

CARBON SEQUESTRATION POTENTIAL OF SELECTED ORNAMENTAL TREES IN ISAAC BORO PARK PORT HARCOURT

¹Ulolo, M. B.,  ²Simbi-Wellington W. S. and ³Nnadi P.C.

^{1,2,3}Department of Forestry and Environment,
Rivers State University, Nkpolu-Oroworukwo Port Harcourt, Nigeria.

*Corresponding Author

DOI: <https://doi.org/10.51193/IJAER.2025.11504>

Received: 28 Aug. 2025 / Accepted: 08 Sep. 2025 / Published: 23 Sep. 2025

ABSTRACT

This research assessed the carbon sequestration potential of ornamental trees within Isaac Boro Park Port Harcourt. Data on tree height and diameter at breast height (DBH) were collected using the purposeful sampling technique with the aid of D-tape and digital clinometer. The allometric method was employed to estimate carbon sequestered from the above and below ground biomass derived from tree height and DBH measurement. *Eucalyptus camaldulensis*, *Peltophorum pterocarpum*, and *Delonix regia* had the highest mean heights of 107.82m, 94.88m, and 52.84m, respectively, while *Roystonea regia* and *Pinus caribaea* recorded the least heights at 96.28m and 81.04m. *Eucalyptus camaldulensis*, *Delonix regia*, and *Peltophorum pterocarpum* recorded the highest mean DBH values of 85.40cm, 63.85cm, and 63.33cm, respectively, while *Roystonea regia* and *Pinus caribaea* had the lowest DBH 46.95cm and 45.33cm respectively. The below ground biomass was highest for *Eucalyptus camaldulensis* (144,426.58kg/m³), followed by *Peltophorum pterocarpum* and *Delonix regia* (67,511.34kg/m³ and 33,914.45kg/m³, respectively). Similarly, *Eucalyptus camaldulensis* recorded the highest above ground biomass (120,355.48kg/m³) and sequestered the highest carbon (160117.9221kg). *Pinus caribaea* and *Roystonea regia* sequestered the lowest carbon (38748.5775kg and 39823.7612kg respectively). This study provides valuable insights into the mean height, DBH, and carbon sequestration potential of ornamental trees in Isaac Boro Park Port Harcourt. *Eucalyptus camaldulensis*, *Peltophorum pterocarpum*, and *Delonix regia* should be integrated into urban forestry initiatives for dual benefits of beautification and climate mitigation.

Keywords: Carbon Sequestration, Ornamental Trees, Isaac Boro Park

INTRODUCTION

Intergovernmental Panel on Climate Change (IPCC) reported that average global temperatures are increasing consistently (IPCC 2001). Global surface temperature has increased by 0.88C since the late nineteenth century, and in addition to sea-level rise of 15–23 cm during the twentieth century (IPCC 2007), there have been notable shifts in ecosystems dynamics. According to research, climate change is mainly caused by human activities and particularly by carbon dioxide (CO₂) emissions (IPCC 2001).

Effect of climate change on components of the environment are reportedly caused by emission of greenhouse gases through anthropogenic activities which include, land-use change, deforestation, biomass burning, draining of wetlands, soil cultivation and fossil fuel combustion. Major GHGs with rising concentrations in the atmosphere that are of environmental concern are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (NO_x), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs) and ozone (O₃) in the lower atmosphere (World Meteorological Organization, WMO, 2006). The concentration of atmospheric GHGs have progressively increased with rise in human population, but especially since the onset of industrial revolution around 1850. According to Simbi-wellington and Ideriah (2020), the concentration of carbon dioxide (CO₂) in the atmosphere has steadily increased over the years. Zia *et al.*, (2022) highlight air pollution as a pressing concern in urban areas, especially mega cities.

Carbon sequestration plays a crucial role in combatting global climate change (Van de Perre *et al.*, 2018). Forest ecosystem accounts for half of the terrestrial carbon sink (Canadell *et al.*, 2007), and plays a significant role in absorbing CO₂ through the photosynthetic process (Kulmala *et al.*, 2013). Trees play a vital role in sequestering carbon from the atmosphere, storing it in parts of its stems, roots, leaves, and branches (Chavan and Rasal, 2010). The forest contains vast amount of carbon distributed across the above-ground biomass, below-ground biomass, deadwood, litter, and soil (Kindermann *et al.*, 2012). However, the rate of carbon sequestration depends on factors such as plant growth, tree species characteristics, wood density, and environmental conditions (Toochi, 2018).

Urban forest is an integral component of the forest ecosystem that generates significant ecosystem services including offset of carbon emission, air purification, micro-environment regulation, and climate change mitigation (Fuwape and Onyekwelu 2011). Urban forest contributes greatly to the conservation of biodiversity and stores carbon much like other forest ecosystems (Aladesanmi and Jonathan, 2020).

Studies revealed that certain tree species, particularly those with medium size and large girth, exhibit significant potential for carbon sequestration. Wang *et al.*, (2021) and Lahoti *et al.*, (2020) emphasize the importance of urban green spaces, particularly parks, in mitigating climate change.

Killicoat *et al.*, (2002) found that trees with larger diameters can remove substantial amounts of air pollution. Singh *et al.*, (2020) note the challenges posed by the urban heat island (UHI) effect, characterized by elevated temperatures in urban areas compared to surrounding rural areas. Urban green spaces, particularly parks, play a crucial role in mitigating the UHI effect by providing shade, evaporative cooling, and thermal insulation. Seiferling *et al.*, (2017) highlight the importance of urban green spaces as habitats for various plant and animal species, contributing to urban biodiversity and ecological resilience.

Emerhi *et al.*, (2012); Ideriah *et al* (2012); Trinya and Ideriah (2015) highlight air pollution as a pressing concern in Port Harcourt due to the high rate of industrialization and population growth. Studies on the carbon sequestration in urban parks, would provide information on the sequestration potentials of trees for urban planners and managers particularly in a rapidly urbanizing city like Port Harcourt. The carbon sequestration potential of selected ornamental tree species within the Isaac Boro park is vital, as such knowledge could be applied in multiple land use practices within the parks to serve dual purposes of recreation and climate mitigation.

MATERIALS AND METHODS

This research was conducted in Isaac Boro Park, Port Harcourt. The Park is an outdoor recreational park situated along the Old GRA axis in the city of Port Harcourt with latitude 4.7N and 7.0E. Port Harcourt is the capital and largest metropolis of Nigeria's Rivers State ranking fifth in terms of population behind Lagos, Kano, Ibadan, and Benin (Port Harcourt, 2023). Port Harcourt is situated in the sub-equatorial region and lies within latitude 4°43 and 4°54N and longitude 6°56 and 7°03E, 59 feet (18 meters) above sea level (Ideriah *et al*, 2011). In the year 2023, Port Harcourt's urban population was estimated at 3.5m. The population of the metropolitan area of Port Harcourt was estimated to be almost twice its urban area population with a 2015 United Nations estimate of 2,344,000 (Port Harcourt, 2023). The city is home to several tertiary institutions and multinational oil companies with rich crude oil reserve. The geographical location of the city is marked with the tropical rainforest with wide range of wildlife and plants species making it a natural tourist hotspot (Oladosu, 2019). The climate in Port Harcourt is a tropical monsoon climate with lengthy and heavy wet season and very short dry season. The heaviest precipitation occurs during September with an average of 367 millimetres or 14.45 inches of rain. December on average is the driest month of the year, with an average rainfall of 20 millimetres or 0.79 inches. Average temperatures in Port Harcourt ranges between 25 and 28 °C (77.0 and 82.4 °F).



Plate 1 Isaac boro Park Port Harcourt

The purposeful sampling technique was used to select six ornamental tree species for the study. Selected ornamental tree species were grouped into strata and samples randomly collected in five replicates within each stratum. Photographs and leaf samples of ornamental trees in the park were taken to the Department of Forestry and Environment, Rivers State University for proper identification. Tree diameter at breast height (1.3m above ground level) were taken in centimetres using 800-647-5368 diameter/Linear tape by Forestry Suppliers Inc. Tree terminal height measurements were taken in meters using digital clinometer by Haglof Sweden. The GPS coordinates of each tree location were taken using the GPS test App.

Table 1: Coordinates of Sampling Units

Name of Tree Species	Latitude	Longitude
<i>Roystonea regia</i>	4° 47'14.562"N	7°00'16.451"E
<i>Roystonea regia</i>	4° 47'14.736"N	7°00'16.974"E
<i>Roystonea regia</i>	4° 47'14.999"N	7°00'16.974"E
<i>Roystonea regia</i>	4° 47'15.389"N	7°00'16.866"E
<i>Roystonea regia</i>	4° 47'15.671"N	7°00'17.171"E
<i>Eucalyptus camaldulensis</i>	4° 47'21.570"N	7°00'18.030"E
<i>Eucalyptus camaldulensis</i>	4° 47'19.031"N	7°00'21.317"E
<i>Eucalyptus camaldulensis</i>	4° 47'19.049"N	7°00'21.252"E
<i>Eucalyptus camaldulensis</i>	4° 47'19.229"N	7°00'21.281"E
<i>Eucalyptus camaldulensis</i>	4° 47'17.940"N	7°00'22.146"E
<i>Terminalia catapa</i>	4° 47'20.376"N	7°00'20.675"E

<i>Terminalia catapa</i>	4° 47'20.562"N	7°00'20.399"E
<i>Terminalia catapa</i>	4° 47'21.017"N	7°00'20.016"E
<i>Terminalia catapa</i>	4° 47'21.335"N	7°00'19.728"E
<i>Terminalia catapa</i>	4° 47'21.366"N	7°00'19.547"E
<i>Peltophorum pterocarpum</i>	4° 47'20.202"N	7°00'18.222"E
<i>Peltophorum pterocarpum</i>	4° 47'20.252"N	7°00'18.120"E
<i>Peltophorum pterocarpum</i>	4° 47'19.740"N	7°00'17.423"E
<i>Peltophorum pterocarpum</i>	4° 47'20.526"N	7°00'17.466"E
<i>Peltophorum pterocarpum</i>	4° 47'20.298"N	7°00'17.585"E
<i>Pinus caribaea</i>	4° 47'15.569"N	7°00'21.780"E
<i>Pinus caribaea</i>	4° 47'16.164"N	7°00'21.276"E
<i>Pinus caribaea</i>	4° 47'16.577"N	7°00'20.813"E
<i>Pinus caribaea</i>	4° 47'17.766"N	7°00'20.154"E
<i>Pinus caribaea</i>	4° 47'18.894"N	7°00'20.460"E
<i>Delonix regia</i>	4° 47'16.410"N	7°00'15.731"E
<i>Delonix regia</i>	4° 47'17.052"N	7°00'19.139"E
<i>Delonix regia</i>	4° 47'14.784"N	7°00'22.731"E
<i>Delonix regia</i>	4° 47'13.157"N	7°00'20.951"E
<i>Delonix regia</i>	4° 47'16.049"N	7°00'22.584"E

Non-destructive approach was used for above ground biomass (AGB) and below ground biomass (BGB) estimation. BGB was estimated from AGB as developed by Ponce-Hernandez (2004) for non-destructive below-ground biomass value of vegetation as 20% of the AGB. Biomass data were used to quantify carbon stock which was used to estimate the amount of carbon sequestered using the allometric equation by Brown (1997) with field measurements of height and diameter at breast height. The algorithm function was used to determine the above-ground green weight of the trees using the formular;

$$AGW = 0.25D^2H: \text{ For trees with } D \leq 28\text{cm}$$

$$AGW = 0.15 D^2H: \text{ For trees with } D \geq 28\text{cm}$$

Where AGW=Above-ground green weight(ton)

D=Stem diameter (cm), H =Total height of tree (m)

The root system weight was estimated at 20% of the above-ground weight. Therefore, the total green weight of the tree was determined by multiplying the above ground weight by 1.2. The above-ground dry weight of each standing tree was determined using the functions of Chavan and Rasal (2010) which states that the average tree is 72.5% dry matter and 27.5% moisture. The function therefore is expressed as

$DW = AGW \times 0.725 = 0.25D^2H \times 0.725$ for trees with $D \leq 28\text{cm}$

$DW = AGW \times 0.725 = 0.15 D^2H \times 0.725$ for trees with $D \geq 28\text{cm}$

Where DW=Dry weight (ton), D=Stem diameter(cm), H =Total height of tree (m)

The weight of carbon in woody biomass is generally 50% of the dry weight (Eneji, *et al.*, 2014). Therefore, the weight of carbon in sampled trees were determined by multiplying the dry weights by the factor of 0.5. The weight of carbon dioxide in the sampled trees was determined using the allometric equation via the estimation of tree height, diameter at breast height and the above and below ground biomass according to Brown (1977). The atomic weight of carbon is 12, the atomic weight of oxygen is 16. The weight of carbon dioxide in a tree was estimated by the ratio of CO₂ to C (44/12 = 3.67). Weight of carbon dioxide, therefore, was estimated by multiplying the weight of carbon in the trees by 3.67 (Birdsey, 1992).

Data collected were subjected to descriptive statistical analysis. The one-way analysis of variance was used to test the significant differences of carbon sequestered by different tree species using IBM SPSS statistics 27. Means were separated using the Duncan Multiple Range Test at a probability of 0.05%.

RESULTS

The ornamental tree species identified in Isaac Boro Park are shown in Table 2. The trees were identified by family and scientific names. Ornamental trees identified include, *Pinus caribaea* of the family Pinaceae, *Terminalia catapa* of the family Combretaceae, *Delonix regia* of the family Leguminosae, *Eucalyptus camaldulensis* of the family Myrtaceae and *Gmelina arborea* of the family Lamiaceae.

Table 2: Ornamental trees in Isaac Boro Park Port Harcourt

S/N	Scientific Name	Family
1	<i>Pinus caribaea</i>	Pinaceae
2	<i>Roystonea regia</i>	Arecaceae
3	<i>Terminalia catapa</i>	Combretaceae
4	<i>Delonix regia</i>	Leguminosae
5	<i>Peltophorum pterocarpum</i>	Leguminosae
6	<i>Eucalyptus camaldulensis</i>	Myrtaceae
7	<i>Hura crepitans</i>	Euphorbiaceae
8	<i>Anacardium occidentale</i>	Anacardiaceae
9	<i>Gmelina arborea</i>	Lamiaceae

Field study 2024

The mean height and diameter at breast height of tree species are shown in Fig.1. The results show that *Eucalyptus camaldulensis* had the highest mean height (107.82m) followed by *Roystonea regia* (96.28m) and *Peltophorum pterocarpum* (94.88) while *Terminalia catapa* and *Delonix regia* recorded the least mean height of 81.04m and 52.84m respectively and was significantly different from other tree species at a probability of 0.05% using the Duncan Multiple Range Test.

Significant differences were observed in the mean DBH of tree species at a probability of 0.05%. *Eucalyptus camaldulensis* recorded the highest mean DBH (85.40cm) followed by *Delonix regia* and *Peltophorum pterocarpum* (63.85cm and 63.33cm) respectively. The least DBH was observed in *Pinus caribaea* and *Roystonea regia* (46.95cm and 45.33cm) respectively (Fig 1).

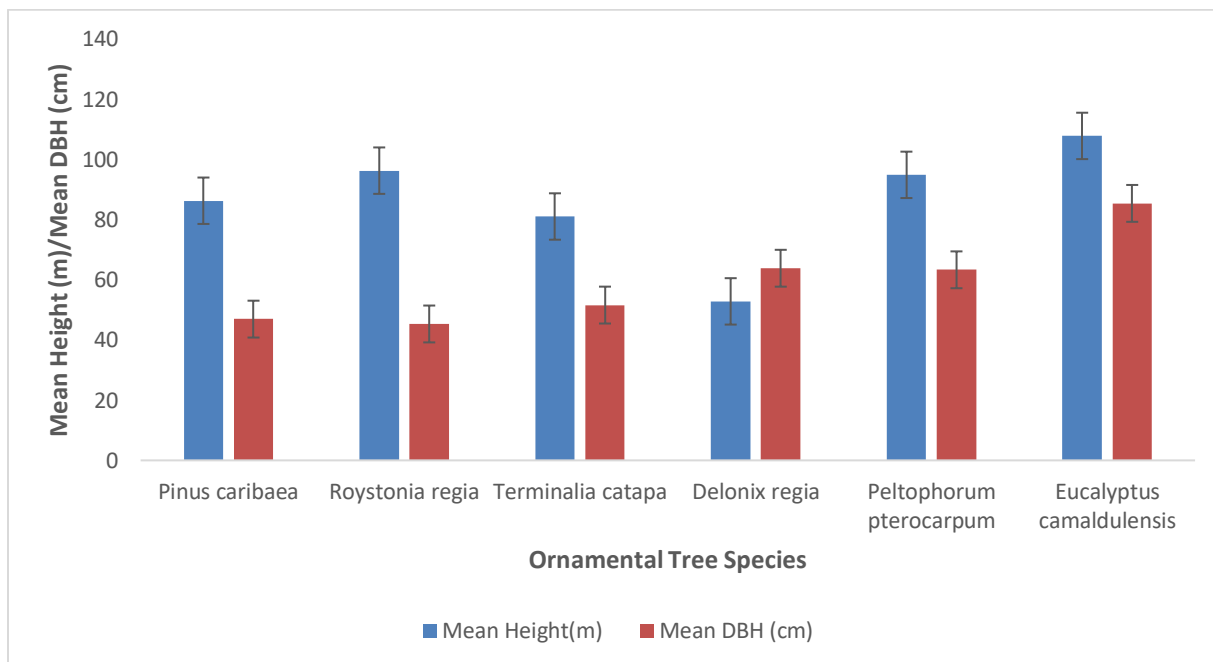


Fig 1: Mean Height and Diameter at Breast Height of Tree Species

Result for above ground and below ground biomass of tree species are presented in Table 3. *Eucalyptus camaldulensis* had the highest mean above ground biomass (120355.48kg/m³) followed by *Peltophorum pterocarpum* and *Delonix regia* (67511.34kg/m³ and 33914.45kg/m³) respectively while *Roystonea regia* and *Pinus caribaea* recorded the least AGB (29934.24kg/m³ and 29126.06kg/m³) respectively at a probability of 0.05%. The result also revealed that *Eucalyptus camaldulensis* had the highest mean BGB (144426.58kg/m³) and was significantly different from the other species. *Pinus caribaea* had the least BGB (34951.27kg/m³).

Table 3: Mean Above Ground and Below Ground Biomass of Tree Species

Species	Mean AGB (kg/m ³) ±SD	Mean BGB (kg/m ³) ±SD
<i>Pinus caribaea</i>	29126.0566 ^c ± 9140.40420	34951.2679 ^c ± 10968.48505
<i>Roystonea regia</i>	29934.2375 ^c ± 6474.08579	35921.0849 ^c ± 7768.90295
<i>Terminalia catapa</i>	33229.7698 ^{b,c} ± 10687.36484	39875.7237 ^{b,c} ± 12824.83781
<i>Delonix regia</i>	33914.4483 ^{b,c} ± 17624.54930	40697.3380 ^{b,c} ± 21149.45916
<i>Peltophorum pterocarpum</i>	67511.3432 ^b ± 44306.41888	81013.6118 ^b ± 53167.70265
<i>Eucalyptus camaldulensis</i>	120355.4803 ^a ± 38676.95899	144426.5763 ^a ± 46412.35081

Within columns means with different superscript are significantly different at P≤0.05 using Duncan Multiple Range Test.

Fig 2. shows result of carbon sequestered among tree species in Isaac Boro Park. *Eucalyptus camaldulensis* sequestered the highest CO₂ (160117.92kg) while *Roystonea regia* (29934.2375) and *Pinus caribaea* (29126.0566) sequestered the least. The order in decreasing sequestered CO₂ across species are *Eucalyptus camaldulensis* > *Peltophorum pterocarpum* > *Delonix regia* > *Terminalia catapa* > *Roystonea regia* > *Pinus caribaea*.

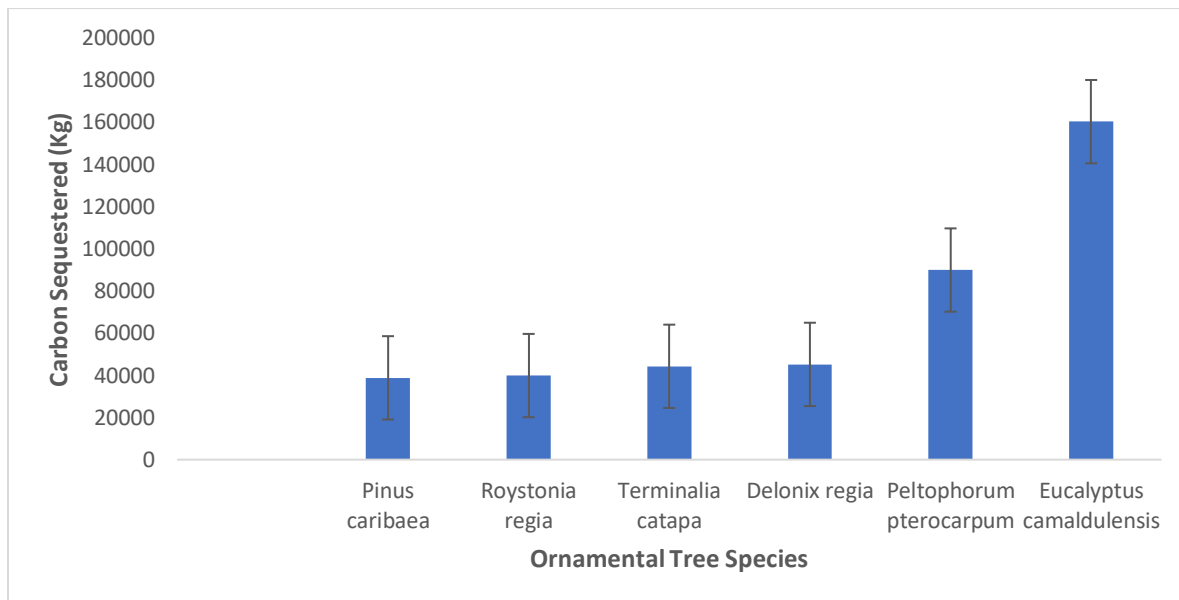


Fig. 2: Mean Carbon Sequestered

DISCUSSION

The results of this study highlight the carbon sequestration potential of various ornamental tree species within Isaac Boro Park, Port Harcourt. Notably, *Eucalyptus camaldulensis* recorded the highest mean diameter at breast height (DBH) and tree height. This finding aligns with Orwa *et al.* (2009), who described *Eucalyptus camaldulensis* as a fast-growing tree species with substantial

height and girth. The observed variations in DBH and height among the studied species can be attributed to inherent genetic traits, growth habits, and environmental adaptations, as noted by Oliver and Larson (1990). These factors are crucial in determining a tree's biomass accumulation and, consequently, its carbon sequestration potential.

The higher carbon sequestration and biomass recorded for *Eucalyptus camaldulensis* compared to other species such as *Pinus caribaea* and *Roystonea regia* corroborates the findings of Samuel and Simon (2020), which states that fast-growing species like *Eucalyptus* and *Terminalia* accumulate biomass at a much higher rate, thereby enhancing their carbon sequestration potential. This observation underscores the critical role of tree species with large above-ground biomass in mitigating atmospheric carbon levels, as highlighted by Aladesanmi and Jonathan (2020). According to the research, the ability of a tree species to amass biomass is directly correlated with its capacity to sequester atmospheric carbon, reinforcing the importance of species selection in urban forestry initiatives.

Furthermore, *Peltophorum pterocarpum* and *Delonix regia* also demonstrated relatively high levels of above-ground biomass and carbon sequestration. This aligns with the findings of Eneji *et al.* (2014), who reported that tree species with dense, broad foliage have higher carbon sequestration potential due to their ability to capture more solar energy, resulting in robust growth and enhanced biomass production. Similarly, Morenike *et al.* (2022) found that *Gmelina arborea* and *Peltophorum* species exhibited high carbon sequestration capacities in tropical climates, supporting the notion that these species contribute significantly to urban carbon sinks.

Roystonea regia and *Pinus caribaea* recorded the lowest DBH, biomass, and carbon sequestered. This finding is consistent with the report by Ishaq *et al.* (2014), which indicated that *Pinus caribaea* has slower growth rates and relatively low carbon sequestration potential compared to fast-growing species like *Eucalyptus* and *Delonix regia*. The lower sequestration potential of these species could be attributed to their narrower growth forms and slower physiological processes, which limit their ability to accumulate biomass quickly. Though *Roystonea regia* displayed the second-highest mean height, its biomass and carbon sequestration were significantly lower than expected. This observation is in agreement with the findings of Eneji *et al.* (2014), which suggested that height alone is not a reliable predictor of carbon sequestration potential.

The significant difference in below-ground biomass (BGB) among the studied species further reinforces the findings of this study. *Eucalyptus camaldulensis* recorded the highest BGB, followed by *Peltophorum pterocarpum* and *Delonix regia*. This pattern aligns with the findings of Henry *et al.* (2019), which highlighted that species with extensive root systems tend to store more carbon underground. This is particularly relevant in urban areas where root systems contribute to soil carbon storage, thereby enhancing long-term carbon sequestration. The importance of below-

ground biomass in carbon storage has also been emphasized by Canadell *et al.* (2007), stating that nearly 50% of a tree's total carbon storage can reside in its root system.

The observed variations in mean carbon sequestration among the studied species further support the role of species selection in urban forestry planning. The highest carbon sequestration recorded in *Eucalyptus camaldulensis* (160,117.92 kg CO₂) underscores its effectiveness in atmospheric carbon mitigation. This is consistent with studies by Aladesanmi and Jonathan (2020), which emphasized that *Eucalyptus* species are among the most effective carbon sequestration agents in urban landscapes. Similarly, Morenike *et al.* (2022) reported that *Peltophorum pterocarpum* is an efficient carbon sink due to its fast growth and high biomass accumulation.

The lower carbon sequestered by *Roystonea regia* and *Pinus caribaea* suggests that these species may be better suited for aesthetic and shade-providing purposes rather than as primary carbon sinks. This finding resonates with the work by Osinaike *et al.* (2019), which indicated that while certain ornamental species contribute to urban beautification, their carbon sequestration potential may be limited due to their slower growth rates and lower biomass accumulation.

For urban planners and policymakers, these results highlight the importance of integrating tree conservation and planting into broader sustainability frameworks. Strategies such as prioritizing diverse, resilient species, in urban areas, and maintaining existing mature trees can enhance long-term carbon storage while simultaneously improving urban livability. Moreover, aligning urban forestry initiatives with climate action plans ensures that tree-planting programs are not just symbolic gestures but measurable interventions that contribute to carbon neutrality goals.

CONCLUSION

The results of this study have underscored the carbon sequestration potentials of ornamental trees in Isaac Boro Park, Port Harcourt. *Eucalyptus camaldulensis* was found to sequester the most carbon, while *Roystonea regia* and *Pinus caribaea* exhibited the lowest carbon sequestration capacities. This research also provided valuable information into the mean height and diameter at breast height (DBH) of the studied ornamental trees. It was evident that the species with the highest mean height and diameter corresponded to greater above-ground and below-ground biomass, leading to enhanced carbon sequestration. Specifically, *Eucalyptus camaldulensis* demonstrated the highest mean height and diameter, while *Rostonia regia* recorded the least DBH and *Delonix regia* recorded the least height. *Eucalyptus camaldulensis* should be promoted in urban forestry initiatives for its dual benefits of enhancing aesthetic appeal and contributing to climate change mitigation.

Urban trees are increasingly recognized as critical components of sustainable city planning. Beyond their ecological value, they provide measurable contributions to climate action strategies

through carbon sequestration, microclimate regulation, and improved air quality. Our findings on tree growth and carbon storage emphasize the potential of urban forests to serve as nature-based solutions for mitigating greenhouse gas emissions. Therefore, the cutting of trees within Isaac Boro Park should be strictly regulated. Any planned tree removal should involve consultation with relevant environmental authorities to ensure sustainable practices. Long-term assessments of trees should be conducted to evaluate how age and environmental factors such as soil characteristics, water availability and air pollution can influence the carbon sequestration potential of the studied species. More ornamental tree species in other recreational parks within the city should be considered for further studies.

REFERENCES

- [1]. Aladesanmi, D. A. & Jonathan C. O. (2020). Tree species diversity, volume yield, biomass and carbon sequestration in urban forests in two Nigerian cities. Springer Science+Business Media, LLC, part of Springer Nature (23) 957-970.
- [2]. Birdsey, R.A. (1992). Carbon Storage and Accumulation in United States Forest Ecosystems, General Technical Report *WO-59*, Radnor PA: United States Department of Agriculture Forset Service, Northeastern Forest Experiment Station. <http://www.ilea.org/birdsey/fcarbon-index.htm#0c>
- [3]. Brown, S. (1997). Estimating Biomass and Biomass Change of Tropical Forests: A Primer. Rome: FAO Forestry paper 134.
- [4]. Canadell J., G, Quéré C. L, Raupach M. R, Field C. B, Buitenhuis E. T, & Ciais P. (2007) Contributions to accelerating atmospheric CO₂ growth from economic activity, carbon intensity, and efficiency of natural sinks. *Proc Nat Acad Sci.* 104:18866–70. doi: 10.1073/pnas.0702737104
- [5]. Chavan B.L, & Rasal G.B. (2010) Sequestered standing carbon stock in selective tree species grown in university campus at Aurangabad, Maharashtra, India. *Int J Eng Sci Technol.* 2:3003–7.
- [6]. Eneji, I. S., Ofoegbu Obinna., & Emmanuel T. Azua (2014). Sequestration and Carbon Storage Potential of Tropical Forest Reserve and Tree Species Located Within Benue State of Nigeria. *Journal of Geoscience and Environment Protection.* 2, 157-166.
- [7]. Emerhi, E.A., Ideriah, T.J.K. & Trinya, W. (2012). Distribution of Ambient Suspended Particulates and Volatile Organic Carbon in a fast-Developing Metropolis in the Niger Delta, Nigeria. *International Journal of Recent Trends in Science and Technology*, 2 (1), 09-24.
- [8]. Fuwape, J.A. & Onyekwelu, J.C. (2011). Urban Forest Development in West Africa: Benefits and Challenges. *Journal of Biodiversity and Ecological Sciences.* 1(1)
- [9]. Henry, O. S., Romoke, M. S., & Oyewole, K. O. (2019). Biomass and Carbon

- Sequestration Potential of Woody Vegetation within Kwara State University Malete, Nigeria. *International Journal of Biodiversity and Conservation*. 23 (3).
- [10]. Ideriah, T.J.K., Emerhi, E.A., Abere, S.A. & Trinya, W. (2011) Levels of Total Hydrocarbon Content in Plants Along Selected Roadsides in Port Harcourt Metropolis, Nigeria. *Journal of Agriculture and Biological Sciences*, 2 (3), 065-070.
- [11]. IPCC 2001 Climate change 2001: the scientific basis. Intergovernmental panel on climate change. Cambridge, UK: Cambridge University Press
- [12]. IPCC 2007 Climate change 2007. Climate change impacts, adaptation, and vulnerability. Working Group II. Geneva, Switzerland: IPCC
- [13]. Ideriah, T.J.K., Abere, S.A. & Trinya, W. (2012). Correlation between selected Ambient Air Pollutants and Total Hydrocarbon Content in Leaves along roadsides in an Industrialized City in the Niger Delta Nigeria. *Journal of Environmental Science, Computer Science and Engineering and Technology*, 1(2). 221-233.
- [14]. Ishaq, M. A., Kolawole, A., & Adeola, J. (2014). Growth performance and carbon sequestration potential of different tree species in Nigeria. *Journal of Agricultural and Environmental Science*, 9(2), 102-110. Jasmin, S.K.S. & Birundha, V.D (2017). Urban Forestry and Pollution Mitigation. *International Journal of Research in Commerce & Management*. 1(8), 36-40.
- [15]. Killicoat P, Puzio E, & Stringer R (2002). The economic value of trees in urban areas: Estimating the benefits of Adelaide's Street trees. *Proceedings Treenet Symposium.*, 94: 106.
- [16]. Kindermann G, Obersteiner M, Sohngen B, Sathaye J, Andrasko K, & Rametsteiner E, (2012). Global cost estimates of reducing carbon emissions through avoided deforestation. *Proc Nat Acad Sci*. (2008) 105:10302–7. doi: 10.1073/pnas.0710616Phelps J, Webb EL, Adams WM. Biodiversity co-benefits of policies to reduce forest-carbon emissions. *Nat Clim Chang*. 2:497–503. doi: 10.1038/nclimate1462
- [17]. Kulmala M, Nieminen T, Chellapermal R, Makkonen R, Bäck J, & Kerminen VM, (2013). Climate Feedbacks Linking the Increasing Atmospheric Co₂ Concentration, BVOC Emissions, Aerosols and Clouds in Forest Ecosystems, in *Biology, Controls and Models of Tree Volatile Organic Compound Emissions*. Berlin: Springer. p. 489–508. doi: 10.1007/978-94-007-6606-8_17
- [18]. Lahoti S, Lahoti A, Joshi RK, & Saito O (2020). Vegetation structure, species composition, and carbon sink potential of urban green spaces in Nagpur City, India. *Land.*, 9(4): 107
- [19]. Morenike O. O., Ezekiel, A., & Ayorinde, A. (2022). Tree Species Diversity and Carbon Sequestration Potentials of the Trees in the Three Ondo State Owned University Campuses, Southwest, Nigeria. *Proceedings of the 8th Biennial Conference of the Forests & Forest Products Society, Held at the Forestry Research Institute of Nigeria, Ibadan, Nigeria*. 263-

- 269
- [20]. Oladosu, R. F. (2019). Impact of social media on the Ecotourism and Hospitality Industry in Rivers State. Unpublished undergraduate thesis. Department of Forestry and Environment, Rivers State University.
- [21]. Oliver, C. D., & Larson, B. C. (1990). Forest stand dynamics. *McGraw-Hill*, New York, NY.
- [22]. Orwa, C., Mutua, A., Kindt, R., Jamnadass, R., & Anthony, S. (2009). Agroforestry database: A tree reference and selection guide (Version 4.0). *World Agroforestry Centre*, Nairobi, Kenya.
- [23]. Osinaike, T.S, Adejobi, M. J, Ojekale, A. B, Onyemeka, R. M, Meduoye, O. A, & Ogun, M. L. (2019). Carbon sequestration potential of plants used in the beautification and greening of Ikeja metropolis, Lagos, Nigeria. *International Journal of Engineering Applied Sciences and Technology*, 4(7): 217-221.
- [24]. Ponce-Hernandez R. (2004), Assessing carbon Stock and Modelling Win-Win scenario of carbon Sequestration Through land use changes. Food and Agriculture organization of the United Nations, Rome.
- [25]. Port Harcourt (2023). Accessed at https://en.wikipedia.org/w/index.php?title=Port_Harcourt&oldid=1176006240
- [26]. Samuel, O. J., & Simon, K. T. (2020). Growth performance and carbon sequestration of tree species in different species stand combinations. *Journal of Forestry Research*, 18(3), 211-221.
- [27]. Seiferling I, Naik N, Ratti C, & Proulx R (2017). Green streets-Quantifying and mapping urban trees with streetlevel imagery and computer vision. *Landsc Urban Plan.*, 165: 93-101.
- [28]. Simbi-Wellington, W.S. & Ideriah T.J.K. (2020). Assessment of Air Quality in Mangrove Forest around Gas Flare in awoba Flow Station in Rivers State Nigeria. *IOSR Journal of Agriculture and Veterinary Science*, 13 (2), 38-47
- [29]. Singh N, Singh S, & Mall RK (2020). Urban ecology and human health: Implications of urban heat island, air pollution and climate change nexus. In: *Urban Ecology*. Elsevier, Amsterdam, Netherland: 317–334.
- [30]. Tooche E. (2018) Carbon sequestration: how much can forestry sequester CO₂. *Forestry Res Eng Int J*. 2:148–50. doi: 10.15406/freij.2018.02.00040
- [31]. Trinya, W. & Ideriah, T.J.K. (2015). Levels of Nitrogen Dioxide and Sulphur Dioxide measured around roadsides Gardens in Port Harcourt Metropolis. *International Journal of Environmental and Agriculture Research*, 1(5), 1-7
- [32]. Van de Perre F, Willig MR, Presley SJ, Andemwana FB, Beeckman H, & Boeckx P. (2018). Reconciling biodiversity and carbon stock conservation in an Afrotropical Forest

- landscape. *Sci Adv.* 4 :6603. doi : 10.1126/sciadv.aar6603
- [33]. Wang Y., Chang Q, & Li X (2021). Promoting sustainable carbon sequestration of plants in urban greenspace by planting design: A case study in parks of Beijing. *Urban For Urban Green.*, 64: 127291.
- [34]. World Meteorological organization (WMO,2006) Greenhouse gas bulletin: the state of greenhouse gases in the atmosphere using global observations up to December 2004. Geneva, Switzerland: World Meteorological Organization.
- [35]. Zia H, Khan T, Hasan S, Fatima HS, Khurram M, Harris NR, & Khalil A (2022). Impacts of urbanization on green spaces of the densely populated City of Karachi, Pakistan - An analysis of 8 years of data for estimating land cover changes [Preprint]. *Res Square.*, 1-17.