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ASSESSMENT OF AVENUE TREES SPECIES DIVERSITY IN TWO SELECTED TERTIARY EDUCATIONAL INSTITUTIONS IN ONDO STATE, NIGERIA

[1]Oyerinde O. V., [2*]Olusola, J. A. and [1]Adeoye, S. A

[1]Department of Forestry and Wood Technology, Federal University of Technology, P.M.B. 704, Akure, Ondo State
[2]Department of Forestry Technology, Federal College of Agriculture, P.M.B. 623, Akure, Ondo State
*Corresponding E-mail: johnsonolusola5@gmail.com, +2348038593536

ABSTRACT

Information on growing stock is required to ensure sustainable management of the avenue trees in and around tertiary educational institutions in Nigeria. This study assessed and mapped the avenue tree species in the main campuses of the Federal University of Technology, Akure (FUTA) and Adekunle Ajasin University, Akungba – Akoko (AAUA), Ondo State, Nigeria. A total enumeration technique was adapted to assess all the avenue trees on both campuses. The coordinates of all the avenue trees were taken with a handheld Global Positioning System (GPS) device and recorded, this was used to produce a map of the road network showing the avenue trees.The study revealed a rich tree species diversity of 513 tree species with 24 different species and grouped into 14 families in FUTA and 22 species with 274 tree species falls into 13 families in AAUA. The family *Caesalpiniaceae* attributed more number of species followed by *Mimosaceae* and *Verbenaceae* on both campuses. The thematic map of both institutions produced revealed that some roads of the university campuses are devoid of avenue trees. Hence, fast growing, disease tolerant and shade providing trees should be raised and planted by the University authorities to fill the gaps to obtain productivity and conducive learning environment cum improve aesthetic view of the entire campus landscape.

Key words: Tertiary, Tree species, Environment, Geographical Information System Technology.

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INTRODUCTION

The socio-economic and environmental benefits of trees in urban landscapes are. Urban trees improve air quality, cool air temperatures, filter and retain storm water, sequester carbon, and contribute to healthier and more beautiful cities (McPherson and Simpson2003, Nowak *et al.,* 2006). Trees on streets and in parks are now recognized as more than just pleasant features, they are the backbone of urban forests and ecosystems. The benefits and uses range from intangible psychological and aesthetic benefits to amelioration urban climate and mitigation of air pollution (Nowak and Dwyer, 2000). In landscaping, an avenue is traditionally a straight path or road with a line of trees or large shrubs running along each side. Avenue trees simply refers to trees growing or deliberately planted along public road right-of-way and managed by the concerned authority, they account for a relatively small fraction of the entire urban forest, but are prominent because of their visual and physical impacts on the quality of urban life (McPherson *et al.*,2005). Municipal forests consist of street/avenue and park trees which are managed for the public good and uses. Avenue tree populations have their own unique structure, tending to be less diverse, containing more large-stature species and exhibiting higher levels of spatial continuity than other components of the urban forest (Jim and Liu, 2001). A study by Kuo (2001) at the University of Illinois Human-Environment Research Laboratory has demonstrated that green views and access to green spaces in urban areas helps in restoring attention and relieve daily pressures of living in poverty. Thus, green spaces also contribute to a healthier environment and foster a sense of community, making them particularly invaluable in inner-city neighborhoods. Avenue trees and urban woodlands provide a number of environmental and social benefits to the society, including contributing to climate change adaptation and mitigation, provision of shade to pedestrians, pleasant aesthetic views, control wind speed and traffic noise conducive environment for different outdoor activities, providing urban green space as well as improving the landscape of the nearby buildings (Carter, 2002).

A study by Lottrup (2013) deduced that easy access to green outdoor environments from workplaces has been found to significantly reduce worker stress while the academic institutions and hospitals have found that natural settings and trees result in measurably positive impacts on students and patients (Wolf *et al.,* 2014). However, the benefits of urban trees are not only well

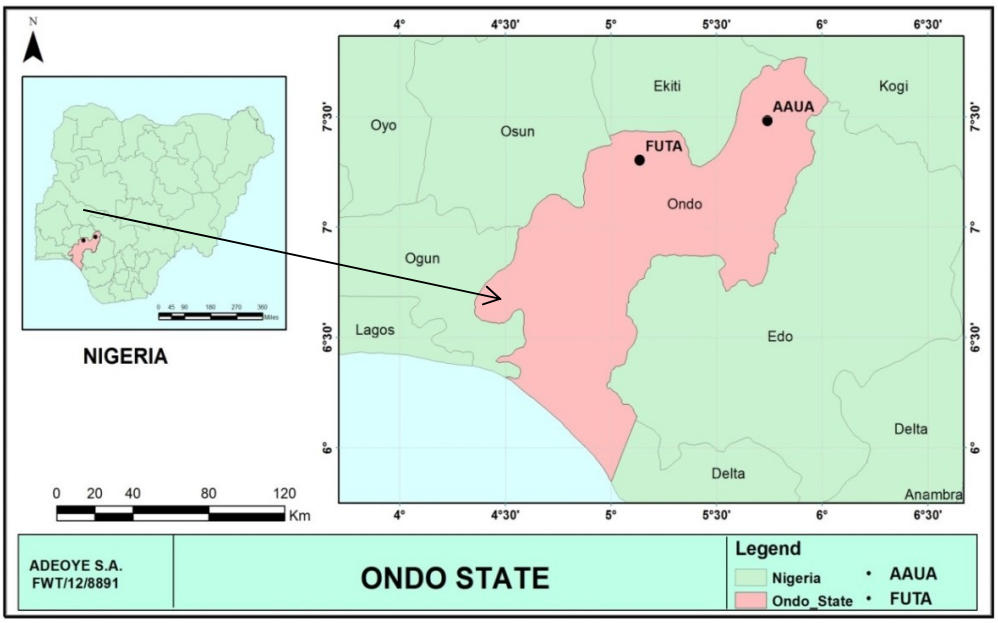
recognized by the academic community, but by municipalities and institutions around the world (Seamans, 2013). Understanding species diversity and relative abundance of avenue trees is important for helping university authority to evaluate the complexity and resources of urban forest on campus. Trees form the major structural and functional basis of urban ecosystems and can serve as robust indicators of changes. Therefore, the aim of this this study is to examine the diversity and relative abundance of the avenue tree species in the selected tertiary educational institutions in Ondo State, Nigeria with a view to ensuring its sustainable management.

METHODOLOGY

The Study Area

This research was carried out in two different campuses in Ondo State, Nigeria. The State was one of the 36 States in Nigeria with Akure as the State capital. It is the 18th most populated State with a population of 3,460,877 million people (NPC 2018, projected estimate). Ondo State (Figure 1) is located in South-western Nigeria with 18 Local Government Areas. Ondo State is a home to 10 tertiary educational institutions which include public and privately owned Universities, Polytechnics and Colleges (Wikipedia, 2017). Ondo State lies between Longitude

5^{o}05'E to 5^{o}083'E and Latitude 7^{o}10'N to 7^{o}17'N in the Southwestern part of Nigeria. It is bounded by Ekiti State in the north, Osun State in the west, Edo State in the east, and Delta State in the south.



Data Collection

The data for this research was collected from the Federal University of Technology Akure (FUTA) and Adekunle Ajasin University, Akungba-Akoko (AAUA), campuses in Ondo State, Nigeria. The selection of two academic institutions for this study was done purposefully due to the presence of well layout of roads and availabilities of avenue trees.

Acquisition of Satellite Imagery and Boundary map

Satellite Imagery was downloaded using Universal Maps Downloader® 9.07 Application Software from Google Earth Pro®. The boundary map of FUTA and AAUA were collected from the Centre for Space Research and Application (CESRA) and the Physical Planning Unit respectively. The data were used to digitize the boundary and major roads in the study areas.

Trees Species Enumeration

A total enumeration of tree species was conducted in all the avenue roads within the two University campuses. All the avenue trees were identified with their scientific. Global Positioning System (GPS) was used to collect the coordinates of all the avenue trees.

Data Analysis

Tree species classification and computation of diversity indices

All tree species that were encountered in each institution were classified into families. The following biodiversity indices were computed.

(a) Species Relative Frequency

Species relative frequency (RF) was calculated for each tree species using equation (1):

$$RF = \frac{ni}{N} \times 100 \quad \text{.....} \quad 1$$

Where: ni = number of individual species and N = Total number of species in the sampled area.

(b) The Shannon–Wiener diversity index (H')

Equation 2 was used to estimate H'.

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$$H' = \sum_{i=1}^{s} pi \ln(pi) \quad \ldots\ldots 2$$

H' = Shannon diversity index,

S = the total number of species in the habitat,

Pi = proportion S (species in the family) made up of the i^{th} species

ln = natural logarithm.

(c) **Species evenness (E)**: This was calculated by adopting Shannon's equitability (E_H) as Stated by Kent and Coker (1992) in equation 3:

$$E_H = \frac{\sum_{i=1}^{s} p_i \ln(p_i)}{\ln(S)} \quad \ldots\ldots 3$$

Map Production

ArcMap 10.3 application was used to produce thematic maps for this study.

RESULTS

Avenue Tree Species Diversity

Result of the tree species diversity and abundance at FUTA, were shown in Table 1. The result shows that 513 individual belonging to 24 different tree species and 14 families were encountered. These comprises of different indigenous and exotic tree species. The following were the most abundance trees species: *Gmelina arborea* (248), *Delonix regia* (58), Acacia *auriculiformis* (48), *Terminalia mantally* (28), *Leucaena leucocephala* (23) and *Azadirachta indica* (21). Meanwhile, *Alstonia boonei*, *Anthocleista djalonensis*, *Erythrina variegate*, *Ficus exasperata*, *Huracrepitans*, *Margaritaria discoidea*, *Peltophorum pterocarpum*, and *Senna siamea* had only one (1) stem each during the period of assessments. The family Caesalpiniaceae, Mimosaceae, Verbenaceae, Anacardiaceae and Combretaceae were dominant families at FUTA (Table 1). The result of Shannon–Wiener diversity index revealed that *Gmelina arborea* (0.35), *Delonix regia* (0.25), *Acacia auriculiformis* (0.22), *Terminalia mantally* (0.16) and *Leucaena leucocephala* (0.14) had the highest value of Shannon- Wiener diversity index (Table 1). Thus, the Shannon–Wiener diversity index for the whole trees species at FUTA was 1.97 while the species evenness for the trees species was 0.32.

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Table 1: Tree species diversity and abundance of Avenue Tree Species at FUTA

S/N	Family	Species	Common Name	Frequency	Relative Frequency	Pi	LnPi	PiLnPi
1	Anacardiaceae	*Anacardium occidentale Linn.*	Cashew	3	0.58	0.01	-5.142	-0.03
2	Anacardiaceae	*Mangifera indica Linn.*	Mango tree	5	0.97	0.01	-4.631	-0.05
3	Apocynaceae	*Alstonia boonei De Wild.*	Ahun (Y)	1	0.19	0.00	-6.240	-0.01
4	Caesalpiniaceae	*Bauhinia monandraKurz*	Orchid tree	6	1.17	0.01	-4.449	-0.05
5	Caesalpiniaceae	*Delonix regia (Boj. ex Hook.) Raf.*	Flamboyant tree	58	11.31	0.11	-2.180	-0.25
6	Caesalpiniaceae	*Peltophorum pterocarpum (DC.) K.H*	Yellow flametree	1	0.19	0.00	-6.240	-0.01
7	Caesalpiniaceae	*Senna fistula Linn.*	Golden shower tree	7	1.36	0.01	-4.294	-0.06
8	Caesalpiniaceae	*Senna siamea (Lam.) H.S. Irwin & Bar*	Golden rain tree	1	0.19	0.00	-6.240	-0.01
9	Combretaceae	*Terminalia catappa Linn.*	Almond tree	10	1.95	0.02	-3.938	-0.08
10	Combretaceae	*Terminalia mantally Linn.*	Madagascar almond	28	5.46	0.05	-2.908	-0.16
11	Euphorbiaceae	*Hura crepitans Linn.*	Tyre Tree	1	0.19	0.00	-6.240	-0.01
12	Fabaceae	*Erythrina variegata Linn.*	Sunshine tree	1	0.19	0.00	-6.240	-0.01
13	Meliaceae	*Azadirachta indica A. Juss*	Neem tree	21	4.09	0.04	-3.196	-0.13

14	Mimosaceae	*Acacia auriculiformis A.Cunn. ex*	Ear leaf tree	48	9.36	0.09	-2.369	-0.22
15	Mimosaceae	*Albizia zygia (DC.) J. F. Macbr.*	Ayunre (Y)	12	2.34	0.02	-3.755	-0.09
16	Mimosaceae	*Leucaena leucocephala (Lam.) de Wit*	White lead tree	23	4.48	0.04	-3.105	-0.14
17	Moraceae	*Ficus exasperate Vahl*	Sandpaper tree	1	0.19	0.00	-6.240	-0.01
18	Palmae	*Roystonea regia (Kunth) O.F.Cook*	Cuban royal palm	8	1.56	0.02	-4.161	-0.06
19	Papilionaceae	*Gliricidia sepium (Jacq.) Walp.*	Gliricidia	5	0.97	0.01	-4.631	-0.05
20	Phyllanthaceae	*Margaritaria discoidea (Baill.) G.L.*	Pheasant-berry	1	0.19	0.00	-6.240	-0.01
21	Pinaceae	*Pinus caribaea Morelet*	Pine	8	1.56	0.02	-4.161	-0.06
22	Verbenaceae	*Anthocleistadja lonensis A.Chev.*	Cabbage tree	1	0.19	0.00	-6.240	-0.01
23	Verbenaceae	*Gmelina arborea Roxb.*	Gmelina	248	48.34	0.48	-0.727	-0.35
24	Verbenaceae	*Tectona grandis Linn. f.*	Teak	15	2.92	0.03	-3.532	-0.10
	Total			513	100	1.00		-1.97
							H'	**1.97**
							E	**0.32**

Tables 2 shows the result of various tree species encountered during the assessment of the tree species of the avenues trees at AAUA. It was revealed that 274 individuals of 22 different species belonging to 13 families were identified. The following tree species were the most abundance: *Polyalthia longifolia* (69), *Acacia auriculiformis* (36), *Terminalia mantally* (26), *Leucaena leucocephala* (25) and *Delonix regia* (21). Meanwhile, *Calotropis procera*, *Khaya ivorensis*, and *Spondias mombin* had only 1 stem each. More so, the result revealed that Caesalpiniaceae, Combretaceae, Mimosaceae and Verbenaceae were the dominant families at AAUA.

It was revealed from the Table 3 that Caesalpiniaceae, Verbenaceae, Anacardiaceae, Mimosaceae and Combretaceae families were most dominant family and common to both campuses. Some families were common to a particular campus while it was absent in the other campus (Annonaceae, Asclepiadaceae, Myrtaceae, Rutaceae and Sterculiaceae only present in AAUA but absent in FUTA while, Apocynaceae, Euphorbiaceae, Fabaceae, Papilionaceae and Pinaceae only present in FUTA).

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Table 2: Tree Species Diversity and Abundance of Avenue Tree Species at AAUA Campus

S/N	Family	Species	Common Name	Frequency	Relative Frequency	Pi	LnPi	PiLnPi
1	Mimosaceae	*Acacia auriculiformis A.Cunn. ex*	Ear leaf tree	36	13.14	0.13	-2.03	-0.27
2	Mimosaceae	*Albizia lebbeck (L.) Benth.*	Indian walnut	8	2.92	0.03	-3.53	-0.10
3	Meliaceae	*Azadirachta indica A. Juss*	Neem tree	14	5.11	0.05	-2.97	-0.15
4	Caesalpiniaceae	*Bauhinia monandraKurz*	Orchid tree	4	1.46	0.01	-4.23	-0.06
5	Asclepiadaceae	*Calotropis procera* (*Aiton*)	Bomubomu (Y)	1	0.36	0.00	-5.61	-0.02
6	Rutaceae	*Citrus sinensis (L.) Osbeck*	Orange	4	1.46	0.01	-4.23	-0.06
7	Caesalpiniaceae	*Delonix regia (Boj. ex Hook.)*	Flamboyant tree	21	7.66	0.08	-2.57	-0.20
8	Palmae	*Elaeis guineensis Jacq.*	Palm tree	15	5.47	0.05	-2.91	-0.16
10	Myrtaceae	*Eucalyptus camaldulensis*	Eucalypt	6	2.19	0.02	-3.82	-0.08
11	Moraceae	*Ficus benjamina Linn.*	Ficus	3	1.09	0.01	-4.51	-0.05
12	Verbenaceae	*Gmelina arboreaRoxb.*	Gmelina	18	6.57	0.07	-2.72	-0.18
13	Sterculiaceae	*Hildegardi abarteri (Mast.) Kosterm.*	Okurugbedu (Y)	6	2.19	0.02	-3.82	-0.08
14	Meliaceae	*Khayai vorensis A. Chev.*	Mahogany	1	0.36	0.00	-5.61	-0.02
15	Mimosaceae	*Leucaena leucocephala de Wit*	White lead tree	25	9.12	0.09	-2.39	-0.22
16	Anacardiaceae	*Mangifera indica Linn.*	Mango	2	0.73	0.01	-4.92	-0.04
17	Annonaceae	*Polyalthia longifolia Sonn.*	Masquerade Tree	69	25.18	0.25	-1.38	-0.35
18	Caesalpiniaceae	*Senna siamea (Lam.) H.S. Irwin*	Cassia tree	2	0.73	0.01	-4.92	-0.04
19	Anacardiaceae	*Spondias mombin Linn.*	Bush mango	1	0.36	0.00	-5.61	-0.02
20	Verbenaceae	*Tectona grandis Linn. f.*	Teak	2	0.73	0.01	-4.92	-0.04
21	Combretaceae	*Terminalia catappa Linn.*	Almond tree	6	2.19	0.02	-3.82	-0.08
22	Combretaceae	*Terminalia ivorensis A. Chev.*	Black afara	4	1.46	0.01	-4.23	-0.06
23	Combretaceae	*Terminalia mantally Linn.*	Madagascar almond	26	9.49	0.09	-2.36	-0.22
				274	100	1.00		-2.50
							H'	**2.5**
							E	**0.45**

Table 3: Family Distributions of Tree Species in the Studied Campuses

S/N	Family	FUTA Campus		AAUA Campus	
		No of species	Percentage	No of Species	Percentage
1	Anacardiaceae	2	8.3	2	9.1
2	Annonaceae	0	0.0	1	4.5
3	Apocynaceae	1	4.2	0	0.0
4	Asclepiadaceae	0	0.0	1	4.5
5	Caesalpiniaceae	5	20.8	3	13.6
6	Combretaceae	2	8.3	3	13.6
7	Euphorbiaceae	1	4.2	0	0.0
8	Fabaceae	1	4.2	0	0.0
9	Meliaceae	1	4.2	2	9.1
10	Mimosaceae	3	12.5	3	13.6
11	Moraceae	1	4.2	1	4.5
12	Myrtaceae	0	0.0	1	4.5
13	Palmae	1	4.2	1	4.5
14	Papilionaceae	1	4.2	0	0.0
15	Phyllanthaceae	1	4.2	0	0.0
16	Pinaceae	1	4.2	0	0.0
17	Rutaceae	0	0.0	1	4.5
18	Sterculiaceae	0	0.0	1	4.5
19	Verbenaceae	3	12.5	2	9.1
	Total	**24**		**22**	

Boundary Map

The boundary map of FUTA and AAUA, indicating the road networks within the campuses were shown in Figures 2 and 3 respectively, while the map of developed area of AAUA is shown in Figure 4. Various road networks within FUTA and AAUA maps are shown as lines, while boundary of the different classes of land use is shown as polygons.

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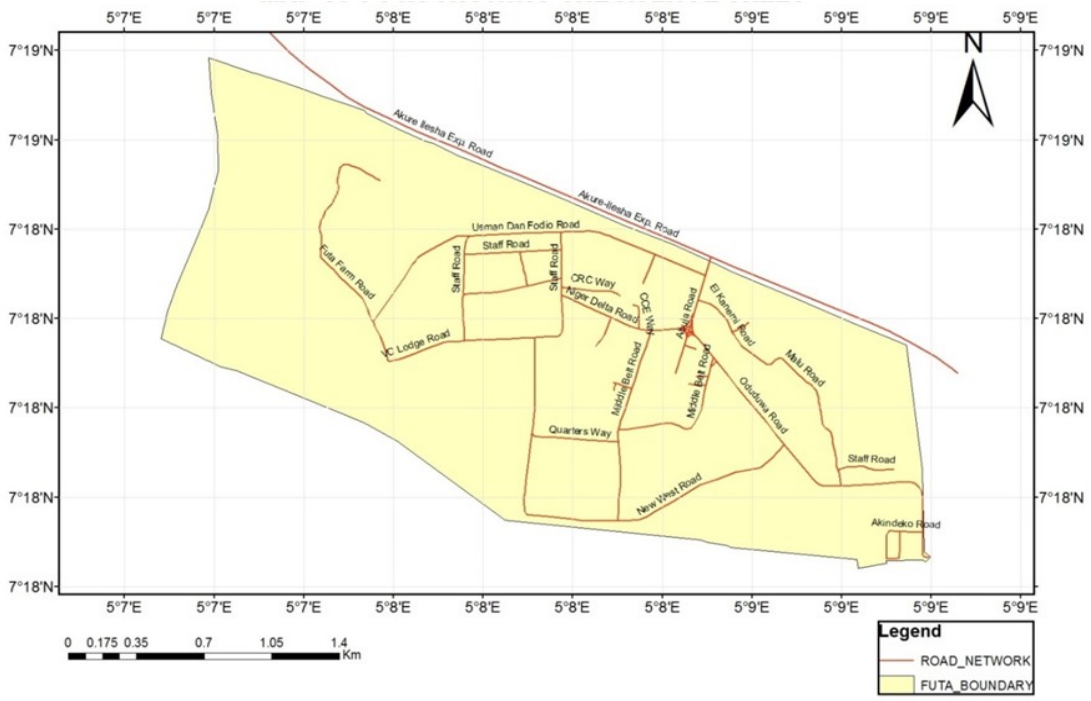

Figure 2: Map of FUTA showing boundary and existing road networks

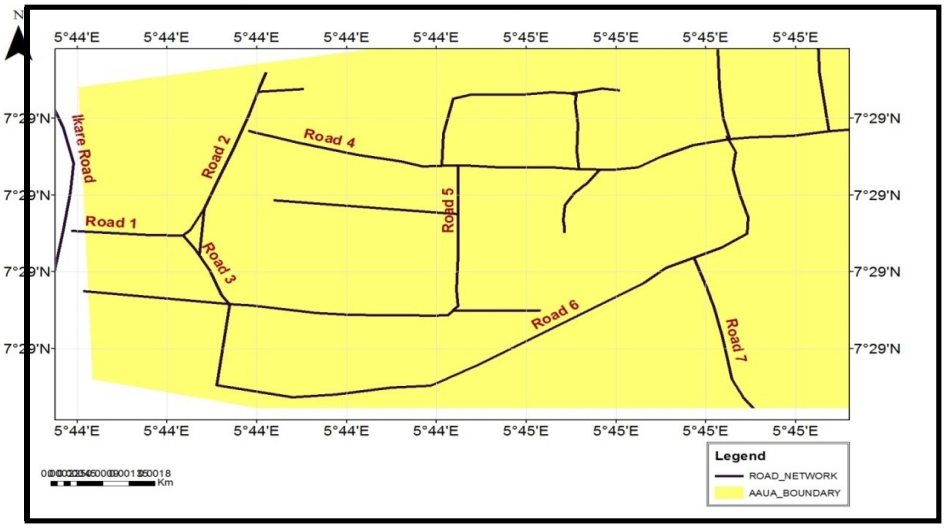

Figure 3: Boundary map of AAUA showing the existing Road Networks

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Thematic Map of the Study Area

The thematic map of FUTA and AAUA campuses are represented in Figures 4 and 5 respectively. These maps showed the existing avenue trees in both Universities campuses. The thematic maps indicated that some road within the two campuses have avenue trees planted on either side or both sides of the road while some road were with no avenue trees as revealed in the study area. It was also observed from the maps of both campuses that only the old roads network in the two campuses has avenue trees while the new roads revealed no avenue trees. Map of FUTA revealed that Quarters road, new west road, University farm road and CRC road did not have any avenue trees planted on them (Figure 4). Map of AAUA on figure 5 revealed that some of the road like road 7 Ikare road did not have avenue trees planted on them.

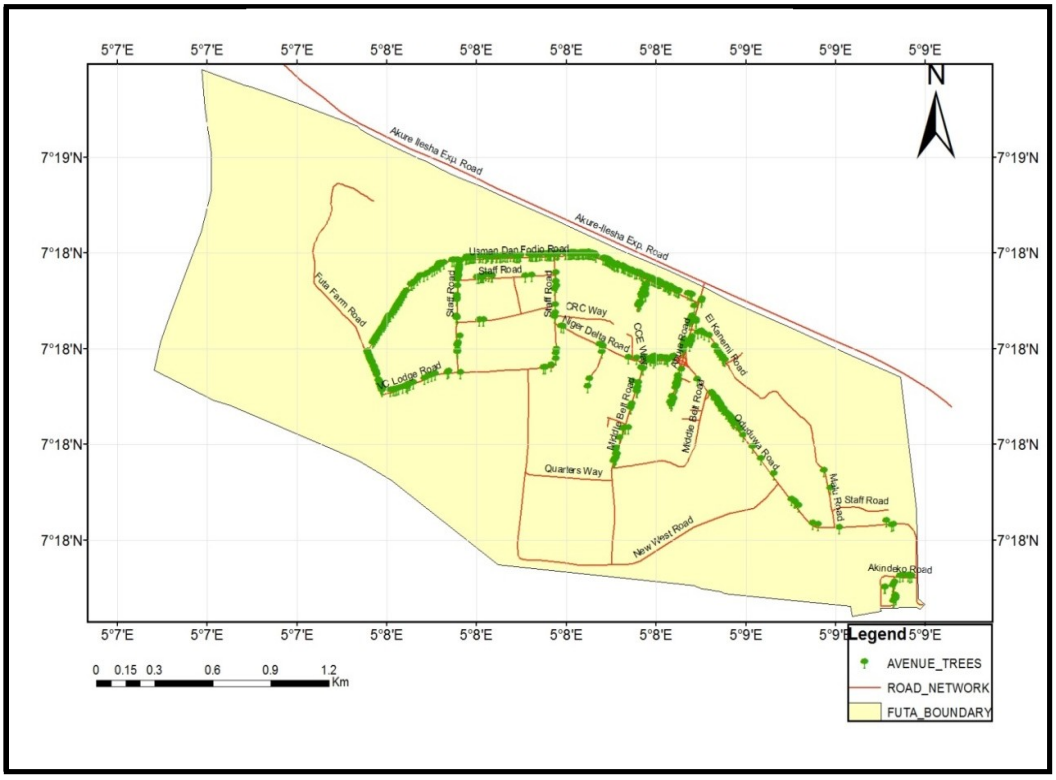

Figure 4: Thematic map of FUTA campus showing the existing Avenue Trees

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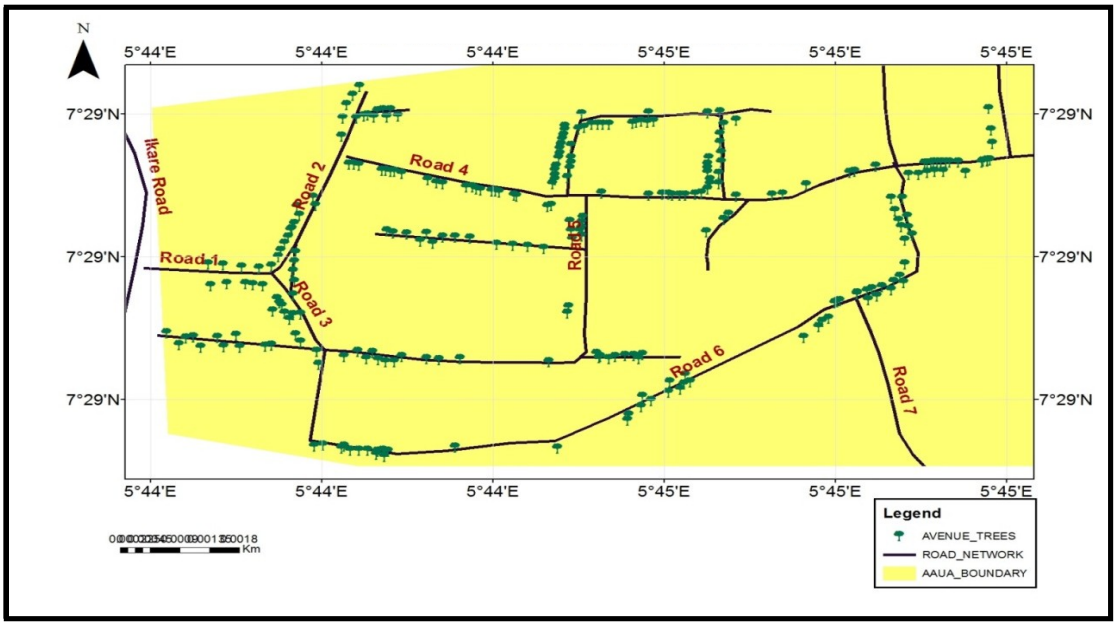

Figure 5: Thematic map of AAUA campus showing the existing Avenue Trees

DISCUSSION

One of the most important characteristics of the tropical rainforest ecosystems is the species richness. Regardless of the plot size, number of tree species in this tropical ecosystem is far greater than any other forest environment and surroundings (Adekunle, 2006; Adeduntan and Olusola, 2015). This result indicated that in FUTA campus tree species like *Gmelina arborea*, *Delonix regia*, *Acacia auriculiformis*, *Terminalia mentally*, *Leucaena leucocephala* and *Azadirachta indica* are the dominant trees on FUTA campus. Also, Acheneje and Olorunmaiye (2015) reported the same tree species as dominant trees in their study, thus this is evidence that some of these tree species are good for the avenue tree. The reasons for this occurrence for avenue tree on campuses might be because of their ability for fire resistance, sources of timber, wood antimicrobial and medicinal values (Marijoan 2011, Olorunmaiye *et al*., 2004, Ahmadu *et al*., 2004, Olorunmaiye *et al*., 2010). Also, *Polyalthia longifolia, Acacia auriculiformis, Gmelina arborea,* are the species that are dominants in AAUA campus. Trees of members of the following families have the highest members of species across the two campuses Caesalpiniaceae, Mimosaceae, Verbenaceae and Combretaceae. These families show a highest numbers of tree species that belong to them. Caesalpiniaceae have the highest number of species

with 5, Mimosaceae, Verbenaceae, Combretaceae, each of these families had 3 members of species. The results of this study confirmed that avenue trees are repository of many indigenous tropical hardwood and exotic tree species in different families, judging by the tree species richness of the two campuses which is similar to or higher than what has been reported in some natural forest ecosystems in Nigeria. Research conducted by 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.

Shannon–Wiener diversity index in FUTA campus was 1.97 while it was 2.50 in AAUA. The diversity index in this study was within the range reported by Adekunle (2006) and Onyekwelu *et al*., (2008). They reported Shannon –Wiener index value ranged between 1.5 to 3.5 and this result falls within the range, but the result of this study was higher than value (1.2–1.4) reported for sacred groves in Tanzania (Mgumia and Oba, 2003). The trees on the two campuses were either planted or reserved during the development of the University which now serve as wind breaker, shades, ornamentals, landscaping designs, control of water erosion as well as production of edible fruits. According to Babalola (2010) as cited in Babalola (2016) and Nowak *et al*., (2001), a main focus in the past for developed countries was the management of urban forest for aesthetic purposes, whereas now, as urban population have been expanded and intensified, it has shifted to management for enhancing ecosystem services. However, urban trees have been reported to provide benefits such as contribution to aesthetic value (Schroeder 1989, Heisler *et al*., 1995) have documented that shade provided by trees reduces summer energy use by 20-25%. More so, Akbari (2002) discovered that trees reduce energy consumption while McPherson and Simpson (2003) concluded that trees reduce the need for air conditioning. This study also confirmed the report of (Eludoyin and Utang, 2010) that remote sensing and GIS Technology is an effective tool in urban forestry mapping. It is however no doubt that mapping in forestry using GIS technology has become very important in the near future, because it is a part and parcel of forest management system and may enhance decision making.

CONCLUSION

This study revealed that FUTA and AAUA were diverse in tree composition; of both indigenous and exotic tree species. The tree species portrayed a very rich floral diversity and potential for uses and values. The trees served as windbreak, aesthetic values, shade, shelter for birds, fruits, fibre, fuelwood, medicinal values as well as environmental function in sequestering carbon among others. In addition, this study has shown that GIS is an effective tool that is not only used for map production but also provides detailed information about the features on the map. It has also revealed the capability of GIS in monitoring, assessing, and evaluation of forest resources and its flexibility in storing, analyzing, and managing vast quality of diverse information that can be updated from time to time.

RECOMMENDATIONS

Since the results of the thematic maps produced indicate some gaps between the tree locations on both campuses, it is therefore recommended that fast growing, disease tolerant and shade providing trees should be raised and planted by the University authorities to fill the gaps to obtain maximum productivity and conducive learning environment for students and to improve the aesthetic view of the entire campus landscape. Also, frequent survey and inventory of trees on campus should be conducted by relevant stakeholders to assess their abundance, distribution and density as well as structural and physical changes necessary for management practices. Threatened and endangered tree species on campus should be properly protected to maintain urban tree diversity and prevent their total removal as a result of developmental projects.

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