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Conservation of floristic composition, vegetation structure and diversity of ecosystems in urban and peri-urban centres of Ekiti State, Nigeria

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Abstract

The tree ecosystem services associated with the functions and benefits of urban forests need to be maximized, and efforts at biodiversity conservation will ensure the desired impacts on the environment. This study was conducted to assess the conservation of floristic composition, vegetation structure, and diversity of the forest ecosystems in urban and peri-urban centres of Ado-Ekiti and Ikole-Ekiti in Ekiti State, Nigeria. Data were collected through the use of semi-structured questionnaire and field surveys to obtain information on the socio-economic and environmental impacts of urban forests from respondents. All the trees with a diameter at breast height (dbh) of 10 cm and above were identified and measured to determine the biodiversity indices of the forests. The highest number of individual trees was 493 in Ado-Ekiti, made up of 372 in the urban centre and 121 in the peri-urban while the 404 individual trees in Ikole-Ekiti consisted of 298 and 106 trees in the urban and peri-urban areas, respectively. The highest tree species were 52 and 42 in the urban centres of Ikole-Ekiti and Ado-Ekiti respectively. The trees in the urban centres had the highest mean dbh at 68.2 cm and 64.7 cm in Ikole and Ado Ekiti respectively. The tree species maximum diversity was 5.65 for Ado and 5.42 for Ikole Ekiti. The urban forests recorded the highest tree species evenness of 0.62 in Ado Ekiti and 0.59 in Ikole Ekiti. The results of this research are indicative of the numerous benefits and functions urban forest ecosystem provides for the urban centres. Considering the services generated by the urban forest ecosystem in provision of socio-economic (sales and consumption of fruits, nuts, vegetables), cultural (meeting, events, and relaxation centres) and environmental (improved air quality, reduction in surface temperature, pollution and erosion) as revealed by this study, to sustain the healthy functions and services of trees to the environment.

Keywords: Conservation potentials; environmental sustainability; socio-economic services,

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Introduction

Urban forests are made up of publicly- and privately-owned trees, shrubs and other vegetative covers within an urban setting that play essential roles in human life (Agbelade, *et al.*, 2017). Thus, urban forestry concerns the proper care and management of tree populations in urban built up areas to improve the urban environment and ensure a healthy society. These include individual trees, avenue trees, home gardens, parks and amusement centres, as well as stands of remnant forests with aesthetic appeal that provide a number of environmental benefits (Nowak *et al.*, 2002). There has been increased research on the quantification of ecosystem services and the direct benefits natural systems provide to people (Millennium Ecosystem Assessment, 2005).

The enumeration of these benefits form natural resources can raise citizen awareness of their

values to the public, such as urban trees on publicly owned lands, and provide a basis for the management to maximize benefits while controlling cost. The cooling costs of a building can be decreased where trees provide shade, which saves energy and avoids the emission of air pollutants and greenhouse gases associated with the production of such energy (McPherson and Simpson 1999). Urban trees improve air quality, serve as wind break, shelter belt, protect water flow, sequester carbon, ameliorate harsh weather the hardship of inner city living, especially when used for income generation. The trees protect the environment against soil erosion, siltation and flooding thereby preventing the loss of valuable agricultural soils. Regular visits to the green areas in cities can counteract the stress of city life, restore energy and attention and improve human health. Biodiversity is crucial for the well-being of people and the earth. Urban biodiversity is influenced by the status of the original conditions, serve as raw materials to wood industries, preserve water sheds and through the root system, prevent soil erosion. The trees reduce air pollutants such as carbon dioxide (CO2), nitrogen dioxide (NO2), sulphur dioxide (SO2), and particulate matter less than 10 microns in size by absorbing gases and intercepting airborne particles. (Nowak *et al.*, 2006). Tree shades increase the longevity of pavements (McPherson and Muchnick 2005) and the urban trees and forests help alleviate some of surrounding ecosystems and by the planning, design and management of the built environment, which, in turn, are influenced by the economic, social and cultural values and dynamics of resident human populations. Even the backyard garden can harbour significant biodiversity. Thus, an assessment of the status and trends of biodiversity is essential for sustainable development strategies at all levels of integration.

Methodology

The Study Area

This study was conducted in Ado Ekiti and Ikole Ekiti in Ekiti State, southwest Nigeria. Ado Ekiti and Ikole Ekiti have population of about 293,000 and 232,300, with projected average increase of 3.54% in 2021 amounting to 497,000 and 387,800 respectively. Ekiti State is mainly an upland zone, rising over 250 meters above sea level, in an area underlain by igneous and metamorphic rocks. The topography is generally undulating with a characteristic landscape consisting of old plains broken by steep-sided rugged hills and outcrops that occur singularly or in groups of ridges as found at Ado-E Aramoko-Ekiti, Efon-Alaaye, Ikere-Ekiti, Igbara-odo-Ekiti and Okemesi-Ekiti. The state enjoys tropical climate with two distinct seasons: rainy season (April–October) and the dry season (November–March) characterized by the prevalence of the south westerly and the northeast trade winds respectively. The temperature ranges between 21 and 28 C with high humidity. The ecological conditions ensure the existence of tropical dry upland forests in the south and central portions while the derived savanna and southern Guinea savannah occupy the northern portion. The state is dominated by the Ekiti people, a sub-ethnic group of the Yoruba tribe.

Data Collection

Demographic characteristics and environmental impacts of urban forests

Data were collected through the use of questionnaire and field surveys carried out in Ado-Ekiti and Ikole-Ekiti metropolis. A semi-structured questionnaire was used to obtain information on the socio-economic characteristics and knowledge of environmental impacts of urban forests from Fifty (50) respondents purposively selected from the urban centre and peri-urban centre in each city. The two hundred (200) copies of the questionnaire administered in the form of interviews and focal group discussions to sort information on ownership, land-use, years of establishment and management practices were retrieved.

Sampling of Tree Biodiversity

The surveys of educational institutions, churches, public and private institution grounds with high level of tree population in Ado-Ekiti and Ikole-Ekiti were carried out. The green areas such as avenue, street, gardens, amusement parks, religious centres, home gardens were visited for detailed enumeration. All the tree species with diameter at breast height (Dbh) at 10 cm or more were identified and locations (coordinates) recorded with hand-held Global Positioning System (GPS). The heights were measured with Spiegel Relaskop and Girth Tape was used to measure the diameter at breast height (Dbh), diameter at the base (D_b), diameter at the middle (D_m) and diameter at the top (D_t) and the frequency was taken. The pictures of the different locations within the cities were taken with the aid

of Digital Camera. The trees were identified using the keys in flora manuals and match-up technique and classified as indigenous or exotic species.

Data analysis

Tree Species Diversity Indices

The species diversity indices were calculated following Adekunle *et al.* (2014):

Species Relative Density (RD):

$$RD = \left(\frac{ni}{N}\right) x\ 100 \qquad (1)$$

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 forest.

Species Relative Dominance (RDo):

$$RD_O = \frac{(\sum Ba_i\ x\ 100)}{\sum Ba_n} \qquad (2)$$

where: Ba_i = basal area of all trees belonging to a particular species *i*;
Ba_n = basal area of all individual tree.

Importance Value Index (IVI):

$$IVI = \frac{(RD + RD_o)}{2} \qquad (3)$$

The importance value index (IVI) for trees was calculated from the values of relative density RD (%) and relative dominance for trees RDo (%) divided by 2.

Species Diversity Index:

$$H' = -\sum_{i=1}^{s} P_i\ In(P_i) \qquad (4)$$

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

Shannon's Maximum Diversity Index:

$$H_{max} = In(S) \qquad (5)$$

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

$$E_H = \frac{H'}{H_{max}} = \frac{-\sum_{i=1}^{s} P_i\ In(P_i)}{In(S)} \qquad (6)$$

Sorensen's Species Similarity Index

$$SI = \left(\frac{2C}{a+b}\right) x\ 100 \qquad (7)$$

where: C = number of species in sites *a* & *b*;
a & *b* = number of species at sites 1 & 2, respectively.

Forest structure analysis

Based on the forest structural analysis of Proctor *et al.* (1983), Newbery (1991) and Adekunle *et al.* (2013), the size distribution was classified under three distinct categories, namely: smaller, medium and upper. The stems were further classified into nine diameter and seven height classes to show the graphical pattern of tree population distribution and vertical stratification respectively. The basal area and volume were computed based on the method adopted by Adekunle *et al.* (2014).

Basal area

$$BA = \frac{\pi D^2}{4} \quad (8)$$

where: BA = Basal area (m^2),
D = Diameter at breast height (cm) and
л= pie (3.142).
The total basal area was obtained by adding the basal area of individual trees in the community.

Volume

$$V = \frac{h}{6}(Db + 4Dm + Dt) \quad (9)$$

where: V = Tree volume (m),
h = tree height (m) measurement,
A_b, A_m and A_t = tree cross-sectional area (m) at the base, middle and top of merchantable height, respectively.

The volume of individual tree species was calculated using Husch *et al.* (2003).
The data obtained from the questionnaire were coded for statistical analysis. Each option under a variable (question) on the questionnaire was assigned a value and entered into Microsoft Excel spreadsheet and the descriptive analysis was used to summarise the data into charts and tables. Student's t-test was used for significant differences in tree growth variables between Ado-Ekiti and Ikole-Ekiti. The tree growth variables and biodiversity indices across the two locations were subjected to Analysis of Variance and the mean separation was with Duncan Multiple Range Test. All statistical analyses were undertaken using Statistical Package for Social Sciences (SPSS 20.0) software package.

Results

Demographic characteristics of the respondents

Table 1 shows the socio-cultural characteristics of the respondents in the studied communities. The urban centres had 50 and 70% as male in Ado-Ekiti and Ikole-Ekiti but 55 and 65% in the peri-urban settlements of Ado-Ekiti and Ikole-Ekiti respectively. Also, 70 and 60% of the respondents are married in urban while 50 and 65% are married in peri-urban in Ado-Ekiti and Ikole-Ekiti respectively. Most of the respondents were within the age bracket of 31-50 years in both urban and peri-urban settlement in the two towns. Ado-Ekiti had 55 and 65% of the respondents in the urban and peri-urban centres in Ado-Ekiti with secondary school education and 15% possessed primary education and tertiary education. At Ikole-Ekiti, 40 and 60% of the urban and peri-urban respondents had no formal education and 30 and 10% had tertiary education respectively.

Tree growth variables and biodiversity indices

Table 2 shows that a total of 493 trees was examined in Ado Ekiti with 372 and 121 trees in urban and peri-urban centres while the total of 404 trees examined in Ikole Ekiti consisted of 298 trees in urban and 106 in peri-urban settlements. The urban settlement in Ikole Ekiti had the highest number of tree species (53) followed by urban and peri-urban settlements in Ado Ekiti with 47 and 22 species respectively. The peri-urban settlement in Ikole Ekiti had the least number of tree species (18). The trees belong to 21 and 17 tree families in the urban settlements in Ado Ekiti and Ikole Ekiti respectively but in 14 and 15 families in the peri-urban of Ado Ekiti and Ikole Ekiti. The trees in the urban settlements have the highest
mean Dbh of 68.2 and 64.7 cm in Ikole Ekiti and Ado Ekiti respectively while the mean Dbh for the trees in the peri-urban centres of Ikole
Ekiti and Ado Ekiti was 54.9 and 49.6 cm respectively. The trees in Ado Ekiti has the highest mean basal area value of 85.47 m^2 and 68.26 m^2 in urban and peri-urban settlements respectively while the mean basal area for trees in Ikole Ekiti were 56.13 m^2 and 47.56 m^2 in in urban and peri-urban settlements respectively. The trees with maximum Dbh (147.6 cm and 131.4 cm) were found in urban and peri-urban settlements respectively in Ikole Ekiti. The urban and peri-urban settlements in Ado Ekiti had the highest tree volume (484.5 m^3 and 364.8 m^3) respectively while the urban settlements in Ado Ekiti and Ikole Ekiti had the highest tree diversity index of 3.26 and 3.18 respectively. The tree maximum diversity was highest in the urban settlements at Ado Ekiti (5.05) and Ikole Ekiti (5.42) that also had the highest tree species evenness of 0.62 and 0.59 respectively.

Table 1: Demographic characteristics of respondents in the studied communities

Variables	Ado-Ekiti		Ikole-Ekiti	
	Urban Forest	Peri-Urban Forest	Urban Forest	Peri-Urban Forest
Gender				
Male	80	55	70	65
Female	20	45	30	35
Marital Status				
Single	15	35	30	25
Married	70	50	60	65
Widowed	15	15	10	10
Age				
<20	15	15	10	10
21-30	10	15	10	20
31-40	20	25	25	25
41-50	25	20	15	15
51-60	20	10	25	15
>60	10	15	15	10
Education Status				
No Formal Education	15	5	40	60
Primary Education	15	15	20	25
Secondary Education	55	65	10	15
Tertiary Education	15	15	30	10
Total	**100**	**100**	**100**	**100**

Table 2: Growth variables and biodiversity indices of trees in the studied communities

Variables	Ado Ekiti		Ikole Ekiti	
	Urban Forest	Peri-Urban Forest	Urban Forest	Peri-Urban Forest
No. of Individual Trees	372	121	298	106
No. of Species	47	22	52	18
No of Families	21	14	17	15
Mean Dbh (cm)	64.7	49.6	68.2	54.9
Basal Area (m^2)	85.47	68.26	56.13	47.56
Maximum Dbh (cm)	114.0	126.5	147.6	131.4
Volume (m^3)	484.5	364.8	307.2	221.8
Diversity Index (H′)	3.26	2.86	3.18	2.62
Max Diversity (H_{Max})	5.65	4.74	5.42	4.87
Species Evenness (E_H)	0.62	0.56	0.59	0.54

Benefits Derived from Urban Forest

Table 3 shows the benefits derived from urban forests as identified by the respondents in the studied communities. The respondents in the urban centre at Ado Ekiti opined those trees provide edible fruits and shade for social gathering (85%) and for relaxation/garden and religion centres (80%) while in the peri-urban 70 and 65% agreed that the urban forests provide edible fruits and beautification respectively while 60% respondents equally identified the use of urban forests for wind break and religion centres. At Ikole Ekiti, 85 and 80% of the respondents in urban settlements noted that the urban forests are used as religion centres and relaxation/garden respectively while 75 and 70% derive beautification and fuel wood respectively. Also, the result shows that 80 and 75% of the respondents in the peri-urban settlement in Ikole Ekiti identified the provision of fuel wood and

religion centres from the urban forests respectively, while 60% equally noted the use of urban forests for wind break and provision of fruits.

Table 3: Benefits derived from urban forests in the studied communities

Uses	Ado-Ekiti		Ikole-Ekiti	
	Urban Forest	Peri-Urban Forest	Urban Forest	Peri-Urban Forest
Edible Fruits (Food)	85	70	60	60
Beautification	55	65	75	50
Medicinal (Herbs)	60	40	55	40
Event Centre	40	40	20	55
Vegetable (Soup)	50	55	65	50
Shade (Social Meeting)	85	50	65	40
Fuelwood (Cooking)	45	40	70	80
Relaxation/Garden	80	50	80	30
Wind break	40	60	55	60
Religion Centre	80	60	85	75

Discussion

The higher number of married, middle-aged men is an indicator that responsible men within the active working age appear to be more involved in urban forest landscaping activities and derived economic benefits from urban forest in the study area. This observation agrees with Agbelade and Fagbemigun (2015) that these groups of people are more involved in the preservation of the environment because of the benefits they derive from urban forests. The involvement of this group of respondents in urban forest management and biodiversity conservation could be attributed to chains of benefits derived from trees. Men, after the day's work usually gather in the evening under shades of trees for meetings and relaxation. The higher tree species diversity indices observed in the urban settlements in the two towns can be attributed to the planting of exotic ornamental trees and indigenous trees for beautification purposes around the offices and homes unlike in the peri-urban settlements where most naturally grown trees are retained to provide shade.

The observed higher tree diameter and volume in urban settlements in both communities could be attributed to conservation measures being put in place by the traditional people of the communities (sacred trees). Most of these big trees are of age and they are found in palaces, markets and shrines and they have been preserved for decades. These trees are revered and cutting of any part of them is highly prohibited. In addition to serving as wind break and provision of shade these trees are socially and culturally important in the communities. The use of tree by majority of the respondents for provision of shades, edible fruits, relaxation and worship centres is an indication that people value the trees for socio-cultural and environmental functions. Kayode (2010) and Agbelade *et al.* (2017) had observed that urban forest trees are useful sources of edible fruits in a number of urban locations in Ekiti State. The number of trees recorded in this study revealed the green nature of both communities while the concentration of more trees in the urban settlements could be attributed to presence of offices, schools, recreation centres and religion centres. Besides, the trees are usually planted within the compounds to provide shade, beautification and also to serve as windbreak (Konijnendijk *et al.*, 2006).

Conclusion and Recommendations

This study has revealed that different species of trees planted for urban landscaping are widespread in the urban and peri-urban centres of Ado Ekiti and Ikole Ekiti. The respondents appreciate the importance of trees in urban landscaping and that the trees are planted to provide socio-cultural and environmental benefits which include shade, food, beautification, relaxation centers and windbreak. Considering the roles played by urban trees in the provision of socio-cultural and environmental benefits, it is recommended that governments, at all levels, should formulate laws and policies that will enhance tree planting for conservation purposes in order to maintain healthy environments.

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