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Carbon Sequestration by Trees in University campus

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ABSTRACT

It is now commonly acknowledged that the primary cause of global warming is the atmosphere's rising concentration of CO_2 and other greenhouse gases. Deforestation and the combustion of fossil fuels are thought to be two human activities that have hastened the continuous growth in its concentration in the atmosphere. The process of taking CO_2 out of the atmosphere and storing it in green plants for an extended period of time is known as carbon sequestration. The best land management practices for reducing atmospheric carbon dioxide are those that involve trees, as they are significant sinks of the gas. There is significant variation in the ability of different species to fix carbon dioxide from the atmosphere and convert it into organic carbon that may be stored in plant biomass. An attempt has been made to investigate the CO_2 sequestration hy MGCGV Campus trees. The Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya (MGCGV), located in Chitrakoot, India, is a rural university. Based on a MP Government Act (9, 1991), Bharat Ratna Nana ji Deshmukh founded it on February 12, 1991. This university, which bears Mahatma Gandhi's name, was established to give rural residents access to higher education. The university is situated on the banks of the Holy River Mandakini near Sphaticshila . In this study 56 tree species were observed in university campus and total carbon sequestration was found 16533.52 kg/year.Maximum CO_2 sequestration was observed by *Azadericta indica* (1588.90 kg/plant/yr) and minimum by *Musa paradisiaca* (4.35 kg/plant/yr).

Key words – Global warming, carbon fixation, carbon Sequestration, university campus, greenhouse gasses

Introduction

The Earth's natural regulatory mechanisms are significantly dependent on greenhouse gases. The natural factors contributing to the observed impact include water vapor, carbon dioxide, ozone, methane, and nitrous oxide. The emission of gases is mostly attributed to four important activities: the combustion of fossil fuels, the production of cement, the use of liquid coolants in fertilizers, and the manufacturing of dielectric fluid. The presence of trees in any given environment is crucial due to the significant biomass they generate and the wide range of shapes they exhibit. Paradoxically, the proliferation of industrialization and technological advancements within human society has led to the deterioration and loss of natural green areas. Plants possess the ability to retain carbon in the form of biomass throughout their lifespan. Upon their demise, the biomass of these organisms undergoes absorption into the food chain,

subsequently undergoing conversion into soil carbon. The plant plays a significant role in the process of carbon sequestration, hence serving as a valuable asset.

Material and Methods

The field survey was conducted to collect the data. Stratified random sampling method was adopted for laying sampling plots within the University campus area of 49 hactear. For the tree species analysis, 35 m × 35 m plots were randomly laid throughout the campus. The quadrates were studied and the tree species found were recorded. Canopy of trees within the plots were recorded and the circumference at breast height (CBH) was measured at 1.37 m above the ground using a measuring tape. The DBH of the individual tree species was ascertained using the formula, DBH = CBH/π. For height measurement of tree, Nikon rangefinder Forestry Pro II was used. This was supplemented by the use of quadrates in areas of difficult terrains. The survey consisted of listing all free stationed trees of at least 11cm or above in diameter (CBH) in each study site. Tree species in this study were identified using the works of Hutchinson and Dalziel (1968-1972).

Calculation: Estimation of amount of carbon dioxide in trees was done by the following method-

1-Determine the total green weight of the tree.
2-Determine the dry weight of the tree.
3-Determine the weight of carbon in the tree.
4-Determine the weight of carbon dioxide sequestered in the tree.
5-Determine the weight of Co_2 sequestered in the tree per year.

1. **Total (green) weight (W1) of the tree:**
   W_1= 0.25D2H (If D11) (Clark *et al*., 1986)
   W_1= 0.15D2H (If D>11) (Clark *et al*., 1986)

2. **Dry Weight (W2) of the Tree:**
   W_2= W1×72.5% (Dewald *et al*., 2005)

3. **Weight of Carbon (C1) present**:
   C_1= W2×50% (Birdsey, 1992)

4. **Determine the weight of CO_2 sequestered in the tree:**
   $CO_2 = C_1$ x 3.6663
5. **Determine the weight of CO_2 sequestered in the tree per year**
   Divided the weight of CO_2 sequestered in the tree by the age of the Tree.

When -

W= Above - ground weight of the tree in pounds
D= Diameter of the trunk in Inches
H= Height of the tree in feet

Result & discussion

A more holistic strategy is being adopted by environmentalists in response to the diminishing amount of trees and the consequent reduction in carbon sinks. Global temperatures have risen as a result of this reduction in the carbon sink, which has also increased carbon emissions. The investigation was carried out on the university campus using the quadrate approach. Sequestration of carbon was calculated in the current study. Below is a discussion of the collected results.

Carbon sequestered by Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot Satna (M.P.)– The total 56 tree species were found in University Campus. Common name, Botanical name, Number of Tree, DBH,

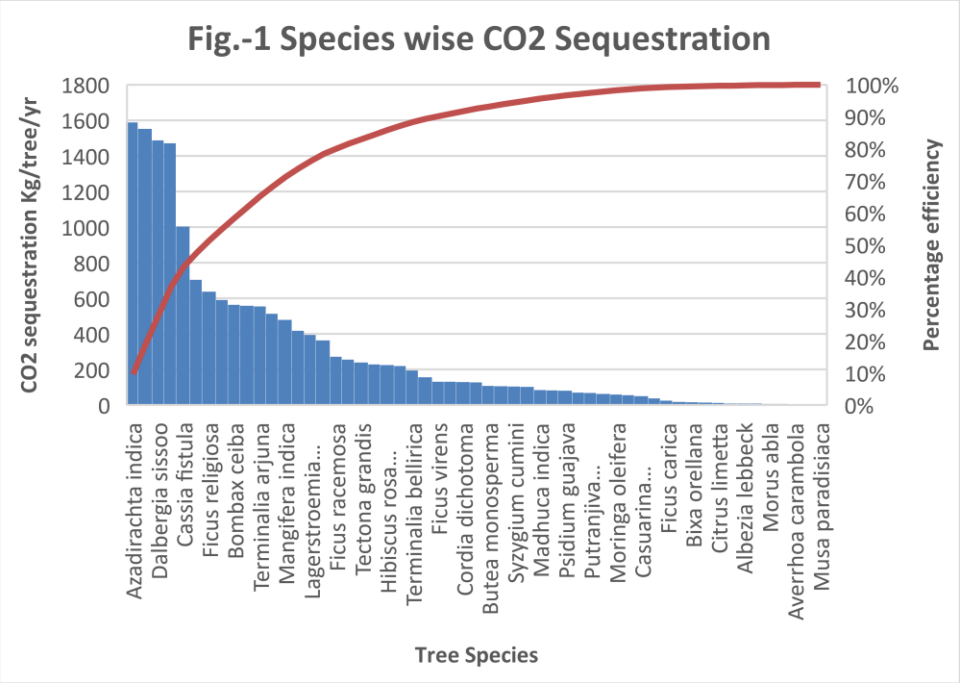
Height, and total sequestered CO_2 is given in Table- 1. A total no. of 1359 individual trees were observed. Detail of individuals tree species i.e. no. of trees per individual, average DBH, mean height and carbon sequestration is given in table 1.The annual total CO_2 sequestration was found **16533.52** kg/year. Most prevalent tree species was *Phyllanthus emblica* in this Campus. Maximum CO_2 sequestration was observed by *Azadirachta indica* 1588.90 (kg)/tree/years followed by *Phyllanthus emblica* 1552.51 CO_2 Kg/tree/year. Minimum CO_2 sequestration was observed for *Musa paradisiaca* 4.35 (kg)/tree/years followed by *Calliandra calothyrsus* 5.0 CO_2 Kg /tree/year. Total CO_2 sequestration was observed **16533.52** Kg/ year in Carbon sequestered by Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot Satna (M.P.).

Table: -1. Integrated CO_2 sequestration in University Campus

S. no.	Botanical Name	Total No. of Trees	Average Age of trees (Y.)	Average DBH (Inch)	Average Height of Trees (ft)	Average Green wait of Trees with Root (lbs)	Average Dry weight of Trees with root(lbs)	Sequestered C (lbs)	Sequestered CO_2/ tree /year (Kg)	Total Sequestered CO_2(kg)/year
1	*Alstonia scholaris*	112	14	4.63	18	115.76	83.93	41.96	4.98	558.27
2	*Lagerstroemia parviflora*	28	18	5.85	41	420.94	305.18	152.59	14.10	394.73
3	*Pongamia pinnata*	20	9	8.94	13	311.70	225.98	112.99	20.88	417.57
4	*Cassia fistula*	20	12	12.03	23	998.57	723.97	361.98	50.16	1003.30
5	*Nyctanthes arbor*	5	6	10.84	12	253.81	184.01	92.01	25.50	127.51
6	*Citrus limon*	80	7	3.54	8.5	31.96	23.17	11.58	2.75	220.16
7	*Murraya koenigii*	26	12	4.03	16.81	81.90	59.38	29.69	4.11	106.98
8	*Dypsis lutescens*	3	13	6.83	32.5	454.83	329.75	164.87	21.09	63.27
9	*Hyophorbe lagenicaulis*	32	9	10.2	22	686.66	497.83	248.92	45.99	1471.81
10	*Bixa orellana*	2	18	5.89	23.6	245.62	178.07	89.04	8.23	16.45
11	*Putranjiva roxburghii*	4	30	7.52	50	848.26	614.99	307.49	17.05	68.18
12	*Artocarpus heterophyllus*	4	18	5.66	29.16	280.25	203.18	101.59	9.39	37.54
13	*Calliandra calothyrsus*	6	5	1.60	9	6.91	5.01	2.51	0.83	5.00
14	*Albezia lebbeck*	5	32	3.95	21.25	99.47	72.11	36.06	1.87	9.37
15	*Albizia odoratissima*	17	31	7.6	40	693.12	502.51	251.26	13.48	229.14
16	*Phoenix dactylifera*	10	19	9	17	413.10	299.50	149.75	13.11	131.07
17	*Callistemon*	42	9	6.0	12	129.60	93.96	46.98	8.68	364.60
18	*Madhuca indica*	4	30	8.9	44.7	1062.21	770.10	385.05	21.34	85.38

19	*Syzygium cumini*	16	23	6.0	23	248.40	180.09	90.05	6.51	104.17
20	*Neolamarckia cadamba*	10	14	5.7	17	165.70	120.13	60.07	7.13	71.35
21	*Artocarpus lacucha*	3	22	7.00	16	235.20	170.52	85.26	6.44	19.33
22	*Ficus racemosa*	14	23	9.4	28	742.22	538.11	269.06	19.45	272.36
23	*Carissa carandas*	11	6	2.1	7	9.26	6.71	3.36	0.93	10.24
24	*Aegle marmelos*	41	21	7.9	32	599.14	434.37	217.19	17.20	705.17
25	*Phyllanthus emblica*	141	18	6.8	23.7	328.77	238.36	119.18	11.01	1552.51
26	*Azadirachta indica*	95	22	7.9	32.6	610.37	442.52	221.26	16.73	1588.90
27	*Saraca asoca*	124	12	3.4	23.8	82.54	59.84	29.92	4.15	514.16
28	*Ficus religiosa*	18	23	9.22	53	1351.63	979.93	489.97	35.43	637.68
29	*Terminalia arjuna*	10	18	13.0	32.7	1657.89	1201.97	600.99	55.52	555.24
30	*Terminalia bellirica*	8	19	10.0	25.6	768.00	556.80	278.40	24.37	194.94
31	*Ficus benghalensis*	8	23	16.9	54.9	2822.40	2046.24	1023.12	73.98	591.81
32	*Cordia dichotoma*	27	21	4.9	23.4	168.55	122.20	61.10	4.84	130.64
33	*Butea monosperma*	8	8	6.9	12.7	181.39	131.51	65.76	13.67	109.35
34	*Hibiscus rosa sinensis*	34	4	3.5	12	44.10	31.97	15.99	6.65	225.97
35	*Tecoma stans*	51	13	5.5	11.9	107.99	78.29	39.15	5.01	255.40
36	*Prosopis cineraria*	8	15	7	21.8	320.46	232.33	116.17	12.88	103.03
37	*Musa paradisiaca*	3	21	3.6	13.0	50.54	36.64	18.32	1.45	4.35
38	*Ficus carica*	2	22	6.9	32.8	468.48	339.65	169.82	12.84	25.67
39	*Sapindus mukorossi*	1	13	5.7	15.9	154.98	112.36	56.18	7.19	7.19
40	*Casuarina equisetifolia*	10	19	6	14.8	159.84	115.88	57.94	5.07	50.71
41	*Samanea saman*	5	11	9	12.4	301.32	218.46	109.23	16.51	82.57
42	*Pterospermum acerifolium*	4	18	4.60	11	69.83	50.63	25.31	2.34	9.35
43	*Gardenia jasminoides*	15	13	5.5	9	81.68	59.21	29.61	3.79	56.81
44	*Moringa oleifera*	5	17	8.94	13.9	333.28	241.63	120.81	11.82	59.09
45	*Mangifera indica*	28	18	12.03	19.6	510.58	370.17	185.08	17.10	478.79
46	*Dalbergia sissoo*	70	15	9.84	18.2	528.67	383.28	191.64	21.25	1487.27

47	*Psidium guajava*	49	17	3.54	12.6	47.37	34.34	17.17	1.68	82.31
48	*Melia azedarach*	5	13	4.01	13.5	65.12	47.22	23.61	3.02	15.10
49	*Tectona grandis*	26	16	6.83	17.5	244.91	177.56	88.78	9.23	239.91
50	*Ficus virens*	5	23	10.2	32.1	1001.91	726.38	363.19	26.26	131.30
51	*Morus abla*	2	21	5.89	12.5	130.10	94.32	47.16	3.73	7.47
52	*Gmelina arborea*	20	16	7.52	12.3	208.67	151.29	75.64	7.86	157.24
53	*Averrhoa carambola*	1	13	5.66	13.7	131.67	95.46	47.73	6.11	6.11
54	*Citrus limetta*	30	9	1.60	8.8	6.76	4.90	2.45	0.45	13.58
55	*Bombax ceiba*	26	23	7.95	43.6	826.69	599.35	299.67	21.67	563.36
56	*Ceiba pentandra*	5	12	7.6	23.6	408.94	296.48	148.24	20.54	102.72
	Total	**1359**								**16533.52**



Conclusion

The study area 1359 trees belonging to 56 different species were observed. The study concluded that the overall CO_2 sequestration by trees was **16533.52** Kg/year. The maximum CO_2 was sequestered by *Azadirachta indica* 1588.90 kg/tree/years and minimum by *Musa paradisiaca* 4.35 kg/tree/ year. Carbon sequestration monitoring in the study area suggests that it is a valuable strategy for reducing excessive atmospheric CO_2 concentrations and hence contributes to the avoidance of global warming. To minimize a rise in temperature for the good of society, measures must maintain the greenery in campus. This study may be helpful in the Campus ecosystem management and CO_2 sequestration by tree and it can also be fruitful for the sustainability aspect which is good for humanitarian prospective. It will also give the idea of the dominant tree species in university campus.

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