Inventory and Spatial Distribution of Trees in Eleme Local Government Area, Port Harcourt, Nigeria

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ABSTRACT

Urban trees provide a wide range of environmental, economic and social benefits to those that live and work within and outside the community. Urban forest assessments are essential in supporting urban forest management and planning to improve environmental quality and human health in cities. The study investigated woody trees distributions in Eleme Local Government Area (Apkajo) Port Harcourt Nigeria, The study area was divided into 3 categories (Academic, Residential and Religious). Total woody tree species enumerations were carried out using tree identification and measurement while remote sensing technique was used to determine spatial distribution of trees and their land surface temperature. Morphological parameters assessed included total height (THT), crown diameter (CD), crown projection area (CPA), slenderness coefficient (SC) Merchantable area (MCH). Findings indicated total number of twenty seven (27) different woody tree species was identified from a sample population of one hundred and eighty five (185) trees. Species identified includes *Mangifera indica, Dacryodes edulis,Terminalia mantaly*, *Azadirchta indica*, *Newbouldia laevis, Persea americana*, *Polyalthia longifolia, Terminalia catappa*..Beneficial roles included medicinal, food security, income generation, beautification and micro-climate purposes. Among the species, *Mangifera indica* was the most abundant with a frequency of occurrence of 47. The result revealed that trees found in academic areas consistently gave higher mean tree growth variable values. Biodiversity was highest in residential areas with a Shannon index of 2.54 and Simpsons index of 0.88. Spatial distribution pattern showed that most tree species are clustered around the residential areas than the religious and academic areas. It was also observed that the trees are active in moderation of the land surface temperature by creating a micro-climate beneath it. The high species richness and diversity within the residential areas, despite its high infrastructural development, showed the importance people placed on urban greening and climate change

Keywords: [Inventory, Biodiversity, Urban, Spatial, Conservation)

1. INTRODUCTION

Around the globe, there is an unprecedented increase in urbanization which has led to economic and environmental challenges. The United Nations report (2020) states that with the current escalation of urbanization, there is a gradual shift of population concentration from rural areas to urban centers, and opined that the rapid growth of population and the number of people inhabiting urban environment could increase by 2.5 billion. Africa and Asia are expected to be worse off with 96% of this increase. Although developing countries have enjoyed positive impact of urbanization, its process has also led to socioeconomic issues (Zhang and Li, 2020), health-related threats (Lu *et al*., 2021; Shao *et al*., 2022), and, most importantly, the negative effect on the sustainability of the environment (Liu *et al* 2019; Zhang *et al* 2021). Urbanization combined with the threat from climate change can cause significant risk on both physical and social environment problems leading to urban heat island (UHI). According to Santamouris (2015) UHI can be represented as local-scale heat temperature differences between urban and rural areas. Memon *et al.* (2009), stated that the intensity of the UHI is the simplest and most quantitative indicator of the thermal changes forced by the city's land use/land cover (LULC) on the region in which the UHI is identified and of its relative warming to the neighboring rural environment.

Urban vegetation, particularly trees, provides numerous benefits that can improve environmental quality and human health in and around urban areas. Trees are a common but decreasing sight within urban areas (Nowak *et al*., 2008).Trees have been part of the urban landscape for many centuries. There are areas in the urban environment with larger numbers of trees than others depending on availability of land for tree planting which in turn reduces the potential canopy cover. Urban forest structure such as tree species, number, tree canopy cover, height, health, composition, tree size, location, health, influences the extent to which land use can provide ecosystem services which in turns can provide useful information for estimating trees' structural characteristics such as leaf biomass and total leaf area, and quantifying multiple ecosystem services and forest functions (Nowak *et al*., 2008).

Urban trees inventory is a powerful management and planning tools that collect accurate information on individual trees planted in cities (Nielsen *et al.,* 2014). These inventories can aid in the management and planning of urban trees (Morgenroth *et al.,* 2016; Roman *et al.,* 2020), which is crucial to assess tree mortality, growth and performance of decision-making in urban greening programs and species selection

2. MATERIAL AND METHODS

2.1 Study Area

This research was carried out in Akpajo community of Eleme Local Government of Rivers state (Longitude of 7.1437N and latitude of 4.7874E). Eleme is one of the 23 Local Government Areas of Rivers State and amongst the 13 federal constituencies representing River State in Nigeria's National Assembly and part of the Rivers East Senatorial District. There are 10 political wards and 10 Clan that make up Eleme local government, which include Ogale, Akpajo, Alode, Ebubu, Onne, Eteo, Alesa, Ekporo, Agbonchia and Aleto (fig 1)

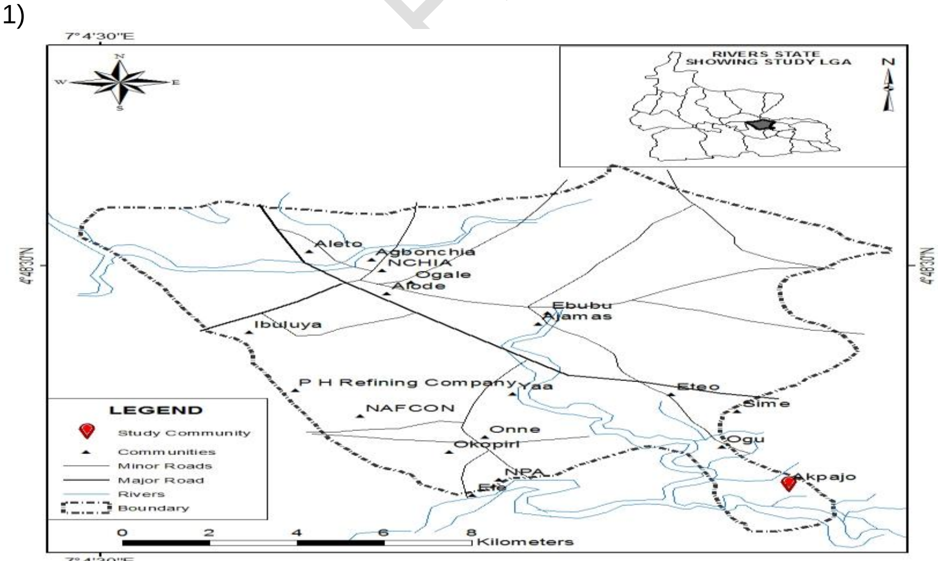

Fig 1: Eleme Local Government showing Akpajo community

2.2 Sample and Sampling Techniques

Reconnaissance survey was carried out at the study sites to access woody tree species composition and diversity so as to provide baseline data for the location in form of primary data The study area was categorized into residential, religious and academic. Trees in the selected categories were enumerated

2.3 Instrument for data collection

The instruments that were used for this study are Haga Altimeter(Height), Gps (coordinate), measuring tape and 3m stable stick used to take the Diameter at Breast Height (DBH), Field note book for data collection.

2.4 Data Collection

Direct physical measurements and visual inspection were carried out for trees identification and growth variable measurement while remote sensing technique was used in determining under tree land surface temperature and spatial distribution of the trees. The variables measured include total height, merchantable height, bole height, diameter at breast height, crown diameter and crown height.

2.5 Data Analysis

Data were processed into analyzable form ahead of the analysis,
Data processing includes the following.
Slenderness coefficient (SLC) was calculated using the formula

$$SLC = \frac{H(m)}{DBH\ (m)} \qquad \text{Eq. 1}$$

Where:
H = Tree height
DBH = Diameter at breast height

Crown projection area (CPA) was estimated using the formula

$$CPA = \frac{\pi(CD^2)}{4} \qquad \text{Eq. 2}$$

Where:
CPA = Crown Projection Area (m^2)
CD = Crown Diameter (m)
The processed data were analysed using descriptive and inferential statistics, F test was used to test significant difference among the study areas and (LSD) was used to separate the means, correlation analysis was used to determine the level of association among the growth variables. Arc GIS was used to determine the land surface temperature beneath trees.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Urban Trees Identification and their usefulness

A total of twenty-seven (27) individual woody tree species along with their coordinates were identified across the residential, academic and religious areas at Akpajo Eleme with a total frequency of occurrence of 185 trees (Table 1). Among the species, *Mangifera indica* was the most abundant with a frequency of 47 trees and *Dacryodes edulis* followed with 17 trees. Other notable species identified include *Terminalia mantaly* (12), *Azadirchta indica* (11), *Newbouldia laevis* (9), *Persea americana* (9), *Polyalthia longifolia* (9) and *Terminalia catappa* (9). Species with single occurrences observed consists of *Psidium guajava*, *Treculia Africana*, *Eucalyptus spp.*, and *Acacia auriculiformis*.

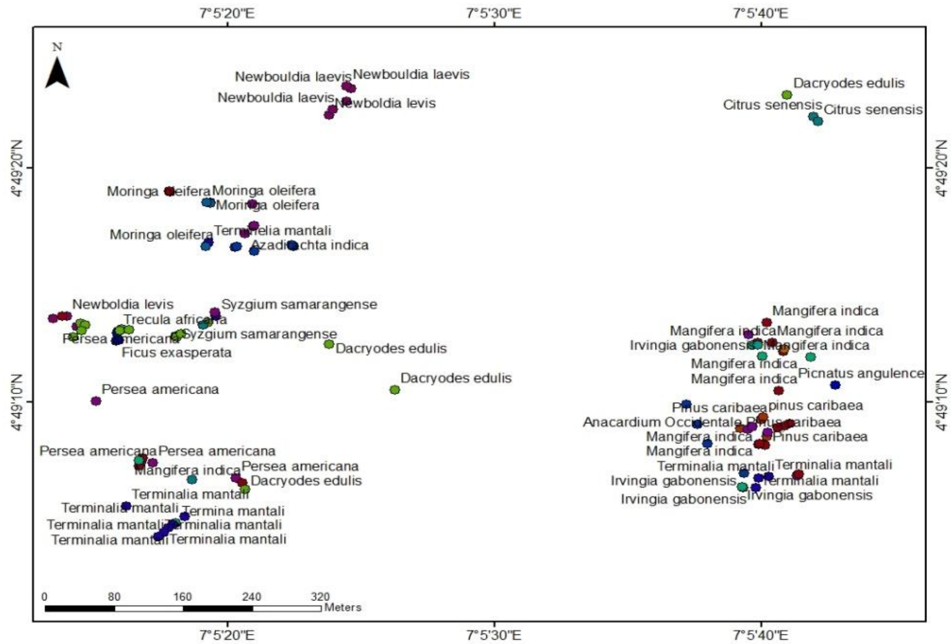

Fig 2: Study area showing the wood trees encountered

From the analysis, it was revealed that there was no special pattern of tree planting though from the observation every land form indicated high preference for green cultivation (fig 2).

Table 1: Urban Trees in Residential, Religious and Academic Areas of Akpajo Eleme

S/N	Species	Common name	Family	N	Uses
1	*Anacardium occidentale*	Cashew	Anacardiaceae	5	Food
2	*Annona muricata*	Soursop	Annonaceae	2	Food
3	*Artocarpus heterophyllus*	Jackfruit	Moraceae	3	Food
4	*Azadirachta indica*	Neem	Meliaceae	11	Medicine, shade
5	*Casuarina equisetifolia*	She-oak	Casuarinaceae	4	Aesthetics
6	*Chrysophyllum albidium*	African star apple	Sapotaceae	3	Food
7	*Citrus sinensis*	Orange	Rutaceae	8	Food
8	*Dacryodes edulis*	African pear	Burseraceae	17	Food
9	*Delonix regia*	Flamboyant tree	Fabaceae	2	Aesthetics, shade
10	*Ficus exasperata*	Sandpaper	Moraceae	3	Medicinal
11	*Hura crepitans*	Sandbox tree	Euphorbiaceae	2	Aesthetic
12	*Irvingia gabonensis*	Wild/bush mango	Irvingiaceae	7	Food
13	*Syzygium samarangense*	Local apple	Myrtaceae	2	Food
14	*Mangifera indica*	Mango	Anacardiaceae	47	Food, shade
15	*Moringa oleifera*	Moringa	Moringaceae	4	Medicinal
16	*Newbouldia laevis*	Boundary tree	Bignoniaceae	9	Aesthetic, boundary
17	*Persea americana*	Avocado, Pear	Lauraceae	9	Food
18	*Picnatus angolence*	African nutmeg	Myristicaceae	2	Food, medicinal
19	*Pinus caribaea*	Pine	Pinaceae	4	Aesthetic
20	*Polyalthia longifolia*	Masquerade tree	Annonaceae	9	Aesthetic
21	*Psidium guajava*	Guava	Myrtaceae	1	Food
22	*Pterocarpus santalinoides*	Gbengbe/Nturukpa	Fabaceae	7	Medicinal, food
23	*Terminalia catappa*	Almond	Combretaceae	9	Food, shade
24	*Terminalia mantaly*	Umbrella tree	Combretaceae	12	Aesthetic, shade
25	*Treculia africana*	Bread fruit	Moraceae	1	Food
26	*Eucalyptus spp.*	-	Myrtaceae	1	Aesthetic, medicine
27	*Acacia auriculiformis*	Acacia	Fabaceae	1	Aesthetic, shade
	Total			**185**	

N = Frequency of occurrence

3.1.2 Tree growth variable Analysis in the selected urban Areas

Tree growth variables such as height, diameter at breast height, crown height, crown diameter, merchantable height, bole height, slenderness coefficient and crown projection area, as well as their mean comparison across the study areas inventoried are presented in Table 2. The result shows that mean height (14.30±2.50m), diameter at breast height (0.41±0.20m), crown diameter (5.25±1.80m), merchantable height (9.84±2.10m) and crown projection area (24.18±15.55m^2) were found to be the highest in academic areas. Tree height was significantly higher in academic area than residential (12.83±2.01m) and religious (12.93±2.43m) areas. Average diameter at breast height (DBH), crown diameter (CD) and crown projection area (CPA) of trees in academic area were statistically similar to those of residential areas (0.35±0.16m; 4.85±1.47m; 20.14±11.75m^2) but different from mean in religious areas (0.28±0.12m; 3.70±1.49m; 12.35±8.44m^2). There was no significant difference observed in the mean crown. Average crown projection area was highest in academic area (24.18±15.55m^2) which was statistically similar with the mean of residential areas (20.14±11.75m^2) but are both statistically different from religious areas (12.35±8.44m^2). Total crown cover for academic was 1886.04m^2 while residential accumulated to 1852.45m^2 and religious area was 185.23m^2. Minimum and maximum crown projection area was 1.09 m^2 and 49.53 m^2, 2.19m^2 and 67.23 m^2, and 1.13 m^2 and 28.10 m^2 for residential, academic and religious areas respectively (Table 2).

Table 2: Means comparison of the parameters measured in the study areas (Mean±SD)

Variables	Residence	Academic	Religion
H (m)	12.83±2.01[b]	14.30±2.50[a]	12.93±2.43[b]
DBH (m)	0.35±0.16[ab]	0.41±0.20[a]	0.28±0.12[b]
CH (m)	4.61±1.56[b]	4.50±0.88[b]	4.27±0.68[b]
CD (m)	4.85±1.47[a]	5.25±1.80[a]	3.70±1.49[b]
MCH (m)	8.12±1.79[b]	9.84±2.10[a]	8.67±2.07[b]
BH (m)	2.40±0.89[a]	2.21±0.51[a]	2.17±0.41[a]
SLC	44.00±19.30[ab]	44.23±24.96[b]	51.01±12.25[ab]
CPA	20.14±11.75[a]	24.18±15.55[a]	12.35±8.44[b]

Mean with same alphabet were not significantly different at $\alpha_{0.05}$

3.1.3 Relationship between Tree Growth Variable of Urban Trees

Tree height has a moderate positive relationship with DBH (0.517), CH (0.493), CD (0.506) BH (0.442) and CPA (0.542), while it exhibited a strong positive relationship with merchantable height (0.888) (Table 3). It can also be seen from the table that DBH has a weak positive relationship with CH (0.284) and BH (0.283), moderate positive relationship with CD (0.614), MCH (0.423) and CPA (0.644), and a strong negative relationship with SLC (-0.799). Crown height showed a strong positive relationship with BH (0.925). The relationship between crown diameter and CPA is strongly and positive correlated (0.980) while slenderness coefficient is negatively correlated with CH (-0.168), CD (-0.448), BH (-0.191) and CPA (-0.445) (table 3).

Table 3: Pearson's Correlation between Tree Growth Variables of Trees in Residential, Religious and Academic Areas of Akpajo Eleme

	H (m)	DBH (m)	CH (m)	CD (m)	MCH (m)	BH (m)	SLC	CPA (m^2)
H(m)	1							
DBH(m)	0.517**	1						
CH(m)	0.493**	0.284**	1					
CD(m)	0.506**	0.614**	0.286**	1				
MCH(m)	0.888**	0.423**	0.091	0.428**	1			
BH(m)	0.442**	0.283**	0.925**	0.291**	0.07	1		
SLC	-0.128	-0.799**	-0.168*	-0.448**	-0.038	-0.191**	1	
CPA(m^2)	0.542**	0.644**	0.275**	0.980**	0.468**	0.280**	-0.445**	1

**Significant at 0.01 level, *Significant at 0.05 level, N = 185; H = Height; DBH = Diameter at breast height; CH = Crown height; CD = Crown diameter; MCH = Merchantable height; BH = Bole height; SLC = Slenderness coefficient; CPA = Crown projection area

3.1.4 Biodiversity Analysis of Urban Trees in the study areas

In terms of species richness, academic area had the highest with 20 individuals followed by residential area which has 16 species and religious areas consist of only 3 species among the study areas (fig 3, 4 and 5). The result shows that the academic area had a species abundance of 78 (42.2%), the residential areas had population of 92 (49.7%), while religious area had 15 (8.1%) trees. Biodiversity was highest in residential areas with a Shannon index of 2.54 and Simpsons index of 0.88. This was closely followed by academic areas with Shannon index of 2.35 and Simpsons index of 0.87 while the religious area was the least diverse community with Shannon index of 1.05 and Simpsons index of 0.64. With a Sorensen's similarity index of 0.5, the residential and academic area share a moderate similarity, while the residential and religious as well as academic and religious have a low similarity index of 0.21 and 0.09 respectively (Table 4.).

Table 4: Biodiversity Indices of Urban Trees in Residential, Religious and Academic Areas of Akpajo Eleme

Species	**Residential**	**Academic**	**Religious**
Anacardium occidentale	1	4	0
Annona muricata	0	2	0
Artocarpus heterophyllus	0	3	0
Azadirachta indica	8	0	3
Casuarina equisetifolia	0	4	0
Chrysophyllum albidium	3	0	0
Citrus sinensis	7	1	0
Dacryodes edulis	11	6	0
Delonix regia	0	2	0
Ficus exasperate	3	0	0
Hura crepitans	1	1	0
Irvingia gabonensis	0	7	0
Syzygium samarangense	1	1	0
Mangifera indica	25	22	0
Moringa oleifera	4	0	0
Newbouldia laevis	3	0	6
Persea Americana	8	1	0
Picnatus angulence	0	2	0
Pinus caribaea	0	4	0
Polyalthia longifolia	0	3	6
Psidium guajava	0	1	0
Pterocarpus santalinoides	7	0	0
Terminalia catappa	1	8	0
Terminalia mantaly	8	4	0
Treculia Africana	1	0	0
Eucalyptus spp.	0	1	0
Acacia auriculiformis	0	1	0
Species Richness	**16**	**20**	**3**
Species Abundance	**92**	**78**	**15**
Species Relative Abundance (%)	**49.7**	**42.2**	**8.1**
Shannon Diversity Index	**2.54**	**2.35**	**1.05**
Simpsons Diversity Index	**0.88**	**0.87**	**0.64**
Sorensen's Similarity:			
Residential	**1**		
Academic	**0.50**	**1**	
Religious	**0.21**	**0.09**	**1**

In the academic area, species such as *Mangifera indica, Terminalia cattappa* were found there. The preference of these tree may be primarily because of shade and wind break and as such has been conserved (Fig 3)

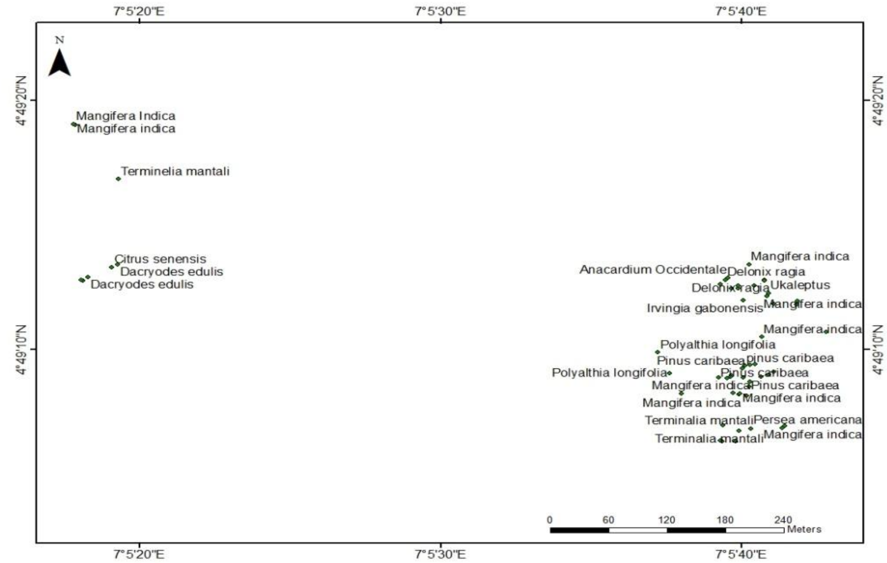

Fig 3: Biodiversity of Urban Trees in Academic Land use

It was observed that there was a form of diversity in the residential area on the choices of tree species. This diversity may have been influenced by individual diversity in terms of belief, language, religion e.t.c. *Mangifera indica, Dacryodes edulis, Citrus sinensis* were dorminat in residential areas. Alo some trees species such as *Moringa oleifera and Azadirachta indica* were found based on their medicinal values (Fig 4).

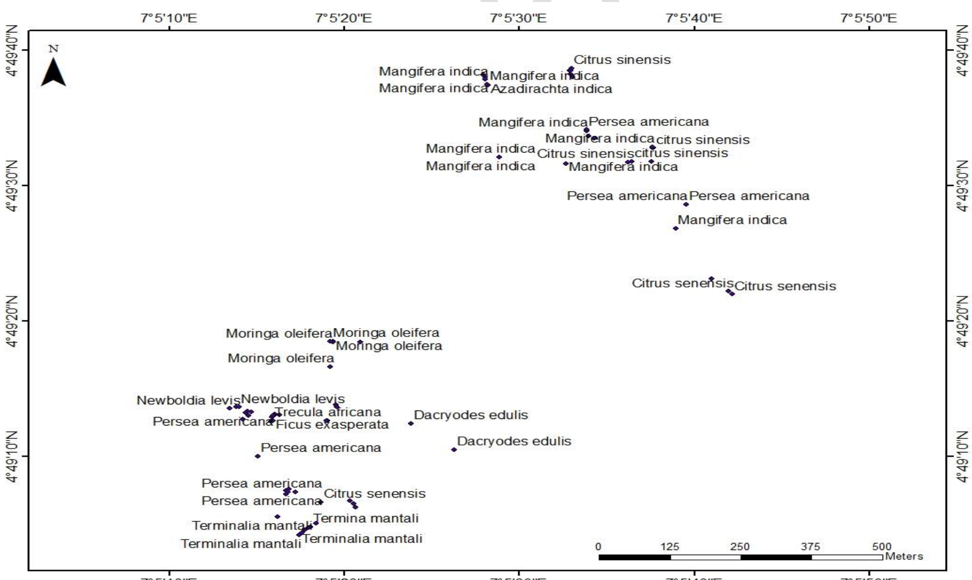

Fig 4: Biodiversity of Urban Trees in Residential Land use

In religious area, *Newbouldia laevis* was most prominent based on the spiritual belief associated with the species. Other species such as *Polyalthia longifolia and Azadirachta indica* were also found based on their aesthetic and shade value (Fig 5)

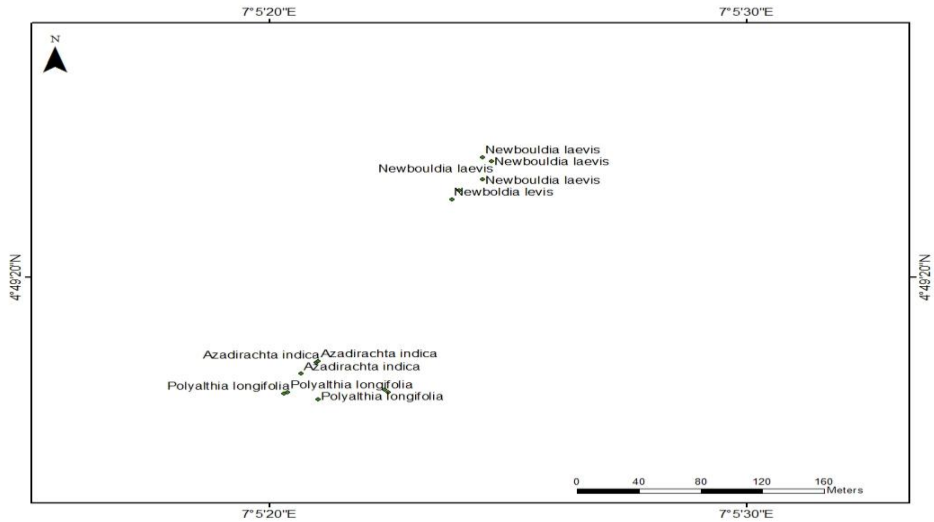

Fig 5: **Biodiversity of Urban Trees in Religious Land use**

3.15 Spatial distribution of urban trees in Akpajo community

The distribution of trees in residential, religious and academic area of Akpajo community and it is land surface temperature is shown in Figures 6 and 7. The spatial distribution of trees did not follow a special pattern. The residential area had a higher spread of tree species compared to religious and academic area (Fig 6).

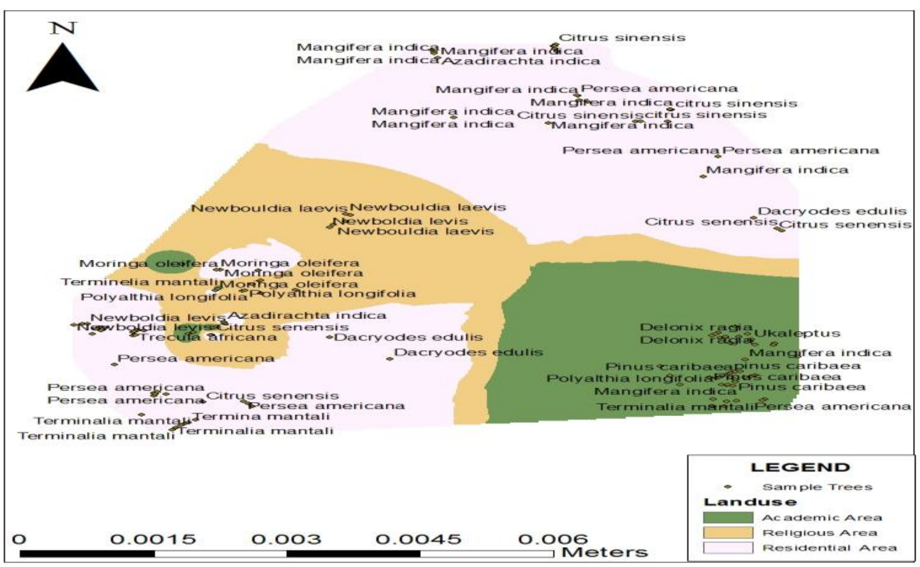

Fig 6: spatial spread of Tree species by landuse (Residential, Religious and Academic)

From the analysis, it was observed that there was general high level of temperature across the study area as shown by the red colour as indicated by the legend (Fig 7). The dots across the image represent the sampled trees. From the image analysis, there is obvious change in the colour spatial displayed indicating a decrease in temperature over space (Fig 7).

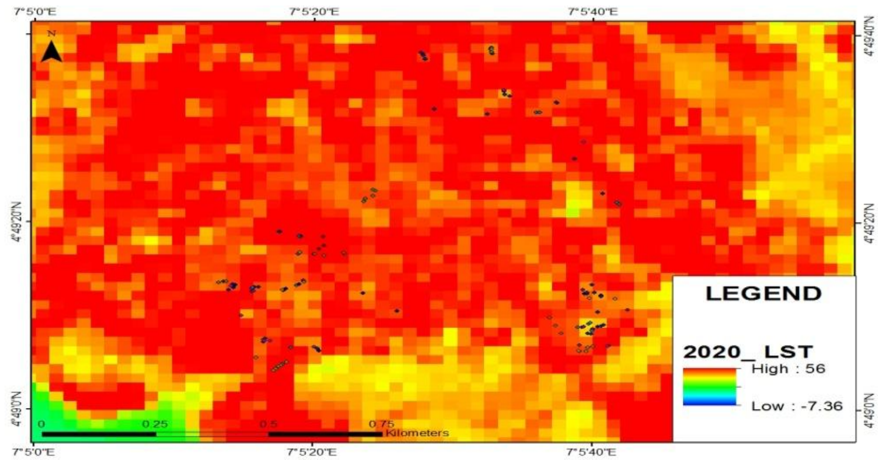

Fig 7: Spatial trend of Undercover Land surface temperature

Result on land surface temperature beneath tree species further buttressed the role of tree in temperature reduction. Land surface temperature beneath tree varies with species. The land surface temperature recorded includes.*Polyalthia longifolia* (25.3), *Anacardium occidentale* (18.6), *Anzadirachta indica* (21.1) *Dacryodes edulis* (17.8) (table 5).

Table 5: Average land surface temperature of studied species

Species	Average
Anacardium occidentale	18.6
Annona muricata	18.6
Artocarpus heterophyllus	18.1
Anzadirachta indica	21.1
Casuarina equisetifolia	17.5
Chrysophyllum albidium	18.5
Citrus sinensis	17.9
Dacryodes edulis	17.8
Delonix regia	17.4
Ficus exasperata	23.4
Hura crepitans	13.6
Irvingia gabonensis	18.3
Syzygium samarangense	17.8
Mangifera indica	17.1
Moringa oleifera	19.7
Newbouldia laevis	18.5
Persea americana	18.4
Picnatus angulence	15.5
Pinus caribaea	16.6
Polyalthia longifolia	25.3
Psidium guajava	11.8
Pterocarpus santalinoides	19.1
Terminalia catappa	18.1
Terminalia mantaly	21.1
Treculia Africana	23.1
Eucalyptus spp.	17
Acacia auriculiformis	15.8

3.2 DISCUSSION

3.2.1Urban trees Identification

Trees grown in the study areas are valuable municipal resources, they provide tangible and intangible benefits for different reasons. Literature has shown that the types and distribution of trees in an urban environment are usually uneven (Handley *et al.,* 2000). Though Alvey (2006) reported that, traditionally, urban forest areas have been regarded as locations of low biodiversity that are dominated by nonnative species; evidence from this study as well as those from published information reveals that urban and suburban areas can contain relatively high levels of biodiversity. A total of 27 different individual woody tree species were encountered with 185 frequency of occurrence Most of the trees were planted on purpose which play very crucial roles in the life of the urban populace in the area of food security to enhance livelihood (Onyekwelu and Olaniyi 2012). Babalola (2010), found similar tree species within the University of Ibadan planted for same purposes. Also providing a multitude of aesthetic and environmental benefits thereby controlling air and noise pollution (Bolund and Hunhammer 1999). Beyond shade and aesthetic value these urban trees also have practical benefits and real monetary value that the urban dwellers are not fully aware of. Furthermore the significance of trees in creating micro climate and cooling environment in the cities and urban settling has also been documented in a study by Akabari *et al.,*2001. There is a large amount of research that demonstrates that trees have many more effects on an area than directly measurable economic benefits (Tyrvainen and Miettinen, 2000; Kaufman and Cloutier, 2006)

Urban tree growth variables

The extent to which land use can provide ecosystem services depends on the current urban forest structure (e.g., tree species, number, tree canopy cover, height, health, composition, tree size, location, health), which can provide useful information for estimating trees' structural characteristics such as leaf biomass and total leaf area, and quantifying multiple ecosystem services and forest functions. The result of this study reveals that the urban trees have a wide range of tree growth variables. Urban forest assessments are essential in supporting urban forest management and planning to improve environmental quality and human health in cities (Nowak *et al* 2008). Due to the limited resources available and inability to demonstrate and quantify all urban forest structures, functions, and economic benefits through standard data analyses, at present few of these benefits and functions are quantifiable (Nowak *et al* 2011).

Biodiversity Analysis of Urban Trees in the study areas

Although many factors may influence urban tree cover. two dominant factors affecting the extent and distribution of urban tree cover are the surrounding natural environment and theland use. The results of this study confirmed that urban forest is a storehouse of many indigenous tropical hardwood and exotic tree species of different families, judging by the tree species richness of the study area, which is similar to or higher than what has been reported in some natural forest ecosystems in Nigeria (Onyekwelu *et al*., 2008; Adekunle, 2006) reported 31 and 51 trees species in tropical rainforest ecosystems of southwestern Nigeria. Thus, the large numbers of tree species that are found in tropical forests could also be said to be characteristics of urban forest landscapes. This similarity of tree species richness of urban environment and natural forest ecosystems underscores the importance of urban forests in biodiversity conservation and thus is evidence that urban forests can be both reservoirs and contributor to global biodiversity conservation. Biodiversity indices of urban and peri-urban forests are generated in order to appreciate the level of diversity and abundance of species in built-up environment. Shannon-Wiener diversity and Evenness indices of this study were similar to the values of Parthasarathy (2001).

Spatial distribution of Urban Trees in the study areas and its implication on land surface temperature.

The spatial distribution of trees in the community did not follow any pattern. It was obvious .that the community have higher preference for urban forestry. The diversity of trees in the residential area could be attributed to individual choice, religion, background, language. Species like *Anacardium occidentale,Dacryodes edulis,Mangifera indica among others* were found in mostly in residential area because of their roles in food security, *Moringa oleifera, Azadirachta indica* were planted for their medicinal value. *Newbouldia laevis* was mostly found in religious area because of the spiritual belief associated with the species. From the result trees decreases land surface temperature there by serving as temperature moderator.Trees cools its surroundings through shading effects and regulation of evapotranspiration (Georgi and Zafiriadis, 2006; Tsiros 2010; Zardo*et al*., 2017),

4. CONCLUSION

Trees exist as part of the urban setting in different parts of the world, this study has shown the importance of having trees around our places of academic, religious and residential areas. The result of this investigation has provided baseline information on urban forests in the Akpajo community, which can be used for the development of tree species database of the territory. The tree species richness of the study area confirms and underscores the importance of urban forests in biodiversity conservation; it is evidence that urban forests can be reservoirs and contributor to biodiversity conservation. Residential areas had higher tree species richness and diversity compared to religious and academic area. The high species richness and diversity in residential areas, despite its high infrastructural development, showed that infrastructural development in the city did not negatively affect its biodiversity conservation potential.

REFERENCES

1. United Nations, Department of Economic and Social Affairs, Population Division. Policies on spatial distribution and urbanization have broad impacts on sustainable development 2020.
2. Zhang X. and Li H. The evolving process of the land urbanization bubble: Evidence from Hangzhou, China. Cities. 2020. 102: 102724
3. Lu XC, Yuan DH, Chen Y, Fung JCH. Impacts of urbanization and long-term meteorological variations on global PM2.5 and its associated health burden. *Environ Pollut* . 2021. 270: 116003. https://doi.org/10.1016/j.envpol.2020.116003
4. Shao Q, Tao R, Luca M. M. The effect of urbanization on health care expenditure: evidence from China. Front Public Health. (2022) 10:850872. https://doi.org/10.3389/fpubh.2022.850872
5. Liu, K.; Lin, B. Research on influencing factors of environmental pollution in China: A spatial econometric analysis. J. Clean. Prod.**2019**. 206, 356–364.
6. Zhang, Q., Decai T., and Brandon J. B.. Impact of Urbanization on the Environmental Regulation Efficiency in the Yangtze River Basin Based on the Empirical Analysis of Spatial Econometrics" *International Journal of Environmental Research and Public Health.* 2021. 18 (17): 9105. https://doi.org/10.3390/ijerph18179105

7. Santamouris, M. Analyzing the Heat Island Magnitude and Characteristics in One Hundred Asian and Australian Cities and Regions. Science of the Total Environment, 2015. 512-513, 582-598. http://dx.doi.org/10.1016/j.scitotenv.2015.01.060
8. Memon R., Leung D. and Liu C.. An investigation of urban heat island intensity (SUHII) as an indicator of urban heating. Atmospheric Research2009. 94(3):491-500 DOI:10.1016/j.atmosres.2009.07.006
9. Nowak D. J., Crane D. E. Stevens J.C. and Hoehn R.E.. A Ground-Based Method of Assessing Urban Forest Structure and Ecosystem Services. Arboriculture & Urban Forestry2008.34(6). DOI:10.48044/jauf.2008.048
10. Nielsena. A. B.., Ostberg J. and Delshammar T.. Review of Urban Tree Inventory Methods Used to Collect Data at Single-Tree Level. Arboriculture & Urban Forestry2014. 40(2):96-111. DOI:10.48044/jauf.2014.011
11. Morgenroth J., Östberg J., Konijnendijk van den Bosch C., Nielsen A.B., Hauer R., Sjöman H., Chen W. and Jansson W.. Urban tree diversity—Taking stock and looking ahead. *Urban Forestry and Urban greening*. 2016. 15; 1-5
12. Roman L., Conway T. M., Eisenmen T. S. and Koeser A. K. Beyond 'trees are good': Disservices, management costs, and tradeoffs in urban forestry. AMBIO A Journal of the Human Environment2020. 50(3). DOI:10.1007/s13280-020-01396-8
13. Handley J., Wood R., and Ruff A. The Red Rose Forest Urban Timber Initiative:A Report on the Sampling of the Street, Park and Garden Tree Population. Red Rose Forest Report. 2000. 76.
14. Alvey, A. Promoting and preserving biodiversity in the urban forest Exit. *Urban Forestry & Urban Greening* 2006. 5:195–201.
15. Onyekwelu J. C. and Olaniyi, D. B. Socio-economic importance of Urban and peri-urban forests in Nigeria," in *Proceedings of the 6th Annual Conference of SAAT, FUTA*, Adebayo, Ed. 200–210, Akure, Nigeria, November 2012.
16. Babalola, T. S. Land Evaluation Studies of Two Wetland Soil in Nigeria. Master's Thesis, Department of Crop, Soil and Environmental Sciences, University of Ado-Ekiti, Ado Ekiti, 2010. 141.
17. Bolund, P. and Hunhammar, S. Ecosystem Services in Urban Areas. Ecological Economics, 1999. 29, 29 3-301. http://dx.doi.org/10.1016/S0921-8009(99)00013-0
18. Akbari, H., Pomerantz, M., & Taha, H. Cool Surfaces and Shade Trees to Reduce Energy Use and Improve Air Quality in Urban Areas. Solar Energy, 2001. 70, 295-310. https://doi.org/10.1016/S0038-092X(00)00089-X
19. Tyrvainen L. and Miettinen, A. Property Prices and Urban Forest Amenities. Journal of Environmental Economics and Management. 2000. 39 (2): 205-223
20. Kaufman, D. and Cloutier, N. The Impact of Small Brownfields and Greenspaces on Residential Property Values. The Journal of Real Estate Finance and Economics, Springer. 2006. 33(1): 19-30.
21. Nowak, D.; Hoehn III, R.; Crane, D.; Weller, L.; Davila, A. Assessing Urban Forest Effects and Values, Los Angeles. Urban Forest; Resource Bullet NRS-47; US Department of Agriculture, Forest Service, Northern Research Station: Newtown Square, PA, USA, 2011. 30.

22. Onyekwelu, J. C. Mosandl R. and Stimm B. Tree Species Diversity And Soil Status Of Primary And Degraded Tropical Rainforest Ecosystems In South-Western Nigeria. Journal of Tropical Forest Science. 2008. 20 (3): 193-204
23. Adekunle, V. A. J. Conservation of Tree Species Diversity in Tropical Rainforest Ecosystem of Southwest Nigeria. Journal of Tropical Forest Science. 2006. 18, 91-101.
24. Parthasarathy, N. Changes in Forest Composition and Structure in Three Sites of Tropical Evergreen Forest around Sengaltheri, Western Ghats. Current Science, 2001. 80, 389-393.
25. Georgi, N. J., & Zafiriadis, K. The Impact of Park Trees on Microclimate in Urban Areas. Urban Ecosystems. 2006. 9, 195-209.
26. Tsiros, Ioannis X.Assessment and energy implications of street air temperature cooling by shade tress in Athens (Greece) under extremely hot weather conditions," Renewable Energy, Elsevier. 2010. 35(8): 1866-1869.
27. Zardo L, Geneletti D, Pérez-Soba M, Van Eupen M. Estimating the cooling capacity of green infrastructures to support urban planning. Ecosyst Serv . 2017. 26:225–235.