

A CASE STUDY OF CARBON SEQUESTRATION CAPACITY AT HEARTFULNESS CAMPUS, YERLA, NAGPUR

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ABSTRACT

At the national level, the management impact on the capacity for carbon sequestration of various land use types is least understood. An important component of a comprehensive plan for managing carbon emissions to lessen the rising CO₂ emissions into the atmosphere is carbon sequestration, a burgeoning area of research. According to projections, terrestrial ecosystems might store a large amount of carbon during the next 50 years. By delaying the need for more drastic reductions in global emissions, the impact of this sequestration may help buy time for other technologies to become operational. There is growing interest in scientific developments that might be used to improve this potential carbon sequestration in soils. There are fresh initiatives to begin research that might help mitigate increasing CO₂ emissions through special efforts to sequester CO₂. Carbon sequestration in terrestrial ecosystems can be defined as the net removal of CO₂ from the atmosphere into long-lived store of carbon. This can include living biomass found above ground (such as trees), biomass-derived wood products with a long usable life (such as lumber), living biomass found in soils (such as roots and microbes), or recalcitrant organic and inorganic carbon in deeper underground habitats. The need to increase photosynthetic carbon fixation alone must be emphasized. Long-lasting pools must have this carbon fixed in them. Thus, one might not be boosting carbon sequestration but rather just changing the magnitude of fluxes in the carbon cycle. Planting more trees has the potential to boost the ability of forests to store carbon. Our study found that the establishment of PNV (protected natural vegetation) is the best practise of restoration projects because it provides a cost-effective mechanism that prevents animals from grazing freely and human interference. We calculated DBH of 190 trees within the 15 acres of campus area within 4 weeks, where we estimated total campus carbon capture to be 600.24kg. We can also estimate the carbon sequestration of PNV's and find out their carbon credits values, this tradable certificate are permits that allow the owner to emit a certain amount of carbon dioxide or other greenhouse gases.

Keywords -carbon sequestration, biomass, carbon cycle, ecosystems, photosynthetic carbon.

1. INTRODUCTION

Developmental activities and increased transportation activities are increasing the concentration of air pollutants as greenhouse gases, especially CO₂ because specific heat radiation wavelengths are being trapped in the atmosphere, this is raising the temperature of the atmosphere. The Kyoto Protocol does a good job of addressing the issue of rising carbon emissions (Ravindranath et. al., 1997). A key part in absorbing atmospheric carbon dioxide is played by trees, shrubs, soil, and seawater. The trees serve as a significant carbon sink, absorbing carbon from the atmosphere and storing it as fixed biomass while they are growing. As a result, planting trees in urban areas may help reduce the amount of CO₂ in the atmosphere by allowing biomass to accumulate there. Trees absorb carbon from the environment and store it in the tissues of the plant as they grow and their biomass rises, which causes the growth of various sections. The carbon storage process involves the active uptake of CO₂ from the atmosphere during the photosynthetic process and its subsequent storage in the biomass of developing trees or plants. In terms of lowering atmospheric carbon dioxide levels, trees in urban settings have the dual advantages of directly storing carbon dioxide and stabilizing the natural ecosystem by increasing nutrient recycling and maintaining climatic conditions through bio-geochemical processes. The study of total carbon sequestered in trees in the Heartfulness Campus situated at Yerla, Nagpur. spread over 15 acres is conducted. Standing trees' biomass and total organic carbon are evaluated using a non-destructive approach. For the purpose of calculating biomass and carbon content, the height and girth of the tree are taken into account. A theoretical model and concept are utilized to measure the height of different tree species with diameters greater than 10 cm. The angle between a tree top and an observer is measured using a theodolite. Allometric model comparisons with total biomass and total organic carbon have been made. The study found that the allometric model, which is based on a theoretical model, may successfully be utilized to calculate the biomass of trees using a non-destructive method during the assessment of organic carbon storage.

2. OBJECTIVES

- To calculate the carbon emission in campus
- To study carbon sequestration capacity of trees.

- To calculate the carbon sequestration capacity of campus.
- Achieving zero carbon emission by planting trees having maximum carbon sequestration capacity.

3. METHODOLOGY

A. STUDY AREA

Srcm Heartfulness Center located at latitude 21.21° N and longitude 78.95° E. It has total about 15 acres of geographical areas, out of which 80% is covered with trees, herbs, shrubs and other vegetation. The total area of campus was related and studied in present investigation. The study was carried out on day light during month of march (spring). The temperature was recorded between 29° - 38°C and humidity around 23% - 35%. Dry vegetation is present over the entire campus because Nagpur itself experience hot climate and has Dry Deciduous Forests.

B. MEASUREMENT OF TREE HEIGHT

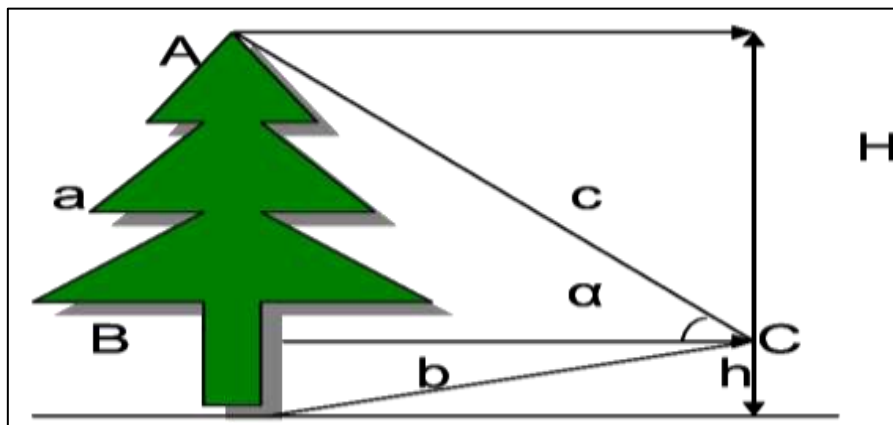


Figure 1: View of tree height measurement by Theodolite at DBH.

It is not advisable to chop specific tree species in order to determine their biomass. By measuring the girth at DBH and the diameter at breast height (DBH), mathematical models can calculate the biomass. The DBH at breast height at roughly 1.3 metre is used to determine girth, and trees with diameters greater than 10 cm are treated as trees and measured as such. Theodolite at DBH measured the height of the tree. For the purpose of measuring tree height and calculating tree height, the angle (α) between the tree top and eye view at breast height is taken into account. The tree height was computed using the angle ACB between the top of the tree and the distance (b) at the observer's position at DBH. If is the angle between the observer's eye and the tree's top, α is the tree's height in feet, c is the slope between the tree and the observer's eye, b is the tree's distance from the observer in feet, and h is the height of the horizontal plane of the theodolite instrument, then the height of the tree (H) is determined using the following formulas:

$$H = h + b \tan \alpha$$

An assessment sheet prepared for the field data of trees from the campus. This summarizes the data collected from the survey in tabular form.

C. CARBON STOCK ESTIMATION IN TREES

The mathematical equations has been developed and used by many researchers for carbon estimation of trees. These equations are species specific, particularly in the tropics. The general equation has been developed in modified form. It is more general in nature and applicable in field. It is impossible to cut all the trees to estimate their carbon sequestration capacity. H is the height of the trees (meter), D is the diameter at breast height in cm. and S the wood density (kg/m^3). The standard average value 0.6 kg/m^3 were taken (Patwardhan et al., 2003).

Below ground biomass was calculated considering 16.7% of the above ground biomass. As per the condition, the trees of same species are also being categorized and calculated on the basis of their dimensions, this will help for accurate results. The sample calculation is shown below:

Sample Calculation of *Tectona grandis* (teak) type - 1

- Diameter of the trunk = 0.25 m
 - Diameter of girth = 1.4 m
 - Number of trees = 7
 - Height of tree (H) = 10.2 m
1. Circumference of the tree = $\pi \times \text{diameter of girth} = \pi \times 1.4 = 4.4 \text{m}^2$
 2. Volume = $\pi r^2 H = \pi (0.25/2)^2 \times 10.2 = 0.5 \text{m}^3$

3. Above ground biomass (AGB) = Volume of tree * S = 0.5 * 0.6 = 0.3 kg/tree
4. Below ground biomass (BGB) = AGB * root-shoot factor =
0.3 * 0.167 = 0.05 kg/tree
5. Total Biomass= AGB + BGB = 0.3 + 0.05 = 0.35 kg/tree
6. Carbon = Biomass * 50% = 0.35 * 50% = 0.18 kg/tree
7. Carbon Sequestration = 3.664 * 0.18 = 0.66 kg/tree
8. total carbon sequestration = number of trees* carbon sequestered by each tree = 7*0.66 = 4.62 kg.
Therefore the total carbon sequestration of Tectona Grandis (teak) type -1 is found to be 4.62 kg, at a rate of 0.66 kg/tree.

4. RESULTS

The 190 number of trees of 57 types, having 20 species present on campus of Heartfulness center, Nagpur, Maharashtra, India is studied. Table No.

1.comprises of one half of assessment sheet ,which includes dimensions and quantity of some trees during the study. Whereas the carbon capture (kg/tree)in the tress is summarized in the table no. 2. Above Ground Biomass(AGB), Below Ground Biomass(BGB) and carbon sequestration capacity in following trees are Azadirachta indica(neem) type-3(4.78,0.79,10.20kg/tree). Parkia biglundulosa type 1(0.16,0.02,0.32kg/tree), Pongome oil tree (1.44, 0.24, 3.07 kg/tree), Ficus religiosa(15.2, 2.53, 32.46kg/tree), Tectona grandis(teak) type-1 is (0.3kg/tree, 0.05kg/tree, 0.66kg/tree), Bambusa vulgaris(5.56, 0.92, 11.87 kg/tree) respectively. Most of the trees is having carbon capture in between 1-10 kg/tree. In similar way carbon capture of 190 trees has been calculated. particular tree.

Table 1: Field Data Of Tree Studied From The Campus

SR. NO	NAME OF TREE	NO. Of TREE	DIA. Of TRUNK (m)	DIA. Of GIRTH (m)	CIRCUMF ERANCE Of TREE	AVARAGE HEIGHT Of TREE (m)
1	Tectona Grandis(Teak) Type - 1	7	0.25	1.4	4.4	10.2
2	Azadirachta Indica(Neem) Type - 3	6	0.88	1.82	5.72	13.1
3	Parkia Biglundulosa Type - 1	6	0.2	0.2	0.62	8.4
4	Pongome Oiltree	7	0.6	1.2	3.76	8.5
5	Ficus Religiosa	1	1.6	2.2	6.911	12.6
6	Bambusa Vulgaris	5	1.2	0.65	2.04	8.2

Table 2: Values Of Bgb,Agb, Carbon Stock

SR NO.	NAME OF TREE	VOL ^m (m3)	AGB (kg/tree)	BGB (Kg/tree)	TOTAL BIOMASS (kg/tree)	CARBON (kg/tree)	CO2 SEQUES TRATED (kg/tree)	Total CO2 SEQUES TRATED (kg)
1	Tectona Grandis(Teak)Type-1	0.5	0.3	0.05	0.35	0.18	0.66	4.62
2	Azadirachta Indica(Neem) Type - 3	7.97	4.78	0.79	5.57	2.785	10.20	61.2
3	Parkia Biglundulosa Type - 1	0.27	0.16	0.02	0.18	0.09	0.32	1.92
4	Pongome Oil-Tree	2.41	1.44	0.24	1.68	0.84	3.07	25.69
5	Ficus Religiosa	25.34	15.2	2.53	17.73	8.86	32.46	32.46
6	Bambusa Vulgaris	9.27	5.56	0.92	6.48	3.24	11.87	59.35

5. CONCLUSION

The present study has calculated total organic carbon stock in 20 trees species in campus of Heartfulness center, Nagpur, Maharashtra, India. The maximum carbon capture/carbon sequestration capacity of trees in the campus is found in *Ficus religiosa* (Peepal) followed by *Azadirachta indica* (neem) type - 3, *Mangifera indica* (Mango) and *Tectona grandis* (teak) type - 8. The average standing stock of organic carbon in 20 well grown trees species in the Srcm Heartfulness Center, yerla, nagpur is about 600.24kg. The best way by which carbon can be absorbed is by creating carbon sinks and Establishment of PNVs (protected natural vegetation) is the best practise for restoration. The study is helpful to estimate the Total Carbon Stock (TCS) present in Nagpur city and other cities or forest covers by using non-destructive method.

6. REFERENCES

- [1] A technical report on grassland management and climate change mitigation, Integrated Crop Management Vol. 9–2010 by Colorado State University Fort Collins, United States of America
- [2] Research Challenges for Carbon Sequestration in Terrestrial Ecosystems
- [3] Soil carbon storage capacity as a tool to prioritize areas for carbon sequestration, Nagpur 440010, India
- [4] Carbon sequestration potential of natural vegetation under grazing influence in Southern Tigray, Ethiopia: implication for climate change mitigation
- [5] Planting has the potential to increase carbon sequestration capacity of forests in the United States. Managed Forest in Carbon Sequestration and Climate Change Mitigation of Tripura, India Dipankar Deb & Mary Jamatia & Jaba Debbarma & Jitendra Ahirwal & Sourabh Deb & Uttam Kumar Sahoo
- [6] A Review of Current Science and Available Practices By Daniel Kane November 2015
- [7] B. L. Chavan et. al. / International Journal of Engineering Science and Technology, Vol. 2(7), 2010, 3003-3007. Sequestered standing carbon stock in selective tree species grown in University campus at Aurangabad, Maharashtra, India.
- [8] MacDicken, K.G., (1997). A guide to monitoring carbon storage in forestry and agro forestry projects. USA, Winrock International Institute for Agricultural Development. 19-99.
- [9] Matthews, E.; Payne, R.; Rohweder, M. and Murray, S., (2000). Forest ecosystem: Carbon storage sequestration. Carbon Sequestration in Soil, Global Climate Change Digest, 12 (2):
- [10] Mohammed Alamgir. and M. Al-Amin., (2007). Organic carbon stock in trees within different Geopositions of Chittagaon (South) forest division, Bangladesh, Journal of Forestry Research, 18(3): 174-180.
- [11] Mohammed Alamgir. and M. Al-Amin., (2008). Allometric model to estimate biomass organic carbon stock in forest vegetation. Journal Forest Research 19(2): 10