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Spatio-ecological Assessment of Urban Plants in the Government Reserved Areas (GRAs) in Some Selected Capital Cities in South-south Region of Nigeria

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--***ABSTRACT***--

The study assessed the spatial and ecological status of urban plants impacts in some selected capital cities in the South-south region of Nigeria. The study established quadrats of 30m x 200m along road (transects) in Government Reserved Areas (GRAs) of Uyo City, Akwa Ibom State and Yenagoa City, Bayelsa State labelled as sampled sites and a quadrat of 100m x 100m were established as control sites (secondary forest) at a minimum of 300m from the sampled sites.. Simpson's diversity index was used to determine the species diversity while Margalef Index was used to determine the level of species richness. Species evenness of urban plants was determined using the Simpson's evenness index. Descriptive statistics were used to describe the frequency and other results pertaining to ecological parameters. Findings showed that Vossia cuspidata was highest (51.4%) in one of the sampled sites in Uyo City while Cynodon dactylon highest (80.6%) in abundance in Yenagoa in one of the sampled roads. Findings also showed that the species composition, diversity, richness and evenness of urban plants were higher in the relatively disturbed forest than the GRAs. The study concluded that the plant species diversity, richness and evenness of urban plants have been severely degraded due to urbanization in the study area; and it shows that urban greening has been affected and the ecosystem services they are expected to supply the humanity have been lowered or shattered totally. The study therefore recommended that planting trees in the streets in the urban centres should be encouraged and taken seriously.

KEYWORDS: *Urban Trees. Ecosystem systems, Species Diversity, Species Richness, Species Evenness, South-south region, Nigeria*

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I. INTRODUCTION

The transformation of land cover types in the urban areas is very tremendous in the recent times and it is mostly influenced by human activities (Dyderski et al., 2017); despite the fact that the plant biodiversity is an important component of urban ecosystems, which contributes to the value of public life through air quality enhancement and aesthetic value improvement of the environment. Urbanisation is increasing worldwide and is regarded a major driver of environmental change altering local species assemblages in urban green areas. Forests are one of the most frequent habitat types in urban landscapes harbouring many native species and providing important ecosystem services (Melliger et al., 2018). The issue of land-use changes, has led to habitat fragmentation loss; degradation of natural and semi-natural habitats; emergence of new, urban habitats, lowering the groundwater table level, increased levels of nutrients, pH, temperature, pollution and disturbance, cities are unfavourable habitats for plant existence (Kowarik, 2011). However, some groups of plant species are more threatened in urban environments than others, especially those with narrow ecological niches, associated with more natural habitats (Knapp et al., 2010). On the other hand, disturbances connected with human settlement facilitate encroachment of alien plant species, along with increased chances of naturalization in urban areas (Dyderski et al., 2015a; Dyderski and Jagodziński, 2016). Studies on urbanisation have reported alterations in abiotic conditions in the urban habitat patches and the alterations have influenced habitat quality (Melliger et al., 2018). The habitat quality has invariably influenced the species richness, species composition, and functional diversity of plants and animals (Comcepcion et al., 2015); and in turn have affected the functioning of ecosystems (Chapin et al, 1997).

As urban growth patterns is now ranging from sprawl to compaction, many cities around the globe are becoming denser and creating pressure on their green spaces (World Bank, 2015). It is thus increasingly important to maximise the capacity of urban green-spaces to support biodiversity and ecosystem services. Implementation of multifunctional nature based solutions (Shanahan et al., 2015; van den Bosch & Ode Sang, 2017) helps to deliver these benefits. Such solutions typically increase biodiversity through habitat creation or ecological restoration schemes, whilst simultaneously providing additional benefits such as flood control, mitigation of urban heat islands (Bolund & Hunhammar, 1999)and atmospheric particulates and pollutants (Janhall, 2015), whilst also providing spaces for recreation and leisure (Chiesura, 2004). Urbanization has generated enormous environmental changes (Pearce et al., 2018) and promotes loss of indigenous species, natural habitats and consistently reduces the accessible areas for many wild species. All these factors combined produced loss in biodiversity in an urban setting.

Urban areas influences regional flora by changing the availability or spatial arrangement of habitats, their species and evolutionary selection of plants populations (Williams et al., 2010). Urban landscaping including planting of species normally supports the introduction of alien species by humans; and poses serious threat to biodiversity (Bigirimama et al., 2012). Alarmingly, growing urban landscaping is expected to promote the introduction of exotic species and this mostly leads to the extirpation of some native plants (Duncan et al., 2011), and decline of native biodiversity.

Similarly in Nigeria especially in the Niger Delta Region, rapid urbanization and land use change in most cities has led to the alteration of structure and composition of forests (Wear, 2013). Novel ecosystem assemblages have developed in both urban and peri-urban forests in response to land use change, as well as species introductions, ecological disturbance, and socio-political and economic shifts (Conway and Bourne, 2013). In addition, many urban floras include both human-cultivated and spontaneously occurring species, each of which is subject to distinct ecological and human influences (Knapp et al. 2012). Although there is evidence of high biodiversity within cities (McKinney 2006, Grimm et al., 2008; Knapp et al. 2008), few studies have disentangled these ecological and human influences that drive urban biodiversity.

Although, urbanization results in native habitat destruction and is regarded as a major threat to biodiversity; some cities are richer than others in terms of plant species, both from intentional and unintentional introductions but also due to natural factors. For instance, in some cases, cities are built up in areas of natural heterogeneity which supports natural biodiversity and thus, makes it richer in terms of plant species diversity (Luc and Emmanuel, 2014). Furthermore, it has been reported that over the years trees have undergone different levels of disturbance due to unprecedented increase in human population, which have led to cutting of trees for firewood collection, charcoal production, and infrastructural developments (Omoro et al., 2010; Ogwu et al., 2016). This has impacted tree diversity, abundance, species composition, indigenous knowledge of tree flora and conservation. Sustainable development advocates that humans and biodiversity coexist side by side (Ogwu et al., 2016). Several studies on urban forest have been carried out in Nigeria among which include Agbelade et al., (2016) which deals with the tree species richness, diversity, and vegetation index for, Abuja, Nigeria; Ogwu et al (2016) deals with the diversity and abundance of tree species in the University of Benin, Benin City, Nigeria; Agbelade et al., (2016) also assessed the population and diversity of urban tree species Ibadan, Nigeria. Very few of these studies involved the effect of urbanization on urban forest in the Niger Delta Region. Thus, the present study focuses at examining the spatio-ecological assessment of species composition, diversity and richness of urban plants in the Government Reserved Areas (GRAs) in Some Selected Capital Cities in South-south Region of Nigeria.

II. MATERIALS AND METHODS

Study Area Description

The study was carried out in Uyo, Akwa Ibom and Yenagoa, Bayelsa States in the South south region of Nigeria (Figure 1). The South south region is found within the Niger Delta of Nigeria. South south region of Nigeria is located between latitudes 5º 00'N and 6º 30'N and longitudes 5º 20'E and 9º 00'E. The South-south region with the Niger River is sitting directly on the Gulf of Guinea on the Atlantic Ocean in Nigeria. The study area features a tropical monsoon climate, designated by the Koppen climate classification as "Am", and it is mostly found in the southern part of the country. This climate is influenced by the monsoons originating from the South Atlantic Ocean, which is brought into the country by the maritime tropical air mass, a warm moist sea to land seasonal wind (Britanica, 2014). Its warmth and high humidity gives it a strong tendency to ascend and produce copious rainfall, which is a result of the condensation of water vapour in the rapidly rising air (Park, 2004). The temperature ranges are almost constant throughout the year. The South-south region of Nigeria experiences heavy and abundant rainfall. These storms are usually conventional in nature due to the regions proximity, to the equatorial belt. The annual rainfall received in this region is very high, usually above the 2,000 mm (78.7 in) rainfall totals giving for tropical rainforest climates worldwide. Over 4,000 mm of rainfall is received in the coastal region of Nigeria around the Niger Delta area. Bonny town found in the coastal region of the Niger delta area in southern Nigeria receives well over 4,000 mm of rainfall annually (Geographical Alliance of Iowa, 2010). The geology includes a new threefold litho-stratigraphic subdivision comprising an upper sandy Benin formation, an intervening unit of alternating sandstone and shale named the Agbada formation, and a lower shaly Akata formation. These three units extend across the whole delta and each ranges in age from early Tertiary to Recent (Short and Staeuble, 1967; Durugbo et al., 2010). The south-south region is well drained with both fresh and salt water. The salt water is caused by the intrusion of seawater inland, thereby making the water slightly salty. Drainage of the study area is poor because of the presence of many surface water and heavy rainfall between 2000mm and 2400mm (Mmom and Fred-Nwagwu, 2013). The vegetation includes the rainforest, swampy forest and mangrove (Geographical alliance of Iowa, 2010). The primary economic activities in most rural communities in the south-south region include peasant farming, petty trading and fishing, shifting cultivation (Slash and burn), which involves cultivating a piece of land for a number of years and then abandoning it for a more fertile land is traditionally practised in the area. Some of the cash crops grown in the study area include oil palm (Elaeis guineensis), cacao (Theobroma cacao), cassava (Manihot esculenta) and rubber (Herea brasiliensis) (Enaruvbe and Atafo, 2015).

Plant Species Identification and Enumeration

The vegetation makes up of sampled roads in each major urban centre's government residential areas (GRAs) and control sites (Table 1). The study made use of (3) major street roads in the GRAs in each major cities, whereby plants were identified and enumerated in order to understand their vegetation status. These roads were selected based on their high vegetation composition and status, while the control sites were selected based on the diverse diverse species of plants can be enumerated and used as basis of comparison for the research. The control sites are the primary or secondary forest, nature parks or any other relatively undisturbed forests in each study area. The control sites were located at a minimum of 300m away from the sampled roads (sites). The study applied transect methods whereby quadrats of 30 m by 200m used for the data collection were selected within each transect (street road). In other words several quadrats were established regularly in relation to the road length for each sampled street roads. Therefore, plant types were identified and enumerated on the spot with the help of a Taxonomist from the start to the end of the street road (transect). Quadrats of 30m x 200m were laid on both sides of the road and a gap of 100m was created till the next quadrat and so on until the end of the street road (Figure 2). On the other hand, the control sites plant species were identified within selected secondary forest using also quadrat methods. Five (5) 30m x 30m randomly selected quadrats were delimited within quadrats of 100m x 100m laid within each control sites for the collection of data on the vegetal composition and the plant species types. The data collection exercise was carried out between March and June, 2019 (for a period of four (4) months). The data collected on plant types and composition were used for the computation of analytical vegetation features such as species composition, species density, species diversity, species richness, species evenness and similarity index which followed standard phyto-sociological methods. The identification of plant was also carried out with the help of a Taxonomist from the University of Port Harcourt. The plants that were not identified in situ were taken to the Herbarium in the University for Proper Identification. Species composition of plants were determined by identifying the plant species while the population of individual species were determined by direct counting of the population of each species in the sampled roads and control sites. The species diversity index (H') of identified plant were computed using Simpson's index (Simpson, 1949). The value of D ranges from 0 to 1. With this index, 0 represents maximum diversity and, 1, no diversity. That is, the bigger the value the lower the diversity (Chima and Omokhua, 2011). The species richness (the number of species in a given community) was determined using Margalef's index (Margalef, 1958). Species evenness (the distribution of individuals among the species) was calculated using Simpson's evenness method (Magurran, 1988). Evenness is a measure of the relative abundance of the different species making up the richness of an area and the Simpson's evenness formula was used for its determination which specifies that evenness is constrained between 0 and 1. The less variation in communities between the species, the higher E' is. The descriptive statistics was used to present the data while inferential statistics was used in the study to analyze the data. The descriptive was employed to explain the species composition in sampling sites and the analysis was computed using SPSS version 24.0.

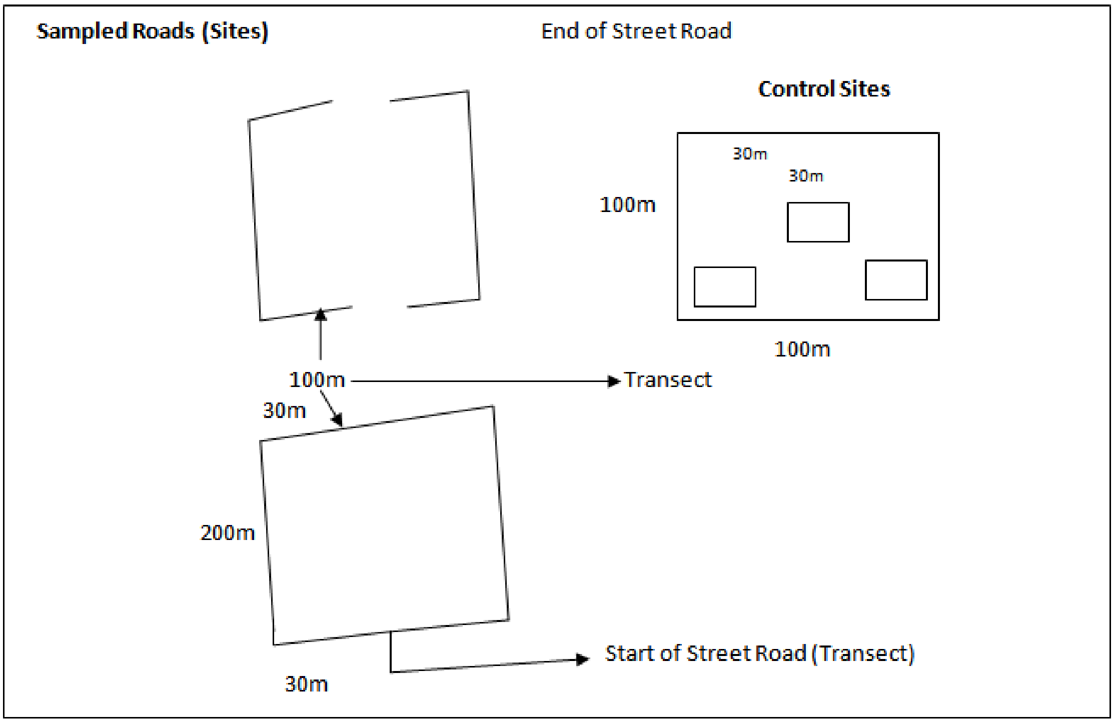

Figure 2: Method of collection of plant species types and composition in the study area

Table 1: Study Areas/Sampled Streets/Roads Names and Locations

State	Capital Cities	GRA	Selected Street name/Sampled Sites	Location	
				Northings	Eastings
Akwa Ibom	Uyo	Ewet Housing	Godwin Abe/1	5.01188^0	7.95012^0
			G-Lane/2	5.01677^0	7.94520^0
			Lagos Street/3	5.01281^0	7.94528^0
Bayelsa	Yenagoa	Otitio GRA	Biogbolo/1	4.93921^0	6.32203^0
			Erepa/2	4.93361^0	6.32187^0
			Otitio/3	4.93638^0	6.31922^0
Control Sites					
Akwa Ibom	Uyo (Secondary Forest)			5.05422^0	7.92774^0
Bayelsa	Yenagoa (Okordia Clan Secondary Forest)			5.14036^0	6.44856^0

III. RESULTS AND DISCUSSIONS

Plant Species Identified along Sampled Roads across the Selected Cities

The plant species composition in the GRAs and control sites in Uyo are displayed on Table 2 and Figure 3. In the first sampled site, it was displayed that Caesalpina pulcherrima recorded 4.7% individuals, Carica papaya recorded 8.2% individuals, Cocos nucifera recorded 8.2% individuals, Cuphea California Torr recorded 3.5% individuals, Ficus benjamina L. and Nutt. recorded 4.7% and 5.9% individuals respectively; Hibiscus arnottiamus recorded 2.4% individuals, Hura crepitans was 3.5% individuals, Mangifera indica was 12.9% individuals, Musa sapientum was 10.6% individuals, Nerium oleander L. recorded 4.7% individuals, Polyalthia longifolia recorded 15.3% individuals, Psidium guajava recorded 7.1% individuals, Syagrus romanzoffiana also recorded 4.7% individuals, while Terminalia mantalis recorded 3.5% individuals from total percentage of identified plants. The study discovered that Polyalthia longifolia (15.3%) recorded the highest number of individual plant species. A total of 15 individuals of different plant species with an overall total number of 85 individual plant compositions were identified. In second sampled site, it was revealed that Carica papaya recorded 4.0% individuals, Delonix regia recorded 4.0% individuals, Ficus nitida recorded 2.3% individuals, Hibiscus arnottiamus recorded 2.8% individuals, Musa paradisiacal recorded 5.2% individuals, Musa sapientum was 6.9% individuals, Polyalthia longifolia recorded 10.4% individuals, Psidium guajava recorded 7.5% individuals, Rhizophora mangus recorded 1.7% individuals, Terminalia cattapa recorded 3.5%

individuals, while the remaining percentage from the total of identified plant species was Vossia cuspidata and it recorded 51.4% number of individuals in the study area. For sampled trees and shrubs, Psidium guajava recorded the highest while only one type of grass (herbs) was identified (Vossia cuspidata). A total of 11 individuals of different plant species with an overall total of 173 individual plant compositions were identified.

In the third sampled site displayed in Table 6, Albizia zygia recorded 3.0% individuals, Anacardium occidentale recorded 4.5% individuals, Anona nuricata recorded 4.5% individuals, Carica papaya recorded 11.9% individuals, Citrus spp recorded 9.0% individuals, Cocos nucifera recorded 9.0% individuals, Cycas revolute recorded 6.0% individuals, Elaeis guineensis recorded 9.0% individuals, Erythrophlem ivorensis recorded 6.0% individuals, Ficus benjamina recorded 7.5% individuals, Ficus carica recorded 6.0% individuals, Mangifera indica recorded 9.0% individuals, Persea Americana recorded 3.0% individuals, Ralphia hookeri recorded 9.0% individuals, while Spondiae cythera recorded 3.0% individuals in the study area. An overall total of 67 individuals of plant species from 15 individuals of different species were identified in the third sampled site.

In the control site, the plant composition revealed that A.laxiflora recorded 1.9% individuals, Acioa barteri recorded 1.0% individuals, Albizia adianthifolia recorded 1.0% individuals, Alstonia boonei recorded 2.2% individuals, Anacardium occidentale recorded 1.0% individuals, Anthocleisti vogelii recorded 1.3% individuals, Anthonotha macrophylla recorded 0.6% individuals, Antiaris Africana recorded 1.0% individuals, Bambusa vulgaris recorded 1.3% individuals, Baphia nitida recorded 1.6% individuals, Bombax buonopozense recorded 0.6% individuals, Centrosema pubescens recorded 13.5% individuals, Chromolaena odorata recorded 9.0% individuals, Cleistopholis patens recorded 7.1% individuals, Cola acuminate recorded 10.6% individuals, Combretum albidum recorded 8.7% individuals, Costus afer recorded 11.2% individuals, Dracena sp recorded 1.3% individuals, Elaeis guineensis recorded 3.8% individuals, Ficus exasperata recorded 2.2% individuals, Garcinia manii recorded 0.6% individuals, Harungana madagascariensis recorded 2.6% individuals, Leea guineensis recorded 1.9% individuals, Musanga cecropioides recorded 3.5% individuals, Myrianthus arboreus recorded 2.2% individuals, Pterocarpus mildbraedii recorded 0.6% individuals, Raphia spp recorded 1.6% individuals, Senna alata recorded 2.9% individuals, Terminalia ivorensis recorded 1.0% individuals, while Urena lobata recorded 0.6% individuals.

Table 2: Identified Plant Species in Sampled and Control Site in Uyo, Akwa Ibom State

Site 1	**Plant Species Types**	**Frequency**	**%**
1	Caesalpinia pulcherrima	4	4.7
2	Carica papaya	7	8.2
3	Cocos nucifera	7	8.2
4	Cuphea california Torr.	3	3.5
5	Ficus benjamina L.	4	4.7
6	Ficus benjamina Nutt.	5	5.9
7	Hibiscus arnottianus	2	2.4
8	Hura crepitan	3	3.5
9	Mangifera indica	11	12.9
10	Musa sapientum	9	10.6
11	Nerium oleander L.	4	4.7
12	Polyalthia longifolia	13	15.3
13	Psidium guajava	6	7.1
14	Syagrus romanzoffiana	4	4.7
15	Terminalia mantaly	3	3.5
	Total	85	100.0
Site 2	**Plant Species Types**	**Frequency**	**%**
1	Carica papaya	7	4.0
2	Delonix regia	7	4.0
3	Ficus nitida	4	2.3
4	Hibiscus arnottians	5	2.9
5	Musa parasidiaca	9	5.2

6	Musa sapientum	12	6.9
7	Polyalthia longifolia	18	10.4
8	Psidium guajava	13	7.5
9	Rhizophora mangus	3	1.7
10	Terminalia cattapa	6	3.5
11	Vossia cuspidata	89	51.4
	Total	173	100.0
Site 3	**Species Types**	**Frequency**	**%**
1	Albizia zygia	2	3.0
2	Anacardium occidentale	3	4.5
3	Anona nuricata	3	4.5
4	Carica papaya	8	11.9
5	Citrus spp	6	9.0
6	Cocos nucifera	6	9.0
7	Cycas revoluta	4	6.0
8	Elaeis guineensis	6	9.0
9	Erythrophlem ivorensis	4	6.0
10	Ficus benjamina	5	7.5
11	Ficus carica	4	6.0
12	Mangifera indica	6	9.0
13	Persea americana	2	3.0
14	Ralphia hookeri	6	9.0
15	Spondiae cythera	2	3.0
	Total	67	100.0
Control Site	**Plant Species Types**	**Frequency**	**%**
1	A. laxiflora	6	1.9
2	Acioa barteri	3	1.0
3	Albizia adianthifolia	3	1.0
4	Alchornea cordifolia	5	1.6
5	Alstonia boonei	7	2.2
6	Anacardum occidentalis Linn	3	1.0
7	Anthocleista vogelii	4	1.3
8	Anthonotha macrophylla	2	0.6
9	Antiaris africana	3	1.0
10	Bambusa vulgaris	4	1.3
11	Baphia nitida	5	1.6
12	Bombax buonopozense	2	0.6
13	Centrosema pubescens	42	13.5
14	Chromolaena odorata	28	9.0
15	Cleistopholis patens	22	7.1
16	Cola acuminate	33	10.6
17	Combretum albidum	27	8.7
18	Costus afer	35	11.2
19	Dracena sp. Linn.	4	1.3

20	Elaeis guineensis	12	3.8
21	Ficus exasperata	7	2.2
22	Garcinia manii	2	0.6
23	Harungana madagascariensis	8	2.6
24	Leea guineensis	6	1.9
25	Musanga cecropioides	11	3.5
26	Myrianthus arboreus	7	2.2
27	Pterocarpus mildbraedii	2	0.6
28	Raphia spp	5	1.6
29	Senna alata	9	2.9
31	Terminalia ivorensis	3	1.0
32	Urena lobata	2	0.6
	Total	312	100.0

Figure 3: Selected Sampled Sites (Roads) in Ewet Housing Estate (GRA), Uyo, Akwa Ibom

In Yenagoa, the plant compositions in the selected road samples and control site are displayed in Table 3 and Figure 4. In sample site 1, the distribution revealed that Carica papaya recorded 3.7% individuals, Cocos nucifera recorded 3.7% individuals, Cycas cecenalis recorded 1.7% individuals, Cynodon dactylon recorded 80.6% individuals, Delonix regia recorded 0.9% individuals, Mangifera indica recorded 2.3% individuals, Musa sapientum was 1.1% individuals, Polyalthia longifolia recorded 2.3% individuals, Psidium guajava recorded 2.9% individuals, while Thuja sinensis recorded 0.9% individuals from total percentage of identified plants. A total of 10 individuals of different plant species with an overall total number of 350 individual plant compositions were identified.

The information for the plant species types identified under sampled sites 2 revealed that Carica papaya recorded 4.0% individuals, Delonix regia recorded 4.0% individuals, Mangifera indica recorded 8.0%

individuals, Musa paradisiaca recorded 17.3% individuals, Polyalthia longifolia recorded 24.0% individuals, Psidium guajava recorded 10.7% individuals, Spondias cethera recorded 4.0% individuals, while Terminalia mantaly recorded 16.0% individuals. A total of 9 individuals of different plant species types with an overall total of 75 individual plant compositions were identified.

In the third sampled site in Yenagoa; Alchornea cordifolia recorded 16.2% individuals, Bambusa vulgaris recorded 6.8% individuals, Carica papaya recorded 4.1% individuals, Citrus spp recorded 5.4% individuals, Delonix regia recorded 13.5% individuals, Elaeis guineensis recorded 13.5% individuals, Mangifera indica recorded 4.1% individuals, Musa paradisica recorded 8.1% individuals, Musa sapientum recorded 5.4% individuals, Psidium guajava recorded 10.8% individuals, Terminalia cattapa recorded 5.4%, while Terminalia mantaly recorded 6.8% individuals in the study area. An overall total of 74 individuals of plant species from 15 different plant species types were identified in the third sampled site.

The identified plant species types recorded under the control site were showed that Alchornea cordifolia recorded 2.7% individuals, Alstonia boonei recorded 3.4% individuals, Alstonia congesis recorded 2.7% individuals, Anthocleistii vogelii recorded 2.7% individuals, Anthonotha macrophylla recorded 2.0% individuals, Bambusa vulgaris recorded 8.7% individuals, Bridella micrantha recorded 2.0% individuals, Cleistopholis patens recorded 2.0% individuals, Combretum micranthia recorded 7.4% individuals, Elaeis guineensis recorded 14.8% individuals, Endodesima calophylloides recorded 3.4% individuals, Erasmopatha microcapa recorded 2.7% individuals, Garcinia kola recorded 2.0% individuals, Guarea cedrata recorded 5.3% individuals, Harungana madagascariensis recorded 2.0% individuals, Hevea brasiliensis recorded 4.7% individuals, Lophira Alata recorded 2.7% individuals, Militia aboensis recorded 1.3% individuals, Musanga cecropioides recorded 3.4% individuals, Newbouldia laevis recorded 1.3% individuals, Picanthus agolensis recorded 4.2% individuals, Psidium guajava recorded 6.7% individuals, Raphia manii recorded 2.7% individuals, Raphia vinifera recorded 5.4% individuals, Rauvolfia vomitoria recorded 2.7% individuals, while lastly Rhizophora racemosa recorded 1.3% individuals in the study area.

Table 3: Identified Plant Species in Sampled Sites 1, 2 and 3 in Yenagoa, Bayelsa State

Site 1	**Species Types**	**Frequency**	**%**
1	Carica papaya	13	3.7
2	Cocos nucifera	13	3.7
3	Cycas cecenalis	6	1.7
4	Cynodon dactylon	282	80.6
5	Delonix regia	3	0.9
6	Mangifera indica	8	2.3
7	Musa sapientum	4	1.1
8	Polyalthia longifolia	8	2.3
9	Psidium guajava	10	2.9
10	Thuja sinensis	3	0.9
	Total	**350**	**100.0**
Site 2	**Species Types**	**Frequency**	**%**
1	Carica papaya	5	6.7
2	Cycas cecenalis	7	9.3
3	Delonix regia	3	4.0
4	Mangifera indica	6	8.0
5	Musa paradisica	13	17.3
6	Polyalthia longifolia	18	24
7	Psidium guajava	8	10.7
8	Spondias cethera	3	4.0

9	Terminalia mantaly	12	16.0
	Total	**75**	**100.0**
Site 3	**Species Types**	**Frequency**	**%**
1	Alchornea cordifolia	12	16.2
2	Bambusa vulgaris	5	6.8
3	Carica papaya	3	4.1
4	Citrus spp	4	5.4
5	Delonix regia	10	13.5
6	Elaeis guineensis	10	13.5
7	Mangifera indica	3	4.1
8	Musa paradisica	6	8.1
9	Musa sapientum	4	5.4
10	Psidium guajava	8	10.8
11	Terminalia cattapa	4	5.4
12	Terminalis mantaly	5	6.8
	Total	74	100.0
Control Site	**Species Types**	**Frequency**	**%**
1	Alchornea cordifolia	4	2.7
2	Alstonia boonei	5	3.4
3	Alstonia congesis	4	2.7
4	Anthocleistii vogelii	4	2.7
5	Anthonotha macrophylla	3	2.0
6	Bambusa vulgaris	13	8.7
7	Bridella micrantha	3	2.0
8	Cleistopholis patens	3	2.0
9	Combretum micranthia	11	7.4
10	Elaeis guineensis	22	14.8
11	Endodesima calophylloides	5	3.4
12	Erasmopatha microcapa	4	2.7
13	Garcinia kola	3	2.0
14	Guarea cedrata	8	5.4
15	Harungana madagascariensis	3	2.0
16	Hevea brasiliensis	7	4.7
17	Lophira Alata	4	2.7
18	Militia aboensis	2	1.3
19	Musanga cecropioides	5	3.4
20	Newbouldia laevis	2	1.3

21	Picanthus agolensis	6	4.0
22	Psidium guajava	10	6.7
23	Raphia manii	4	2.7
24	Raphia vinifera	8	5.4
25	Rauvolfia vomitoria	4	2.7
26	Rhizophora racemosa	2	1.3
	Total	149	100.0

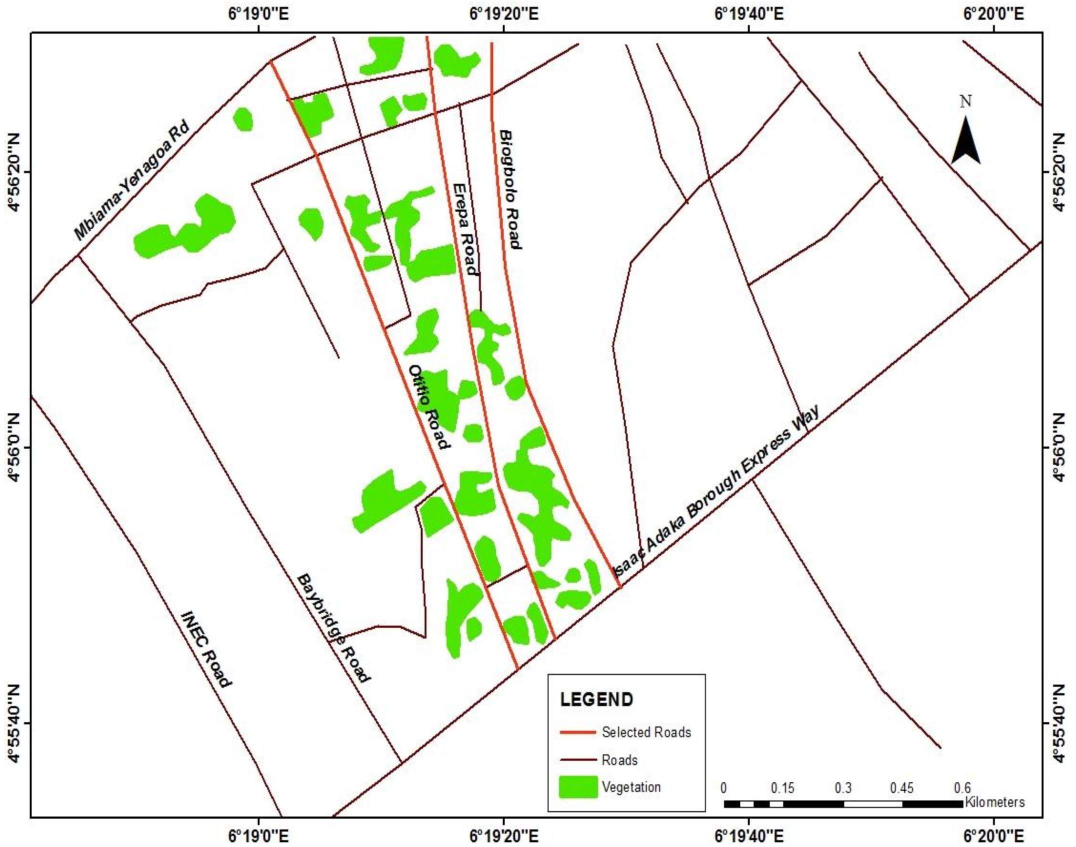

Figure 1: Selected Sample Sites (Roads) in Yenagoa, Bayelsa State

Species Diversity, Richness and Evenness of Urban Plants in the GRAs

The species diversity of identified plants between the sampled sites and control site in the study area was displayed on Table 4 and Table 5. In Uyo, the results showed that species diversity was 0.895 under the sampled sites and 0.932 under the control site. In Yenagoa, findings showed that the species diversity of identified plants was 0.658 under the sampled sites and 0.946 under the control sites. This shows that the species diversity in the relatively disturbed forest was higher than that of the built up area. The implication is that urban plants diversity have been influenced because of construction and development. Except Elaeiss guineensis that is common between the control and samples sites; all other urban plants are totally heterogenous.

Table 4: Plant Species Diversity in the GRAs and Control Sites in Uyo

		Control			GRA		
S/N	**Species Types**	**ni**	**ni-1**	**ni(ni-1)**	**ni**	**ni-1**	**ni(ni-1)**
1	A. laxiflora	6	5	30	0	0	0
2	Acioa barteri	3	2	6	0	0	0
3	Albizia adianthifolia	3	2	6	0	0	0
4	Albizia zygia	0	0	0	2	1	2
5	Alchornea cordifolia	5	4	20	0	0	0
6	Alstonia boonei	7	6	42	0	0	0
7	Anacardium occidentale	0	0	0	3	2	6
8	Anacardum occidentalis Linn	3	2	6	0	0	0
9	Anona nuricata	0	0	0	3	2	6
10	Anthocleista vogelii	4	3	12	0	0	0
11	Anthonotha macrophylla	2	1	2	0	0	0
12	Antiaris africana	3	2	6	0	0	0
13	Bambusa vulgaris	4	3	12	0	0	0
14	Baphia nitida	5	4	20	0	0	0
15	Bombax buonopozense	2	1	2	0	0	0
16	Caesalpinia pulcherrima	0	0	0	4	3	12
17	Carica papaya	0	0	0	22	21	462
18	Centrosema pubescens	42	41	1722	0	0	0
19	Chromolaena odorata	28	27	756	0	0	0
20	Citrus spp	0	0	0	6	5	30
21	Cleistopholis patens	22	21	462	0	0	0
22	Cocos nucifera	0	0	0	13	12	156
23	Cola acuminate	33	32	1056	0	0	0
24	Combretum albidum	27	26	702	0	0	0
25	Costus afer	35	34	1190	0	0	0
26	Cuphea california Torr.	0	0	0	3	2	6
27	Cycas revoluta	0	0	0	4	3	12
28	Delonix regia	0	0	0	7	6	42
29	Dracena sp. Linn.	4	3	12	0	0	0
30	Elaeis guineensis	12	11	132	6	5	30
31	Erythrophlem ivorensis	0	0	0	4	3	12
32	Ficus benjamina	0	0	0	7	6	42
33	Ficus benjamina Nutt.	0	0	0	5	4	20
34	Ficus carica	0	0	0	4	3	12
35	Ficus exasperata	7	6	42	0	0	0
36	Ficus nitida	0	0	0	4	3	12
37	Garcinia manii	2	1	2	0	0	0
38	Harungana madagascariensis	8	7	56	0	0	0
39	Hibiscus arnottians	0	0	0	7	6	42
40	Hura crepitan	0	0	0	3	2	6

41	Leea guineensis	6	5	30	0	0	0
42	Mangifera indica	0	0	0	17	16	272
43	Musa parasidiaca	0	0	0	9	8	72
44	Musa sapientum	0	0	0	21	20	420
45	Musanga cecropioides	11	10	110	0	0	0
46	Myrianthus arboreus	7	6	42	0	0	0
47	Nerium oleander L.	0	0	0	4	3	12
48	Persea americana	0	0	0	2	1	2
49	Polyalthia longifolia	0	0	0	31	30	930
50	Psidium guajava	0	0	0	19	18	342
51	Pterocarpus mildbraedii	2	1	2	0	0	0
52	Ralphia hookeri	0	0	0	6	5	30
53	Raphia spp	5	4	20	0	0	0
54	Rhizophora mangus	0	0	0	3	2	6
55	Senna alata	9	8	72	0	0	0
56	Spondiae cythera	0	0	0	2	1	2
57	Syagrus romanzoffiana	0	0	0	4	3	12
58	Terminalia cattapa	0	0	0	6	5	30
59	Terminalia ivorensis	3	2	6	0	0	0
60	Terminalia mantaly	0	0	0	3	2	6
61	Urena lobata	2	1	2	0	0	0
62	Vossia cuspidata	0	0	0	89	88	7832
		N=312 N(N-1) = 97032		$\Sigma n_i(n_i - 1)$ = 6580 D= 0.068	N= 323 N(N-1) =104006		$\Sigma n_i(n_i - 1)$= 10878 D=0.105
				Diversity= 0.932			**Diversity = 0.895**

Table 5: Plant Species Diversity in the GRAs and Control Sites in Yenagoa

		GRA			**Control**		
S/N	**Species Types**	**ni**	**ni-1**	**ni(ni-1)**	**ni**	**ni-1**	**ni(ni-1)**
1	Alchornea cordifolia	12	11	132	0	0	0
2	Alchornea cordifolia	0	0	0	4	3	12
3	Alstonia boonei	0	0	0	5	4	20
4	Alstonia congesis	0	0	0	4	3	12
5	Anthocleistii vogelii	0	0	0	4	3	12
6	Anthonotha macrophylla	0	0	0	3	2	6
7	Bambusa vulgaris	5	4	20	13	12	156
8	Bridella micrantha	0	0	0	3	2	6
9	Carica papaya	21	20	420	0	0	0
10	Citrus spp	4	3	12	0	0	0
11	Cleistopholis patens	0	0	0	3	2	6
12	Cocos nucifera	13	12	156	0	0	0
13	Combretum micranthia	0	0	0	11	10	110
14	Cycas cecenalis	13	12	156	0	0	0
15	Cynodon dactylon	282	281	79242	0	0	0

16	Delonix regia	16	15	240	0	0	0
17	Elaeis guineensis	10	9	90	22	21	462
18	Endodesima calophylloides	0	0	0	5	4	20
19	Erasmopatha microcapa	0	0	0	4	3	12
20	Garcinia kola	0	0	0	3	2	6
21	Guarea cedrata	0	0	0	8	7	56
22	Harungana madagascariensis	0	0	0	3	2	6
23	Hevea brasiliensis	0	0	0	7	6	42
24	Lophira Alata	0	0	0	4	3	12
25	Mangifera indica	17	16	272			
26	Militia aboensis	0	0	0	2	1	2
27	Musa paradisica	19	18	342	0	0	0
28	Musa sapientum	8	7	56	0	0	0
29	Musanga cecropioides	0	0	0	5	4	20
30	Newbouldia laevis	0	0	0	2	1	2
31	Picanthus agolensis	0	0	0	6	5	30
32	Polyalthia longifolia	18	17	306	0	0	0
33	Psidium guajava	26	25	650	0	0	0
34	Psidium guajava	0	0	0	10	9	90
35	Raphia manii	0	0	0	4	3	12
36	Raphia vinifera	0	0	0	8	7	56
37	Rauvolfia vomitoria	0	0	0	4	3	12
38	Rhizophora racemosa	0	0	0	2	1	2
39	Spondias cethera	3	2	6	0	0	0
40	Terminalia cattapa	4	3	12	0	0	0
41	Terminalia mantaly	17	16	272	0	0	0
42	Thuja sinensis	3	2	6	0	0	0
		N= 491 N(N-1) = 240590		$\Sigma n_i(n_i -1)$ =82390 D =0.342	N=149 N(N-1) = 22052		$\Sigma n_i(n_i -1)$ =1182 D= 0.054
				Diversity = 0.658			**Diversity = 0.946**

Plant Species Richness in Sampled Sites and Control Sites in the Study Area

The plant species richness computed for sampled sites and control sites in the study area were displayed on Table 6. The result of the plant species richness showed that species richness was higher under the control site than the sampled sites in both Uyo and Yenagoa. In Uyo, the species richness of urban plant was 5.398 under the control site while in the GRA, the species richness was 5.365. On the other hand, the species richness of urban plants was 4.996 in the control sites and 2.744 in GRAs.

Table 6: Plant Species Richness in all Study Sites (GRA and Control sites)

Study Sites		S	N	ln N	S-1	(S-1)/ln N
Uyo	Sampled Sites	32	323	5.778	31	5.365
	Control Sites	31	312	5.743	31	5.398
Yenagoa	Sampled Sites	18	491	6.196	17	2.744
	Control Sites	26	149	5.004	25	4.996

S-Number of species; N-Total number of individual species identified; ln-Natural logarithms

Plant Species Evenness in the Study Area

The information for the plant species evenness in the study area was displayed on Table 7. The species evenness for the study describes the distribution of number of individuals of each species among identified plant species in the GRA and control sites. The values of E' ranged between 0.03 and 0.04 which indicated lower variations. Thus, it can be concluded that the species evenness of identified plant species in both sampled sites and control sites in the study area was low suggesting that the plant species in the control sites was higher. This showed that the urban plants have less heterogeneity in terms of species composition.

Table 7: Tree species Evenness in all sampled study sites

Study Sites		D'	S	D'/S	*E' variations
Uyo	Sampled Sites	0.895	32	0.030	0.03
	Control Sites	0.932	32	0.029	0.03
Yenagoa	Sampled Sites	0.658	18	0.038	0.04
	Control Sites	0.946	26	0.036	0.04

IV. DISCUSSION OF FINDINGS

Findings showed that the identified plant species in the GRAs were lower than that of control site with respect to species composition and individual plant species. The low plant species composition and individual plants in the GRA may be due to urbanization and construction. Mellinger et al., (2018) reported that the degree of urbanization on species diversity revealed that even distribution of plant species type reduced with level of urbanization. Furthermore, Grimm et al. (2005) and Groffman et al. (2014) have reported that urban land-use change has been identified as one of the major components of environmental change because of its effects on climate, water, biodiversity, carbon (C), and nutrients across large areas of the globe. The species composition of urban plants in the GRAs was completely different from that of the control site except the presence of Elaiess guineensis which was common in both sites. This may be due to the introduction of alien plant species in the urban centre. Liang et al (2008) reported that in the process of urbanization, exotic plants have been widely introduced, which has affected species composition and the proportion of native plants. Similarly, Clemants and Moore (2003) and Ignatieva (2010) reported that cities harbour a large number of non native plant species. Findings revealed that the species diversity of urban plants was lower in the GRA than the natural forest. This is in contrary to the findings of McKinney (2006) and Kendal et al. (2012) who reported that cities are recognised centers of plant diversity. Meanwhile, Liang et al (2008) has reported that it is clear that artificial green spaces always will have a lower level of plant diversity than natural green spaces. The lower species diversity could be attributed to urbanization which is measured through human activities. Many human activities like reclamation, overgrazing, resource exploitation and unsystematic land-use are decreasing plant diversity, affecting the natural environment on which people rely (Czech et al., 2000). Among these activities, transforming the ecosystem, urbanization is believed to be the main driving force of environmental changes and species extinction. More importantly, the socio-economic status of the urban areas could affect the plant diversity found in the area. Bottom-up anthropogenic forces also affect diversity and abundance patterns at a household scale (Walker et al, 2009). In an earlier study on plant diversity in Phoenix, Hope et al. (2003) suggested so-called “luxury effect”, in which wealthier neighbourhoods tended to have increased numbers of perennial gen-era, afforded by homeowners' additional disposable income. The species richness of urban plants was discovered to be lower in the GRAs than the natural forest. MicKinney (2002) reported urbanization is a major cause of native species extinction. Ogwu et al (2016) buttressed further that the constraints to tree availability in the urban areas of Benin City included building constructions, urbanisation, unlawful felling of trees and lack of orientation of the inhabitants on the uses of trees.

V. CONCLUSION AND RECOMMENDATIONS

The study has revealed that the plant species diversity, richness and evenness of urban plants have been severely degraded due to urbanization in the study area. It shows that urban greening has been affected and the ecosystem services they are expected to supply the humanity have been lowered or shattered totally. The study therefore recommended that planting trees in the streets in the urban centres should be encouraged and taken seriously. Furthermore, government and other stakeholder should provide monitoring team that will always evaluate the tree composition periodically.

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