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Biomass and Carbon Capture in Trees at Amelia Earhart Park, Miami Dade County, Florida, US

Antonio Mijail Perez, Dora Pilar Maul, and Luis Alfredo Cendan

ABSTRACT

In the context of climate change, scientists strive to look for ways to calculate the constant CO_2 emissions as well as carbon sequestration to find solutions to reduce the emission of greenhouse gases. In this context, it is important to recognize that trees within urban environments operate as "carbon sinks" that significantly contribute to the effort of reducing carbon in the atmosphere. During previous studies in biomass and carbon stock determination conducted in the St. Thomas University campus we have found evidence that "urban forests" play an important role in sequestering carbon from the atmosphere and can serve as a foundation for developing biomass recordings within nearby locations, to support the importance of increasing the number of parks and hardwood trees in urban environments that operate as "carbon sinks". Our project was conducted in the Amelia Earhart Park, in Hialeah, Florida, with the purpose of calculating the amount of Biomass and Carbon Stock produced by the hardwood trees and palm trees in selected areas of the park. Tree perimeters were measured using a tailor's tape as a first step to determining their biomass. Data transformation and allometric equations were used to determine biomass and carbon stock. The objectives of our project were (1) to determine the average total biomass and carbon stock (expressed in Kg and Mg) in selected locations, 2) compare the biomass and carbon sequestration between hardwood trees and palm trees. The 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 (2,825.75 Mg), and Carbon Stock ca. 1,328,104 Kg (1,328.10 Mg). In order to calculate the totals, we only used Brown & Iverson equation. In conclusion, total Biomass calculated expressed by area is 33.9 Mg Ha^{-1}, and Carbon Stock is 15.93 Mg Ha^{-1}. This information strongly supports 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) (Tables 3 to 8). Differences in Biomass between hardwood trees, and palm trees, are very significant ($T= 7.67$, $p< 0.01$). Between the palm trees and hardwood, 16 species were identified in different areas of the Amelia Earhart Park. Of the palm trees, *Sabal palmetto* and *Sabal mexicana palm* are the most abundant with over 68 trees in total. Of hardwood trees, *Casuarina equisetifolia* and *Quercus virginiana* are the most abundant with over 430 trees combined.

Keywords: Amelia Earhart Park, Biomass, Carbon Capture, Miami Dade County, South Florida, Trees, US.

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A. M. Perez*
St. Thomas University, College of Health Sciences and Technology, USA.
(e-mail: AntonioPerez@stu.edu)
D. P. Maul
St. Thomas University, College of Health Sciences and Technology, USA.
(e-mail: pmaul@stu.edu)
L. A. Cendan
St. Thomas University, College of Health Sciences and Technology, USA.
(e-mail: Lcendan@stu.edu)

Corresponding Author

I. 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 [1]. 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 [2]. Biomass is the measure of biological matter expressed in weight and can apply to individual trees or entire communities across a unit of area. Plant biomass can be subdivided into above-ground biomass (AGB) or below-ground biomass (BGB) with further subdivisions of each according to the morphology of different species. Scientists calculate the biomass of different tree species using different allometric equations based on tree measurements. The aboveground carbon stock is calculated under the premise that the carbon content is approximately 48% to 50% of the total aboveground biomass [3]-[7].

The urban environment presents important considerations for global climate change. Over half of the world's population lives in urban areas [8]. 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. Trees in a community help to reduce air and water pollution, alter heating and cooling costs, and increase real estate values. Trees can improve physical and mental health, strengthen social connections, and are associated with reduced crime rates. Trees, community gardens, and other green spaces get people outside, helping to foster active living and neighborhood pride [9]. In addition, urban forests present important considerations for global climate change. Trees within a densely populated area, including those in parks, on streetways, and on private property, operate as "carbon sinks" that significantly contribute to the effort of reducing carbon in the atmosphere.

This project aimed at collecting information to support the importance of increasing the number of parks and hardwood trees in urban environments that operate as "carbon sinks" as well as identifying tree species that capture the highest amounts of CO_2 within the urban area of our study.

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.

II. Materials and Methods

A. 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.

B. 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, = 130 cm) into diameters. To determine biomass and carbon stock we used procedures and equations taken from the scientific literature, already used in previous projects: [10]-[11], for Hardwood Trees, and [12], for Palm Trees. The equations are given in (1), (2) and (3).

1) Hardwood Trees

$$Y\ (Kg/tree) = 21.297 - 6.953\ (DBH + 0.740(DBH)^2 \quad (1)$$

$$Ln(Y) = e^{(-1.716+2.413 * lnDBH)} \quad (2)$$

2) Palm Trees

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

C. Analysis of Carbon Stock

Using (4), we calculated the aboveground biomass, and carbon stock by assuming that the carbon content is approximately 47% of the total aboveground biomass [3]-[7].

$$Carbon = Biomass * 0.47 \quad (4)$$

The dataset obtained was analyzed to address the hypotheses of this study. All statistical analyses were conducted using Excel Data Analysis adds in, and PAST [13].

Abbreviations are: *Q.v.: Quercus virginiana*, *C.e.*: *Casuarina equisetifolia, S.mex.: Sabal mexicana, S.pal.: Sabal palmetto.* St. Dev.: Standard Deviation, Min.: Minimum, Max.: Maximum.

III. Results

A. 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 (2,825.75 Mg), and Carbon Stock ca. 1,328,104 Kg (1,328.10 Mg). To calculate the totals, we only used [10] equation, since it's the one that yielded the highest Determination Coefficient for this study (r2= 0.89) (Table I, Table II, Table III, and Table IV).

To express the results by units of area we made the following extrapolations. We know from the web [14], that the total area for Amelia Earhart Park is 208.41 Ha, of which using Google Earth maps concluded that 40% is land area, 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}.

TABLE I: Overall Biomass Calculated

	(1)
Mean	1209.65403
St. Dev.	1569.24774
Min.	33.5597349
Max.	13883.8063
Sum	706437.954
Count	584

TABLE II: OVERALL CARBON STOCK CALCULATED

	(4)
Mean	568.537394
St. Dev.	737.546439
Min.	15.7730754
Max.	6525.38896
Sum	332025.838
Count	584

TABLE III: BASIC STATISTICS FOR THE RELATIONSHIP BETWEEN DIAMETER AND BIOMASS USING (1) ALLOMETRIC EQUATION

Regression Statistics	
Multiple R	0.945375426
R Square	0.893734695
Adjusted R Square	0.89351377
Standard Error	536.2547291
Observations	483

TABLE IV: BASIC STATISTICS FOR THE RELATIONSHIP BETWEEN DIAMETER AND BIOMASS USING (2) ALLOMETRIC EQUATION

Regression Statistics	
Multiple R	0.913105449
R Square	0.833761562
Adjusted R Square	0.833415951
Standard Error	1256.871713
Observations	483

B. *Species Composition and Abundance*

In the data collected between the palm trees and hardwood, 16 species were identified in different areas of Amelia Earhart Park. Of the palm trees, *Sabal palmetto* and *Sabal mexicana* are the most abundant with over 68 trees total in the park. Of hardwood trees, *Casuarina equisetifolia* and *Quercus virginiana* are the most abundant with over 430 trees combined in the park.

C. *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) (Table V and Table VI).

TABLE V: BASIC STATISTICS BIOMASS FOR ALL THREE FORMULAS FOR HARDWOOD AND PALM TREES

Stats	(1)	(2)	(3)
Mean	1426.95	2265.85	170.49
St. Dev.	1643.33	3079.46	145.98
Min.	35.68	60.55	33.56
Max.	13883.81	28081.96	1158.49
Sum	689218.93	1094407.01	17219.02
Count	483	483	101

TABLE VI: BASIC STATISTICS CARBON STOCK FOR ALL THREE FORMULAS FOR HARDWOOD AND PALM TREES

Stats	(1)	(2)	(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	13198.52	544.49
Sum	323932.9	514371.3	8092.94
Count	483	483	101

Differences in Biomass based on [10] allometric equation, as well as Donkor (2016) allometric equation for Palm Trees, 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.

D. *Biomass of Most Abundant Tree Species*

The calculated biomass, and carbon stock of the most important tree species present in Amelia Earhart Park, are shown in kilograms (kg) in Table VII, Table VIII, Table IX, and Table X. These four species make up 77% of the whole set of trees measured in the area (584 trees) (Fig. 1 and Fig. 2, Table VII, Table VIII, Table IX, and Table X).

TABLE VII: BIOMASS USING (1) AND (3), FOR HARDWOOD AND PALM TREES RESPECTIVELY.

Stats	*Q. vir.*	*C. eq.*	*S. pal.*	*S. mex.*
Mean	881.99	3787.92	133.97	452.80
St. Dev.	801.68	2886.05	55.08	61.21
Min.	42.05	354.12	50.60	365.17
Max.	8083.18	13120.40	330.43	507.82
Sum	248722.34	378791.90	8574.15	1811.18
Count	282	100	64	4

TABLE VIII: CARBON STOCK USING (1) AND (3), FOR HARDWOOD AND PALM TREES RESPECTIVELY

Stats	*Q. vir.*	*C. eq.*	*S. pal.*	*S. mex.*
Mean	414.54	1780.32	62.97	212.81
St. Dev.	376.79	1356.44	25.89	28.77
Min.	19.76	166.44	23.78	171.63
Max.	3799.09	6166.59	155.30	238.68
Sum	116899.50	178032.19	4029.85	851.26
Count	282	100	64	4

TABLE IX: BIOMASS USING (2) AND (3) EQUATIONS, FOR HARDWOOD AND PALM TREES RESPECTIVELY

Stats	*Q. vir.*	*C. eq.*
Mean	1310.01	6589.99
St. Dev.	1355.73	5723.08
Min.	69.24	487.03
Max.	14977.07	26288.26
Sum	369423.81	658999.36
Count	282	100

TABLE X: CARBON STOCK USING (2) EQUATION

Stats	*Q. vir.*	*C. eq.*
Average	615.71	3097.30
Standard Deviation	637.19	2689.85
Min	32.54	228.91
Max	7039.23	12355.48
Sum	173629.19	309729.70
Count	282	100

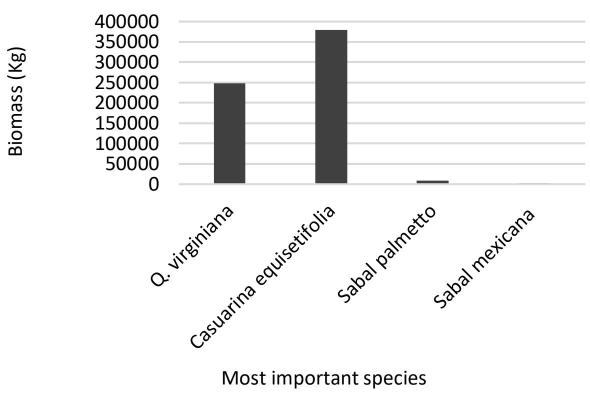

Fig. 1. Biomass contribution from most important species using [10] and [12] Equations, for Hardwood and Palm Trees respectively.

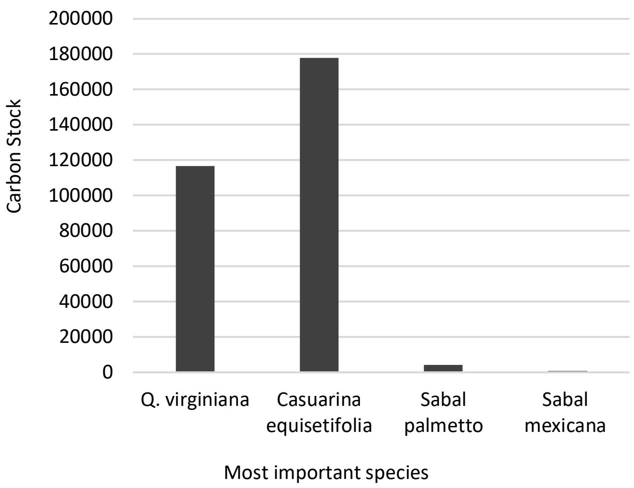

Fig. 2. Carbon Stock contribution from most important species using [10] and [12], and equations (1), (2) and (3).

IV. Discussion

When compared to the Amelia Earhart Park results, the STU forest results, according to [15], total Biomass calculated from all tree species in the STU forest was 561.43 Mg or 17.54 Mg Ha-1 (Mean 1098.70, SD 881.78, Range 134.97-6,169.62, N= 511), or 561,428.30 Kg (Table I). Becknell *et al.* [16] in their study on seasonally dry tropical forests (SDTFs) obtained a biomass of 39 to 334 Mg ha^{-1}, which is a much higher amount than the one obtained in our study, but it may be due to the fact that the campus forest has wide gaps, with no trees.

In a tropical dry forest in northwestern Mexico, [17] obtained 73 Mg ha^{-1} for total above-ground biomass, although they not only used the DBH but also the trunk-specific gravity, which is added to the DBH. Their data was obtained from 637 trees. Other results are not comparable because they encompass not only AGB but also BGB, such as the ones from [12] and others.

Results for total aboveground biomass from [10], collected in forests from Peninsular Malaysia show that Disturbed forests produce much less biomass than undisturbed for a rather similar area.

Alves *et al.* [18], obtained similar results studying the Biomass of primary and secondary vegetation in Rondonia, Western Brazilian Amazon. Aboveground biomass in primary forests was greater than biomass in any other forest type, all of them less mature, regardless of the allometric equation since they used 11 equations. Our results provided additional evidence to support increasing urban forests since they contribute significantly to carbon sequestration from the atmosphere

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Conflict of Interest

Authors declare that they do not have any conflict of interest.

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