Carbon Capture in Trees

Antonio Mijail Perez[a], Dora Pilar Maul, and Luis Alfredo Cendan

St. Thomas University, College of Health Sciences and Technology, Miami Gardens, FL. USA

Our project was conducted in Amelia Earhart Park, in the city of Hialeah, Florida, with the purpose of calculating the total amount of Biomass and Carbon Stock produced by trees in selected areas of Amelia Earhart Park.[b]

Introduction

The world's forests play a pivotal role in the mitigation of global climate change. Particularly, tropical forests have assumed increasing importance in international efforts to mitigate climate change thanks to their capacity to store carbon and because of the significant emissions caused by their destruction [2]. Researchers have strived to look for different ways to calculate the constant CO_2 emissions as well as carbon sequestration to find solutions to reduce the emission of greenhouse gases and manage the expanding climate change challenge.

Determination of carbon sequestration potential in terrestrial ecosystems through biomass estimation has been the most widely followed approach. Biomass is the measure of biological matter expressed in weight and can apply to individual trees or entire communities across a unit of area.

The urban environment presents important considerations for global climate change. Over half of the world's population lives in urban areas. The term "urban forest" refers to all trees within a densely populated area, including trees in parks, on streetways, and on private property. Though the composition, health, age, extent, and costs of urban forests vary considerably among different cities, all urban forests offer some common environmental, economic, and social benefits.

Our project was conducted in Amelia Earhart Park, in the city of Hialeah, Florida, with the purpose of calculating the total amount of biomass and carbon stock produced by trees in selected areas of the park, the contribution from hardwood trees and palm trees, and the amount of carbon dioxide that different tree species sequester from the atmosphere.

Materials and methods

Study site

The project was conducted in Amelia Earhart Park, City of Hialeah. The 515 acre (208.4 ha) park is situated just south of the Miami-Opa Locka Executive Airport and offers a series of recreational attractions together with wide green spaces with winding pathways beneath trees of over 20 different species. 40% of the park (83.4 ha) is land area, the rest is water parks and pools. We selected a 21 ha area (ca. 25% of the land area) in the park for sampling; an area that contains a diversity of tree species including hardwood trees and palm trees. Tree species were identified using taxonomical keys.

From Eq. (1)	
Mean	1209.654 03
St. Dev.	1569.247 74
Min.	33.559 734 9
Max.	13 883.8063
Sum	706 437.954
Count	584

Table 1: Overall biomass calculated.

From Eq. (1)	
Mean	568.537 394
St. Dev.	737.546 439
Min.	15.773 075 4
Max.	6525.388 96
Sum	332 025.838
Count	584

Table 2: Overall carbon stock calculated

Analysis

We measured Tree perimeters in centimeters using a Tailor's tape on hardwood tree species and palm trees, as a first step to determining their biomass. We also measured the height of the trees using a clinometer. We transformed perimeters (at breast height, i.e. 130 cm above the ground) into diameters. To determine biomass and carbon stock we used procedures and equations taken from the scientific literature. As already used in previous projects, equations are given by

$$Y = 21.297 - 6.953\ \mathrm{DBH} + 0.740\ \mathrm{DBH}^2 \quad (1)$$

$$\ln Y = e^{-1.716\ +\ 2.413 \ln \mathrm{DBH}} \quad (2)$$

for the Hardwood Trees, and

$$Y = 0.00388\ (\mathrm{DBH}^2)^{1.6063} \quad (3)$$

for the Palm Trees. In all the equations Y is the biomass, its units are $[Y] = Kg/\mathrm{tree}$, and DBH stands for Diameter at Breast Height.

Stats	Eq. (1)	Eq. (2)	Eq. (3)
Mean	1426.95	2265.85	170.49
St. Dev.	1643.33	3079.46	145.98
Min.	35.68	60.55	33.56
Max.	13 883.81	28 081.96	1158.49
Sum	689 218.93	1 094 407.01	17 219.02
Count	483	483	101

Table 3: Basic statistics of biomass for all three formulas for hardwood and palm trees.

Stats	Eq. (1)	Eq. (2)	Eq. (3)
Mean	670.67	1064.95	80.13
St. Dev.	772.36	1447.34	68.61
Min.	16.77	28.46	15.77
Max.	6525.39	13 198.52	544.49
Sum	323 932.9	514 371.3	8092.94
Count	483	483	101

Table 4: Basic statistics of carbon stocks for all three formulas for hardwood and palm trees.

Analysis of Carbon Stock

We calculated the aboveground biomass, and carbon stock by assuming that the carbon content is approximately 47% of the total aboveground biomass [3, 4]

$$\text{Carbon} = \text{Biomass} \times 0.47 \qquad (4)$$

The dataset obtained was analyzed to address the hypotheses of this study. All statistical analyses were conducted using the Data Analysis add-in in Excel and PAST.

Results

General results

Overall biomass was 706 437.95 kg (706.44 Mg), and overall, carbon stock was 332 026 kg (332.02 Mg). The area sampled constitutes around 25% of the park land area, so if we extrapolate to the whole land area of the park, we could say that the overall biomass would be roughly 2 825 751.80 kg (2825.75 Mg), and carbon ctock ca. 1 328 104 kg (1328.10 Mg). To calculate the totals, we only used equation (1), since it's the one that yielded the highest determination coefficient for this study ($r2 = 0.89$). See Table 1 and Table 2.

To express the results by units of area we made the following extrapolations. We know from the web that the total area for Amelia Earhart Park is 208.41 ha, of which, using Google Earth maps, we estimated that 40% is land area and the rest is water parks and pools. That 40% represents 83.36 ha of which we sampled ca. 25%, for an effectively sampled area of 20.84 ha. In conclusion, the total biomass calculated, expressed by area, is 33.9 Mg ha^{-1}, and the carbon stock is 15.93 Mg ha^{-1}.

Hardwood and Palm Trees

We collected information to support the importance of increasing the number of parks, and hardwood trees in urban environments that operate as "carbon sinks", and consequently carbon reservoirs. Total biomass for hardwood trees was 689 218.93 kg (689.22 Mg), and total biomass for palm trees, was 17 219.02 kg (17.22 Mg). See Table 3 and Table 4.

Differences in biomass based on allometric equations, as well as Donkor allometric equation for palm trees [3], are very significant ($T = 7.67$, $p < 0.01$). We obtained the same value in the T-test conducted between both carbon stocks compared, so differences are equally very significant.

Notes

a. Email: AntonioPerez@stu.edu

b. Original report on this study is Ref. [1]

References

[1] Perez A. M., Cendan L. & Maul DP., Biomass and Carbon Capture in Trees at Amelia Earhart Park, Miami Dade County, Florida, US, *European Journal of Environment and Earth Sciences* **3** 6 (2022) 18-22

[2] Brown S., & Iverson L. R., Biomass estimates for tropical forests, *World Resoures Review* **4** 3 (1992) 366–383

[3] Nogueira E. M., Fearnside P. M., Nelson B. W., Barbosa R. I. & Keizer E. W. H., Estimates of forest biomass in the Brazilian Amazon: new allometric equations and adjustments to biomass from wood-volume inventories, *For. Ecol. Manag.* **256** 11 (2008) 1853-1867

[4] Donkor E., Osei Jnr E. M., Prah B. E. K., Amoah A. S. & Mohammed Y., Estimation and Mapping of Carbon Stocks in Bosomkese Forest Reserve, *International Journal of Remote Sensing Applications (IJRSA)* **6** (2016) 41-52