

SEQUESTERED STANDING CARBON STOCK IN SELECTIVE TREE SPECIES GROWN IN NAGPUR, MAHARASHTRA INDIA

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ABSTRACT

The management influence on the potential for carbon sequestration of diverse land use types is little understood at the national level. Carbon sequestration, a booming area of research, is a key component of a complete plan for controlling carbon emissions to reduce rising CO₂ emissions into the atmosphere. According to estimates, terrestrial ecosystems might store a significant quantity of carbon during the next 50 years. The impact of this sequestration may help buy time for other technologies to become operational by postponing the need for more extreme reductions in world emissions. There is considerable interest in scientific breakthroughs that might be utilized to increase soil carbon sequestration. There are new plans to initiate research that may assist decrease rising CO₂ emissions through particular efforts to sequester CO₂. Carbon sequestration in terrestrial ecosystems is defined as the net removal of CO₂ from the atmosphere into long-lived carbon storage. This can comprise live biomass located above ground (such as trees), biomass-derived wood products with a long useful life (such as timber), living biomass found in soils (such as roots and microorganisms), or refractory organic and inorganic carbon in deeper subsurface ecosystems. The necessity to boost photosynthetic carbon fixation alone must be emphasized. Long-lasting pools must have this carbon fixed in them. Thus, one may not be increasing carbon sequestration but rather 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 protected natural vegetation is the best practise of restoration because it provides a cost-effective mechanism that prevents animals from grazing freely and human interference in nature. We calculated DBH of 200 trees within the 60,703 m² of campus area within 3 weeks, where we estimated total campus carbon capture to be 601kg.

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

1. INTRODUCTION

Carbon sequestration is the process of capturing carbon dioxide from the atmosphere and storing it in long-term reservoirs, such as underground geological formations, forests, and oceans. This is done to reduce the amount of carbon dioxide in the atmosphere, which is a major contributor to climate change. Carbon sequestration can be accomplished through various methods, such as afforestation (planting trees), soil carbon sequestration, ocean fertilization, and carbon capture and storage (CCS) technologies. These methods have the potential to remove significant amounts of carbon dioxide from the atmosphere and help mitigate climate change. Carbon sequestration is important because it helps to reduce greenhouse gas emissions and slow the rate of global warming. The excessive accumulation of carbon dioxide in the atmosphere traps heat from the sun and causes the Earth's temperature to rise, leading to a wide range of negative impacts such as sea level rise, more frequent and severe weather events, and loss of biodiversity. By sequestering carbon, we can help to reduce the amount of carbon dioxide in the atmosphere, which can mitigate the negative impacts of climate change. Additionally, carbon sequestration can provide other benefits such as improved soil health, increased biodiversity, and enhanced ecosystem services. 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. 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. The study found that the 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 study carbon sequestration capacity of trees.
- To calculate the carbon sequestration capacity of the area.
- Nullify carbon emission by planting trees having maximum carbon sequestration capacity.

3. METHODOLOGY

A. STUDY AREA

Our study area at Yerla, Nagpur is located at latitude 21.21° N and longitude 78.96° E. It has total about 60,703 m² of geographical areas, out of which 80% is covered with trees, herbs, shrubs and other vegetation. The total area of campus is studied in present investigation. The study was carried out on day light during month of march (spring). The temperature was recorded between 30° – 39° C and humidity around 25%–35%. Dry vegetation is present over the entire campus because Nagpur itself experience hot climate and has Dry Deciduous Forests due to its geographical and topographical location.

B. MEASUREMENT OF TREE HEIGHT

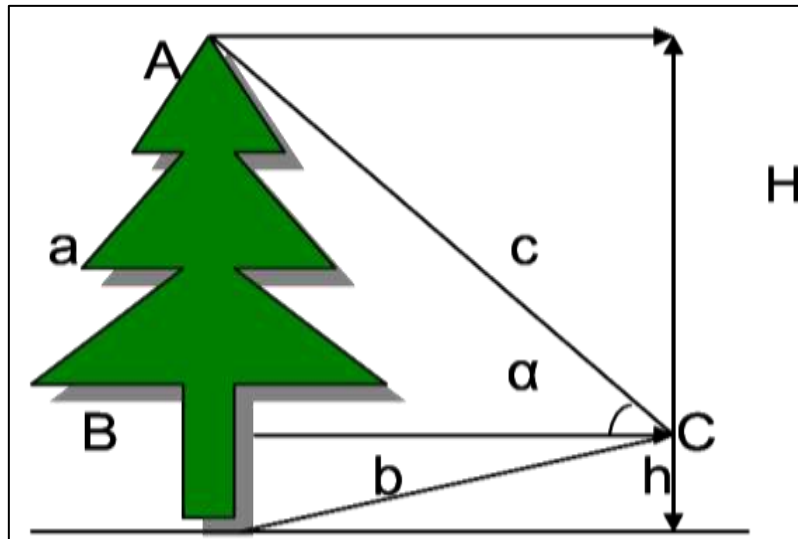


Figure 1: View of tree height measurement by Theodolite at DBH.

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 1.30 metre is used to determine girth, and trees with diameters greater than 0.1 m 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 data of trees from the area. This summarizes the data collected from the survey in tabular form.

C. CALCULATION

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.
- S is the wood density (kg/m^3). The standard average value is 0.6 kg/m^3 (Patwardhan et al., 2003).
- Below ground biomass was calculated considering 16.7% of the above ground biomass.

According to 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 Ficus religiosa (Peepal):

- Diameter of the trunk = 1.6 m
- Diameter of girth = 2.2 m
- Number of trees = 1
- Height of tree (H) = 12.6 m

1. Circumference of the tree = $\pi \times \text{diameter of girth} = \pi \times 2.2 = 6.911\text{m}^2$
2. Volume = $\pi r^2 H = \pi (1.6/2)^2 \times 12.6 = 25.34\text{ m}^3$
3. Above ground biomass (AGB) = Volume of tree * S = $25.34 \times 0.6 = 15.2\text{ kg/tree}$
4. Below ground biomass (BGB) = AGB * root-shoot factor = $15.2 \times 0.167 = 2.53\text{ kg/tree}$
5. Total Biomass= AGB + BGB = $15.2 + 2.53 = 17.73\text{kg/tree}$
6. Carbon = Total Biomass*50% = $17.73 \times 50\% = 8.86\text{ kg/tree}$
7. Carbon Sequestration = $3.664 \times 8.86 = 32.46\text{ kg/tree}$
8. total carbon sequestration = number of trees* carbon sequestered by each tree = $1 \times 32.45 = 32.46\text{ kg}$.

Therefore the total carbon sequestration of Ficus religiosa (Peepal) is found to be 32.46 kg, at a rate of 32.46 kg/tree.\

4. RESULTS

The 200 number of trees of 57 types, having 20+ species present in Yerla 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 Psidium guajava (3.66,0.62,7.87kg/tree). Buchanania cochinchinensis(0.7,0.12,1.5kg/tree), Parkia biglundulosa type -2 (0.9, 0.15, 1.93kg/tree), plumeria (frangipani) (0.23, 0.04, 0.5kg/tree), Butea monospermea (palash) is (0.35kg/tree, 0.05kg/tree, 0.73kg/tree), white round kumizh teak is (0.23, 0.4,0.5 kg/tree) respectively and so on. Most of the trees is having carbon capture in between 1-10 kg/tree. In similar way carbon capture of 200 trees has been calculated.

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	AVARA GE HEIGHT OF TREE (m)
1	Psidium guajava	3	0.8	1.1	3.5	4
2	Buchanania cochinchinensis	2	0.35	0.45	1.41	10
3	Parkia biglundulosa type -2	5	0.4	0.5	1.57	11.2
4	plumeria (frangipani)	1	0.2	0.3	0.95	4
5	Butea monospermea (palash)	4	0.25	0.36	1.13	9.3
6	white round kumizh teak	1	0.2	0.25	0.72	2.7
7	seaned tree	1	0.4	0.5	1.57	10.3
8	Azadirachta indica - 8	3	0.5	0.45	1.41	1.6
9	Azadirachta indica -9	5	0.15	0.6	1.88	1
10	Azadirachta indica -10	1	0.35	0.6	1.88	1
11	Azadirachta indica -11	2	0.9	1.4	4.39	8.5
12	Bambusa vulgaris -1	4	1	1.5	4.71	8.3
13	Bambusa vulgaris -2	5	1.2	0.65	2.04	8.2
14	Bambusa vulgaris -3	3	0.7	0.3	0.94	7
15	Azadirachta indica - 12	2	0.65	0.3	0.94	6.2
16	Bambusa vulgaris -4	2	0.6	1.2	3.77	8
17	Bambusa vulgaris -5	3	0.4	1.2	3.77	8.6
18	detarium	1	0.6	0.9	2.83	12
19	Azadirachta indica - 13	2	0.5	0.7	2.2	9.4
20	Azadirachta indica - 14	1	0.4	0.5	1.57	7.6
21	bauhinia blakeania	3	0.3	0.4	1.25	5.7
22	Mangifera indica	2	0.15	0.2	0.63	4.5

23	citrus limon - 1	2	0.1	0.14	0.44	4.5
24	bautinia	1	0.2	0.25	0.78	7
25	Tectona grandis -5	1	0.1	0.15	0.47	4.5
26	Parkia biglundulosa type -2	2	0.3	0.4	1.25	8.7
27	Parkia biglundulosa type -2	3	0.15	0.2	0.63	4.5
28	Citrus limon -3	3	0.15	1.4	4.39	3

SR. NO	NAME OF TREE	NO. OF TREE	DIA.OF TRUNK (m)	DIA.OF GIRTH (m)	CIRCUMFERENCE OF TREE	AVERAGE HEIGHT OF TREE (m)
29	Mangifera indica	2	0.9	0.9	2.83	9
30	Azadirachta indica	3	0.5	0.4	1.57	9.4
31	bauhinia blakeania	3	0.5	0.3	0.94	4.6
32	citrus limon - 2	2	0.2	0.12	0.37	4.5
33	Tectona grandis -6	4	0.2	0.35	1.09	8.7
34	Azadirachta indica	5	0.9	0.9	2.83	4.5
35	Tectona grandis - 7	3	0.2	0.2	0.62	1.2
36	Psidium Guajava	3	0.7	0.2	0.62	2.3
37	Prunus avium -1	3	0.35	0.45	1.41	10.3
38	Prunus avium -2	1	0.4	0.45	1.41	10
39	Tectona grandis(teak) type - 1	7	0.25	1.4	4.4	10.2
40	Tectona grandis(teak) type - 2	3	0.32	1.047	4.62	11.1
41	Tectona grandis(teak) type - 3	6	0.21	1.05	3.3	9.8
42	Tectona grandis(teak) type - 4	5	0.38	1.45	4.55	10.4
43	Azadirachta indica(neem) type - 1	8	0.75	1.6	5.03	12
44	Azadirachta indica(neem) type - 2	5	0.82	1.75	5.5	12.8
45	Azadirachta indica(neem) type - 3	6	0.88	1.82	5.72	13.1
46	Azadirachta indica(neem) type - 4	7	0.35	1.1	3.45	8
47	Azadirachta indica(neem) type - 5	4	0.42	1.4	4.4	8.72
48	Azadirachta indica(neem) type - 6	3	0.45	1.44	4.52	8.78
49	Azadirachta indica(neem) type - 7	7	0.35	0.6	1.88	6
50	Mangifera indica(Mango)	2	1.2	1.9	5.96	9.02
51	Tectona grandis(teak) type - 5	6	0.2	1.2	3.76	14
52	Chimarris	3	0.2	1.3	4.08	5
53	Parkia biglundulosa type - 1	6	0.2	0.2	0.62	8.4
54	Moringa oleifera	3	0.5	1.6	5.02	8.6

55	Pongome oiltree	7	0.6	1.2	3.76	8.5
56	Stryphnodendron	4	0.3	1.2	3.76	7
57	Ficus religiosa	1	1.6	2.2	6.911	12.6

Table 2: Values Of BGB, AGB and Carbon Stock

SR. NO	NAME OF TREE	VOL ^m (m3)	ABOVE GROUND BIOMASS (kg/tree)	BELOW GROUND MASS (Kg/tree)	TOTAL BIOMASS (kg/tree)	CARBON (kg/tree)	CO ₂ SEQUESTERED (kg/tree)	Total CO ₂ SEQUESTERED (kg)
1	Psidium guajava	6.1	3.66	0.62	4.28	2.15	7.87	23.61
2	Buchanania cochinchinensis	1.15	0.7	0.12	0.82	0.41	1.5	3
3	Parkia biglondulosa type -2	1.5	0.9	0.15	1.05	0.525	1.93	9.65
4	plumeria (frangipani)	0.38	0.23	0.04	0.27	0.135	0.5	0.5
5	Butea monosperma (palash)	0.59	0.35	0.05	0.4	0.2	0.73	2.92
6	white round kumizh teak	0.38	0.23	0.04	0.27	0.135	0.5	0.5
7	seaned tree	1.5	0.9	0.15	1.05	0.525	1.93	1.93
8	Azadirachta indica - 8	0.31	0.18	0.03	0.21	0.1	0.36	1.08
9	Azadirachta indica -9	0.17	0.1	0.01	0.11	0.05	0.18	0.9
10	Azadirachta indica -10	0.76	0.45	0.07	0.52	0.26	0.95	0.95
11	Azadirachta indica -11	5.4	3.24	0.54	3.78	1.89	6.92	13.84
12	Bambusa vulgaris -1	6.51	3.8	0.65	4.55	2.27	8.31	33.24
13	Bambusa vulgaris -2	9.27	5.56	0.92	6.48	3.24	11.87	59.35
14	Bambusa vulgaris -3	2.69	1.61	0.26	1.87	0.9	3.4	10.2
15	Azadirachta indica - 12	2.05	1.23	0.2	1.43	0.71	2.6	5.2
16	Bambusa vulgaris -4	2.26	1.35	0.22	1.57	0.78	2.85	5.7
17	Bambusa vulgaris -5	1.08	0.64	0.1	0.74	0.37	1.35	4.05
18	detarium	3.39	2.034	0.34	2.374	1.187	4.35	4.35
19	Azadirachta indica - 13	2.35	1.41	0.24	1.65	0.825	3.02	6.04
20	Azadirachta indica - 14	1.5	0.9	0.15	1.05	0.525	1.92	1.92
21	bauhinia blakeania	0.85	0.51	0.085	0.6	0.3	1.1	3.3
22	Mangifera	0.22	0.132	0.022	0.154	0.077	0.282	0.564

	indica							
23	citrus limon - 1	0.095	0.057	0.001	0.08	0.03	0.11	0.22
24	bautinia	0.38	0.228	0.038	0.27	0.135	0.5	0.5
25	Tectona grandis -5	0.1	0.06	0.01	0.07	0.04	0.15	0.15
26	Parkia biglundulosa type -2	0.85	0.51	0.09	0.6	0.3	1.1	2.2
27	Parkia biglundulosa type -2	0.22	0.132	0.22	0.154	0.077	0.282	0.846
28	Citrus limon - 3	0.05	0.03	0.005	0.035	0.017	0.06	0.18
29	Mangifera indica	1.27	0.76	0.12	0.88	0.44	1.61	3.22
30	Azadirachta indica	0.58	0.34	0.05	0.39	0.19	0.69	2.07
31	bauhinia blakeania	0.58	0.34	0.05	0.39	0.19	0.69	2.07
32	citrus limon - 2	0.06	0.03	5.01	5.01	2.25	9.23	18.46
33	Tectona grandis -6	0.12	0.07	0.01	0.08	0.04	0.14	0.56
34	Azadirachta indica	3.18	1.9	0.31	2.21	1.1	4.03	20.15
35	Tectona grandis - 7	0.09	0.05	8.35	8.4	4.2	15.38	46.14
36	Psidium Guajava	1.15	0.69	0.11	0.8	0.4	1.46	4.38
37	Prunus avium -1	0.28	0.16	0.02	0.18	0.09	0.32	0.96
38	Prunus avium -2	0.12	0.07	0.01	0.08	0.04	0.14	0.14
39	Tectona grandis(teak) type - 1	0.5	0.3	0.05	0.35	0.18	0.66	4.62
40	Tectonagrandis(teak) type - 2	0.89	0.53	0.09	0.62	0.31	1.13	3.39
41	Tectona grandis(teak) type - 3	0.34	0.2	0.03	0.23	0.115	0.42	2.52
42	Tectona grandis(teak) type - 4	1.18	0.71	0.12	0.83	0.415	1.52	7.6
43	Azadirachta indica(neem) type - 1	5.3	3.18	0.53	3.71	1.86	6.82	54.56
44	Azadirachta indica(neem) type - 2	6.76	4.06	0.68	4.74	2.37	8.68	43.4
45	Azadirachta indica(neem) type - 3	7.97	4.78	0.79	5.57	2.785	10.20	61.2
46	Azadirachta indica(neem) type - 4	0.77	0.462	0.08	0.54	0.27	0.99	6.93

47	Azadirachta indica(neem) type - 5	1.21	0.73	0.12	0.85	0.425	1.56	6.24
48	Azadirachta indica(neem) type - 6	1.4	0.84	0.14	0.98	0.49	1.795	10.77
49	Azadirachta indica(neem) type - 7	0.57	0.34	0.05	0.39	0.195	0.72	5.04
50	Mangifera indica(Mango)	10.21	6.12	1.02	7.14	3.57	13.08	26.16
51	Tectona grandis(teak) type - 5	0.43	0.25	0.04	0.29	0.145	0.54	3.24
52	Chimarris	0.15	0.09	0.01	0.1	0.05	0.18	0.54
53	Parkia biglunulosa type - 1	0.27	0.16	0.02	0.18	0.09	0.32	1.92
54	Moringa oleifera	1.68	1	0.16	1.16	0.58	2.12	6.36
55	Pongome oiltree	2.41	1.44	0.24	1.68	0.84	3.07	25.69
56	Stryphnodndron	0.50	0.3	0.05	0.35	0.175	0.64	2.56
57	Ficus religiosa	25.34	15.2	2.53	17.73	8.86	32.46	32.46

5. CONCLUSION

In Yerla, Nagpur, Maharashtra, India, over 20 different tree species were counted in the current study to determine the total organic carbon stock. *Ficus religiosa* (peepal), *Azadirachta indica* (neem) type 3, *Mangifera indica* (mango), and *Tectona grandis* (teak) have the highest carbon capture/carbon sequestration potential among the local trees. It is discovered that 20 well-grown tree species have an average standing storage of organic carbon of roughly 601 kg. The greatest method for absorbing carbon is via developing long-lasting carbon pools, and the best restoration strategy is to establish protected natural vegetation. The study may be used to determine the Total Carbon Stock (TCS) in Nagpur and other cities or forest cover using a non-destructive technique.

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