			
7.	Kola	*Kola nitida*	*Sterculianceae*	4	Tree				x
8.	Zuni sweeten	*Lasiathera africanum*	*Icacinacaea*	4	Shrub	x			
9.	Siam weed	*Chromolaena odorata*	*Asteracaea*	35	Herb	x			
10.	Common ginger lily	*Costas afer*	*Zingiberacaea*	20	Herb				x
11.	Palm tree	*Elaeis guinensis*	*Palmae*	20	Tree	x			
12.	African mango	*Irvingia gabouensis*	*Irvingiacaea*	9	Herbs			x	
13.	Holarrhena	*Holarrhena floribunda*	*Apolynacaea*	5	Tree				x
14.	Velvet sun fruit	*'netisferruginea*	*Connaracaea*	3	Shrub				x
15.	Ant- plant	*Barteria nigriliana*	*Passifloracaea*	5	Tree				x
16.	Sulamun melonganel	*Dioscoreophy-llumcumminsii*	*Menispermaceae*	8	Shrubs				x
17.	Raffia palm	*Raphia Afriana oledo*	*Arecaceae*	24	Tree	x			
18.	Camwood	*Baphia nitida*	*Fabaceae*	2	Shrubs				x
19	Wild cherry	*Antidesma vogelinanum*	*Euphorbiaceae*	6	Herbs			x	
20	Sword fern	*Nephrolepis biserrata*	*Daralliaceae*	24	Herbs	x			
21	Hog plum	*Spondias mombin*	*Anacanridaceae*	12	Herbs		x		
22	Bush willow	*Combretum racemosum*	*Combrelaceae*	19	Tree	x			
23	Wild African rubber	*Funtumia elastic*	*Apocyanceae*	17	Tree	x			
24	Screw pin	*Pandamis demtdatits*	*Pandanaceae*	9	Tree			x	
25	Apado	*Anthonotha macrophylla*	*Fabaceae*	11	Tree		x		
26	Ofu	*Cleistopholus osun*	*Fabaceae*	17	Tree		x		
27	Miraculous plant	*Thoumatococcus danillii*	*Morantaceae*	8	Herbs			x	

28	Ficus	*Ficus spp*	*Moraceae*	1	Tree				x
29	Holarrhena	*Holarrhena floribunda*	*Apolynacaea*	3	Tree				x
30	Egg woman	*Phyllantus amarus*	*Euphorbiaceae*	4	Herbs				x
31	Devil bean	*Crotalarca retusa*	*Papilionaceae*	3	Herbs				x
32	Red camwood	*Pterocarpus osun*	*Fabaceae*	8	Tree			x	
33	Waterside camwood	*Pterocarpus santaliniodes*	*Fabaceae*	12	Tree		x		
34	Burkil	*Pandiaka involucrate*	*A maranthaceae*	10	Herb			x	
35	Cattle stick	Carpolobia lutea	Polygalaceae	5	Shrub				x
36	Water lily	Nymphaea lotus (L)	Nymphaceceae	15	Herb		x		
37.	Swamp arum	Cyrtosperma senegalensis	Araceae	39	Herb	x			
38.	Christmas bush	Alchonea Laxiflora	Euphorbiaceae	5	Shrub				x
39.	Cattle stick	Corpolobia Lutea	Polygalaceae	1	Shrub				x
40.	Garden quinine	Clerodendron Splendens	Verbenaceae	3	Shrub				x
41	Fern plant	Pteridium Aquilinum	Dennestiadaceae	27	Herb	x			
42	Northern black wattle	Acacia aericuliformis	Mimosaceae	5	Tree				x
Total				509					

Source: authors Field analysis (2019)

Table 1.3 **Native and non-native species in zone 1 (Highly built-up area of Calabar Municipality**

S/N	Common Name	Botanical Name	Family Name	Life form Habit	Species Type		Ecological Status			
					Native	Non-native	A	C	O	R
1.	Neem tree	*Azadirachta indica*	*Meliaceae*	Tree		Exotic		x		
2.	flame of the forest	*Delonie regia*	*Caesalpinaceae*	Tree		Exotic			x	
3.	Fan palm	*Borassus flabellifer*	*Palmae*	Tree		Exotic	x			
4.	Afara	*Terminalia montalv*	*Combretaceae*	Tree		Exotic	x			
5.	Custard apple	*Greenwayodendroh synonmys*	*Annonaceae*	Tree		Exotic			x	
6.	Indian almond	*Terminalia catapa*	*Combretaceae*	Tree		Exotic				x
7.	Odan tree	*Ficus thoningii*	*Moraceae*	Tree		Exotic				x
8.	Avocado pear	*Persea amercana*	*Lauraceae*	Tree		Exotic				x
9.	Mango tree	*Mangifera indica*	*A nacardiaceae*	Tree	Native				x	
10.	Palm tree	*Elaeis guinensis*	*Palmae*	Tree	Native					x
11.	Thunder tree	*Croton zambesicus*	*Euphorbiaceae*	Tree		Exotic				x
12.	Drumstick northern b	*Moringa oleifera*	*Moringaceae*	Tree		Exotic				x
13.	Comb teak	*Gmelina arborea*	*Verbanaceae*	Tree		Exotic				x
14.	Stoll wood	*Alstona boonci*	*Apocynaceae*	Tree	Native					x

15.	Cashew nut tree	*Anacardium occidentalis*	*Anacardiaceae*	Tree		Exotic			x	
16.	Native pear	*Dacryodes edulis*	*Bursaraceae*	Tree	Native					x
17.	kassod tree	*Cassia siamea*	*Caesalpinaceae*	Tree		Exotic				x
18.	Spanish shawl	*Dissolis roiundifolia*	*Melastomataceae*	Herb	Native					x
19	Arabica seed	*Urena cobata*	*Malvaceae*	Herb	Native					x
20	Ring worm plant	*Cassia alata*	*Caesalpiniaceae*	Shrub	Native					x
21	Burkil	*Pandiaka involucrate*	*Amaranthaceae*	Herb		Exotic				x

Source: Researcher's Field, work (2019)
Note: species frequency of 1-5 are rare species, 6-10 occasional species, 11-15 species, 16 and above abundant species.

Table 1.4 Native and non-native species in zone 2 (moderately built-up are of Calabar Municipality

S/N	Local Name	Botanical Name	Family Name	Life form Habit	Specie type		Ecological status		
					Native	Non-native			
1	Siam weed	*Chromolaena Odoraia*	*Asleruceae*	Herb	Native		x		
2	Morning glory weed	*Ipomoza Involucrata*	*Convolvulceae*	Herbs	Native			x	
3.	Palm tree	*Elaeis guinensis*	*Palmae*	Tree	Native		x		
4.	African lak plant	*Clerodendrum splendens*	*Verbenceae*	Shrub	Native				x
5	Broom weed	*Sida acuta*	*Malvaceae*	Herb	Native			x	
6	Haemorhage plant	*Aspilic Africana*	*Asteraceae*	Herbs	Native		x		
7	Spanish shawl	*Dissotis rotundifolia,*	*Melastomataceae*	Herb	Native				x
8	Arabica seed	*Urena cobata*	*Malvaceae*	Herb	Native				x
9	Common ginger lily	*Costus afer*	*Zingiberaceae*	Herb	Native				
10	Ring worm plant	*Cassia alata*	*Caesalpiniaceae*	Shrub	Native				x
11	Burkil	*Pandiaka involucrate*	*A maranthaceae*	Herb		Exotic		x	
12	Gmeliaa tree	*Gmelina arhorea*	*Verbenaceae*	Tree		Exotic			x
13	Teak	*Teclona grundis*	*Verbenceae*	Tree		Exotic			x
14	Guava	*Psidium guajava*	*Mvrtaceae*	Tree		Exotic			x
15	Asthma weed	*Erigeron florib unda*	*Asteraceae*	Herb	Native				x
16	Sweet broom	*Scoparia dulcis*	*Scrophularcaceae*	Herb	Native				x
17	T hunder tree	*Croton zambersicus*	*Euphorbiaceae*	Tree		Exotic			x
18	Narrow-leave	*Uapaca standiii*	*Enphorbiaceae*	Tree		Exotic		x	
19	Camwood	*Baphia nitida*	*Fabaceae*	Tree		Exotic	x		
20	Table fern	*Pteris prolifera*	*Pleridaceae*	Herbs	Native			x	

21	Apado	*Anthonotha tnacrophylla*	*Fabaceae*	Tree	Native			x

Source: Researcher's Field, work (2019)
Note: species frequency of 1-5 are rare species, 6-10 occasional species, 11-15 species, 16 and above abundant species.

Table 1.5 Native and non-native species in zone 3 (sparsely built-up area) of Calabar Municipality

S/N	Local Name	Botanical Name	Family Name	Life form Habit	Specie Type		Ecological Status			
					Native	Non-native	A	C	O	R
1.	Christmas bush	*Alchornea cordifolia*	*Euphorbiaceae*	Shrub	Native					x
2.	Cabbage tree	*Anthoclecista vogelli*	*Loganiaceae*	Tree	Native			x		
3.	Raphia palm	*Raphia African otedo*	*Arececeae*	Tree	Native		x			
4.	Umbrella tree	*Musanga cecropiordes*	*Moraceae*	Tree	Native					x
5.	Sand- paper tree	*Ficus exasperate*	*Moraceae*	Shrub	Native					x
6.	Ringworm plant	*Cassia alata*	*Caesalpiniacea e*	Shrub	Native				x	
7.	Bamboo	*Bambusa vulgaris*	*Poaceae*	Shrub	Native			x		
8.	Cattle stick	*Carpolobia lutea*	*Polygalaceae*	Shrub	Native					x
9.	Water lily	*Nymphaea lotus (L)*	*Nymphaceceae*	Herb	Native			x		
10.	Swamp arum	*Cyrtosperma senegalensis*	*Araceae*	Herb	Native		x			
11.	Blood tree	*Harungana Madagascariensis*	*Hypericacae*	Shrub	Native					x
12.	Christmas bush	*Alchonea Laxiflora*	*euphorbiaceae*	Shrub		Exotic				x
13.	Raphia palm	*Raphia hookeri*	*Arecaceae*	Tree	Native		x			
14.	Cattle stick	*Corpolobia Lutea*	*Polygalaceae*	Shrub	Native					x
15.	Stool wood	*Alslonia Boone*	*Apocynaceae*	Tree	Native					x
16.	Garden quinine	*Clerodendron Splendens*	*Verbenaceae*	Shrub		Exotic				x
17.	Fern plant	*Nephrolepisbiserfata*	*Davalliaceae*	Herb	Native		x			

18.	Siam weed	*Chromolaena odorata*	*Asteraceae*	Herb	Native		x	
19.	Fern plant	*Pteridium Aquilinum*	*Dennestiadaceae*	Herb	Native		x	
20.	Haemorhage plant	*Aspilia Africana*	*Asteraceae*	Herb	Native		x	
21.	Broom Weed	*Sida acuta*	*Malvaceae*	Herb	Native		x	
22.	Northern black wattle	*Acacia aericuliformis*	*Mimosaceae*	Tree		Exotic		x

Source: Researcher's Field, work (2019)
Note: species frequency of 1-5 are rare species, 6-10 occasional species, 11-15 species, 16 and above abundant species.

Test of hypothesis

The hypotheses are stated as thus:

H_0: There is no significant variation in species diversity between the zones (highly, moderately and sparsely built-up areas and the non-built-up areas) in Calabar

H_1: There is a significant variation in species diversity between the zones (highly, moderately and sparsely built-up areas and the non-built-up areas) in Calabar

The hypotheses explained species diversity, species richness and species evenness between the urban formations.

Flora Species diversity

Tree species diversity is the variety of tree species found in the study area and this was presented with respect to the built-up areas (Zones). The diversity of the flora species diversity in the study area, Shannon Wiener index was use to achieved species diversity. The results of the computation is presented in Table 2 from the results, the non-built up area with diversity index of 6.421 was more diverse than the other zones. This was followed by the moderately built-up area (zone 2) with diversity index of 2.978. Accordingly, highly built-up area had a diversity index of 2.871 while sparsely built-up area had a diversity index of 2.304. From the results, the null hypothesis which states that there is no significant difference in flora species diversity among the various built-up areas was rejected. It was concluded based on the results of table 4.17 that there is a significant difference in flora species diversity in the study area.

Table 1.6

Shannon wiener index results showing species diversity in the different zones

S/N	Built – up area (Zone)	Diversity
1	Highly built-up area – Zone 1	2.871
2	Moderately built-up area – Zone 2	2.978
3	Sparsely Built-up area – Zone 3	2.304
4	Non – Built up area - Zone 4	6.421

Source: Author's Field Work (2019)

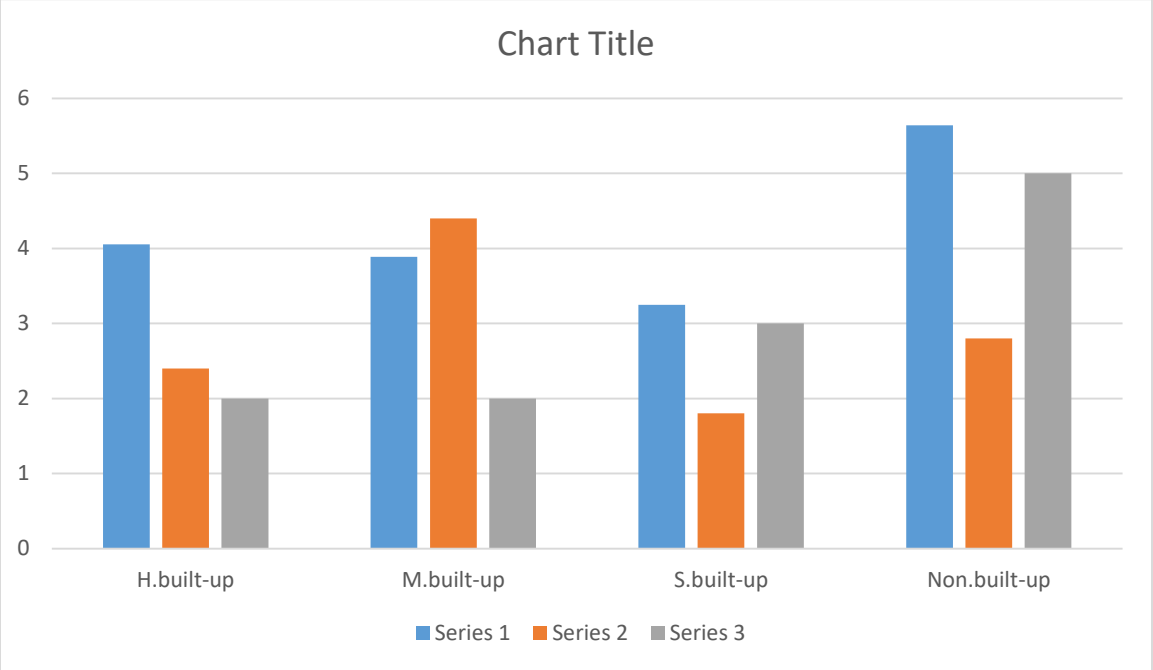


FIG.3

Flora Species Richness

Flora species richness is the total number of species in an area and is one indicator of biodiversity. From the total number of flora species occurrence within the zones, the Margalef (1951) indices for species richness was used for the calculation. The species richness was considered according to the built-up areas (zones) to determine the area that was richer in flora species. The results were as presented in Table 3. From the results, the non-built up area with richness index of 5.640 was richer in flora species. This was followed by the highly built up and moderately built-up areas with richness index of 4.053 and 3.885 respectively. The sparsely built-up area was the least in terms of richness.

TABLE 1.7

Margalef (1951) species richness index in the different zones

S/N	Built – up area (Zone)	Richness
1	Highly built-up area – Zone 1	4.053
2	Moderately built-up area – Zone 2	3.885
3	Sparsely Built-up area – Zone 3	3.248
4	Non – Built up area - Zone 4	5.640

Source: Author's Field Work (2019)

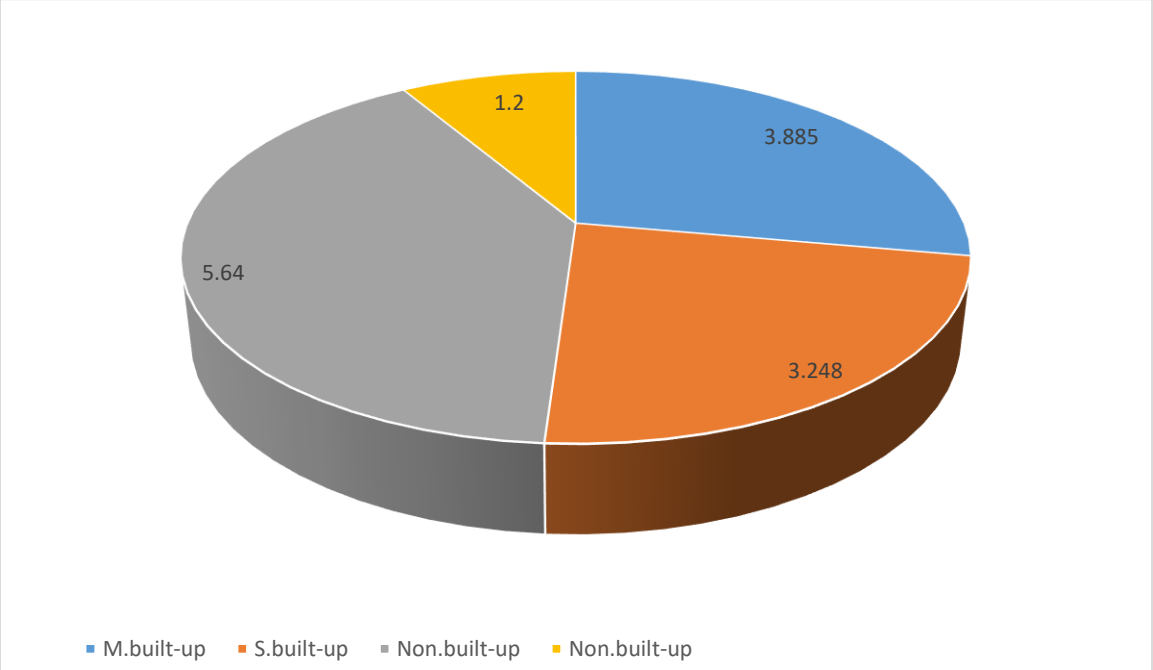


FIG.4

Flora Species evenness

Species evenness refers to how close in numbers each species in an environment is. It is a measure of biodiversity which quantifies how equal the flora community is numerically. The Pielou (1966) indices for species evenness were used for the analysis. The results were as presented in Table 4. From the results, the non-built up area with evenness index of 1.806. This was followed by the moderately built up and highly built-up areas with evenness index of 0.978 and 0.943 respectively. The sparsely built-up area was the least in terms of evenness with index of 0.782.

TABLE 1.8
Pielou 1966, species evenness index in the different zones

S/N	Built – up area (Zone)	Evenness
1	Highly built-up area – Zone 1	0.943
2	Moderately built-up area – Zone 2	0.978
3	Sparsely Built-up area – Zone 3	0.782
4	Non – Built up area - Zone 4	1.806

Source: Author's Field Work (2019)

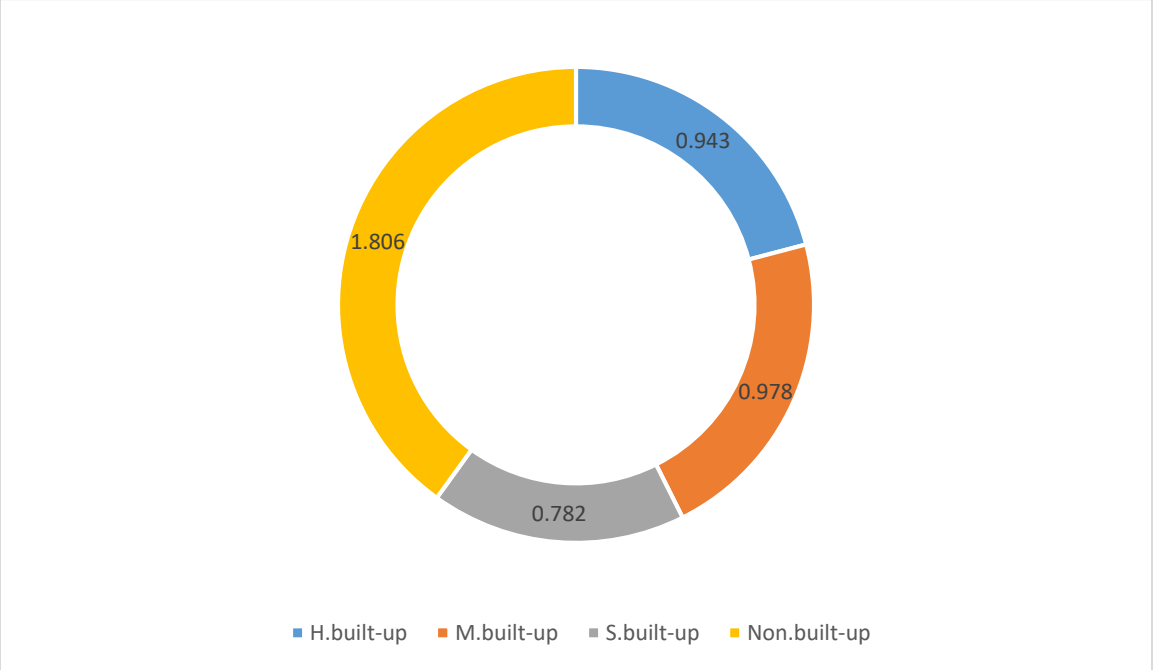


FIG.5

DISCUSSION

From Table 1.1 the identify flora species in the built-up area of Calabar, 30 flora species were in total. 19 tree flora species were identify such as *Azadirachta indica, Delonie regia, Borassus flabellifer, Terminalia montalv, Greenwayodendroh synonmys, Terminalia catapa, Ficus thoningii, Persea amercana, Mangifera indica, Elaeis guinensis, Croton zambesicus, Moringa oleifera, Gmelina arborea, Alstona boonci, Anacardium occidentalis, Dacryodes edulis, Cassia siamea, Teclona grundis, Psidium guajava, Erigeron florib unda, Cassia alata, Carpolobia lutea* and*Nymphaea lotus,* 3 shrubs speciewhich were counted ininclude*Cassia alata, Carpolobia lutea,* while 8 herbs specie were also identify they include *Dissolis roiundifolia, Urena cobata, Pandiaka involucrate, Ipomoza, Sida acuta, Costa afer, Erigeron florib unda* and *Nymphaea lotus.*

In Table 1.2, a total of 42 flora species were encountered in the non built-up area. 20 tree flora species were identify such as *Alstonia conggensis, Mittragyna stepolusa, Musanga cecropioides, Harimgana madagariensis, Bambusa vulgaris, Alchohea cordifolia, Kola nitida, Elaeis guinensis, Holarrhena floribunda, Barteria nigriliana, Raphia Afriana oledo, Baphia nitida, Antidesma vogelinanum, Spondias mombin, Combretum racemosum, Funtumia elastic, Pandamis demtdatits, Anthonotha macrophylla, Cleistopholus osun, Ficus spp, Pterocarpus osun*and*Pterocarpus santaliniodes.* 5 shrubes flora species were in number such as *Alchohea cordifolia, Lasiathera africanum, 'netisferruginea, Dioscoreophy-llumcumminsii, Baphia nitida* while 9 flora herbs species encountered such as *Chromolaena odorata, Costas afer, Irvingia gabouensis, Antidesma vogelinanum, Nephrolepis biserrata, Spondias mombin, Thoumatococcus danillii, Phyllantus amarus, Crotalarca retusa* and *Pandiaka involucrate.*

In assessing the native and non-native species in zone 1 (highly built up area) of Calabar Municipality, the study revealed a total number of seven (7) native flora species were found in the area. Out of this number, none of the flora species was in abundance and none was common. However, one of the species (*Magnifera indica*) was occasionally occurring in the area while six (6) flora species namely *Elaeis guinensis, Alstona boonci, Dacryodes edulis,, Dissolis roiundifolia, Urena cobata*and, *Cassia alata* were rare species.

On the other hand, fourteen (14) of the flora species were non-native species. From this number, two (2) species namely *Borassus flabellifer* and *Terminalia montalv* were in abundance while one species (*Azadirachta indica) was common.* Furthermore, three (3) non-native species were occasionally occurring. They include *Delonie regia, Greenwayodendroh synonyms* and *Anacardium occidentalis*. The study also showed that eight (8) of the non-native species were raely found in the area. They include *Terminalia catapa, Ficus thoningii, Persea amercana, Croton zambesicus, Moringa oleifera, Gmelina arborea, Cassia siamea and Pandiaka involucrate*. This was shown in table 1.3.

Table 1.4 shows the native and non-native flora species in zone 2 (moderately built up area) of Calabar Municipality. From the study, a total of fourteen (14) native flora species were encountered in the area. From this number, three (3) of the species namely *Chromolaena Odoraia, Elaeis guinensis* and Aspilic *Africana*, were in abundance while none of the flora species found was common . Also, four (4) of the flora species namely *Ipomoza Involucrata, Sida acuta, Pteris prolifera* and *Anthonotha tnacrophylla* occurred occasionally while thirteen (6) of the native species were rare. They include *Clerodendrum splendens, Dissotis crotundifolia, Urena cobata, Cassia alata, Erigeron floribunda and Scoparia dulcis,*

On the other hand, a total of seven (7) non-native species were encountered in the area. Out of this number, one species (*Baphia nitida)* was abundance while none of the flora species were commonly found and two (2) species namely *Pandiaka involucrate* and *Uapaca standiii* occurring occasionally. Furthermore, four (4) of the species were rare. They include *Gmelina arhorea, Teclona grundis, Psidium guajava* and *Croton zambersicus.*
From the analysis of native and non-native species in zone 3 (sparsely built-up area) of Calabar Municipality, it was revealed that a total of nineteen (19) native flora species were encountered with eight (8) flora species being in abundance. They include; *Raphia African otedo, Cyrtosperma senegalensis, Raphia hookeri,Nephrolepisbiserfata,Chromolaena odorata, Pteridium Aquilinum, Aspilia Africana and Sida acuta.*while common native flora species found in the area were three (3)in number and they include *Anthoclecista vogelli, Bambusa vulgaris and Nymphaea lotus (L).*Furthermore, one native flora specie *(Cassia alata) was common in the area while seven (7) native flora species were rare. They include Alchornea cordifolia, Musanga cecropiordes, Ficus exasperate, Carpolobia lutea, Harungana Madagascariensis, Corpolobia Lutea*and *Alslonia Boone.*

The analysis went further to show the non-native species found in the area. From the analysis, it was discovered that three (3) non-native species namely; *Alchonea Laxiflora, Clerodendron*

Splendens and *Acacia aericuliformis* were encountered with all of them being rare in the area. This was shown in table 1.5. From the results, the non-built up area with richness index of 5.640 was richer in flora species. This was followed by the highly built up and moderately built-up areas with richness index of 4.053 and 3.885 respectively. The sparsely built-up area was the least in terms of richness. On the other hand, the Pielou (1966) indices for species evenness were used for the analysis to determine species evenness between the zones in the area. From the results, the non-built up area has an evenness index value of 1.806. This was followed by the moderately built up and highly built-up areas with evenness index of 0.978 and 0.943 respectively. The sparsely built-up area was the least in terms of evenness with index of 0.782.

CONCLUSION

The evaluation of flora species carried out in the study show that Calabar is blessed with diverse indigenous and foreign species of plants but with many disappearance of the of the native species who has been eroded by the introduction of more exotic species in the area. This is because the indigenous species that were dominance in time past are now found with rare and occasionally occurring ecological status across the built-up area of the study. The study thus, conclude that if measures are not undertaken to prevent further colonization of native species by the exotic ones or erosion of key native flora species in Calabar, the city may experience some ecological implications in the near future.

Recommendations

Proceeding from the result obtained, the study thus makes the following recommendations.

- Ecological flora survey should be carried out periodically in Calabar and the state at large for proper monitoring to ascertain the affected species.
- Therefore, a need to enhance conservation of native flora species so that it would not be eroded.
- Panels of researchers and conservation agency should adopt rare and occasional species of flora as indicators to use when assessing progress towards global conservation goals and ecological status of flora diversity in the study area.
- The Government of the state should make an all-inclusive flora (trees, shrubs and herbs) policy in its urban beautification strategies and also, emphasis should be placed on native species that have evolved and adapted to the locality.

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