REIMAGINING THE PURPOSE OF ENERGY EDUCATION BEYOND CONSERVATION

Editors

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ESTIMATION OF CARBON SEQUESTRATION POTENTIAL OF TREE SPECIES AT ALL SAINTS' COLLEGE, THIRUVANANTHAPURAM

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Abstract

Urban green areas, particularly trees, have great potential to sequester carbon from the atmosphere and mitigate the impacts of climate change in cities. Large university campuses offer prominent area where such green area can be developed in order to offset the increasing greenhouse gas emissions, as well as other benefits. All Saints' College, Thiruvananthapuram is spread over 26 acres with dense tree plantations in and around the college. The present study is a sustainability initiative to inventory the tree species on the college and assess their total carbon sequestration potential (CSP). Individual trees on the college were measured for their height and girth, and estimates of carbon storage were performed using technical support. There is a total of 25 different tree species on the college with the total CSP equivalent to approximately 18 tons. The results also reveal that Samanea saman was the predominant species on the college with CSP equivalent to 4.735 tons, followed by Peltophorum pterocarpum

with carbon storage of 1.843 tons. The present work highlights the role of urban green spaces, not only as ornamental and aesthetic plantations but also in mitigating the impacts of climate change at a local level. Current study points out the need for establishing a green cover in higher education institutions so as to act as local carbon sinks.

Keywords: Carbon Sequestration, Tree Species

I. INTRODUCTION

Carbon is an indispensable component for sustaining life and it can be found naturally in organic and inorganic forms with a very small exchange rate between them. Carbon is present in the nonliving environment as carbon dioxide gas in the atmosphere, as dissolved carbon in water and in carbonate rocks, coal, petroleum, natural gas, and dead organic matter. Carbon is primarily and profoundly found in the atmosphere as CO_2, CH_4, and chloro fluorocarbons. All the activities including energy consumption and waste management have their equivalent carbon emission and they positively contribute to the carbon footprint of the campus. Carbon sequestration is the reverse process, at which the emitted carbon dioxide will get sequestrated according to the type of Carbon sequestration employed. Even Though there are many natural sequestration processes involved in campus, the major type of sequestration among them is the Carbon sequestration by trees. A tree absorbs atmospheric carbon dioxide through the biochemical process of photosynthesis and stored as carbon in their leaves, trunk, branches and roots, the process called carbon sequestration.

Tree cover in urban areas around the world, is declining and impenetrable cover is increasing due to the demand of the area for development. With expanding urbanization in the twentieth century, the incorporation of trees into urban settlements has also expanded - to the point that the management of all trees within the urban area is considered a distinct discipline of forestry (Kaya et al., 2012). Carbon storage and sequestration by urban trees in the United States was quantified to assess the magnitude and role of urban forests in relation to climate change. Anthropogenic causes of warming in the globe have become a biggest topic of concern in front of the world because of the life-threatening changes that could result from increase in global heat and temperature. Even if the planet's average temperature increased by 2.0°C could be very harmful to the environment, and some of the models which are predicting change of up to 5.0° Which is warmer than average temperatures of history (IPCC, 2007).

By clearing forests and burning fossil fuels more rapidly than the carbon can be sequestered, industrialization may have altered this equilibrium. Since before the Industrial Revolution, CO_2 concentrations in the atmosphere have increased from 280 parts per million (ppm) to nearly 380 ppm in 2005. CO2 emissions from energy use are projected to increase between 40 to 110 percent between 2000 and 2030. Increases in atmospheric CO_2 concentration may be generating increases in average global temperature and other climate change impacts. Rising global temperatures could raise sea levels, change precipitation patterns and affect both weather and climate conditions (EPA 2012). In 2008, the urban population exceeded the rural population. In 2050, 70% of the world population will live in urban centers. Rapid urbanization is altering the ecosystem C budget. Principal components with regards to Carbon sequestration include home lawns and turfs, urban forests, green roofs, park and recreational/sports facilities and urban agriculture (Rattan and Augustin, 2013). Additionally, trees in the urban environment are contributing toward many benefits, eg. social benefits (recreational opportunities, improving physical/mental health) aesthetic benefits (landscape variation through different colors/textures/forms and densities of plants) climatic benefits (cooling, wind control, air pollution reduction, atmospheric carbon storage, impact on climate) and economic benefits (increased property values, tourism, providing fruits and small timber). In accordance with the 74th amendment of the Indian Constitution in 1992, the municipal and urban development authorities are responsible for creating and maintaining parks and other recreational spaces in city areas (Granville, 2009).

II. MATERIALS AND METHODS

Study Area

The site selected will be All Saints' college Thiruvananthapuram 10 acres of campus with lush green vegetation used for the study. Higher tree species diversity at college will make the procedure easier. Trees located from canteen block to auditorium block were selected for estimating the carbon sequestration potential.

a. *Tree Height and Girth*

A non-destructive method of biomass estimation was used to measure the tree height and Girth of individual trees of the college. Individual trees greater than 15cm in girth and height (above 150cm) were enumerated. Tree girth was measured by measuring tape, by using the girth calculate diameter. Field data were recorded in spreadsheets and species level identification of trees was obtained through visual observation and species level identification of trees were obtained through visual observation. The doubtful samples are identified with the help of teachers.

b. *Estimation of Carbon sequestration*

Carbon sequestered by a tree can be found out by using different methods. Since this study has employed the volumetric pproach, the calculation consists of the five processes as follows.

- Determining the dry weight of the tree
- Determining the dry weight of the tree
- Determining the weight of carbon in the tree
- Determining the weight of Carbon dioxide sequestrated in the tree
- Determining the weight of CO_2 sequestrated in the tree per year

. RESULTS AND DISCUSSIONS

All the activities including energy consumption and waste nagement have their equivalent carbon emission and they itively contribute to the carbon footprint of the campus. Carbon uestration is the reverse process, at which the emitted carbon xide will get sequestrated according to the type of carbon uestration employed. Even though there are many natural uestration processes which are involved in a campus, the major e of sequestration among them is the carbon sequestration by es. Trees sequestrate carbon dioxide through the biochemical cess of photosynthesis and it is stored as carbon in their trunk, nches, leaves and roots. The amount of carbon sequestrated by ee can be calculated by different methods. In this study, the umetric approach was taken into account, thus the details luding CBH (Circumference at Breast Height), height, average , and total number of the trees, are required.

Particular Carbon	TCO2e
Sequestration	18.00

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1. Determining the total weight of the tree
2. Determining the dry weight of the tree
3. Determining the weight of carbon in the tree
4. Determining the weight of CO_2 sequestrated in the tree
5. Determining the weight of CO_2 sequestrated in the tree per year.

A total of 25 species of trees were enumerated on the college campus. The most dominant species in the study area is *Casuarina equisetifolia*, with a total of more than 50 trees. This species is commonly found in urban plantations as it is shade tolerant, can survive drought conditions and requires very little maintenance. The second and third most common tree species were *Cocos nucifera* and *Peltophorumpterocarpum*. *Mangifera indica* and *Honduran mahogany* also had over 25 tree plantations in the study area.

Table also gives average carbon sequestration per day of each individual tree. *Syzygiumciminihas* the highest average carbon sequestration per day and the lowest carbon sequestrating species was *Delonix regia*. The rate of carbon sequestration varies with Height and girth of each individual and it was found to be different in different species.

Sl.No.	Name of Tree (Common name / Scientific name)	Number of Trees	Average Carbon Sequestration
1	Cocos nucifera	30	0.457
2	Honduran mahogany	21	0.132
3	Mangifera indica	18	0.375
4	Peltophorumpterocarpum	25	1.843
5	casuarina equisetifolia	53	0.91
6	Delonix regia	7	0.109

7	Samanea saman	5	4.7358
8	Polyalthia longifolia	10	0.4196
9	Acacia fasciculifera	2	1.7
10	Tectona grandis	1	1.313

Table No.1 List of Selected Tree Species and their average carbon sequestration

There are more than 10 species including 200 individuals that have been recorded in All Saints' College. Selected 10 tree species present in the college and Carbon sequestrated in per species is shown for comparison purpose. *Honduran mahogany* present in the study area having 21 trees sequestrated 0.132 tons of carbon. The major carbon sequestrating species were *Samanea saman* (4.7358 tons), followed by *Peltophorumpterocarpum* (1.843 tons), *Acacia fasciculiflora* (1.7 tons), *Tectona grandis* (1.313 tons), *casuarinaequisetifolia* (0.910 tons), *Polyalthia longifolia* (0.4196 tons). The *Delonix regia* has the lowest carbon sequestration (0.109 tons).

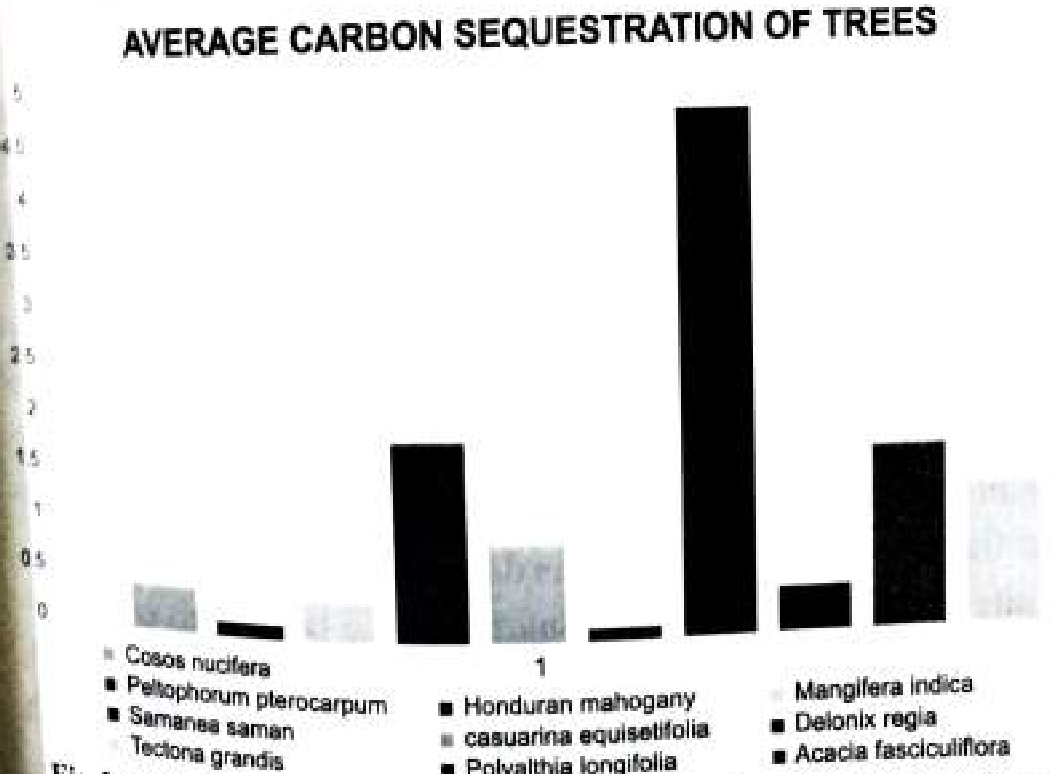

Fig 1. Bar diagram showing Average Carbon Sequestration of trees

Pandya *et al.*, (2013) reported, as the diameter of species (when age increases) increases, its biomass and carbon storage capacity increases which also enhances more carbon sequestration and removes more carbon dioxide from the atmosphere.

Large healthy trees more than 77 cm in diameter capture approximately 90 times more carbon as compared to small healthy trees which have diameter less than 8 cm (Nowak, 1994). Large trees also preserve approximately 1000 times maximum carbon than smaller trees (Nowak, 1994). More research work is required on the overall effects of trees, soils and its proper management in the urban areas (*e.g.*, Pataki *et al.*, 2006).

As urban areas discharge large number of emissions of carbon, tree creates an impact carbon emission through changing in climates at micro level, albedo, use of energy, maintenance of emissions require to be added with tree storage and capture estimates to improve a more complete evaluation of the role of trees of urban area on climate change (Nowak *et al.*, 2013)

I. CONCLUSION

The present study is a sustainability initiative to inventory the trees of All Saints' College, Thiruvananthapuram and compute their carbon storage capacity. A total of 200 trees belonging to 2[illegible] different species have been recorded on the college, with the carbon sequestration potential of 18. The results of the study illuminate the value of urban trees, not only as ornamental but also in mitigating the impacts of climate change at a local level. In the present research work calculation of carbon sequestration potential rate of tree species was done by nondestructive method. Results show that *Samanea saman* has the better carbon sequestration potential rate which sequestered 4.7358 /tree of CO[illegible] whereas *Delonix regia* has the least sequestration rate which equestered 0.109/tree of CO_2 as compared to other species. Keeping in mind the deteriorating condition of the environment nd the health of the people in urban cities, the need for evaluating nd assessing the trees in parks and gardens in an urban ecosystem as become imperative. Planting trees that have the potential to equester more carbon dioxide must be encouraged and promoted. n the present study, from the data obtained it can be concluded that *amanea saman, Peltophorumpterocarpum, Acacia fasciculifera* nd *Tectona grandis* trees can be planted more to improve the nvironment status of this city and also combat the issue of climate hange.

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This book constitutes the refereed proceedings of the First International Conference on Sustainable Energy Education, ICSEE 2021, held in Department of Education, University of Kerala, on 10-12, January, 2022 in the online mode. The conference discussed "WHAT" of energy education - should be. It then asks the contributors to bring forth their best ideas regarding "HOW" to implement the education process, and finally "WHY" we should be educating about energy. We hope that the interesting scholarly work and case studies that the contributors have brought us, will trigger an on-going dialog about how to frame energy education in the much bigger picture of energy cycles and their fundamental importance to powering our life, and its increasingly energy - hungry industrialized, urbanized and digitized infrastructure. The book serves as a reference resource on sustainable energy education for researchers and practitioners in academia and industry.

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