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Ecological Services of a Peri-Urban Recreation Centre in Abeokuta, Ogun State, Nigeria

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Research Article

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Abstract

Purpose

This study examines the consumption of renewable natural resources without market price by the people to promote conservation in the outlier of urban environment. The resources however offer ecosystem services to protect man and the environment

Methods

Socio-economic profile of respondents and natural resources data were gathered using two methods. Questionnaire as a socio-economic tool was used to gather data from respondents for socio-economic profile and natural resources data were obtained through bio-physical study of available renewable resources. Both descriptive and inferential statistics were used for data analysis

Results

The result shows gender sensitivity with female domination (64%) of the respondents and 36% male, age range 21-40years accounted for 43% with mean age of 41years. Further, some (44%) respondents were Christian, Tertiary education recorded the highest educational level with 53% and Ogun State had the highest State of origin distribution with 77%. A total of 30 flora species was identified and family Fabaceae with 6 species contributed more to the ecosystem services of the park than other families with 3 species. Furthermore, trees with diameter >11cm had higher carbon sequestration potential with 1009,776 $kgCha^{-1}$, Above Ground Biomass of 2456.795kg and Below Ground Biomass of 272.33kg. A total of 25 fauna species was recorded as offering ecosystem services and Mammals with 31 species had the highest number of species offering ecosystem services followed by Aves with 14 species and reptiles with 13 species.

Conclusion

In conclusion, the study revealed that flora and fauna species offer a wide range of ecosystem services ranging from cultural, supporting, regulating, and provisioning services. It is suggested that recreation policy should ensure that proper and adequate sensitization through electronic media to enlighten the general public on recreation and the significance of flora and fauna in human health and the environment.

Introduction

Ecosystem services and human welfare are interconnected through the link of supply of environmental goods and services from natural areas [5; 13]. Therefore, any alteration to the supply link requires proper understanding of both tangible and intangible benefits form the environment [8; 20]. The tangible benefits are easily measured through direct market approach because they are traded in the market with prices dictated by demand and supply for example water treatment cost or market prices of food items. However, Intangible benefits, or non-traded products that may be referred to as cultural ecosystem services (CES), are difficult to evaluate due to absence of existing markets for the products (but not impossible) using methods that rely on human preferences to measure demand for the products. [7; 21]. Consequently, it is not an over statement that ecosystems goods and services play major role in the existence of humanity [11; 16]. Globally, communities and societies exploit nature for array of benefits ranging from ecological, economic to aesthetic-cultural values. More than 60 percent of the global population depends on plants for their medicine. Aesthetic-cultural values like nature tourism are also provided through ecosystems [4; 13; 19]. However, over dependence on these resources by man along with other anthropological activities, altered the balance between man and the environment in the negative direction towards environment thus leading to climate change, loss of habitat and a continuous loss of the earth's biodiversity. The concept of peri-urban and peri-urbanization can be described as loose concepts. They may be used to describe newly urbanized zones at the fringes of cities mostly in developing countries, which may later be referred to as ‘peri-urban interface’ [3; 16]. Perhaps, emerging European perspective shows peri-urban areas to be mixed areas under an urban influence but with a rural morphology.

According to [12; 15], reported that [17] develops one of the most acceptable classifications in the study of ecosystem services [17]. The classification approach divides the services into four sections: provisioning, regulating, supporting and cultural services. Provisioning services refer to tangible goods obtained from ecosystems; Regulating services refer to benefits obtained from the regulation of ecosystem processes; Cultural services –intangible products or non material benefits obtained from the ecosystem and supporting services – support production of all other services. Thus, ecosystem services are mostly undervalued and therefore fail to show the significance of the services to humanity on a global scale [9]. This underscores the objectives of this study which are to identify zoo park flora and fauna providing ecological services for biodiversity conservation and climate protection and to describe the profile of visitors to the zoo park.

Methodology

The Study Area

The study was conducted in the Federal University of Agriculture, Abeokuta (FUNAAB) Zoo Park (Plate 1), Ogun State, Nigeria. It is located on Latitude 7.2^{o} N; Longitude 3.4^{o}E. FUNAAB Zoo Park is directly managed by the University through a Zoo Directorate created by the institution.

Plate 1: Map of FUNAAB Zoo Park, Abeokuta, Ogun State, Nigeria

The Zoopark was commissioned in May 23, 2012. The Study accommodated feral animals i.e. free roaming living animals and the Zoo animals i.e animals under captivity (especially the carnivorous animals) in the FUNAAB Zoo Park. The Zoopark was established on the tripodal mandate of the University of teaching, research and extension. The Park, though for recreation also serves as field laboratory for students practical in terms of teaching, conservation for research and wildlife identification for extension services. The Zoopark occupies a forty-hectare land in the northern fringes of Ogun State, Nigeria in derived Savanna vegetation.

Scope of Study

The study was divided into two; Socio economic study and Biophysical study

Socio-economic study

Data Collection

Data were collected from 100 visitors with structured questionnaire at the zoo park using simple random sampling technique. Furthermore, personal contacts, oral interviews and observations were used during visitation; this aided the data collection.

Biophysical Study: Sampling procedure

A systematic sampling technique was used to collect data from the study area. Four plots of 10m by 10m were laid close to the major animal sections in the park and complete enumeration was carried out within the plots to estimate carbon sequestration potential of plants and animals.

Aboveground Biomass (AGB) Estimation

The rate of carbon sequestration depends on the growth characteristics of the plant species, the conditions for growth, where the plant is located and the density for woody stems. For the purpose of this research, recourse was made to the dry weight technique for biomass estimation used by [1]. Thus, non-destructive method of estimating tree carbon weight was adopted for the purpose of this study.

Girth Measurement

The girth of individual tree species was obtained with the aid of girthing tape at 1.3m and the unit of measurement (cm) and was converted to m using 0.3m correction factor [14].

Tree Height

Tree height was measured with Haga altimeter- calibrated before use i.e. 9m for tall trees and 3m for short trees [14].

Above ground biomass of a tree was calculated as follows:

For trees with diameter less than 11cm: W=0.25D2H and W=0.15D2H for dbh ≥ 11cm

W=Above ground biomass (Kg)

D= Dbh of the trunk (m).

H= Height (m)

Below Ground Biomass (BGB) Estimation

Regression models were used to predict root biomass based on the Above Ground Biomass (ABG) [5]. Root-to-shoot (RS) ratio provide general description of the relationship between roots and shoots biomass [18]. The allometric model proposed for the root biomass assessment is that of [5)

BGB = exp (-1.3267 + 0.8877 × ln (AGB) + 0.1045.ln(AGE) ………… (1)

Carbon Sequestration

The combination ratio derived from the atomic weights of the elements making up CO_2 molecule to that of carbon (C), i.e. 3.7 was used to estimate sequestered CO_2. Ratio (3.7) was multiplied with (AGB) and (BGB) for different trees to estimate CO_2 sequestered

Total CO_2 sequestrated = 3.7 * (AGB + BGB) ……………. ………………. (2)

Data Analysis

Descriptive statistics were used to summarize socio economic characteristics of respondents, perception and preferences of services generated in the study area.

Likert Scale

Likert scale with class boundaries of means were used to draw inferences [11] on perception. Statements as variables in 5 perceptional arrangements were presented to the respondents for rating ranging from strongly agreed (5), agreed (4), undecided (3), disagreed (2) and strongly disagreed (1). For inferences, class boundaries are: < 1.5 = Strongly disagreed, ≥1.5 <2.5 = Disagreed; ≥2.5<3.5 = Undecided; ≥3.5<4.5 = Agreed; ≥4.0≤5.0 = Strongly agreed

Results

Socio economic characteristics of respondents

Table 1 shows that Ogun State has the highest State of origin distribution with 77%, the study is gender sensitive with majority, (64%) of the respondents were female and 36% male, household 3 – 6 members recorded the highest percentage of 67% with mean household size of 6. Age distribution shows age bracket (21-40yrs) accounted for 43% with mean age of 41years. Furthermore, some respondents were Christian with 44%, Tertiary education (53%) recorded the highest level of education. Majority, (67%) came from Abeokuta the catchment location of the park. Also, majority, (68%) visit alternative recreation centres.

Table 1
Socio-economic characteristics of respondent

Variables	Frequency	Percentage	Mean/Mode
Age (Years)			
≤ 20	21	21	
21-40	43	43	41Years
41-60	19	19	
≥ 60	17	17	
Total	**100**	**100**	
Gender			
Male	64	64	
Female	36	36	
Total	**100**	**100**	
Family size			
≤ 2	21	21	
3-6	67	67	6
≥6	12	12	
Total	**100**	**100**	
Location			
Ogun	77	77	Ogun
Oyo	12	12	
lagos	11	11	
Total	**100**	**100**	
Religion			
Christian	44	44	
Muslim	35	35	
Traditional	21	21	
Total	**100**	**100**	
Education			

Source: Field Survey, 2018

Variables	Frequency	Percentage	Mean/Mode
Tertiary	53	53	Tertiary
Secondary	23	23	
No formal education	11	11	
Total	**100**	**100**	
Income (₦)			
5,000 – 10,000	18	18	₦26,521
10,000 – 15,000	24	24	
15,000 – 20,000	12	12	
≥20,000	46	46	
Total	**100**	**100**	
Native of Abeokuta			
Yes	67	67	Yes
No	33	33	
Total	**100**	**100**	
Occupation			
Civil Servant	33	32	
Farming	21	21	
Artisan	22	22	
Self employed	25	25	
Total	**100**	**100**	
Are you aware of substitute recreation centres			
Yes	67	67	Yes
No	33	33	
total	100	100	
Source: Field Survey, 2018			

Bio-Physical Study

Table 2 presents a checklist of flora species in the zoo park. A total of 30 plant species was identified with 17 families. Fabaceae family with 6 species recorded the highest number of species. Other families were as follows; Moraceae (2), Anacardiaceae (2), Euphorbiaceae (3), Apocynaceae (2), Gentianaceae (1), Poaceae (1), Sapindaceae (2), Malvaceae (3), Ulmaceae (1), Ebeneceae (1), Meliaceae (1), Areceae (1), Samydaceae (2)

Table 2
Checklist of plant species in the study area

S/N	Species	Common Name	Local name (Yoruba)	Forms	Family
1	*Ficus exasperate*	Sandpaper tree	Ipin	Tree	Moraceae
2	*Mangifera indica*	Mango	Mangoro	Tree	Anacardiaceae
3	*Anarcadium occidentalis*	Cashew	Kasu	Tree	Anacardiaceae
4	*Albizia adianthifolia*	Flat crown	-	Tree	Fabaceae
5	*Albizia ferruginea*	Albizia	-	Tree	Fabacea
6	*Albizia zygia*	Albizia	-	Tree	Fabacea
7	*Alcornea cordifolia*	Christmas bush	-	Shrub	Euphorbiaceae
8	*Alcornea laxifora*	Lowveld bead-string	-	Shrub	Euphorbiaceae
9	*Alstonia boonei*	God’s tree	-	Tree	Apocynaceae
10	*Antiaris Africana*	Mull berry	-	Tree	Moraceae
11	*Anthocleista vogelii*	Planch tree	-	Tree	Gentianaceae
12	*Bambusa vulgaris*	Bamboo	Oparun	Grass	Poaceae
13	*Baphia nitida*	Camwood	-	Tree	Fabaceae
14	*Blighia sapida*	Achee	-	Tree	Sapindaceae
15	*Blighia unijugata*	Triangle tops	-	Tree	Sapindaceae
16	*Bridelia artroviridis*	Bredelia	-	Tree	Euphorbiaceae
17	*Ceiba pentandra*	Kapok	-	Tree	Malvaceae
18	*Celtis zenkeri*	African celtis	-	Tree	Ulmaceae
19	*Chrysophyllum albidum*	Cherry	Agbalumo	Tree	Sapotaceae
20	*Cola nitida*	Kola	Obi	Tree	Malvaceae
21	*Cola millenii*	Kola	Obi	Tree	Malvaceae
22	*Delonix regia*	Royal tree	-	Tree	Fabaceae
23	*Diospyros dendo*	Yellow persimmon	-	Tree	Ebenaceae
24	*Entandrophragma angolense*	Utile	-	Tree	Meliaceae

Source: Field Survey, 2018

S/N	Species	Common Name	Local name (Yoruba)	Forms	Family
25	*Elaeis guineensis*	Oil palm	-	Tree	Arecaceae
26	*Funtumia elastica*		-	Tree	Apocynaceae
27	*Guarea thomsonii*	Black guarea	-	Tree	Meliaceae
28	*Gliricidia sepium*	Gliricidia	-	Tree	Fabaceae
29	*Holoptelea grandis*		-		Samydaceae
30	*Homalium africanum*		-		Samydaceae
Source: Field Survey, 2018					

Above Ground Biomass of Tree Species < 11cm DBH

Table 3 shows the species with diameter less than 11cm. Tree height with diameter was used to calculate the above ground biomass using Model 1.

Table 3
Above ground biomass of tree species < 11cm DBH

Species	No of stem	Mean DBH	Mean height	Model	AGB(kg)
Delonix regia	3	7.8	11.1	W=0.25D2H	43.29
Bridelia artroviridis	3	10.7	19.9	W=0.25D2H	106.47
Ceiba pentandra	10	7.8	17.7	W=0.25D2H	69.03
Cola millenii	7	7.8	23.8	W=0.25D2H	185.64
Diospyros dendo	8	10.8	25.6	W=0.25D2H	138.24
				Total	542.67
Source: Field Survey, 2018					

Below Ground Biomass Computation

BGB = exp (-1.3267 + 0.8877 × ln (AGB) + 0. 1045.ln(Age)

BGB = exp (-1.3267 + 0.8877 × ln (542.67) + 0. 1045.ln(542.67)

BGB = exp (-1.3267 + 0.8877 × 6.297) + 0.1045.(6.297)

BGB = exp (4.263) + 0.6580

BGB = 71.023 + 0.6580

BGB = 71.681kg

Total CO_2 sequestrated

Total CO_2 sequestrated = 3.7 * (AGB + BGB)

= 3.7 * (542.67 + BGB)

= 3.7 * (542.67 + 71.681

Total CO_2 sequestrated =227310 $kgCha^{-1}$

Above Ground Biomass of tree species > 11cm DBH

Table 4 indicated the species with diameter greater than or equal to 11cm. Tree height along with the dbh was used to calculate the above ground biomass using Model 2 (Adeleye *et al.*, 2021).

Table 4
Above Ground Biomass of tree species > 11cm DBH

Species	No of stem	Mean DBH	Mean height	Model	AGB(kg)
Ficus exasperata	9	11.8	9.3	W=0.15D2H	32.92
Anarcadium occidentalis	12	12.0	10.4	W=0.15D2H	37.44
Albizia adianthifolia	5	13.0	11.7	W=0.15D2H	45.63
Albizia ferruginea	7	12.4	9.2	W=0.15D2H	34.22
Albizia zygia	4	24.1	11.0	W=0.15D2H	72.22
Alstonia boonei	8	18.0	18.2	W=0.15D2H	98.28
Antiaris africana	9	16.0	16.5	W=0.15D2H	79.2
Anthocleista vogelii	2	14.4	20.5	W=0.15D2H	88.56
Bambusa vulgaris	10	26.1	24.2	W=0.15D2H	189.49
Baphia nitida	10	40.0	18.4	W=0.15D2H	220.8
Blighia sapida	5	18.1	16.9	W=0.15D2H	91.77
Blighia unijugata	7	21.9	18.0	W=0.15D2H	118.26
Celtis zenkeri	9	12.0	31.5	W=0.15D2H	113.4
Chrysophyllum albidum	5	13.0	20.6	W=0.15D2H	80.34
Cola nitida	8	11.8	16.1	W=0.15D2H	56.99
Entandrophragma angolense	11	12.0	22.7	W=0.15D2H	81.72
Elaeis guineensis	6	13.0	22.5	W=0.15D2H	87.75
Funtumia elastica	8	12.4	32.0	W=0.15D2H	119.04
Guarea thompsonii	10	24.1	34.5	W=0.15D2H	249.435
Gliricidia sepium	11	39.0	17.8	W=0.15D2H	208.26
Holoptelea grandis	11	17.1	24.2	W=0.15D2H	124.15
Homalium africanum	6	20.0	24.2	W=0.15D2H	145.20
Mangifera indica	8	12.2	15.9	W=0.15D2H	81.72
				Total	2456.795

Below Ground Biomass Computation

$$BGB = \exp(-1.3267 + 0.8877 \times \ln(AGB) + 0.1045.\ln(AGE)$$

$$BGB = \exp(-1.3267 + 0.8877 \times \ln(2456.795) + 0.1045.\ln(2456.795)$$

$$BGB = \exp(-1.3267 + 0.8877 \times 7.807) + 0.1045(7.807)$$

$$BGB = \exp(5.604) + 0.8158$$

$$BGB = 271.51 + 0.8158$$

$$BGB = 272.33kg$$

Total CO_2 sequestrated: 3.7 * (AGB + BGB)

= 3.7 * (2456.795+ BGB)

= 3.7 * (2456.795 + 272.33)

= 3.7* (2729.125)

= 10097.76 =1009776 $kgCha^{-1}$

Ecosystem Services of the Flora Species

Provisioning Services

These are services that describe the material or energy outputs from the ecosystems. Provisioning services (Table 5) offered by the floristic resources of the study were categorized into food/fruit production and medicinal values. Majority, (60%) of the plants encountered offers provisioning services while Fabaceae (33%) recorded the highest percentage of plants offering this service.

Table 5
Plant species offering provisioning services in the park

Family	Plant species	Number of Species	Percent
Anacardiaceae	*Mangifera indica*	2	11
	Anarcadium occidentalis		
Fabaceae	*Albizia adianthifolia*	6	33
	Albizia ferruginea		
	Albizia zygia		
	Baphia nitida		
	Gliricidia sepium		
	Delonix regia		
Poaceae	*Bambusa vulgaris*	1	6
Malvacea	*Ceiba pentandra*	3	17
	Cola nitida		
	Cola millenii		
Palmae	*Elaeis guineensis*	1	6
Euphorbiacea	*Alcornea cordifolia*	3	17
	Alcornea laxiflora		
	Bridelia artroviridis		
Sapotaceae	*Chrysophyllum albidum*	1	6
Apocynaceae	*Funtumia elastica*	1	6

Family	Plant Species	Number of species	Percent
Fabaceae	*Albizia zygia*	1	20
Apocynaceae	*Alstonia boonei*	1	20
Moraceae	*Antiaris africana*	2	40
	Ficus exasperata		
Malvaceae	*Ceiba pentandra*	1	20
Source: Field Survey, 2018			

Cultural Services

These are non-material benefits people obtained from ecosystems through spiritual enrichment cognitive development, reflection, recreation and aesthetic experiences. Accordingly, plants at Children play ground provides educational values and these plants are *Ficus exasperata, Albizia zygia, Alstonea boonei, Antaris africana, Ceiba pentandra.* Table 6 shows that Moraceae (40%) recorded the highest percentage of plants offering this service.

Regulating Services

These are services rendered by trees to address all forms of biological control. All plants encountered perform various regulating services varying from air quality regulation, water regulation and climate regulation. Table 7 shows that Fabaceae had the highest percentage (20%) of plants offering regulating services in the park.

Table 7
Plant species offering regulating services in the park

Family	Plant Species	Number of species	Percentage
Anacardiaceae	*Mangifera indica* *Anarcadium occidentalis*	2	7
Fabaceae	*Albizia adianthifolia* *Albizia ferruginea* *Albizia zygia* *Baphia nitida* *Gliricidia sepium* *Delonix regia*	6	20
Poaceae	*Bambusa vulgaris*	1	3
Malvaceae	*Ceiba pentandra* *Cola nitida* *Cola millenii*	3	10
Palmae	*Elaeis guineensis*	1	3
Euphorbiaceae	*Alcornea cordifolia* *Alcornea laxiflora* *Bridelia artroviridis*	3	10
Sapotaceae	*Chrysophyllum albidum*	1	3
Apocynaceae	*Funtumia elastica*	1	3
Moraceae	*Antiaris africana* *Ficus exasperata*	2	7
Gentianaceae	*Anthocleista vogelii*	1	3
Poaceae	*Bambusa vulgaris*	1	3
Sapindaceae	*Blighia sapida* *Blighia unijugata*	2	7
Ulmaceae	*Celtis zenkeri*	1	3
Ebenaceae	*Diospyros dendo*	1	3

Family	Plant Species	Number of species	Percentage
Meliaceae	*Guarea thomsonii* *Entandrophragma angolense*	2	7
Samydaceae	*Holoptelea grandis* *Homalium africanum*	2	7

Source: Field Survey, 2018

Ecosystem Services of the Fauna Species

Ecosystem services provided by the fauna species across the fauna group was conducted. The ecosystem services reviewed are provisioning services, supporting services, regulatory services and cultural services. Details of the ecosystem services are presented in Table 8. A total of 25 fauna species were recorded as offering ecosystem services. A breakdown of the number of species with respect to fauna group revealed that mammals with 31 species had the highest number of species offering ecosystem service, followed by Aves with 14 species and reptiles with 13 species.

Table 8
Ecosystem services of the Fauna Species

Ecosystem services	Mammals	Aves	Reptiles
Provisioning	12	7	6
Regulating	2	-	1
Cultural	11	7	6
Supporting	6	-	-
Total	31	14	13

Source: Field Survey, 2018

Table 9 shows the list of animals in the park offering the different ecosystem services. Thus, various animal groups offer ecosystem services from the avian and reptiles to mammals.

Table 9
Fauna species in the park offering ecosystem services

Provisioning services	Regulating services	Cultural services	Supporting services
Avian	**Avian**	**Avian**	**Avian**
African grey parrot	-	African grey parrot	-
Rose ringed parakeet	-	Rose ringed parakeet	-
Crown crane	-	Crown crane	-
Mallard duck	-	Mallard duck	-
White geese	-	White geese	-
Yellow billed kite	-	Yellow billed kite	-
Ostrich	-	Ostrich	-
Reptiles	**Reptiles**	**Reptiles**	**Reptiles**
Water turtles	-	Water turtles	-
Monitor lizard	-	Monitor lizard	-
Crocodile	Crocodile	Crocodile	-
Gabon viper	-	Gabon viper	-
Puff adder	-	Puff adder	-
Rock python	-	Rock python	-
Mammals	**Mammals**	**Mammals**	**Mammals**
Antelopes	Common jackal	Donkeys	Antelopes
Donkeys	Civet cat	Common jackal	Donkey
Common jackal	-	Civet cat	Mona monkey
Civet cat	-	Crested porcupine	Vervet monkey
Crested porcupine	-	Giant Tortoise	Red capped mangabey
Giant Tortoise	-	Patas monkey	White putty-nosed monkey
Patas monkey	-	White putty-nosed monkey	-
White putty-nosed monkey	-	Mona monkey	-
Mona monkey	-	Vervet monkey	-

Provisioning services	Regulating services	Cultural services	Supporting services
Vervet monkey	-	Red capped mangabey	-
Red capped mangabey	-	Baboon	-
Baboon	-	-	-

Conclusion

This study has shown that zoopark as a recreation centre offers a wide range of ecosystem services in terms of provisioning, cultural, supporting and regulating services. Supporting services, such as, microclimate regulation, soil formation, primary production, nutrient cycling or biogeochemical cycling, water cycling, photosynthesis and pollination are services that support the production of all other ecosystem services, therefore, they are non marketable within the park. The carbon sequestration evaluation in FUNAAB Zoo Park was in line with UNFCCC and Kyoto carbon credit trading while substantiating the importance of preserving our tree species. This is because recent importance has been attached to emissions reduction from tropical deforestation in future climate change policy. Thus, it will be wise to consider the possibilities of having more plant species in our recreation centres for biodiversity conservation and climate mitigation. These species of trees will not only aid in CO_2 sequestration but also provide services ranging from shade, food and other unquantifiable benefits for the populace. Suggestions include government to put in place appropriate measures to include peri- urban recreation centers with more flora and fauna as part of community development plans since zoopark is part of the environment. Thus, recreation policy should ensure proper and adequate sensitization through electronic media to enlighten the general public on the importance of flora and fauna and most especially the flora (trees) in our entire environment while ensuring sustainable development.

Declarations

Data available on request due to privacy or other restrictions:

The data that support the findings of this study are available on request from the corresponding author (J.S). The complete data are not publicly available due to state restrictions, the data contain information restricted to the institution and that could compromise research participant privacy/ consent

‘Consent to participate’

Verbal informed consent was obtained prior to the interview for the study

References

1. Aboal JR, Arevalo JR, Ferrnadez A. Allometric relationships of different tree species and stand above ground biomass in the Gomera laurel Forest (Canary Island), Floral -Morphology, Distribution. Funtional Ecology of Plants. 2005;200:264–74.
2. .Adeleye AO, Moussa SH, Taffa AA, Atanda TA, Osoba AE. Role of urban zoological park in woody species conservation and carbon sequestration: insight from FUNAAB zoo park in Abeokuta, Nigeria. LC International Journal of Stem. 2021;2(3):56–63.
3. Adell G. Theories and models of the peri-urban interface. A changing conceptual landscape, strategic environmental planning and management for the peri-urban interface research project. London: Development Planning Unit, University College; 1999.
4. Bratman GN, Hamilton JP, Hahn KS, Daily GC, Gross JJ. Nature experience reduces rumination and subgenual prefrontal cortex activation. Science. 2015;112:8567–72.
5. Cain MA, Brown SH, Helmer EH, Baumgardner GA. Root biomass allocation in the world's upland forests. Springer- Oecologia. 1997;111:1–11.
6. Carpenter SR, Mooney HA. Science for managing ecosystem services: beyond the millennium ecosystem assessment. Science. 2009;106:1305–12.
7. Chan KMA, Guerry AD, Balvanera P, et al. Where are cultural and social in ecosystem services? A framework for constructive engagement. Bioscience. 2012a;62:744–56.
8. Chan KMA, Satterfield T, Goldstein J. Rethinking ecosystem services to better address and navigate cultural values. Ecol Econ. 2012b;74:8–18.
9. De Groot RS, Wilson MA, Boumans R. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol Econ. 2012;41:393–408.
10. Del S. (2010): Assessment Survey Neag School of Education University of Connecticut.e-Mail, http://www.delseigle.com.
11. Diaz S, Fargione J, Chapin FS III, and D.Tilman. Biodiversity loss threatens human well-being. PLoS Biol. 2006;4(8):e277. doi:10.1371/journal.pbio.0040277.
12. Fisher B, Turner RK, Morling P. Defining and classifying ecosystem services for decision making. Ecol Econ. 2009;68:643–53.
13. Guruswamy LD, McNeely JA, editors. 1998 *Protection of global biodiversity, Converging Strategies*. Durham and London: Duke University Press, 1998.
14. Hamilton L. 1973. The Why and How of Tree Measurement. Chiltern Woodlands Project. www.chilternsaonb.org. Retrieved Dec 3, 2021.
15. MA. (2005). Ecosystems and human well-being: synthesis. Island Press, Washington DC, Mace GM. (2014). Whose conservation? *Science*, 345, 1558-1560.
16. McGregor D, Simon D, Thompson D. The peri-urban interface: approaches to sustainable natural and human resource use. London: Earthscan; 2006.
17. Millennium Ecosystem Assessment. Ecosystems and Human Well-being. Washington DC: Island Press; 2005.

18. Mokany K, Raison RJ, Prokushkin AS. Critical analysis of root: shoot ratios in terrestrial biomes. Glob Change Biol. 2006;12:84–96.
19. Perrings C, Naeem S, Ahrestani F, Bunker DE, Burkill P, Canziani G, Elmqvist T, Ferrati R, Fuhrman J, Jaksic F, Kawabata Z, Kinzig A, Mace GM, Milano F, Mooney H, Prieur-Richard AH, Tschirhart J, Weisser W. (2010). "Ecosystem Services for 2020". *Science*, núm. 6002, p. 323-324.
20. Russell R, Guerry AD, Balvanera P, et al. Humans and nature: how knowing and experiencing nature affect well-being. Ann Rev Environ Res. 2013;38:473–502.
21. Satz D, Gould RK, Chan KMA, et al. The challenges of incorporating cultural ecosystem services into environmental assessment. AMBIO. 2013;42:675–84.

Figures

Figure 1

Plate 1: Map of FUNAAB Zoo Park, Abeokuta, Ogun State, Nigeria