

Assessment of tree species diversity and benefits in selected recreation centres for biodiversity conservation in Ibadan Metropolis, Nigeria

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Abstract

The present study assessed the trees species diversity and the benefits that arise from their presence in five selected recreation centers in the urban area of Ibadan: Agodi Gardens, Ibadan Recreation Club, National Museum of Unity, Ibadan Golf Club and Ibadan Polo Club. The selected areas were purposively chosen due to the presence of tree species in the urban landscape. Both primary and secondary data were used for the study. Agodi Garden had in total 537 individuals, 46 tree species within 25 families. Ibadan Recreation Club had the total number of 148 trees, whereas 32 species within 22 families were represented. National Museum of Unity had a total number of 770 trees, classified in 23 species within 17 families. Ibadan Polo Club had a total number of 97 trees, 20 species and 15 families were represented. Ibadan Golf Club had a total number of 915 trees, 31 species and 9 families. Fabaceae family had the highest occurrence in Ibadan Recreation Club, National Museum of Unity, Ibadan Golf Club and Ibadan Polo Club, while Verbenaceae was more represented in Agodi Gardens. The study has shown the high occurrence of invasive species in tropical environment based on their regeneration potential. Data collected on total number of tree species, frequency of occurrence and families were subjected to descriptive analysis. A semi-structured questionnaire was used to obtain information. These centers serve as *ex-situ* urban centers/parks that still maintain and conserve various tree species and are important resources for social, economic and educational use. Biodiversity indices were also analyzed and it can be concluded that the type of organization and the main activity of the centers strongly influence the species diversity. The trend of Shannon-Wiener diversity index (H') showed that Ibadan Polo Club was the most diverse. Despite the higher number of individual trees encountered in NMUI, the H' value was very low, indicating the dominance of a few tree species within the area. From E_H values obtained in the study, it can be concluded that trees species are most evenly distributed in IPC, followed by IRC, AG, IGC and lastly by NUMI.

Keywords: biodiversity; conservation; environmental protection; human well-being; tree species

Introduction

Urban forests are affected by urbanization due to the increase in human population. Nigeria is one of the most densely populated countries in the world and is affected by urbanization which has resultant effect on forest cover (Fuwape and Onyekwelu, 2011). Urban forestry is one of the strategies for addressing the problems associated with urbanization (Agbelade *et al.*, 2016a). 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 that trees provide to the society (Konijnendijk *et al.*, 2006).

Urban trees are seen as a forest or collection of trees that grows within a city, town, or a suburb. In a wider sense, these groups of trees may include any kind of woody plants, vegetation growing in and around human settlements (FAO, 2006; Canno-purt, 2012). The benefit of urban trees and shrubs are numerous, among which beautification, reduction of urban heat and cooling, reduction of storm water run-off, reduction of air pollution, reduction of energy costs through increased shade over buildings, enhancement of property values, improved wildlife habitat and overall urban environment impact (FAO, 2006; Wilson, 2011) are worth mentioning.

Recreation centers include facilities, buildings, areas that are opened to the public, where meetings are held, sports are played, people of all ages can work out and have different activities. Recreation is an activity of leisure, leisure being discretionary time (Cushman and Laidler, 1990). The need to do something for recreation is an essential element of human biology and psychology (Bruce, 1995). Recreation activities are often done for enjoyment, amusement, or pleasure and are considered to be fun. Recreation is an essential part of human life and finds many different forms which are shaped naturally by individual interests, but also by the surrounding social constructions (Bruce, 1995).

Ibadan metropolis, being the largest city in West Africa, has different recreation centers with little or no information available on the different tree species present in these areas. There is no baseline information/ data on the tree species that can be found in these centers for biodiversity conservation. Hence, the present study assessed the tree species' diversity and their benefits in five selected recreation centers in Ibadan metropolis, Nigeria, in regard with biodiversity conservation.

Materials and Methods

Study area

The study was carried out in five representative recreation centers in Ibadan Metropolis, Nigeria, namely: Agodi Gardens, Ibadan Recreation Club, National Museum of Unity, Ibadan Golf Club and Ibadan Polo Club (Figure 1).

Agodi gardens (AG)

Agodi Garden is a recreational center located in Ibadan Oyo province in Nigeria. Ibadan is the third largest city by population in the country and also the third largest city in Africa. The garden is situated near the center of the sprawling Ibadan metropolis, near the Oyo State Secretariat Complex. It stands out as a green lung in the surrounding urban landscape with a great recreational potential. It is located on latitude 7° 24' 20" N and longitude 3° 54' 11" E and altitude 193 m. Agodi Garden has been completely renovated to contain a Botanical Garden, Zoo, swimming pool, guest house bar and a restaurant. Agodi Garden has a lot of other attractions enclosed in it such as playground areas for children, water park and animal enclosure. Agodi Garden is a place set for locals and tourists who love natural and cosmopolitan environment.

National Museum of Unity (NMUI)

The National Museum of Unity is located at Aleshinloye in Ibadan North West local government area of Oyo state. It is located on latitude $3^{\circ} 52' 7.66''$ E and longitude $7^{\circ} 23' 5.64''$ N. It has annual rainfall of 24.0 mm to 708.0 mm, with the average temperature ranges from 21.15°C to 34.8°C . The premier museum in Ibadan is the Museum of National Unity. It is classified into four distinct galleries: The Unity Gallery, Yoruba Gallery, Masquerade Gallery and Pottery Gallery. The Unit Gallery is a compilation of a wide variety of musical instrument from all over Nigeria. The objects consist of drums, gongs, rattles and several types of xylophones. The Yoruba Gallery gives insight into the nation's transitory past, faith and the numerous archaeological findings. It also homes in on a fleeting history of the race, symbols of their indigenous religions and excavations from their lands in Southwestern Nigeria, among others. Pottery Gallery displays a unique collection of ceramics vessels that served different purposes. The object displayed there are cleared indication of the workmanship that existed around 3,000 BC. Masquerade Gallery is dedicated to various departed spirits that are an integral part of Nigeria tradition. This segment of the museum also displays a wide range of exotic masks and several musical devices.

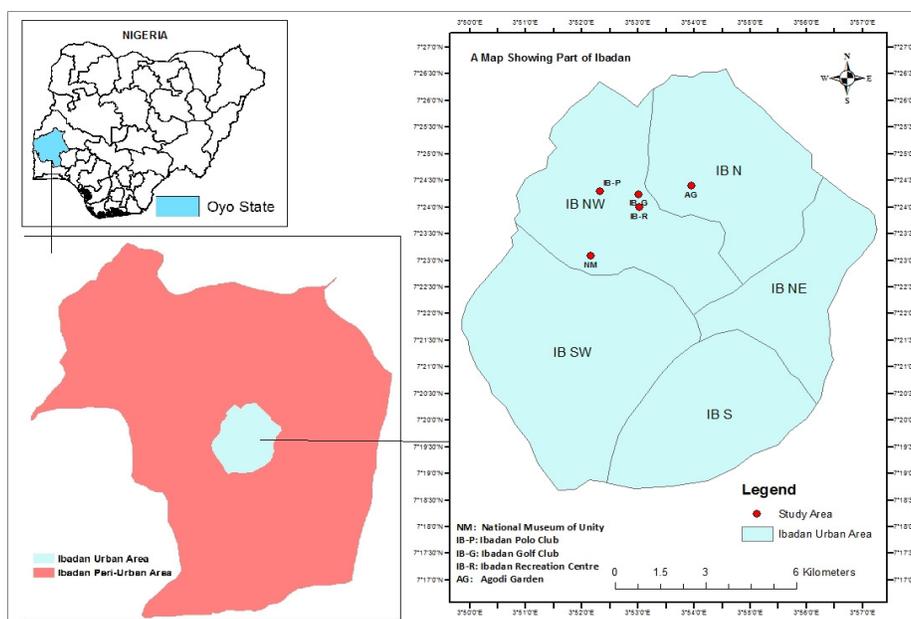


Figure 1. Map showing study areas

Ibadan Recreation Club (IRC)

Ibadan Recreational Club was formerly known to be Ibadan European Club which was established in the year 1902. The European Club became Ibadan Recreation center in 1950. Ibadan Recreational Club is located at Sabo area, Onireke GRA, Ibadan North, Oyo province. It is located on latitude $7^{\circ} 23' 56''$ N and longitude $3^{\circ} 52' 57''$ E and altitude 189 m. It mostly rain from March to September, it is dry from October to February. The average day time temperature is 27°C and the night time temperature is 22°C . The recreation club is equipped with bar, tennis courts, basketball courts, a large swimming pool furnished with pool-beds, an indoor squash court and a billiard table.

Ibadan Golf Club (IGC)

Ibadan Golf Club is located at Onireke Reservation Area, Ibadan North, Oyo State. The club was established in 1990. It is located on latitude $7^{\circ} 23' 56''$ N and longitude $3^{\circ} 52' 57''$ E and altitude 189 m. It rains from March to September and the weather is dry from October to February. The average day time temperature

is 27 °C and the night time temperature is 22 °C. One thing that marks the ancient city of Ibadan as a converging spot is the grand-scale golf club. It offers the ability to find a quiet space to relax or get work done and escape the hectic work, with amenities like free Wi-Fi, full business facilities, lounge, restaurant, conference rooms, etc.

Ibadan Polo Club (IPC)

Ibadan Polo Club is located along Eleyele Road, Eleyele, Ibadan North West. It is located on latitude 7° 23' 56" N and longitude 3° 52' 57" E and altitude 189 m. Ibadan Polo Club was declared open in 2016. It mostly rains from March to September, it is dry from October to February. The average day time temperature is 27 °C and the night time temperature is 22 °C. The polo club is equipped with a bar and restaurant for members only and is visited usually on weekends.

Plant enumeration and data analysis

Total enumeration of the five selected recreation centers was carried out. In each study area, detailed information about all the tree species present were recorded through complete enumeration of plant resources. A taxonomist from Forest Herbarium Ibadan (FHI), Forestry Research Institute of Nigeria (FRIN) with the knowledge of plant identification was involved in the study, to identify all the tree species encountered. In addition to the above, the frequency and diversity of all tree species in the selected recreation centers were recorded. Leaves, barks and fruits were collected from the trees that could not be identified on the field and taken to the FHI in FRIN for identification.

Data collected on total number of tree species, frequency of occurrence and families were subjected to descriptive analysis. A semi-structured questionnaire was used to obtain information on the environmental benefits of trees present in the recreation centers. Ten (10) respondents were noted in each recreation centers which translated to a total of fifty (50) questionnaires for this study. Administration of questionnaires was done using simple random sampling. Respondents were represented by staff members and tourists in the recreation centers. These questionnaires were administered in form of interview guide, such that respondents were requested to complete and return them immediately, thus resulting in 100 % retrieval.

Data analysis for biodiversity indices

Species diversity index was computed using the Shannon-Wiener diversity index (equation 1); (Kent and Kent and Coker, 1992; Guo *et al.*, 2003).

$$H = - \sum_{i=1}^S p_i \ln(p_i) \dots (1)$$

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

Shannon's maximum diversity index was calculated using equation (2) (Guo *et al.*, 2003)

$$H_{max} = \ln(S) \dots (2)$$

Where: Hmax = Shannon's maximum diversity index; S= total number of species in the community.

Species evenness in each recreation center was determined using Shannon's equitability (EH), which was obtained using equation (3) (Kent and Coker, 1992).

$$EH = \frac{H^i}{H_{Max}} = \frac{\sum_{i=1}^S p_i \ln(p_i)}{\ln(S)} \dots (3)$$

Data collected on total number of tree species, frequency of occurrence and families were subjected to descriptive analysis. Data on biodiversity indices were subjected to Analysis of Variance (ANOVA). Duncan Multiple Range Test (DMRT) was used to test for level of significance between the recreation centers. Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS 20.0).

Results

Biodiversity indices for the investigated recreation centers

From Agodi Gardens, a total of 537 trees were recorded, whereas 25 families were represented, with Verbenaceae having the highest occurrence. The results revealed that *Tectona grandis* had the highest frequency and was followed by *Eucalyptus torelliana* and *Terminalia catappa*, while *Newbouldia leavis*, *Senna sesame*, *Ficus lutea* and *Ficus exasperata* had the least frequency (Table 1).

A total of 148 tree species were identified, belonging to 22 families with Fabaceae having the highest occurrence, in Ibadan Recreation Center. The results revealed that *S. sesame* had the highest frequency, was followed by *Vernonia amygdalina*, *Casuarina equisetifolia* and *T. grandis*. *Afzelia Africana* and *Azadirachia indica* had the least frequency (Table 2) in the investigated area.

A total of 23 species of trees were recorded, while 17 families were represented, with Fabaceae having the highest frequency in National Museum of Unity, Ibadan. The results revealed that *S. sesame* had the highest frequency; it was followed by *T. grandis*, while *Blighia sapida*, *Chrysophyllum albidum* and *Bombax buonopozense* had the least frequency (Table 3).

A total of 20 species of trees were recorded and assign to 15 families among which Fabaceae had the highest occurrence in Ibadan Polo Club. The results revealed that *Albizia lebeck* had the highest frequency and was followed by *Cedrela odorata*, *T. grandis*, while *Spondias mombin*, *N. leavis* and *C. equisetifolia* had the least frequency (Table 4).

Table 5 shows the number of species present in Ibadan Golf Club. A total of 31 trees species were recorded, while 9 families were represented, with Fabaceae having the highest occurrence. The results revealed that *Delonix regia* had the highest frequency which was followed by *Eucalyptus globules*. *Roystonea regia* and *Ceiba pentandra* had the least frequency in the investigated area.

Table 1. Taxonomy and frequency distribution of tree species in Agodi Gardens

No.	Species	Common/Local Names	Family	Freq.	Percent (%)
1	<i>Terminalia catappa</i>	Almond tree	Combretaceae	47	8.7
2	<i>Anthocephalus cadamba</i>	Kadam	Rubiaceae	13	2.4
3	<i>Newbouldia leavis</i>	Ewe akoko	Bignaniaceae	1	0.2
4	<i>Delonix regia</i>	Flame of the forest	Fabaceae	3	0.6
5	<i>Tectona grandis</i>	Teak	Verbenaceae	154	28.5
6	<i>Eucalyptus torelliana</i>	Cadaghi	Myrtaceae	82	15.2
7	<i>Senna sesame</i>	Kassod tree	Fabaceae	1	0.2
8	<i>Ceiba pentandra</i>	Kapok tree	Malvaceae	5	0.9
9	<i>Khaya senegalensis</i>	Africa mahogany	Meliaceae	3	0.6
10	<i>Ficus exasperata</i>	Sand paper	Moraceae	1	0.2
11	<i>Ficus mucuso</i>	Obobo	Moraceae	3	0.6
12	<i>Gmelina arborea</i>	White teak	Lamiaceae	26	4.8
13	<i>Spondias mombin</i>	Iyeye	Anacardiaceae	3	0.6
14	<i>Lagerstroemia speciosa</i>	Banaba	Lythraceae	19	3.5
15	<i>Samanea saman</i>	Money pod	Fabaceae	1	0.2
16	<i>Dracaena manni</i>	Dragon tree	Asparagaceae	1	0.2
17	<i>Mangifera indica</i>	Mango	Anacardiaceae	2	0.4

18	<i>Terminalia ivorensis</i>	Black afara	Combretaceae	13	2.4
19	<i>Mansonia altissima</i>	Mansonia	Sterculiaceae	8	1.5
20	<i>Albizia lebbek</i>	Flea tree	Fabaceae	1	0.2
21	<i>Triplochiton scleroxylon</i>	Obeche/arere	Sterculiaceae	42	7.8
22	<i>Canthium spp</i>	-	Rubiaceae	2	0.4
23	<i>Gliricidia sepum</i>	Quick stick	Fabaceae	1	0.2
24	<i>Melaleuca leucadendron</i>	White paper bark	Myrtaceae	43	7.9
25	<i>Lecaniodiscus cupanioides</i>	Akika	Sapindaceae	4	0.7
26	<i>Cleistopholis patens</i>	Salt and oil tree	Annonaceae	5	0.9
27	<i>Dacryodes edulis</i>	Butter tree	Burseraceae	1	0.2
28	<i>Ficus vogeliana</i>	Ficus	Moraceae	1	0.2
29	<i>Casuarina equisetifolia</i>	Iron wood	Casuarinaceae	2	0.4
30	<i>Eucalyptus camaldulensis</i>	River redgum	Myrtaceae	3	0.6
31	<i>Ficus lutea</i>	Rubber tree	Moraceae	1	0.2
32	<i>Bambusa vulgaris</i>	Bamboo	Poaceae	1	0.7
33	<i>Blighia sapida</i>	Akee apple	Sapindaceae	2	0.2
34	<i>Pterocarpus santalinoides</i>	Mututi	Fabaceae	2	0.4
35	<i>Chrysophyllum albidum</i>	Star apple/agbalumo	Sapotaceae	1	0.4
36	<i>Trema orientalis</i>	Charcoal tree	Ulmaceae	1	0.2
37	<i>Cedrela odorata</i>	Spanish cedar	Meliaceae	4	0.2
38	<i>Borassus aethiopum</i>	African fan palm	Arecaceae	2	0.7
39	<i>Elaeis guineensis</i>	African oil palm	Arecaceae	11	0.4
40	<i>Musanga cecropioides</i>	Umbrella tree	Urticaceae	2	2
41	<i>Malacantha alnifolia</i>	Soft flower	Sapotaceae	1	0.4
42	<i>Ficus thonningii</i>	Ficus	Moraceae	1	0.2
43	<i>Bombax buonopozense</i>	Bombax	Malvaceae	1	0.2
44	<i>Peltophorum pterophorum</i>	Yellow flame tree	Fabaceae	14	0.2
45	<i>Melia azeachdarach</i>	Bead tree	Meliaceae	1	2.6
46	<i>Alstonia boonei</i>	Stool wood/awun	Apocynaceae	1	0.2
			TOTAL	537	100

Table 2. Taxonomy and frequency distribution of tree species in Ibadan Recreation Club

No.	Species	Common/Local Names	Family	Freq.	Percent (%)
1	<i>Terminalia catappa</i>	Almond tree	Combretaceae	6	4.1
2	<i>Senna sesame</i>	Kassod tree	Fabaceae	33	22.3
3	<i>Cocos nucifera</i>	Coconut palm	Arecaceae	7	4.7
4	<i>Psidium guajava</i>	Common guava	Myrtaceae	1	0.7
5	<i>Alexandra palm</i>	King palm	Arecaceae	1	0.7
6	<i>Delonix regia</i>	Flame of the forest	Fabaceae	6	4.1
7	<i>Citrus sinensis</i>	Sweet orange	Rutaceae	3	2
8	<i>Ficus benjamina</i>	Ficus tree	Moraceae	3	0.7

9	<i>Tecoma stans</i>	Yellow trumpet bush	Bignoniaceae	7	4.7
10	<i>Lagerstroemia indica</i>	Crape myrtle	Lythraceae	1	0.7
11	<i>Moringa oleifera</i>	Drum stick tree	Moringaceae	1	3.4
12	<i>Morinda lucida</i>	Ugiga	Rubiaceae	5	0.7
13	<i>Vernonia amygdalina</i>	Bitter leaf	Asteraceae	16	2
14	<i>Gliricidia sepium</i>	Quick stick	Fabaceae	7	0.7
15	<i>Casuarina equisetifolia</i>	Iron wood	Casuarinaceae	11	10.8
16	<i>Mangifera indica</i>	Mango	Anacardiaceae	1	4.7
17	<i>Calotropis procera</i>	Sodom apple	Apocynaceae	2	7.4
18	<i>Eucalyptus camaldulensis</i>	River red gum	Myrtaceae	5	0.7
19	<i>Eucalyptus torelliana</i>	Cadaghi	Myrtaceae	8	1.4
20	<i>Azadirachia indica</i>	Neem tree	Meliaceae	1	1.4
21	<i>Carica papaya</i>	Pawpaw	Caricaceae	1	3.4
22	<i>Ficus spp</i>	Ficus	Moraceae	2	5.4
23	<i>Pinus caribaea</i>	Caribbean pine	Pinaceae	7	0.7
24	<i>Ceiba petandra</i>	Kapok tree	Malvaceae	3	0.7
25	<i>Ficus exasperate</i>	Sand paper	Moraceae	2	1.4
26	<i>Terminalia spp</i>	Terminalia	Combretaceae	1	4.7
27	<i>Leucaena leucocephala</i>	Leucaena	Fabaceae	1	2
28	<i>Tectona grandis</i>	Teak	Lamiaceae	1	1.4
29	<i>Afzelia Africana</i>	African mahogany/ oak	Fabaceae	1	0.7
30	<i>Plumeria alba</i>	Nosegay	Apocynaceae	1	0.7
31	<i>Callitris intratropica</i>	Cypress pine	Cupressaceae	2	0.7
32	<i>Polyalthia longiflora</i>	False ashoka	Annonaceae	1	0.7
			TOTAL	148	100

Table 3. Taxonomy and frequency distribution of tree species in National Museum of Unity, Ibadan

No.	Species	Common/Local Names	Family	Freq.	Percent (%)
1	<i>Leucaena leucocephala</i>	Leucaena	Fabaceae	4	0.5
2	<i>Tectona grandis</i>	Teak	Verbenaceae	29	3.8
3	<i>Senna siamea</i>	Kassod tree	Fabaceae	664	86.2
4	<i>Mangifera indica</i>	Mango	Anacardiaceae	6	0.8
5	<i>Albizia lebbek</i>	Flea tree	Fabaceae	8	1
6	<i>Psidium guajava</i>	Guava	Myrtaceae	7	0.9
7	<i>Delonix regia</i>	Flame of the forest	Fabaceae	3	0.4
8	<i>Pinus caribaea</i>	Caribbean pine	Pinaceae	1	0.1
9	<i>Elaeis guineensis</i>	African oil palm	Arecaceae	4	0.5
10	<i>Anacardium occidentale</i>	Cashew	Anacardiaceae	1	0.1
11	<i>Terminalia catappa</i>	Almond tree	Combretaceae	2	0.3
12	<i>Persea Americana</i>	Avocado	Lauraceae	5	0.7
13	<i>Chrysophyllum albidum</i>	Starapple/agbalumo	Sapotaceae	1	0.1
14	<i>Azadirachta indica</i>	Neem tree	Meliaceae	2	0.3

15	<i>Morinda lucida</i>	Oruwo	Rubiaceae	3	0.4
16	<i>Albizia adiantifolia</i>	Flat crown	Fabaceae	1	0.1
17	<i>Blighia sapida</i>	Ishin/Akee apple	Sapindaceae	1	0.1
18	<i>Bombax buonopozense</i>	Bombax	Malvaceae	1	0.1
19	<i>Citrus sinensis</i>	Sweet orange	Rutaceae	4	0.5
20	<i>Thuja occidentalis</i>	White cedar	Cupressaceae	1	0.1
21	<i>Terminalia randii</i>	Cameroun tree	Combretaceae	1	0.1
22	<i>Strombosia pustulata</i>	Oliv	Strombosia	1	0.1
23	<i>Carica papaya</i>	Pawpaw	Caricaceae	20	2.6
			TOTAL	770	100

Table 4. Taxonomy and frequency distribution of tree species in Ibadan Polo Club

No.	Species	Common/Local Names	Family	Freq.	Percent (%)
1	<i>Terminalia catappa</i>	Almond tree	Combretaceae	6	6.2
2	<i>Cedrela odorata</i>	Spanish cedar	Meliaceae	14	14.4
3	<i>Terminalia ivorensis</i>	Black afara	Combretaceae	5	5.2
4	<i>Eucalyptus globules</i>	Blue gum oil	Myrtaceae	6	6.2
5	<i>Spondias mombin</i>	Iyeye	Anacardiaceae	1	1
6	<i>Leucaena leucophala</i>	Leucaena	Fabaceae	3	3.1
7	<i>Morinda lucida</i>	Oruwo	Rubiaceae	2	2.1
8	<i>Hevea brasiliensis</i>	Rubber tree	Euphorbiaceae	6	6.2
9	<i>Gmelina arborea</i>	White teak	Lamiaceae	6	6.2
10	<i>Albizia lebbeck</i>	Flea tree	Fabaceae	19	19.6
11	<i>Gliricidia sepium</i>	Quick strick	Fabaceae	9	9.3
12	<i>Bombax buonopozense</i>	Bombax	Malvaceae	1	1
13	<i>Irvingia wombolu</i>	Ogbono	Irvingiaceae	1	1
14	<i>Irvingia gabonensis</i>	Ogbono	Irvingiaceae	1	1
15	<i>Azadirachta indica</i>	Neem tree	Meliaceae	3	3.1
16	<i>Tectona grandis</i>	Teak	Verbenaceae	9	9.3
17	<i>Ficus exasperate</i>	Sand paper tree	Moraceae	2	2.1
18	<i>Newbouldia leavis</i>	Ewe akoko	Bignoniaceae	1	1
19	<i>Casuarinas equisetifolia</i>	Iron wood	Casuarinaceae	1	1
20	<i>Persea americana</i>	Avocado	Lauraceae	1	1
			TOTAL	97	100

Table 5. Taxonomy and frequency distribution of tree species in in Ibadan Golf Club

No.	Species	Common/Locals Names	Family	Freq.	Percent (%)
1	<i>Delonix regia</i>	Flame of the forest	Fabaceae	259	28.3
2	<i>Albizia lebbeck</i>	Flea tree	Fabaceae	89	9.7
3	<i>Terminalia randii</i>	Cameroon tree	Combretaceae	34	3.7

4	<i>Eucalyptus camaldulensis</i>	River redgum	Myrtaceae	37	4
5	<i>Eucalyptus globules</i>	Blue gum oil	Myrtaceae	196	21.4
6	<i>Gmelia arborea</i>	White teak	Lamiaceae	19	2.1
7	<i>Bombax buonopozense</i>	Bombax	Malvaceae	8	0.8
8	<i>Newbouldia leavis</i>	Ewe akoko	Bignaniaceae	10	1.1
9	<i>Gliricida sepium</i>	Quick stick	Fabaceae	42	4.6
10	<i>Terminalia superb</i>	Afara	Combretaceae	10	1.1
11	<i>Terminalia catapa</i>	Almond tree	Combretaceae	17	1.9
12	<i>Mangifera indica</i>	Mango	Anacardiaceae	32	3.5
13	<i>Pinus caribaea</i>	Caribbean pine	Pinaceae	23	2.5
14	<i>Cocos nucifera</i>	Coconut palm	Arecaceae	4	0.4
15	<i>Tectona grandis</i>	Teak	Verbenaceae	41	4.5
16	<i>Leucaena leucocephala</i>	Leucaena	Fabaceae	19	2.1
17	<i>Azadirachta indica</i>	Neem tree	Meliaceae	9	0.9
18	<i>Cassia senna</i>	Senna	Fabaceae	12	1.3
19	<i>Cassia fistula</i>	Golden shower tree	Fabaceae	11	1.2
20	<i>Anthiaris toxicaria</i>	False iroko	Moraceae	1	0.1
21	<i>Albizia adianthifolia</i>	Flat crown	Fabaceae	4	0.4
22	<i>Plumeria alba</i>	Nosegay	Apocynaceae	1	0.1
23	<i>Spondias mombin</i>	Iyeye	Anacardiaceae	2	0.2
24	<i>Ceiba pentandra</i>	Kapok tree	Malvaceae	1	0.1
25	<i>Nauclea diderrichii</i>	Opepe	Rubiaceae	2	0.2
26	<i>Alexandra palm</i>	King palm	Arecaceae	2	0.2
27	<i>Elaeis guineensis</i>	African oil palm	Arecaceae	12	1.3
28	<i>Roystonea regia</i>	Royal palm	Arecaceae	1	0.1
29	<i>Polyalthia longifolia</i>	False ashoka	Annonaceae	14	1.5
30	<i>Piptadeniastrum africanum</i>	African greenheart	Fabaceae	11	1.2
31	<i>Strombosia pustulata</i>	Oliv	Strombosiaceae	1	0.1
			TOTAL	915	100

Biodiversity indices of the investigated recreation centers are shown in Table 6. The results show that Ibadan Golf Club had the highest population of trees, with 915 trees, followed by National Museum of Unity with 770 trees. Agodi Gardens had 537 trees, followed by Ibadan Recreation Club with 148 trees, while Ibadan Polo Club had the least population of trees, with 97 trees. However, Agodi Gardens had the highest number of tree species, with 46 species represented, followed by Ibadan Recreation Club with 32 tree species. Ibadan Golf Club had 31 tree species, followed by National Museum of Unity, Ibadan with 23 tree species, while Ibadan Polo Club had the least number of tree species, with 20 species. Moreover, Agodi Gardens had the highest number of families of tree species, with 25 families represented and followed by Ibadan Recreation Club with 22 families. National Museum of Unity had 17 families, followed by Ibadan Golf Club with 16 families, while Ibadan Polo Club had the least number of families of tree species, with 15 families represented.

The result of Shannon-Wiener diversity index (H) for AG, IRC, NMUI, IPC and IGC areas were 2.60, 2.90, 0.76, 2.98 and 2.47 respectively, while Shannon's maximum diversity index was 6.29, 5.00, 6.65, 4.57 and 6.83 respectively. The result of tree species evenness (Shannon's equitability (EH) index) in AG, IRC, NMUI, IPC and IGC were 0.41, 0.58, 0.11, 0.65 and 0.36 respectively. The results of the analysis of variance (ANOVA)

for comparing tree species diversity in the different recreation centers investigated are presented in Table 6. Shannon-Wiener diversity index (H') and Shannon maximum diversity index (H_{max}) was found to be significantly different in the selected recreation centers.

The results of mean separation revealed that H' was significantly higher in the recreation centers except in NUMI that had lower H' . Shannon-Wiener diversity index in AG, IRC, IPC and IGC were not significantly different from each other but significantly different from the H' in NUMI. Shannon maximum diversity index was significantly higher in AG, NUMI and IGC compared to other recreation centers. Species evenness (Shannon's equitability (E_H) index) was significantly different from each other.

Table 6. Summary of biodiversity indices of the investigated recreation centers

Biodiversity Indices	AG	IRC	NMUI	IPC	IGC
No. of individual trees	537 ^c	148 ^d	770 ^b	97 ^c	924 ^a
No. of tree species	46 ^a	32 ^b	23 ^c	20 ^c	31 ^b
No. of families	25 ^a	22 ^a	17 ^b	15 ^b	16 ^b
Shannon Diversity Index (H')	2.60 ^a	2.90 ^a	0.74 ^b	2.98 ^a	2.47 ^a
Shannon Maximum Diversity Index (H_{max})	6.29 ^a	5.00 ^b	6.65 ^a	4.57 ^c	6.83 ^a
Species evenness (E_H)	0.41 ^b	0.58 ^a	0.11 ^c	0.65 ^a	0.36 ^b

Note: AG = Agodi Garden, IRC = Ibadan Recreation Club, NMU = National Museum of Unity, IPC = Ibadan Polo Club, IGC = Ibadan Golf Club

Benefits derived from different tree species in the investigated recreation centers

The effects that can be related with urban trees are multiple, all with an increase of the physical, emotional and ecological state. Table 7 below shows the benefits derived from the tree species present in the recreation centers studied. The results indicate that respondents are aware of the various benefits derived from the existence of trees in an urban setting. From the five recreations centers selected, a high percentage of 60 to 80% of the respondents submitted that the trees reduce the heat perception in the recreation areas. Among 30 to 50% of the respondents stated that the trees serve as a wind break. The percentage of respondents that identified that the trees present in the recreation areas are used for shade were between 50 to 70%. Higher percentage (from 60 to 80%) of the respondents submitted that the trees are used for beautification purposes in the recreation centers; likewise, higher percentage (between 70 to 85%) of the respondents derive fresh air from trees in the recreation centers. Concerning water conservation, between 15 to 70% of the respondents opined that the trees help in the conservation of water in the recreation centers. Between 50 to 85% of the respondents submitted that the trees in the recreation centers help in soil conservation, while between 70 to 85% of the respondents identified that they use the trees' presence for relaxation. Lastly, between 50 to 70% of the respondents stated that the trees are used for research purposes (Table 7).

Table 7. Benefits derived from tree species present in the studied recreation centers

Benefits derived	AG (%)	IRC (%)	NMUI (%)	IPC (%)	IGC (%)
Reduction of heat	65	60	80	70	65
Wind break	30	50	30	40	50
Shade	70	50	50	65	70
Beautification	60	70	75	80	70
Provision of quality air	85	75	70	70	65
Conservation of water	70	30	35	10	15
Soil conservation	50	65	50	60	85
Relaxation	75	85	75	70	70

Edible fruit/ Medicine (Herbs)	50	70	55	60	65
Research purposes	65	55	70	50	55

Note: AG = Agodi Garden, IRC = Ibadan Recreation Club, NMU = National Museum of Unity, IPC = Ibadan Polo Club, IGC = Ibadan Golf Club

Discussion

The total number of tree species identified in the selected recreation centers is a representation of good compendium of various tree species and their diversity, which in turn could serve as educational purpose for locals and tourist, as well as heritage for Oyo State. The results corroborate the assertion of Diouf (1997) who reported that forest trees species are the most important terrestrial gene banks on Earth that must be conserved. Ibadan Golf Club had the highest total number of trees, which could be due to the large expanse of the land used for the golf course. Lower number of trees encountered in Ibadan Polo Club might be due to the relatively small space available for polo games, which could not accommodate more trees as compared with the land size of other recreation centers. Agodi Gardens had the highest total number of tree species and families, which might be due to the ecological attributes including horticulture, botanical conservation, zoo, natural and semi-natural bodies of water. This corroborates the assertion of Agbeja and Akindele (2016) who reported that the presence of different tree species and landscape have provided huge attraction to people in and outside Ibadan, which is the renowned largest city in West Africa. Lower number of tree species and families were observed in Ibadan Polo Club which can be correlated to the lower number of total trees encountered in the location.

The high number of tree species recorded in some of the recreation centers of the hereby study indicate a high structural diversity in urban areas of Ibadan. Exotic tree species were found to occur the most in the different study locations compared to the occurrence of indigenous tree species in recreation centers of urban settlements of Ibadan metropolis. This might be due to the fast growing nature of the exotic species, which inform the choice of some tree species planted in the recreation centers. Such a state has encouraged a higher level of conservation of exotic tree species than the indigenous tree species (Sarrailh and Ayrault, 2001). The more rapid growth rate of exotic tree species have led to them being favoured for planting, rather than the indigenous ones (Emtage, 2004). Despite the high occurrence of exotic tree species in the recreation centers, the studied areas still harbor some number of indigenous tree species that have been reported to be endangered.

The family dominance (fam. Fabaceae) of the tree species in the recreation centers investigated is in correlation with what has been reported within other tropical rainforest ecosystems. Previous studies on rainforest ecosystems in Nigeria have reported that Fabaceae is one of the most dominant family of tree species in such forests (Adekunle *et al.*, 2013; Olajuyigbe and Adaja, 2014; Olusola and Oyeleke, 2015; Olajuyigbe and Jeminiwa, 2018; Olajuyigbe and Akwarandu, 2019). Even more, Agbelade *et al.* (2016a) recorded Fabaceae as the family that dominated the most in-urban and peri-urban areas of Abuja, which is noted as savanna and not rain forest. This shows the wide spread of Fabaceae family across Nigeria. However, Onyekwelu *et al.* (2008) did not encounter Fabaceae family in the Queen's forest, Oluwa forest and Elephant forest in tropical rainforest ecosystems. Fabaceae is the third largest plant family and also the most common in the tropical rainforest, comprising trees, shrubs, lianas and herbs species (Mahbubur-Rahman and Ismot-Ara-Parvin, 2014; Olajuyigbe and Akwarandu, 2019). The dominance and abundance of species from the Fabaceae family could be attributed to their invasive nature. These are tree species that are able to survive, reproduce and spread, unaided, and sometimes at alarming rates, across the landscape (van Wilgen *et al.*, 2001).

Biodiversity indices are produced to bring the diversity and abundance of the species in different habitats to alike scale for comparison and when the richness of the species is high, it shows that the diversity value is also high (IIRS, 2002). The Shannon Wiener diversity index (H') has been used for characterizing community diversity in tropical forest ecosystems in urban and rural settings (Onyekwelu *et al.*, 2008; Agbelade *et al.*, 2016b; Olajuyigbe and Jeminiwa, 2018; Olajuyigbe and Akwarandu, 2019). The trend of H' in the present

study showed that Ibadan Polo Club (IPC) was the most diverse of the five recreation centers investigated, followed by Ibadan Recreation Center (IRC), Agodi Gardens (AG), Ibadan Golf Club (IGC) and lastly by National Museum of Unity Ibadan (NMUI). Despite the higher number of individual trees encountered in NMUI, the H' value was very low, indicating the dominance of a few tree species. It was observed that *Senna siamea* occurred 664 times out of the 770 number of individual trees in NMUI. The result corroborates the very low H' value obtained for NMUI. Values for H' for the study locations were lower than their maximum diversity indices, which is an indication that all species in these locations did not have equal area abundance. From E_H values obtained in the study, it can be concluded that trees species are most evenly distributed in IPC, followed by IRC, AG, IGC and lastly by NUMI. The H' of the recreation centers of the study are within the range of mean of 3.00 obtained by Rao *et al.* (2011) for sacred groves in Southeastern Ghats, India and also within the range of 2.94 – 3.99 reported by Agbelade *et al.* (2016b) for urban forest and peri-urban areas of Ibadan city in Southwestern Nigeria. Also, H' for IPC and IRC was higher than the value obtained for Elephant forest in south western Nigeria by Onyekwelu *et al.* (2008).

Tree species in recreation centers found in urban settings have different benefits that they provide to people such as food (edible fruits), medicine (herbs), soil and water conservation, relaxation etc. (Agbelade *et al.* 2016b). The trees in Ibadan Golf Club help to prevent the soil from erosion, thereby helping in the smooth play of sport, which in turn increased the number of trees in the location. Ibadan Golf course has helped to reduced carbon emission in the area due to the larger number of trees. Even more, the trees species in the recreation centers provide several services such as beautification of car parks, provision of quality air, conservation of water, clone of trees providing shade, fountains protected with trees, protection of swimming pools, protection of animals hosted within and so on (Agbeja and Akindele, 2016).

Conclusions

The results of the present study revealed the basic information on the tree diversity in five selected recreation centers, data that can be used for the development of tree species database for Ibadan metropolis. The potentials of these recreation centers in conserving biodiversity, providing necessary services towards social value and environmental management of the city was revealed within the investigation. The study provided baseline information on the contributions and benefits of trees present in recreation centers in Ibadan metropolis. The five selected areas have helped in the conservation of different timber tree species and fruit trees. Exotic tree species are more abundant than indigenous tree species, showing the level of their regeneration. Fabaceae was found to occur most in the selected recreation centers, revealing the invasive nature of these species in tropical environment. The studied centers serve as *ex-situ* urban centers/parks that still maintain and conserve various tree species for enjoyment of the locals and tourists on daily basis. However, the management of the areas should be such that it will remain a heritage that must be preserved. These recreation centers serve as an avenue where research activities can always be carried out. The government at all levels should create measures which will involve planting and conservation of trees in recreation centers during construction and development of infrastructure in urban settlements.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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