USING OPEN SOURCE SOFTWARE TO QUANTIFY THE ECOSYSTEM SERVICES OF CAMPUS TREES

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Introduction

Trees provide essential ecosystem services to urban environments. Urban forests attenuate air pollution, mitigate flooding, reduce energy consumption, raise property values, promote community cohesion, and enhance quality of life (e.g., Lavy and Hagelman 2019). To maximize these services, colleges, universities, and associated campus organizations engage in a host of activities designed to enhance the structure and function of their urban forests. These activities include protecting and preserving trees, planting and maintaining trees, and offering outreach on the benefits of trees. Additionally, tree measurements present an opportunity to assess the extent to which campus trees provide important services to the university and the surrounding community. The purpose of this research is to quantify the ecosystem services of trees on the TCU campus.

Research Question

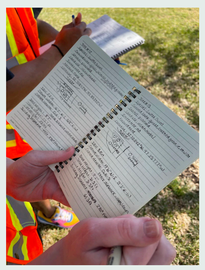
To what extent do trees provide ecosystem services to the TCU campus community?

Study Area

Our research focused on trees located in the urban forest of Texas Christian University campus, in Fort Worth, Texas. Trees make college campuses more livable, healthy, and beautiful which benefits students and the environment. TCU is recognized by the Arbor Day Foundation as a Tree Campus, which involves observation of Arbor day, adherence to a campus tree care plan, and the establishment of a campus tree advisory committee (ADF 2022). This concession reveals enthusiasm for the care and management of campus trees at TCU.

Methods

We recorded standard tree measurement variables, including trunk diameter, tree height, and crown width. Next, we used i-Tree Eco, an open source urban forestry software from the USDA Forest Service, to quantify the ecosystem services of campus trees (Nowak et al. 2008). We calculated the following services: 1) pollution removal and human health impacts; 2) carbon sequestration and storage; and 3) hydrology effects, including avoided run-off, interception, and transpiration.

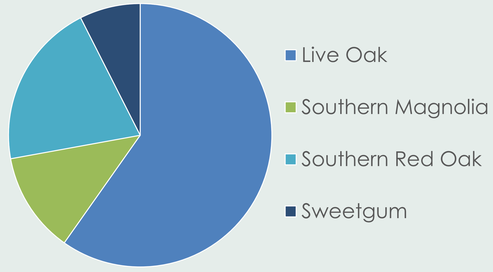


i-Tree®

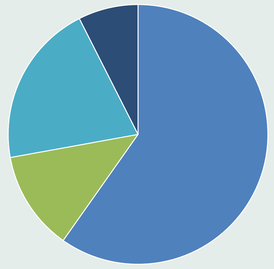
Results

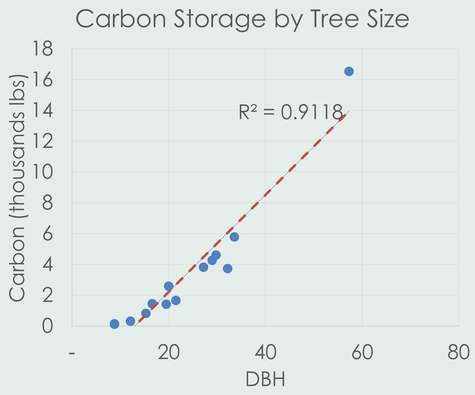
Tree ID	DBH (in)	Carbon Storage (lb)	Replacement Value ($)	Gross Carbon Sequestration (lb/yr)	Avoided Runoff (ft³/yr)	Carbon Avoided (lb/yr)	Pollution Removal (oz/yr)	Energy Savings ($/yr)	Total Annual Benefits ($/yr)
Southern Magnolia	19.50	1,413.00	6,319.76	93.70	69.90	30.80	43.40	12.05	33.14
Southern Magnolia	15.30	815.70	3,995.18	66.70	69.90	158.70	43.40	53.03	82.74
Live Oak	57.30	16,534.70	42,590.77	2.00	166.10	41.30	103.10	13.47	42.06
Live Oak	33.60	5,788.60	20,714.72	69.10	121.30	-	75.20	-	24.05
Live Oak	29.80	4,610.70	16,774.99	121.50	131.30	-	81.50	-	30.04
Live Oak	29.00	4,268.10	15,897.18	130.70	61.20	42.30	38.00	13.77	37.69
Live Oak	27.20	3,821.00	14,009.42	148.90	95.80	47.20	59.40	15.38	46.46
Live Oak	20.00	2,583.10	7,667.65	100.80	50.60	12.00	31.40	4.07	21.27
Live Oak	16.60	1,448.80	5,345.47	120.40	49.90	3.20	31.00	1.10	19.12
Southern Red Oak	32.20	3,728.60	18,093.16	128.30	166.90	-	103.60	-	35.97
Southern Red Oak	21.50	1,664.50	8,365.96	86.00	63.70	-	39.50	-	16.89
Sweetgum	12.10	313.70	2,343.23	26.40	52.20	43.00	32.40	14.69	28.43
Sweetgum	8.80	143.40	1,392.57	16.60	11.00	8.40	6.80	2.81	6.59
Sweetgum	8.80	114.80	1,392.57	24.30	21.30	-	13.20	-	5.26
Total	**312.20**	**45,835.70**	**158,582.87**	**1,041.70**	**1,061.20**	**356.10**	**658.50**	**118.32**	**396.57**

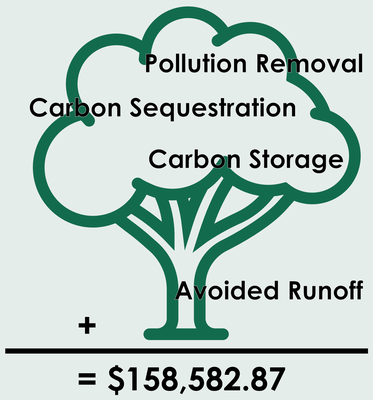
Avoided Runoff (ft³/yr)

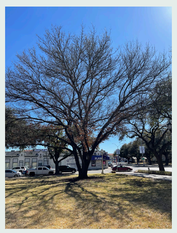


Pollution Removal (oz/yr)









Pictured here are three of the measured campus trees. From left to right: live oak, live oak, and southern red oak.

Conclusions

Trees provide essential ecosystem services, including surface runoff prevention, pollution removal, carbon sequestration, and providing habitat for wildlife. Of the 14 campus trees measured, the replacement value was $158,582. If these 14 trees were removed, it would cost $158,582 to replace their ecosystem services. Even if we attempted to mitigate these costs by planting new trees, it would take years for the trees to produce the same level of valuable services provided by the original trees. This dollar value is substantial and only accounts for the 14 of the approximately 5,000 trees on the TCU campus. Our campus tree research will continue, and as we measure more trees, the total dollar value of campus trees will only continue to rise. In addition to services provided to the environment, trees benefit humans by making urban areas more livable, healthy, and beautiful. Our research illustrates the undeniable social, economic, and environmental advantages of managing and protecting trees as we continue to industrialize and urbanize the modern world.

References

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Nowak, David J.; Crane, Daniel E.; Stevens, Jack C.; Hoehn, Robert E.; Walton Jeffrey T.; Bond, Jerry. 2008. 'A Ground-Based Method of Assessing Urban Forest Structure and Ecosystem Services', Arboriculture & Urban Forestry, 34: 347-58.

Acknowledgements

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