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Spatial Analysis of Trees Composition, Diversity and Richnesss in the Built up Areas of University of Port Harcourt, Nigeria

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Abstract**—**The study investigated the spatial analysis of trees composition, diversity and richness in the built up area of University of Port Harcourt, Nigeria. Four quadrats of 25m x 25m size were laid randomly in each of the three parks and inventories of trees ≥10cm girth at breast height were taken and used to calculate the species composition, diversity and richness. Results showed that species composition and diversity in Abuja Park was the highest with 134 species and 0.866 respectively while the species richness was highest in Choba Park with a value of 2.496. The correlation between the size of park (spatial coverage) and species composition was 0.99 while the correlation between the size of the park and species diversity was 0.78. There was direct relationship between species composition and diversity while the relationship between species composition and species richness was inversely proportional. Rational use of these resources is encouraged.

Keywords**—**Built up area, composition, diversity, richness, spatial analysis, urban tree.

I. Introduction

THE urban landscape transformation due to urbanization is a matter of concern to environmental managers in recent times because of environmental problems derived from such land use change. In this regard, the roles of urban forestry which is concerned with enhancing the vegetation within any entire urban area cannot be over emphasized.

Urban forestry means the planning, establishment, protection, and management of trees and associated plants individually in small groups or under forest conditions within cities than suburbs and towns [1]. Reference [2] affirmed that urban trees are scattered trees in permanent meadows and pastures; permanent tree crops such as fruit trees and coconuts, trees in parks and gardens, around buildings and in lines along streets, roads, railways, rivers, streams and canals, trees in shelterbelts of less than 20m width and 0.5 ha area.

Urban trees make positive contributions to living conditions in and around the third world towns and cities. This gives an impression that urban forestry is very beneficial to mankind and its importance cannot be underestimated especially during this period when developing countries are witnessing tremendous changes. The importance include microclimate and air quality enhancement, temperature modification [3], wind breaker, noise reduction, watershed management [4] erosion control, solid waste and land reclamation

Reference [5] believed that urbanization increases the land area that is covered with impermeable surfaces and thus the incidence of flooding is experienced because of the increase in the runoff. However, [6] submitted that tree canopies intercept rainfall, thereby preventing flooding and sedimentation of waterways.

Comprehensively, [7] affirmed that sustainable urban forestry aims at achieving and maintaining a balanced forest structure within and around each urban locality, to ensure continuous tree cover and attainment of diverse benefits for current and future generations.

References [8] and [9] revealed that urban forestry structures considered in city planning and development include the size of the tree species composition, tree heights, crown spread, biomass and location. The urban tree composition and diversity are important aspect of urban forestry because of their roles in enhancing and aiding adequate monitoring and management. As a matter of fact, urban trees composition and diversity are influenced by several factors which range from physical (soil, climate etc), to economic factors.

According to [3], the factors that influence urban forest composition and diversity include function or purpose, popularity of species, public control mobility, nostalgia and socio-economic factors. Monitoring and managing urban trees in an institutional landscape is very necessary but few studies have been carried out on the tree composition, diversity and richness in the institutional-based landuse and as a result, the management of trees in a landuse type like this suffers.

This study therefore investigates and compares the tree species composition and diversity in the built up area among the three parks (Abuja, Delta and Choba) within the University of Port Harcourt.

II. Methods and Materials

A. Study Area

The study was conducted in the three parks (Abuja, Delta and Choba) University of Port Harcourt, Nigeria. The study area is located on latitudes 4^{o} 52'N and 4^{o} 55'N and longitudes 6^{o} 54'E and 6^{o} 56'E (Fig. 1) and has a tropical monsoon climate with mean annual temperature of 28^{o}C and annual rainfall over 2500mm. The relative humidity is very high with

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an annual mean of 85%. The soil is usually sandy or sandy loam underlain by a layer of impervious pan and is always leached due to the heavy rainfall. The relief is generally lowland which has an average of elevation between 20m and 30m above sea level and the geology of the area comprises basically of alluvial sedimentary basin and basement complex. The vegetation found in this area includes light rain forest and fresh swamp forest. The study area is well drained with freshwater.

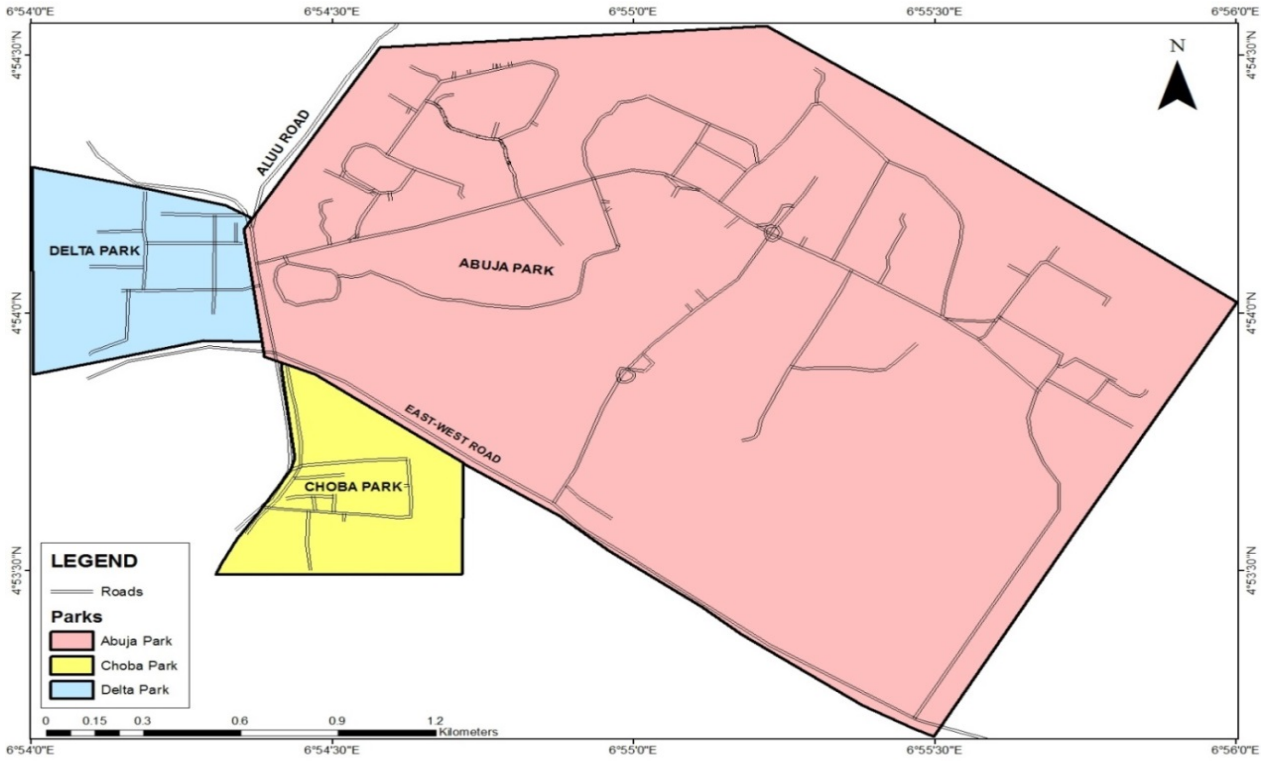

Fig. 1 Map of University of Port Harcourt

B. Urban Tree Sampling

Fourquadrats of 25m x 25m size were laid randomly in the built up area landuse in each of the three parks in the study area whereby inventories of trees with ≥10cm girth at breast height were taken. The trees were properly identified. The species composition was determined as explained in [10] while the species richness was determined with the use of Margalef's Index [11] (1). Species diversity was determined using Simpson's index of diversity [12] (2). Relationships between species composition and species diversity; species composition and species richness were determined using regression analysis. Correlation analysis was used to determine the relationship between the size of the park and the tree composition and diversity. The size of the park (spatial coverage) was determined using ArcGIS 9.3 in squared kilometers.

$$\text{Margalef's Index of richness (Dmg)} = {S-1}/{\ln N} \quad (1)$$

where S = Total number of species;N = Total number of individuals.

$$\text{Simpson index of diversity} = 1 - D = 1 - \sum(Pi)^2 \quad (2)$$

where, D = Simpson index of dominance,Pi= the proportion of important value of the i^{th} species, $Pi = {ni}/{N}$, ni is the number of individuals in i^{th} species, $N$is the total number of individuals in the entire population.

III. RESULTS

Table I presents the species composition of urban trees in the three parks whereby a total of 251 trees of 15 species were found. Of this total, 51 trees of 11 species were found in Choba Park, 134 trees of 10 species were found in Abuja Park while 62 trees of 11 species were found in Delta Park (Fig. 2).

Among the trees, *Terminali aivoriensis* had the highest composition with 15.14% of the total composition while *Psidium guajava*, and *Alchornea cordifolia* had 13.94% and 12.75% respectively. *Magnifera indica* had a total composition of 4.38% in the study area while *Citrus sineensis*, *Chrysophyllum albidum*, *Polyatia longifolia* had 1.99%, 2.79% and 1.59% respectively.

Musanga cecropoides recorded the least among the trees found in the study area and it represented only 0.40% of total tree composition in the area.

TABLE I
SPECIES COMPOSITION OF URBAN TREES AMONG THE PARKS

S/N	Tree Species	Choba	Abuja	Delta	Total	%
1	*Gmelina arborea*	5	8	6	19	7.57
2	*Terminali aivoriensis*	7	8	23	38	15.14
3	*Caselpinia pulcherima*	17	-	3	20	7.97
4	*Magnifera indica*	2	6	3	11	4.38
5	*Jathropha curcas*	7	-	2	9	3.59
6	*Psidium guajava*	5	29	1	35	13.94
7	*Cocos nucifera*	1	4	15	20	7.97
8	*Citrus sineensis*	1	-	4	5	1.99
9	*Musanga cecropoides*	1	-	-	1	0.40
10	*Chrysophyllum albidum*	7	-	-	7	2.79
11	*Terminalia catappa*	2	10	1	13	5.18
12	*Elaies guineensis*	-	26	-	26	10.36
13	*Citrus reticulate*	-	11	-	11	4.38
14	*Polyatia longifolia*	-	2	2	4	1.59
15	*Alchornea cordifolia*	-	30	2	32	12.75
	Total	**55**	**134**	**62**	**251**	**100.00**

Source: Authors' Fieldwork, 2012

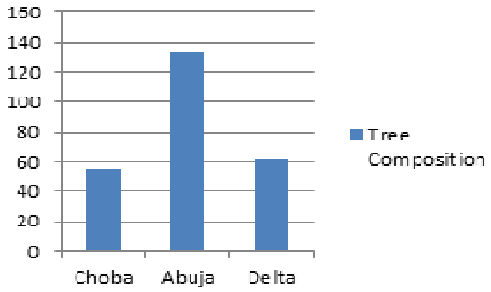

Fig. 2 Species composition of trees in the parks

Table II explains the species diversity of tree species found in the three parks. The species diversity in three parks was high but the highest was observed in Abuja Park with a value of 0.866 while the least species diversity was discovered in Delta Park with a value of 0.723. This is also depicted in Fig 3.

Table III presents the species richness of each of the three parks and it was discovered that the highest was recorded in Choba Park while the least was recorded in Abuja Park. The species richness in Delta Park was higher than that of the Abuja Park. Fig. 4 also depicts the analysis of species richness.

TABLE II
SPECIES DIVERSITY OF URBAN TREE SPECIES

SN	Tree Species	Choba			Abuja			Delta		
		S	**Pi**	**Pi^2**	**S**	**Pi**	**Pi^2**	**S**	**Pi**	**Pi^2**
1	*Gmelina arborea*	5	0.0909	0.0083	8	0.05517	0.0030	6	0.2609	0.0681
2	*Terminali aivoriensis*	7	0.1273	0.0162	8	0.05517	0.0030	23	0.3710	0.1376
3	*Caselpiila pulcherima*	17	0.3091	0.0955	-	-	-	3	0.0484	0.0023
4	*Magnifer aindica*	2	0.0364	0.0132	6	0.04137	0.0017	3	0.0484	0.0023
5	*Jathropha curcas*	7	0.1273	0.0162	-	-	-	2	0.0323	0.0010
6	*Psidium guajava*	5	0.0909	0.0083	29	0.20000	0.0400	1	0.0161	0.0003
7	*Cocos nucifera*	1	0.0181	0.0003	4	0.0276	0.0007	15	0.2419	0.0585
8	*Citrus sineensis*	1	0.0181	0.0003	-	-	-	4	0.0645	0.0042
9	*Musanga cecropoides*	1	0.0181	0.0003	-	-	-	-	-	-
10	*Chrysophyllum albidum*	7	0.1273	0.0162	-	-	-	-	-	-
11	*Terminali acatappa*	2	0.0364	0.0132	10	0.06897	0.0048	1	0.0161	0.0003
12	*Elaies guineensis*	-	-	-	26	0.1793	0.0321	-	-	-
13	*Citrus reticulate*	-	-	-	11	0.07586	0.0058	-	-	-
14	*Poliytia longifolia*	-	-	-	2	0.0149	0.0002	2	0.0323	0.0010
15	*Alchornea cordifolia*	-	-	-	30	0.2068	0.0428	2	0.0323	0.0010
	Total	**55**		**0.188**	**134**		**0.134**	**62**		**0.277**
	Species Diversity			**0.812**			**0.866**			**0.723**

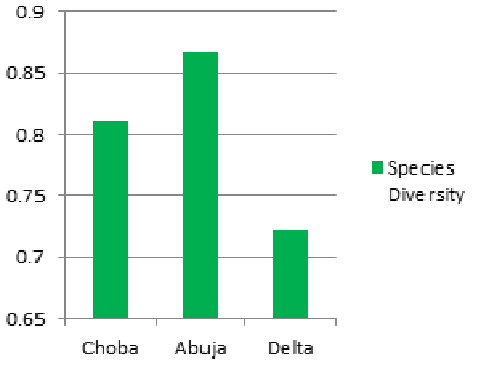

Fig. 3 Species diversity of trees in the parks

TABLE III
SPECIES RICHNESS OF URBAN TREE SPECIES

S/N	Location	S	N	S-1	lnN	(S-1)/ lnN
1	Choba	11	55	10	4.007	2.496
2	Abuja	10	134	9	4.899	1.837
3	Delta	11	62	10	4.127	2.423

Source: Authors' Analysis, 2012

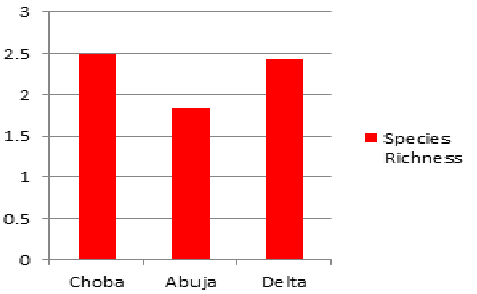

Fig. 4 Species richness of trees in the parks

Relationship between size of the park and species composition and species diversity

TABLE IV
SIZE OF PARK, SPECIES COMPOSITION AND SPECIES DIVERSITY

Parks	Size (Sq Km)	Species Composition	Species Diversity
Abuja	4.61	134	0.866
Delta	0.40	62	0.723
Choba	0.35	55	0.812

Table IV presents the size of the park, species composition and species diversity. The information in the table was used to determine the influence of the size of each park on the species composition and species diversity.

The correlation coefficient (r) between the size of the parks (X) and species composition (Y) was 0.99 while ther^2 was 0.98 and the coefficient of determination was 98.0%. This shows that size of park determines 98.0% of the species composition in the study area. Similarly, the correlation coefficient (r) existing between the size of park and species diversity was 0.78 while the r^2 was 0.61 and the coefficient of determination was 61.0%. This analysis also shows that size of parks determines 61% of species diversity in the University of Port Harcourt.

Relationship between Species composition, Species Diversity and Species Richness

Figs. 5 and 6 explain the regression analysis between the species composition and each of species diversity and species richness respectively. The regression analysis shows that there was a direct relationship between species composition and species diversity with R^2 of 0.54. This shows that 54.0% of tree diversity can be explained by species composition of trees in the study area. Similarly, the regression analysis shows that inverse relationship existed between species richness and species composition with R^2 of 0.996. This suggests that 99.0% of species richness can be explained by species composition in the study area.

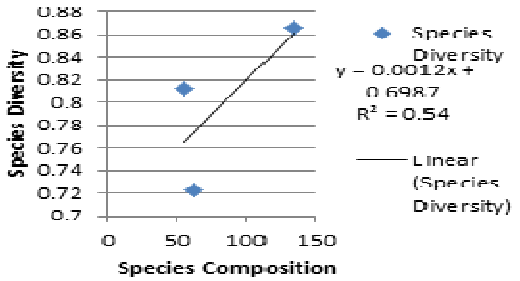

Fig. 5 Regression analysis between species diversity and species composition

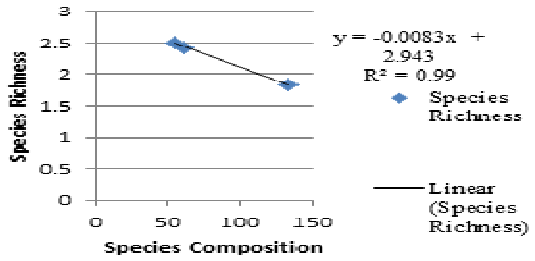

Fig. 6 Regression analysis between species richness and species composition

IV. DISCUSSION

The results of the analysis reveal that the species composition and species diversity were highest in Abuja Park. The reason may be due to the large spatial coverage of the park and the awareness of the roles of urban forestry which is being used as a guide to develop the park as the University Park whereby trees, shrubs and ornamentals are planted along the walkways to provide shade and around buildings to contribute to environmental quality of the place. Reference [13] affirmed that urban afforestation includes the planting of trees, herbs, shrubs and ornamental trees on public lands such as roadsides, walks, parks, city squares and private gardens while [14] submitted that urban forestry is practiced for aesthetic beautification of urban landscapes. The insignificant difference in the species diversity may be due the indifference in the urban environmental conditions being experienced in the three parks while cities represent an accumulation of species diversity in intensively managed landscapes. Reference [15] asserted that high heterogeneity of the urban

environment provides plants with habitats convenient for all kinds of strategies. The low species richness in Abuja Park may be due to the rapid infrastructural development in the park which might have led to cutting down some trees species. This finding is similar to that of [16] which concluded that the urban sites exhibited lower tree species richness and evenness than rural sites. Reference [17] cited in [18] concluded that the increasing urbanization had a strong effect upon some urban trees, many of which are confined to specific habitats and are typical of village settlements rather than urban landscape.[17] therefore affirmed that human activities within urban areas utilize large quantities of natural resources, alter energy and chemical cycles, and generate waste products. It was also pinpointed that these processes disrupt non-human ecological systems and the organisms that depend on them [19] cited in [17]. In addition, [20] reported that cutting down trees, overgrazing and other factors influenced biodiversity by reducing the number of stems desired, affected species diversity and their size. The species composition had a direct relationship with species diversity while the relationship was inversely with species richness. This result is similar to the study of [21] who submitted that the individual quadrat with the highest diversity also had the highest richness. This suggests that species richness appeared to be the primary source of variation in diversity [22].

V. Conclusion and Recommendations

The present study has shown that the spatial analysis of urban trees in the built up area land use is very important due to the fact that the functions attached to these trees. It is thus revealed that there were spatial differences in the species composition, species diversity and species richness though the variations were insignificant. In a nutshell, the species composition and species were highest in the Abuja Park while the species richness was very low among all other parks. The study therefore recommended that forest resources consumption and removal of vegetation cover as a result of human-induced activities for agriculture and structural developmental purposes should be controlled and more importantly, periodic studies on tree composition, diversity and richness should be carried out regularly especially among other landuse types in an urban environment.

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