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Tree Species Diversity and their Benefits in Urban and Peri-Urban Areas of Abuja and Minna, Nigeria

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ABSTRACT

This study was conducted to investigate the tree species diversity in two cities in Nigeria ascertain their biodiversity conservation potentials. Data for this study were collected using both semi-structured questionnaire and inventory of tree species in Abuja and Minna of Nigeria. The questionnaire was used to obtain information on the socio-economic and environmental benefits of urban and peri-urban forests. Twenty respondents were purposefully selected in each urban and peri-urban centres of Minna and Abuja, which translated to a total of eighty (80) questionnaires for this study. Administration of questionnaires was done using snowball sampling; respondents were those who own tree(s) or who have association(s) with tree(s). The biodiversity assessment entails complete enumeration of tree species in public parks/garden, private gardens/home gardens, avenue/roadside trees, school grounds, public and private institutions and any space with conglomerates of trees. In the study location, all trees with diameter at breast height (dbh) ≥ 10cm were identified, dbh measured and their frequency taken. Data were analyzed using descriptive analysis, student's T-test, one-way ANOVA and correlation analysis. ArcGIS 10.3 software package was used to produce Normalized Difference Vegetation Index (NDVI) map for this study. The tree species diversity assessment and questionnaire administration results obtained were used to compute the tree species diversity indices, determine socio-economic and environmental importance of trees in urban and peri-urban centres. A total of 27 families (27 in urban and 12 in peri-urban areas of Abuja; 17 in urban and 9 in peri-urban areas of Minna) were encountered. The results of Shannon-Wiener diversity index were 3.56 and 2.24 in urban and peri-urban areas of Abuja, respectively as well as 3.08 in 2.34 in urban and peri-urban areas of Minna, respectively while species evenness were 0.54 in urban and 0.42 in peri-urban area of Abuja as well as 0.54 in urban and 0.50 in peri-urban area of Minna. The benefits (food, edible fruits, vegetables, fuelwood, herbs, animal fodders, parks, windbreak, pollution reduction, beautifications, recreation and event centres) derived by the people from urban and peri-urban forests are indications that urban forest support the livelihood of the populace through the provision of food and nutritional supplements, economic empowerment, social support and environmental sustainability. This study provides baseline information for ecosystem management of urban forest tree species.

Key words: Biodiversity indices, Tree species diversity, Economic values, , Urban forest and peri-urban forests

INTRODUCTION

The rapid growth of urban centres in the developing countries as a result of rural-urban migration is alarming. The population density tends to increase infrastructural development of the cities in order to cater for the rapid urbanization within the cities. Population growth in Nigeria has more than quadrupled over the past five decades, increasing from 34 million in 1950 to 141.4 million in 2005 (Fuwape and Onyekwelu, 2011), with a projected rise to 193.1 million by 2020 (UN, 2006).Annual population growth rate in urban centres in Nigeria is about 4.1%, which is higher than the world average rate of 2.1% (UN, 2007a). By 2005, about 46.2% of Nigerian lived in urban centres (UN, 2007a & b; UNOWA, 2007), indicating that the urban centres are highly populated and congested. While mean population density for the entire country in 2005 was 153 per km^2, it was 4,390 per km^2 in urban centres (Fuwape and Onyekwelu, 2011). The increasing urban population growth in developing countries has led to a wide range of challenges which has now put lots of pressure on land, scarce natural resources, infrastructures and the environment. In our growing urbanized environments, the

maintenance and development of urban vegetated areas are among the challenges of sustainable urban planning. Urban forestry is defined as the "art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society" (Konijnendijk *et al*. 2006).Other challenges of urbanization include: food insecurity, energy, deteriorating air quality, high temperatures, health hazards and increased noise levels (Fuwape and Onyekwelu, 2011). Nigeria being one of the most densely populated countries in the world is greatly affected by urbanization which has affected forest cover. The highly populated urban centres need organization, arrangement, management and planning to enhance environmental sustainability. The benefits derived from urban forest cover are enormous ranging from healthy environment which translates to healthy citizens, aesthetical, social, environmental, ecological benefits. Urban forestry is one of the strategies for addressing the problems associated with urbanization. Urban vegetation, particularly trees, provides numerous benefits that can improve environmental quality and human health in and around urban areas. These benefits include improvements in air and water quality, building energy conservation, cooler air temperatures, reductions in ultraviolet radiation, and many other environmental and social benefits (Dwyer *et al.* 2000; Kuo and Sullivan 2001; Westphal 2003; Wolf 2003; Nowak and Dwyer 2007; Agbelade *et al.,* 2016).This study determines tree species diversity and their benefits in urban and peri-urban centres of Abuja and Minna, Nigerian.

METHODS

Location of study areas

The study was conducted in guinea savanna ecosystem of Nigeria. Two cities were selected from this ecosystem for enumeration. The cities are located between latitude $9^0 03'$ and $9^0 40'$N and longitude $7^0 26'$ and $7^0 49'$E (Abuja); latitude $9^0 35'$ and $9^0 61'$N and longitude $6^0 25'$ and $6^0 55'$E (Minna) in the North central region of Nigeria. The climate is tropical with distinct rainy and dry seasons. The rainy season begins in May and ends October, while the months of November to April are dry season. Mean annual rainfall ranges from 1000 mm to 1600 mm in the two cities. Mean monthly temperature ranges between 25.8^0C and 30.2^0C (Adakayi, 2000; Balogun, 2001) for Abuja and about 20 to 36^0C in both Abuja and Minna respectively. Prominent tree species in these cities include: *Khaya* spp., *Parkia biglobosa*, *Delonix regia*, *Eucalyptus* spp., *Azadirachta indica* and *Gmelina arborea*.

Data collection

The two cities were purposefully selected for this research based on the population density and economic importance of the cities (Abuja and Minna). The core areas of the cities were selected as the urban sectors while the closest satellite towns were selected as the peri-urban areas. Both semi-structured questionnaire and sampling of tree species were used for the data collection. The questionnaire was used to obtain information on the socio-economic and environmental benefits of urban and peri-urban forests. Twenty respondents were purposefully selected in the selected urban and peri-urban centres of the two cities. The questionnaires were administered to the respondents in form of interview guide, which enabled 100% retrieval. In some cases, focal group discussion was also used to collect additional data. Thus, a total of eighty (80) questionnaires were administered for this work. . The study covers 20% of Abuja and Minna built up centres and complete enumeration was done in the selected areas. Data for biodiversity assessment were obtained through sampling of tree species in public parks/garden, private gardens, avenue/roadside trees, school grounds, public and private institution and any space with conglomerates of trees. Within the selected urban and peri-urban centres, all trees with diameter at breast height (dbh) $\geq$ 10cm were identified, diameters at breast height, base, middle, and top, as well as their total heights were measured. This was used to compute for the biodiversity indices of the cities.

Data Analysis for Biodiversity Indices

All tree species within the selected city were assigned to families using Keay (1989) as guide.

Basal area

The basal area of each tree in the sample community was calculated using the formula (eqn 1):

$BA = (лD^2)/4$ …..(1)

where, BA = Basal area (m^2), D = Diameter at breast height (cm) and л= pie (3.142). The total BA for each city was obtained by adding all trees BA in the selected areas of the city.

Volume

Volume of each individual tree was estimated using tree volume equation developed Newton's formula (Hush *et al*., 2003) (eqn 2):

$V = (h/6)\ (Db + 4\ Dm + Dt)$……(2)

where, V = Tree volume (m^3), Db, Dm and Dt = diameters at the base, middle and top, respectively (m^2) and h is tree total height (m).

Species relative density index, which is used for assessing species relative distribution (Brashears *et al*., 2004), was computed with equation (3).

RD = (ni/N) x 100 ….(3)

Where: RD (%) = species relative density; n_i = number of individuals of species i; N = total number of all individual trees of all species in the entire community.

Species relative dominance (RD (%)), used in assessing relative space occupancy of a tree, were estimated using equation (4) (Aidar *et al.*, 2001).

$$RDo = \frac{\sum Ba_i \ x\ 100}{\sum Ba_n} \quad ….(4)$$

Where: Ba_i = basal area of all trees belonging to a particular species *i*; Ba_n = basal area of all trees in a city

The Importance Value Index (IVI) of each species was computed with the relationship: (RD + RDo)/2) (Brashears *et al*., 2004).

Species diversity index was computed using the Shannon-Wiener diversity index (equation (5); (Kent and Coker, 1992; Guo *et al*., 2003).

$$H = -\sum_{i-1}^{s} p_i \ln(p_i) \quad …(5)$$

Where: H' = Shannon-Wiener diversity index; S = total number of species in the community; p_i = proportion of *S* made up of the *i*th species; ln = natural logarithm.

Shannon's maximum diversity index was calculated using equation (6) (Guo *et al*., 2003)

$$H_{max} = \ln (S) \quad …..(6)$$

Where: H_{max} = Shannon's maximum diversity index; S= total number of species in the community.

Species evenness in each city was determined using Shannon's equitability (E_H), which was obtained using equation (7) (Kent and Coker, 1992).

$$E_H = \frac{H^i}{H_{max}} = \frac{\sum_{i-1}^{S} P_i \ln(Pi)}{\ln(s)} \quad ….(7)$$

Normalized Difference Vegetation Index (NDVI) was computed using equation (8)

$$NDVI = \frac{NIR-VIS}{NIR+VIS} \quad ……(8)$$

Where: NDVI = Normalized Difference Vegetation Index, NIR = Near Infrared, VIS = Visible Red reflectance.

Analysis of Variance (ANOVA) and Student's t-test was used to test for significant difference in the growth variables of individual trees in urban and peri-urban areas for the study. Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS 20.0).Normalized Difference Vegetation Index of the entire city was calculated and analysed in ArcGIS 10.3 environment to determine the level of greenness of the city between year 2000 and 2015.

RESULTS

Biodiversity indices and Growth Variables

A total of thirty-one (31) families (27 and 12) and (17 and 9) were encountered in urban and peri-urban of Abuja and Minna, respectively (Table 1). Family with high number of species includes Fabaceae, Meliaceae, Areceae, Combretaceae, Verbenaceae, Anacardiaceae, Annonaceae and Casuarinaceae in urban and peri-urban areas of the two cities. A pooled total of seventy-five tree species (69 and 20 in Abuja as well as 36, 13 in Minna) were identified in urban and peri-urban areas of the two cities. Numbers of tree species in Abuja urban and peri-urban was significantly higher than that of Minna in the Guinea savanna vegetation zone of Nigeria (Table 1). The maximum dbh (cm) of individual trees were 120.3 cm and 100.7 cm (in Abuja) as well as 108.8 cm and 101.6 cm (in Minna) for urban and peri-urban areas, respectively. The mean dbh (cm) of trees in urban and peri-urban centres of Abuja was 59.3 cm and 16.2 cm, respectively while it was 27.7 cm and 11.7 cm for Minna. Mean total volume (m^3) of the tree species in urban and peri-urban areas was 752.8 m^3 and 191.0 m^3 as well as 428.5 m^3 and 291.7 m^3 in Abuja and Minna, respectively. The Basal area (BA (m^2) production of tress were 51.03 m^2 and 13.70 m^2 as well as 19.65 m^2 and 10.07 m^2 for urban and peri-urban areas, respectively of Abuja and Minna. The ANOVA result of growth variables [mean dbh (cm), basal area (m^2) and volume (m^3)] was found to be significantly higher in urban centre than peri-urban centres of Abuja and Minna.

The biodiversity indices of tree species within the selected urban and peri-urban centres in Abuja and Minna are presented below. The results of Shannon-Wiener diversity index (H′) for urban and peri-urban centres were: 3.56 and 2.24 (Abuja) as well as 3.08 and 2.34 (Minna), while Shannon's maximum diversity index (H_{max}) was 6.54 and 5.36 (Abuja), 5.68 and 4.72 (Minna) for the urban and peri-urban areas, respectively (Table 1). The result of tree species evenness (Shannon's equitability (E_H) index) in urban and peri-urban centres was 0.54 and 0.42 (Abuja), 0.54 and 0.50 (Minna). The result of the analysis of variance (ANOVA) for comparing tree species diversity in urban and peri-urban forests is presented in Table 1.

Shannon-Wiener diversity index (H') and Shannon's maximum diversity indexes (Hmax) was found to be significantly different in the urban and peri-urban centres of Abuja and Minna. The results of mean separation revealed that H′ and Hmax was significantly higher in the urban centres when compared with those of the peri-urban centres. Species evenness(Shannon's equitability (E_H) index) was not significantly different between the urban and peri-urban centres of Abuja and Minna.

Benefits Derived from Urban forests

Urban forest benefits are numerous, including but not limited to improving economic and social aspects of livelihood, reducing environmental health related problems and contributing to the amelioration of both micro-climate and macro-climate. Table 2 indicates that respondents are aware of the various benefits derived from urban and peri-urban forests. Between 50 to 70% of the respondents in the cities selected from the two cities, opined that they derive fresh air from trees around them.

Table 1: Summary of the results of biodiversity indices and growth variables of tree species in Abuja and Minna cities

Benefits Derived	Abuja		Minna	
	Urban Forest	Peri-Urban Forest	Urban Forest	Peri-Urban Forest
No. of Individual Trees	695[a]	213[b]	294[ab]	112[b]
No. of Species	69[a]	20[b]	36[ab]	13[b]
No of Family	27	12	17	9
Mean Dbh (cm)	59.3[a]	16.2[b]	27.7[ab]	11.7[b]
Basal Area (m^2)	51.03[a]	13.70[b]	19.65[ab]	10.07[b]
Maximum Dbh (cm)	120.3[a]	100.7[b]	108.8[ab]	101.6[b]
Volume (m^3)	752.8[a]	191[b]	428.5[ab]	291.7[b]
Diversity Index (H′)	3.56[a]	2.24[b]	3.08[ab]	2.34[b]
Max Diversity (H_{Max})	6.54[a]	5.36[b]	5.68[ab]	4.72[b]
Species Evenness (E_H)	0.54[a]	0.42[a]	0.54[a]	0.50[a]

Table 2: Benefits Derived from Urban and Peri-Urban Forest

Benefits Derived	Abuja		Minna	
	Urban Forest	Peri-Urban Forest	Urban Forest	Peri-Urban Forest
Fresh Air	70	70	50	50
Fuelwood (Cooking)	10	85	55	75
Edible Fruits (Food)	50	65	40	55
Vegetable (Soup)	50	40	40	50
Wind break	60	75	75	85
Shade (Meeting)	65	70	75	60
Medicinal (Herbs)	40	50	35	70
Beautification	90	50	50	30
Relaxation/Garden	70	60	80	65
Animal Fodder	15	50	40	85

NOTE: (Respondents is allowed to choose more than one option)

About 40 to 65% of the respondents derived edible fruits as benefit from urban and peri-urban forests in Abuja and Minnna. Between 40 and 50% of the respondents indicated that they derived vegetables from urban and peri-urban forests. Higher percentage (60 to 85%) of respondents use tree as windbreak in the two cities with the guinea savanna ecosystem. The percentage of respondents using trees for shade/social gathering in the two cities within guinea savanna was very high (60 to 75%) while the use of urban and peri-urban trees for relaxation/garden/bar/joint purposes was indicated by between60 to 80% of the respondents. In the two cities between 35 to 70% of the respondents used urban and peri-urban trees for medicinal purposes (Table 2), which indicated high level of the dependence of the people on urban and peri-urban trees for healthcare delivery.

The result also revealed the species Relative Density (RD) which ranged from (0.14 – 10.41% and 0.47 – 33.80%) Abuja, and (0.34 – 12.93% and 1.79 – 16.07%) in Minna for individual tree species for the urban and peri-urban centres respectively (Tables 3 and 4). Species with high Relative Density (RD) are: *Azadirachta indica* (12.93%), *Delonix regia* (8.16%) and*Terminalia radii* (8.16%) for the two centres in Minna while for the two centres in Abuja, *Gmelina arborea* (10.41%), *Terminalia radii* (6.07%) and *Terminalia catappa* (5.35%) had high RD. Species Relative Dominance (RD_o) for urban and peri-urban centre varied from (0.04 – 2.86% and 0.15 – 20.85%) in Abuja and (0.01 – 0.19 and 0.61 - 22.97%) in Minna. Species with high Relative Dominance (RD_o) were: *Spathodea campanulata* (6.94%), *Nuclea latifolia* (5.68%) and *Azadirachta indica* ((5.60%) for both centres in Abuja andwhile *Pterocaarpus soyauxii* (12.66%), *Khaya senegalensis* (7.99%) and *Mangifera indica*(5.97%) in the two centres in Minna. Trees within the selected cities varied in the importance value index, with trees like *Gmelina arborea* (5.82%), *Azadirachta indica* (3.96%), *Khaya senegalensis* (3.74%) being important in the floristic composition of Abuja city while the species that are important in the floristic composition of Minna city were *Azadirachta indica* (9.35%),*Mangifera indica* (6.90%), *Pterocarpus soyauxii* (6.50%).

Table 3a: Summary of growth characteristics and diversity indices for six most important tree species in urban area of Abuja

Tree species	Family	FQ	MHt	MDbh	B.A	Vol.	RD	RD_O	IVI
Khaya senegalensis	Meliaceae	32	17.6	4.3	1.46	25.65	4.62	2.86	3.74
Terminalia catappa	Combretaceae	37	7.9	0.7	0.05	0.37	5.35	0.09	2.72
Terminalia ivorensis	Combretaceae	42	9.1	0.7	0.08	0.7	6.07	0.15	3.11
Delonix regia	Fabaceae	37	14.2	1.2	0.17	2.38	5.35	0.33	2.84
Eucalyptus citriodora	Myrtaceae	32	17.6	4.3	1.46	25.65	4.62	2.86	3.74
Gmelina arborea	Verbenaceae	72	14	1.2	0.63	8.83	10.4	1.24	5.82

FQ – number of tree stems in the city, B.A. – Basal area of trees in the city, Vol. – Volume of trees in the city, MHt – Mean height, MDbh – Mean diameter at breast height, RD – Species relative density, RDo – Species Relative dominance

Table 3b: Summary of growth characteristics and diversity indices for six most important tree species in Lugbe peri-urban area of Abuja

Tree species	Family	FQ	MHt	MDbh	B.A	Vol.	RD	RD_O	IVI
Azadirachta indica	Meliaceae	16	19.1	11.9	2.86	54.56	7.51	20.85	14.18
Delonix regia	Fabaceae	17	14.2	2.7	0.17	2.38	7.98	1.22	4.6
Gmelina arborea	Verbenaceae	72	14	1.2	0.63	8.83	33.8	4.6	19.2
Mangifera indica	Anacardiaceae	20	11.1	2.1	0.13	1.48	9.39	0.97	5.18
Parkia biglobosa	Fabaceae	26	16.3	4.5	1.09	17.8	12.21	7.97	10.09
Vachellia nilotica	Fabaceae	17	9.2	3.6	0.3	2.74	7.98	2.18	5.08
		213			13.7	191			

FQ – number of tree stems in the city, B.A. – Basal area of trees in the city, Vol. – Volume of trees in the city, MHt – Mean height, MDbh – Mean diameter at breast height, RD – Species relative density, RDo – Species Relative dominance, IVI – Importance Value Index.

Table 4a: Summary of growth characteristics and diversity indices for six most important tree species in urban area of Minna

Tree species	Family	FQ	MHt	MDbh	B.A	Vol.	RD	RD_O	IVI
Azadirachta indica	Meliaceae	38	15.1	3.2	1.13	17.14	12.93	0.19	6.56
Delonix regia	Fabaceae	24	12.5	3.8	0.66	8.24	8.16	0.11	4.14
Ficus goliath	Moraceae	26	12.1	2.8	0.42	5.04	8.84	0.07	4.46
Mangifera indica	Anacardiaceae	23	139	5.3	1.17	163.04	7.82	0.19	4.01
Gmelina arborea	Verbenaceae	18	16.2	6.7	1.14	18.54	6.12	0.19	3.16
Terminalia catappa	Combretaceae	24	11.7	2.9	0.39	4.58	8.16	0.07	4.11

FQ – number of tree stems in the city, B.A. – Basal area of trees in the city, Vol. – Volume of trees in the city, MHt – Mean height, MDbh – Mean diameter at breast height, RD – Species relative density, RDo – Species Relative dominance, IVI – Importance Value Index.

Table 4b: Summary of growth characteristics and diversity indices for six most important tree species in Bosso peri-urban area of Minna

Tree species	Family	FQ	MHt	MDbh	B.A	Vol.	RD	RD_O	IVI
Azadirachta indica	Meliaceae	18	12.1	6.7	1.13	13.73	16.07	11.27	13.67
Delonix regia	Fabaceae	14	12.5	12.3	2.31	28.91	12.5	22.97	17.73
Gmelina arborea	Verbenaceae	18	14.2	6.7	1.14	16.25	16.07	11.36	13.72
Mangifera indica	Anacardiaceae	13	13.9	9.4	1.17	16.3	11.61	11.65	11.63
Parkia biglobosa	Fabaceae	12	14.3	8.3	0.78	11.12	10.71	7.72	9.22
Khaya senegalensis	Meliaceae	8	17.7	17.7	1.57	27.8	7.14	15.6	11.37

FQ – number of tree stems in the city, B.A. – Basal area of trees in the city, Vol. – Volume of trees in the city, MHt – Mean height, MDbh – Mean diameter at breast height, RD – Species relative density, RDo – Species Relative dominance, IVI – Importance Value Index.

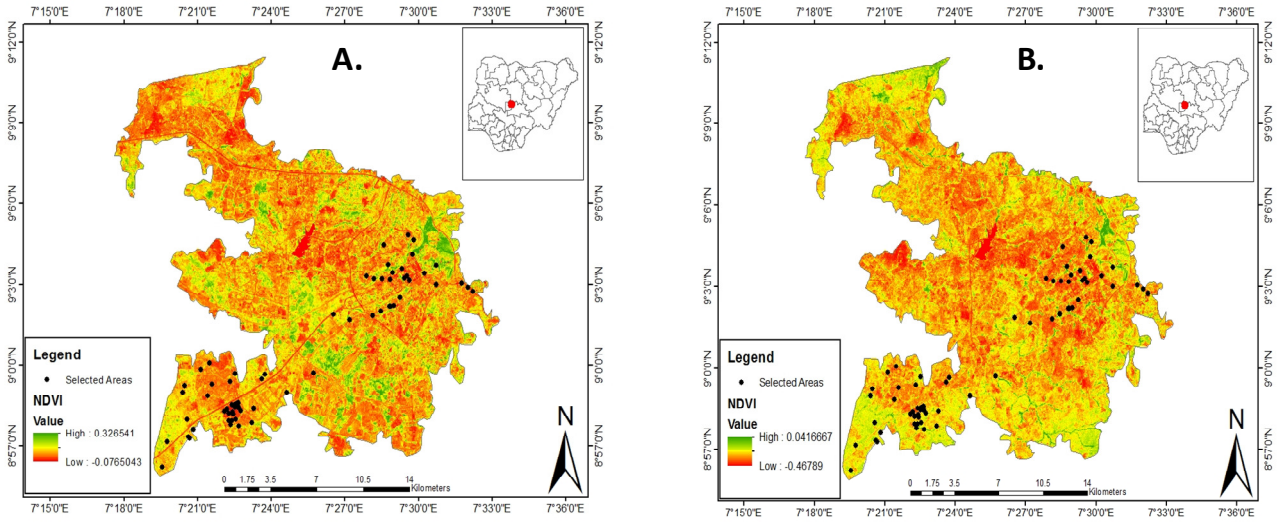

Figure 1: Map of Abuja showing the green area index (NDVI) in year 2000 and the field sampling locations (A) and the green area index (NDVI) in year 2015 and the field sampling locations (B).

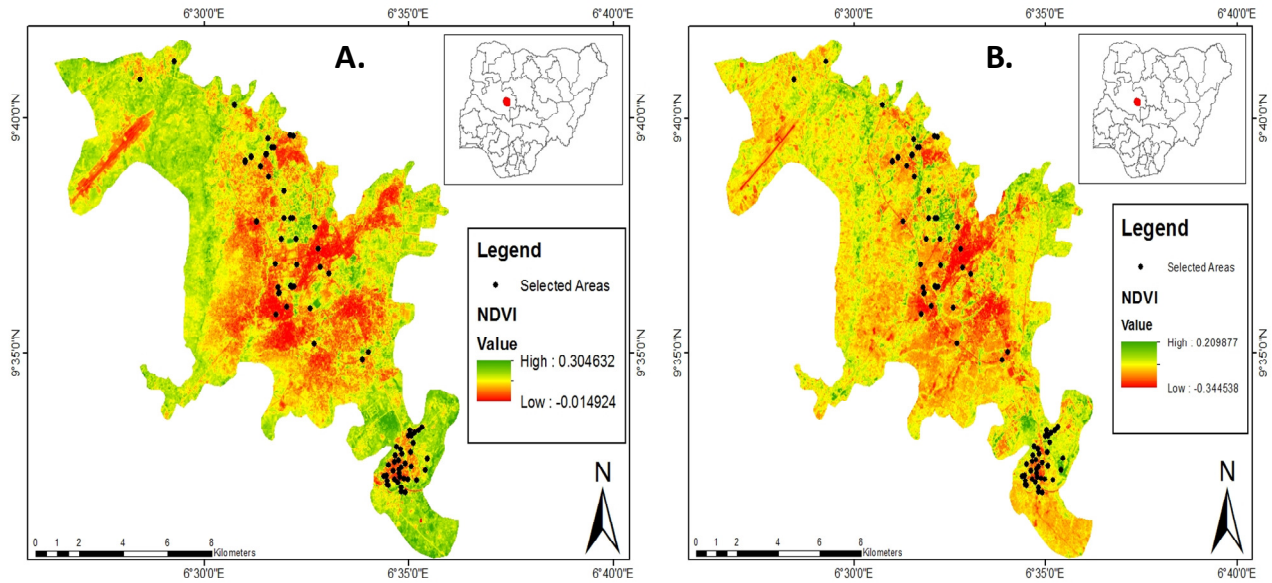

Figure 2: Map of Minna showing the green area index (NDVI) in year 2000 and the field sampling locations (A) and the green area index (NDVI) in year 2015 and the field sampling locations

Thematic Map Production and Green Area Index of the three Ecological Zones

The thematic maps of Abuja and Minna were produced from their satellite imageries using ArcGIS 10.3 software, which led to the generation of green area index of the selected cities for this research (Figures 1 and 2). The maps show the boundary of each city, the locations visited for data collected and green area index for each city. Greenness indices of all the cities were calculated within the ArcGIS 10.3 environment to determine the level of greenness of the cities within each ecological zone. Normalized Difference Vegetation Index (NDVI) of the cities selected from the guinea savanna (Abuja and Minna) for this study were calculated statistically within the ArcGIS 10.3 environment to determine the level of greenness of the cities within this ecological zone. The greenness indices of the two locations (cities) were calculated and analysed in ArcGIS 10.3 environment from 2000 and 2015 satellite imageries. Abuja Normalized Difference Vegetation Index value was found to be highest at (0.327) and at the lowest (-0.077) for year 2000 and NDVI value recorded in 2015 was highest at (0.042) and lowest at (-0.468) (Figure 1a & 1b). Normalized Difference Vegetation Index (NDVI) value in Minna city was highest at (0.305) and lowest at (-0.015) in year 2000 while it was highest (0.210) and lowest at (-0.345) in year 2015 (Figure 2a & 2b).In the year 2000, the NDVI value was higher in Abuja (0.327), than the NDVI in Minna (0.305), for the same year under investigation, which is an indication that Abuja has green vegetation coverage than Minna in year 2000. However, in 2015, the NDVI was higher in Minna (0.210) than in Abuja (0.042), implying that Minna became greener than Abuja between 2000 and 2015.

DISCUSSION

Biodiversity indices and growth yield variables

Biodiversity indices of urban and peri-urban areas of Abuja and Minna were generated in to assess the status of biodiversity conservation in the cities and compare them with the biodiversity of forest reserves. IIRS (2002) noted that biodiversity indices are generated to bring the diversity and abundance of species in different habitats to similar scale for comparison and the higher the value, the greater the species richness. The results of Shannon-Wiener diversity index (H′) for the two cities are: 3.08 (Minna), and 3.56 (Abuja) while Shannon's maximum diversity index (H_{max}) are: 6.54 (Abuja) and 5.68 (Minna) (Table 2). The result of tree species evenness (Shannon's equitability (E_H) index)) was 0.54 (Abuja) and 0.54 (Minna). The Shannon-Wiener diversity index and species evenness of this study were higher than the values of Rajkumar and Parthasarathy (2008) and Yang *et al.,* (2008) Xishuangbana, China. In a another study, Duran *et al.* (2006) obtained a Shannon-Wiener diversity indices range of 2.69 to 3.33 which indicated that their study ecosystems were less diverse than the urban and peri-urban forests in

this study. The Shannon-Wiener index of the urban and peri-urban areas of the study cities are higher than the mean of 3.00 obtained by Rao *et al*. (2011) for sacred groves in south Eastern Ghats, India but within the range of 2.94 - 3.99 reported by Agbelade *et al*. (2016) for urban forest and peri-urban areas of Ibadan city in south western Nigeria. Also, Shannon-Wiener diversity indices for the cities in this study was higher than the value obtained by Onyekwelu *et al*. (2008) for Queen's forest, Oluwa Forest and Elephant forest in south western, Nigeria. There is an indication that biodiversity is relatively higher in Abuja urban centre than in Minna urban centre, which could be attributed to the high level of campaign for tree planting in Abuja and the careful landscape planning of Abuja. The mean dbh of trees in urban and peri-urban areas of the cities were: 59.3 cm and 16.23 cm, respectively for Abuja as well as 27.7 cm and 11.67 cm, respectively. Mean total volumes were: 752.8m^3 and 191.0m^3 for urban and peri-urban areas of Abuja respectively and 428.5$m^3$and 291.7m^3) for urban and peri-urban areas of Minna, respectively while Basal area (B.A.) values were 51.03m^2 and 13.70m^2 for trees in urban and peri-urban areas of Abuja and 19.65m^2 and 10.07m^2 for trees in urban and peri-urban areas of Minna (Table 2). The growth and yield of trees in both the urban and peri-urban areas of Abuja and Minna is an indicative of the level of conservation of tree species which urban forest can offer.

Benefits Derived from Urban and Peri-urban Forests

Urban and peri-urban trees species have products that are suitable for food, medicine and nutrition supplements for healthy life. Examples include edible fruits, nuts, vegetables, medicinal substances, etc. Onyekwelu and Olaniyi (2012) opined that urban forestry practices improves food security for poor urban people through the provision of edible vegetable, fruits, nuts, planting of low-care fruit bearing trees, etc, which agrees with the results of this study. Some environmental benefits were derived from urban forest such as purification of air (fresh air), wind break, provision of shade, beautification, provision of relaxation parks and gardens. A higher percentage of fuelwood and animal folder was recorded in peri-urban centres. A high percentage of fuelwood and animal folder obtained from urban and peri-urban forests in the study cities were sold for income generation, Income generation from urban and peri-urban forest products in Akure, Nigeria ranged from ₦10,000.00 to ₦50,000.00 (Olaniyi, 2012). Parks and recreation centres employed people as service men and women, which is very important for their livelihood sustainability. Recreational centres differ from one another because of their relatively small size and type of use with relative amount of income generation for the people and government (Onyekwelu and Olaniyi, 2012). Recreation centres are suitable places for causal meetings, lunch outing, association meeting, family relaxation, business meetings and holiday relaxation. The different benefits (Social, Economic and Environmental) derived from urban forest has created their interest in having trees around them but they tend to belief it is expensive to plant and maintain trees in open spsces and home garden. Fuwape and Onyekwelu (2011) observed that parks and recreation centres in cities across West Africa serve as small businesses centres, community meeting place, religious worship centres and shades for groves in some urban and peri-urban centres.

Green Index Mapping using Normalized Difference Vegetation Index (NDVI)

The forests around us, especially urban centres, are taken for granted due to lack of adequate knowledge about their functions and capability to enhance our health. The forest cloth us, feed us, shield us and provides a conducive atmosphere for all living organisms to thrive. The consistent level of increase in urban population growth and decrease rural population growth on the other implies active rural – urban migration in Nigeria (Onyekwelu, 2013). This has resulted in over-exploitation of forest within and around urban settlements, which has in turn affected climate (micro and macro-environment). The analysis of Normalized Difference Vegetation Index (NDVI) calculated for this research indicated that vegetation cover of Abuja and Minna improved a little within year 2000 and year 2015. Abuja and Minna NDVI is on the decline between 2000 and 2015, which is an indication that forests within and around the cities was destroyed without plan to replace them within this period. The negative NDVI values in Abuja and Minna range of (-0.0765 to -0.0149) in year 2000 and (-0.4679 to -0.3446) in year 2015 is an indication that if concerted efforts to plant more trees are not quickly harnessed, vegetation coverage of these cities will no longer be supportive in providing services such as protection of the environment and enhancing livelihood of the populace. Gillies and Carlson (1995) reported in their study that vegetation coverage have different impacts on recreation potential and microclimate of the environment, as well as improving the socio-economic values of green spaces.

The result of the NDVI map indicated that Abuja was greener than Minna in year 2000 and Minna became greener than Abuja in year 2015, this is affirming the level of expansion and population growth in Abuja. The rate of greenness is calculated in ArcGIS environment to indicate details about the vegetation within such environment. Plants that are under intense stress can be determined and those with high vigour can be protected from stress and other environmental factors. Green environment could

result in healthy lives without environmental hazards and create economic satisfaction for the populaces to thrive.

CONCLUSION AND RECOMMENDATION

The result of this research revealed the basic information on urban and peri-urban forests in Abuja and Minna city centres which can be used for the development of tree species database in the two cities investigated. The importance of urban forest to conserve biodiversity has been neglected due to the rate of forest clearing for infrastructure and high rates of urban population growth. This could have negative impact on urban vegetation and could lead to environmental degradation and biodiversity loss. The potential of urban forests in conserving biodiversity, providing essential products and services towards environmental management, economic empowerment and social values of the society were revealed in this study. Most of the people appreciate trees in their environment but hold the belief that it is responsibility of government to plant trees and that tree can only be planted and maintained by rich people. The results revealed the diversity of tree species within the urban and peri-urban settlements of Abuja and Minna and their contribution to biodiversity conservation. Urban forest will provide serene environment, reduce pollution, reduce harsh weather, healthy society, garden for relaxation, fruits as food and sale which could boost the populace social and economic life.

The information of tree species diversity within the two cities are vital in the development of green areas database. This study provides baseline information on the contributions and benefits of urban forests to the people of Abuja and Minna cities. It is recommended that forestry extension services should do more in educating the people on the benefits, importance and contributions of urban forest to the environment and the people. It is important for government at all levels to be involved and create measures for the development of urban forests in every State in the guinea savannah zone of Nigeria. Therefore, during construction, expansion and development of infrastructures, attention should be paid on conserving trees rather than cutting them down.

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