SPECIES DIVERSITY AND PUBLIC PERCEPTIONS OF URBAN TREES IN ILORIN METROPOLIS, KWARA STATE, NIGERIA

[1] Moshood, F.J.[*], [2] Muhali, M.O. and [1,3] Ngwuli, C.P.
[1] Department of Forest Production and Products, University of Ibadan, Ibadan, Nigeria
[2] Department of Forest Resources Management, University of Ilorin, Ilorin, Nigeria
[3] Department of Forestry and Environmental Management, Michael Okpara University of Agriculture, Umudike, Nigeria
* Corresponding author: moshoodfarhan@gmail.com

Abstract
Urban trees are part of the human environment; they provide direct, indirect, tangible, and intangible ecosystem services. This study was designed to investigate species diversity and public perception of urban trees in Ilorin metropolis, Kwara State, Nigeria. A systematic sampling technique was used to select road networks and houses with trees for enumeration. Socioeconomic data were obtained from 400 randomly selected respondents drawn among students, traders, government workers and marketers. Data were obtained using a structured questionnaire, interview schedule and personal discussions. Eighty-six (86) tree species belonging to 23 families were encountered in the study area. Polyalthia longifolia was the most occurring species, with a frequency of 271 and a relative frequency of 8.40%. The least occurring species were Ceiba pentadra, Ficus carica, and Strychnos spinosa, with frequency and relative frequency of 2 and 0.06% each. The values of Shannon-Wiener and Margalef indices were 3.88 and 10.52, respectively. Majority of the respondents noted that trees beautify the environment, provide shades and help mitigate environmental pollution. On the other hand, the majority also stated that branches of trees litter the environment, and trees reduce visibility on roadsides. The study concludes that the diversity and richness of urban trees was relatively high compared to some urban forests in Nigeria and there was a heightened awareness of the benefits and threats of urban trees in Ilorin metropolis. It recommends that the state government establishes a committee that will look into the conservation and management of urban trees.

Keywords: *Urban trees, ecosystem services, Shannon-Wiener diversity index, Margalef index, environmental pollution*

Introduction

Urban forests are ecosystems characterized by trees and other vegetation associated with human developments. They include all publicly and privately owned trees within an urban area, including individual trees along streets and backyards and stands of the remnant forest (Nowak *et al*., 2001). They are composed of parks, street trees, gardens, river and coastal promenades, greenways, nature preserves, boulevard plantings, and many more (Eckart, 2018).

Urban forests have been regarded as essential elements for improving the green infrastructure network in the urban landscape (Riitters *et al*., 2012). They have become a concomitant aspect of the human environment, generating essential ecosystem services. Ecosystem services are the direct and indirect, tangible and intangible benefits people derive from the ecosystem. According to the Millennium Ecosystem Assessment (MEA, 2005), the ecosystem services are provisioning, regulating, supporting, and cultural services. Hence, urban forests help offset carbon emissions, remove air pollutants, control the microenvironment and mitigate climate change, among other functions (Fuwape and Onyekwelu, 2011).

Urban centres are fast-growing in Nigeria as a result of rural-urban migration. For instance, it was estimated that 43.48% of Nigerians lived in urban areas in 2010, 47.84% in 2015, and 51.96% in 2020 (www.statista.com). This development pattern has resulted in the destruction of urban forests and the development of social amenities, making the urban centres attractive for high migration potentials (Agbelade *et al*., 2016b).

Since urban forests are gradually declining and the quality of life in urban areas are greatly influenced by the amount and quality of their green spaces (Popoola and Ajewole, 2001), it is essential to encourage the people to be involved in their rejuvenation. Therefore, it is necessary to understand the public's shared beliefs and attitudes toward trees that promote their care, management, and protection (Faleyimu, 2014).

Materials and methods

Study Area

The study was carried out in Ilorin, the capital of Kwara State (Figure 1). It lies within latitude 08°26′237″ - 08°31′267″ N and longitude 04°30′02″ - 04°33′77″ E of the equator. It is situated within the North central geopolitical zone and Nigeria's Guinea savanna ecological region. The three major Local Government Areas that form Ilorin are; Ilorin East, Ilorin South, and Ilorin West. The 2006 National Population Census gives the population as 777, 667 with an annual population change of about 3% (NPC, 2006). Ilorin has a tropical climate with dry and wet seasons. The annual rainfall varies from 1000 mm to 1500 mm, with its peak occurring between September and early October; the temperature ranges from 33 º to 35 ºC between November to January and 34 º to 37 ºC from February to April (Ahmed, 2008; Ajadi *et al*., 2016).

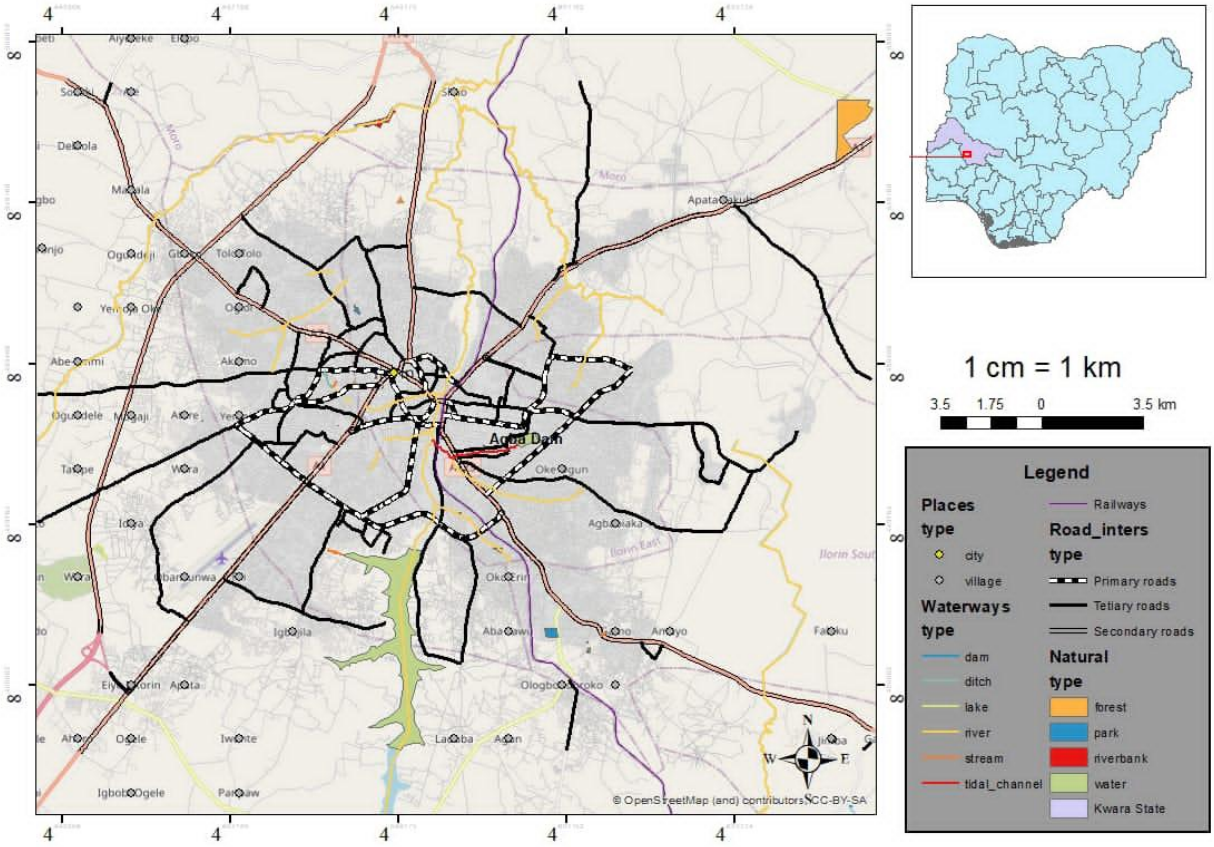

Figure 1: Map of Ilorin metropolis (inset: Map of Nigeria showing Kwara State)

Data Collection

The study purposively selected Ilorin as the study area. Data collection for the study consisted of two parts: (1) a botanical survey based on tree species enumeration and (2) a socioeconomic survey based on questionnaire, interview schedule and personal discussions. The data for tree species enumeration were collected from the central districts covering approximately one-fifth (20%) of the urban areas (Agbelade and Onyekwelu, 2020). The areas covered were: Irewolede (New Yidi Road), Asadam, Taiwo, Muritala Mohammed way, Offa Garage, Ahmadu Bello way, Fate, Tanke, Gaa Akanbi, Sawmill, Adewole, Olohunsogo, Kwara Polytechnic campus, Kwara State College of Education campus, and University of Ilorin campus. The enumeration was done using a systematic sampling to select road networks and houses with trees in the central districts of Ilorin. The service of an experienced taxonomist was employed to identify trees to species level. Socioeconomic survey was employed to collect data on public perception of urban trees in Ilorin metropolis through the use of structured questionnaire administered to four hundred (400) randomly selected respondents. The respondents were drawn among students, traders, government workers and marketers. Interviews and personal discussions were used to support the questionnaire. The questions focused on the demography of the respondents, perception statements using a five-scale Likert, and perception questions with a yes or no response.

Data Analysis

Tree species relative frequency was calculated using:

$$\text{RF (\%)} = \frac{number\ of\ individual\ species}{total\ number\ of\ species} \times 100 \quad \text{(I)}$$

Tree species diversity index was computed using the Shannon-Wiener diversity index:

$$H' = -\sum PiIn(Pi) \quad (2)$$

Where $Pi = \frac{n}{N}$, n = number of individual species, N = total number of tree species, and *In* = natural logarithm

Tree species richness in the area was computed using Margalef index of species richness:

$$d = \frac{S}{\sqrt{N}} \quad (3)$$

Where S = the number of species encountered and N = the total number of individuals of all the tree species in the area.

The Likert scale on perception statements was ranked as: Strongly Agreed (5), Agree (4), Undecided (3), Disagree (2), and Strongly Disagree (1).

Microsoft Excel 2016 and Paleontological Statistic (PAST 4.03) were used to enter, clean, and analyze the data. Data were analyzed and summarized using descriptive statistics such as frequency and percentage.

Results and discussion

Urban Trees Composition in Ilorin Metropolis

A total of 86 tree species belonging to 23 families were encountered in the area. *Polyalthia longifolia* was the most occurring species, with a frequency of 271 and a relative frequency of 8.40%. The least occurring species were *Ceiba pentadra*, *Ficus carica*, and *Strychnos spinosa* with frequency and relative frequency of 2 and 0.06% each (Table 1; Figure 2). The species diversity (ShannonWiener) and richness (Margalef) indices for the area were 3.88 and 10.52, respectively (Table 2).

The knowledge of species diversity and composition is vital in comparing the composition of different species (Naidu and Kumar, 2016). Biodiversity assessment in any ecosystem is useful because it indicates the ecological functioning and processes. The Shannon-Wiener diversity index was higher than 3.56 in Abuja urban forests, 3.08 in Minna urban forests (Agbelade *et al*., 2016a), 3.35 in Ibadan metropolis (Agbelade *et al*., 2016b) and 3.39 for Port Harcourt urban forests (Agbelade and Onyekwelu, 2020). It was also higher compared with the findings in some natural forests, where 3.54 was obtained in Old Oyo National Park (Adeyemi and Taofeek, 2020) and 3.74 for Akure Strict Nature Reserve (Adekunle *et al*., 2013). This could be attributed to factors such as socioeconomic conditions, government policy, increased awareness, and perhaps fewer developmental projects that may cause the removal of many tree species. Higher species diversity is expected to contribute to the greenness of the city and help sequester more carbon which will largely influence the atmospheric condition. Fabaceae was the most dominant family in the study area. This agrees with Iheyen *et al*. (2009), Ogwu *et al*. (2016) and Moshood *et al*. (2022). Members of the Fabaceae family largely disperse their seed by the wind. However, the poor representation of some families may be attributed to edaphic and climatic conditions not suitable for the growth of those species or anthropogenic activities such as the construction and expansion of roads.

Table 1: Tree species composition in Ilorin metropolis

Tree Species	**Family**	**Frequency**	**Rel. Freq**
Acacia auriculiformis A.Cunn. Ex Benth.	Fabaceae	12	0.37
Acacia nilotica (L) Willd. Ex Delile	Fabaceae	6	0.19
Acacia polycantha (willd.) Seigler & Ebinger	Fabaceae	16	0.50
Acacia senegalensis (L). Brittton	Fabaceae	5	0.16
Adansonia digitata L	Malvaceae	30	0.93
Afezelia africana SM	Fabaceae	7	0.22
Albizia coriaria Welwex Oliv	Fabaceae	32	0.99
Albizia lebbeck (Lam) Benth.	Fabaceae	79	2.45
Abizia zygia (D.C.) JFMacbride	Fabaceae	43	1.33
Anacardium occidentale L	Anacardiaceae	78	2.42
Annoigeissus leocarpus (DC.) Guill. &Perr	Combretaceae	56	1.74
Annona senegalensis Pers	Annonaceae	8	0.25
Annona muricata L	Annonaceae	87	2.70
Anthocliesta djalonensis A.Chev	Loganiaceae	5	0.16
Anthocliesta nobilis G.Don	Gentianaceae	6	0.19
Atrocarpus altilis (Parkinson)Fosberg	Moraceae	5	0.16
Azadirachta indica A. Juss	Meliaceae	205	6.36
Blighia sapida K.D.Koenig	Sapindaceae	132	4.09
Bridelia ferruginea Benth	Euphorbiaceae	18	0.56
Burkea africana Hook	Fabaceae	6	0.19
Butea superba (Lam.) Taub.	Fabaceae	9	0.28
Bombax constratum	Bombacaceae	4	0.12

Tree Species	Family	Frequency	Rel. Freq
Buhienia veriegata	Fabaceae	10	0.31
Calotropis procera (Aiton) Ait.f	Gentianaceae	11	0.34
Cassia fistula Linn	Fabaceae	48	1.49
Casuarina equisetifolia L	Casuarinaceae	9	0.28
Cedrela odorata L	Meliaceae	23	0.71
Ceiba pentadra L	Malvaceae	2	0.06
Cocos nucifera L	Arecaceae	22	0.68
Combretum molle R.Br. ex G.Don	Combretaceae	16	0.50
Crescentia cujete L	Bignoniaceae	6	0.19
Croton gratissimus Burch.var	Euphorbiaceae	4	0.12
Dalbergia latifolia Roxb.	Fabaceae	8	0.25
Daniella oliveri (Rolf) Hutch & Dalz	Fabaceae	62	1.92
Delonix regia (Hook) Raf.	Fabaceae	6	0.19
Detarium microcarpum	Fabaceae	29	0.90
Erythrina senegalensis Dc	Fabaceae	62	1.92
Erythrina sigmoidea Hua	Fabaceae	18	0.56
Eucalyptus camadalensis Dehn	Myrtaceae	62	1.92
Eucalyptus citrodora Hook.	Myrtaceae	60	1.86
Eucalyptus toreliana F. Muell	Myrtaceae	12	0.37
Ficus benjamina L	Moraceae	39	1.21
Ficus carica L	Moraceae	2	0.06
Ficus capensis Thunb	Moraceae	5	0.16
Ficus exasperate Vahl	Moraceae	37	1.15
Ficus macrophylla Desf. ex Pers	Moraceae	69	2.14
Ficus microcarpa L. Fil	Moraceae	187	5.80
Ficus mucoso Welw ex Ficalho	Moraceae	73	2.26
Ficus sur Forssk.	Moraceae	4	0.12
Ficus sycomorous L	Moraceae	29	0.90
Ficus thoningii L	Moraceae	34	1.05
Gmelina arborea Roxb	Lamiaceae	81	2.51
*Gliricidia sepium (*Jacq.) Walp	Fabaceae	13	0.40
Hildegardia barteri (Mast.) Kosterm.	Malvaceae	7	0.22
Hura crepitans L.	Euphorbiaceae	12	0.37
Khaya grandifoliola C. DC.	Meliaceae	6	0.19

Tree Species	**Family**	**Frequency**	**Rel. Freq**
Khaya senegalensis (Desr) A. Juss	Meliaceae	32	0.99
Kigelia Africana (Lam.) Benth	Bignoniaceae	6	0.19
Lannea acida A. Rich	Anacardiaceae	11	0.34
Lannea barteri (Oliv) England	Anacardiaceae	21	0.65
Leucena leucocephala (Lam.) de wit	Fabaceae	62	1.92
Mangifera indica L	Anacardiaceae	89	2.76
Millieta thonningii. (Schumach.) Baker	Fabaceae	3	0.09
Newbouldia laevis (P. Beauv*)*	Bignoniaceae	22	0.68
Nuclear latifolia. Sm	Rubiaceae	9	0.28
Parinari polyandra. Aubl	Chrysobalanceae	71	2.20
Parkia biglobosa (Jacq)R. Br ex G.Don	Fabaceae	66	2.05
piliostigma thonningii. (Shcum) Milne-Redh	Fabaceae	38	1.18
Plumeria alba L	Apocyanaceae	23	0.71
Polyalthia longifolia (Sonn.) Thwaites	Annonaceae	271	8.40
Prosopsis africana (Guill & Perr) Taub.	Fabaceae	17	0.53
Pterocarpus erinaceus Poir.	Fabaceae	5	0.16
Roystonea regia (H. B. K) F. cook	Arecaceae	45	1.40
Senna siamea (Lam) Irwin & Barneby	Fabaceae	38	1.18
Securidaca longepedunculata. Fresen	Polygalaceae	4	0.12
Spathodea campanulata P. Beauv.	Bignoniaceae	16	0.50
*Spondias mombin.*L	Anacardiaceae	32	0.99
Sterculia setigera. Delile	Sterculiaceae	12	0.37
Strychnos spinosa. Lam	Loganiaceae	2	0.06
Tectona grandis Linn. F.	Lamiaceae	44	1.36
Terminalia catappa L	Combretaceae	110	3.41
Terminalia mantaly H. Perrier	Combretaceae	164	5.09
Terminalia glaucescens. Planch. Ex Benth	Combretaceae	11	0.34
Vitellaria paradoxa C.F Gaertn.	Sapindaceae	43	1.33
Vitex doniana L.	Lamiaceae	35	1.09
Ziziphus abyssinica Hochst.ex A. Rich	Rhamnaceae	6	0.19
TOTAL		3225	100.00

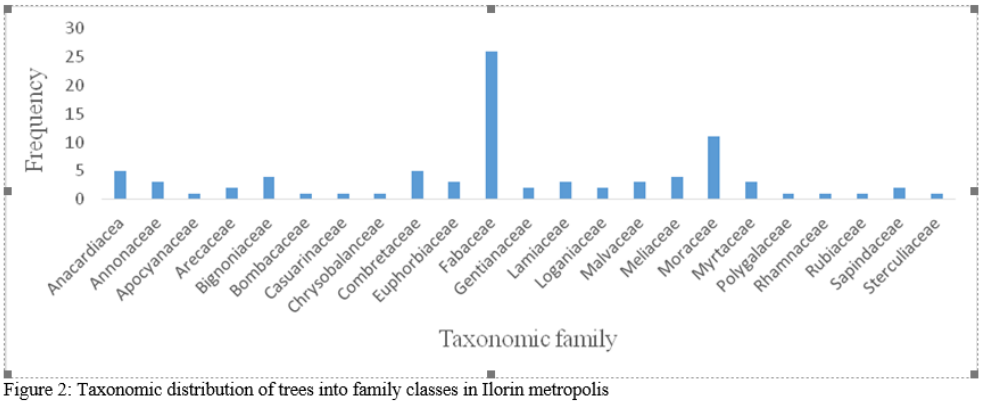

Figure 2: Taxonomic distribution of trees into family classes in Ilorin metropolis

Table 2: Results for Shannon-Wienner and Margalef indices in Ilorin metropolis

S/N	Indices	Value
1	Shannon-Wiener Index of Diversity	3.88
2	Margalef Index of Species Richness	10.52

Demographic Information of Respondents in Ilorin Metropolis

Table 3 presents the demographic information of respondents in the study area. The most of the respondents (75.50%) were within the age bracket of 20-30, while the a few (2.0%) were above sixty years of age (>60). Age classes of 31-40, 41-50, and 51-60 represented 15.0%, 4.5%, and 3.0% of respondents, respectively. The results also show that most of the respondents were male (70.0%), 71.25% were single, and 75.25% practiced Islam. It was further showed that large number of respondents (77.0%) had tertiary education. Some (20.25%) and a few (2.75%) had secondary and primary education, respectively. Two hundred and fifty-seven (257), which represents about 64.25%, were students, 28 (7.0%) were private workers, 82 (20.50%) were government workers, 8 (2.0%) were self-employed, and 25 of them, representing 6.25%, were unemployed.

Given that majority of the respondents were within the age bracket 20-30 disagrees with the findings of Faleyimu and Akinyemi (2014), who observed that most of the respondents in Okitipupa, Ondo State were within the age bracket of 31-40 and had a mean age of 47 years. This is a good indication that most of the respondents were within their productive period and could actively participate should any green programme initiative be introduced in Ilorin metropolis. The level of literacy in the study area was relatively high, which indicates social stability and is fundamental to growth and development. The high literacy level could be attributed to the respondents' awareness of urban forests. According to Etim *et al*. (2012), sensitization and enlightenment programmes will thrive due to high student population indicates that sensitization will be easy provided that proper enlightenment is conducted in schools, and by extension, the students will willingly extend the knowledge to their peer and relatives.

Perception of Respondents on Urban Trees in Ilorin Metropolis

Respondents' perception of urban trees in Ilorin metropolis was accessed by requesting them to respond to some statements (Figure 3) and answer yes or no to others (Table 4). Most (80%) and few (20%) of the respondents strongly agreed and agreed, respectively, to the fact that urban trees beautify the environment. On the provision of shades by trees, some (65.25%) of the respondents strongly agreed that trees provide shades better than other things, while few (1.5%) strongly disagreed. Some of the respondents (62.5%) strongly agreed that trees help mitigate environmental pollution, and about a few (12.5%) disagreed that trees reduce visibility on roadsides. The most agreed that branches and leaves of trees litter the environment, while a few (2%) were undecided. The results further showed that most of the respondents (87.5%) knew of the term "urban forests," while almost all (99.0%) loved trees around them. However, 90.5% of the respondents were not satisfied with the number of trees in their surroundings, further corroborating the majority (97.5%) who showed interest in planting trees in their surroundings. When asked whether or not the government should introduce a new policy banning indiscriminate felling of urban trees in Ilorin, three hundred and sixty-nine (369) of the respondents, equivalent to 92.25%, said yes, while the rest (31 respondents, 7.75%) said no.

Urban forests, like natural forest ecosystems, provide a host of ecosystem services to mankind. The benefits may be tangible or intangible. On the other hand, they pose some dangers to the environment, especially when they are not adequately managed. According to Ajewole *et al*. (2013), some of the common challenges associated with trees are branch and root conflicts with infrastructure and site use and accidental tree fall. It is worthy to note that the respondents were largely aware of urban forestry, environmental services provided by trees, and some of the threats associated with urban forests in Ilorin metropolis. This could be explained by the high literacy level and the fact that most of the respondents were students who might have come across those terms at one point or the other, especially in recent times where virtually every literate has access to the internet. This is similar to the results obtained by Etim *et al*. (2012) in Maiduguri, Borno State.

Table 3: Demographic characteristics of respondents in Ilorin metropolis

Variable	Category	Frequency	Percentage (%)
Age			
	20-30	302	75.50
	31-40	60	15.00
	41-50	18	4.50
	51-60	12	3.00
	>60	8	2.00
Gender			
	Male	280	70.00
	Female	120	30.00
Marital status			
	Married	110	27.50
	Single	285	71.25
	Divorced	4	1.00
	Widowed	1	0.25
Religion			
	Islam	301	75.25
	Christianity	97	24.25
	Others	2	0.50
Education			
	No formal	0	0.00
	Primary	11	2.75
	Secondary	81	20.25
	Tertiary	308	77.00
Employment			
	Unemployed	25	6.25
	Self employed	8	2.00
	Government worker	82	20.50
	Private worker	28	7.00
	Student	257	64.25

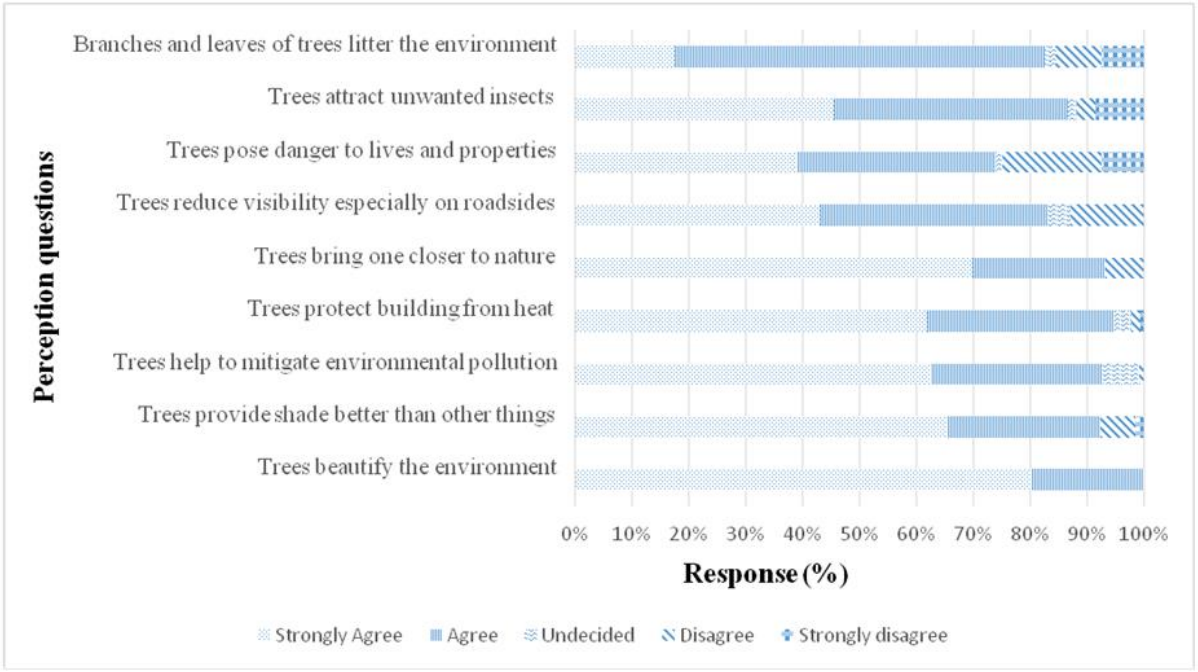

Figure 2: Peoples' perception of urban trees in Ilorin metropolis

Table 4: Respondents' perception of urban trees in Ilorin metropolis

Questions	**YES**		**NO**	
	Frequency	(%)	Frequency	(%)
Are you aware of the term "urban trees"?	350	87.50	50	12.50
Do you love trees around you?	398	99.50	2	0.50
Are you willing to plant trees in your environment?	390	97.50	10	2.50
Are you willing to participate in a tree planting exercise?	356	89.00	44	11.00
Are you satisfied with the present number of trees in your environment?	38	9.50	362	90.50
Should the government bring up a policy to ban the indiscriminate removal of trees in Ilorin?	369	92.25	31	7.75

Conclusion and recommendation

The diversity and richness of urban trees in Ilorin metropolis was relatively high compared to some urban forests in Nigeria. People's perceptions of urban forests in the study area was relatively high compared to other urban centres. The species diversity was higher than in some of the cities in Nigeria, which shows a positive conservation effort. It is praiseworthy that most of the respondents were familiar with the term "urban forest" and were aware of the benefits and threats of urban trees. Hence, the state government and other environmental Non-Governmental Organizations (NGOs) should intensify their efforts in managing and conserving the urban trees in Ilorin metropolis.

The study, therefore, recommends that:

(i) the state government should establish a tree management committee that will look into the conservation and management of urban trees in Ilorin metropolis;

(ii) campaigns and awareness on the importance of tree planting should be taken to the doorsteps of people, and more emphasis should be laid on tree planting in media houses;

(iii) policies prohibiting indiscriminate removal of trees should be put in place;

(iv) inventory of trees should be done at reasonable intervals to note the local status of each tree species.

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