Sequestration and storage of carbon by trees in and around University campus of Aurangabad city in Maharashtra, India.

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Abstract: Trees from the urban regions currently store carbon, which can be released into the atmosphere after the death of tree, and capture carbon as they grow. A major challenge is the lack of correct and spatially explicit estimates of tree carbon storage over the entire urbanized area. The study was carried out in and around university campus of Aurangabad city to know the CO_2 sequestration from the selected ten tree species. Assessment of the carbon sequestration of urban trees was carried out through the biomass estimation and quantification. For the estimation of total CO2 sequestration DBH and height measured. Wood densities were obtained from world agroforestry centre. It is found that highest CO_2 3916. 81 kg/tree captured by *Swietenia mahagoni* followed by *Pithocellobium dulce* which is captured 1401.18 kg of CO_2 per tree. Total above ground biomass 3463.10, total below ground biomass 900, total biomass 4363.50, total carbon 2181.75 kg/tree. Total tree count is 835 out of which *Roystonea regia* found 206 tree count which is maximum. It is found that total CO_2 sequestered by the selected area is 565.32 tonnes. Carbon sequestration is a way to mitigate the accumulation of greenhouse gases in the atmosphere released by the burning of fossil fuels and other anthropogenic activities.

KEYWORDS: - biomass, tree, CO_2 sequestration, gas, fuels

1. INTRODUCTION

More than half of the population at the global level now lives in urban regions, and this figure will continue to increase at a rate of 4% a decade by 2050 [1]. Carbon sequestration is one of the important processes of storage of CO_2 or other forms of carbon to mitigate environmental issues like global warming, green house effect and its one of the important clause of Kyoto Protocol, through biological, chemical or physical processes; CO_2 is sequestered from the atmosphere. The Kyoto Protocol to the UN Framework Convention on the Climate Change has provided a vehicle for considering the various effects of carbon sinks and sources, as well as addressing issues concerned to fossil fuels emission. Growing concern about the climate change and concerned problems led to the research quantifying the overall effects of trees from the urban area on atmospheric carbon dioxide (CO_2) [4,5,6,7,8,9]. Trees from Urban area also affect temperatures of air and building energy use, and consequently alter carbon release from numerous urban sources [2]. Thus, urban trees potentially influence the climate at the local level, carbon cycles, energy use and the climate change [10, 11, 12, 13, 14]. Urban trees affect climate change, but these trees are often disregarded because their environmental services are not so well understood or quantified. Trees act as a sink for carbon dioxide (CO_2) by fixing carbon during the photosynthesis and storing carbon as the biomass. The clear long-term CO_2 origin dynamics of the forests change through time as trees grow, die, and decay. Human influences on forests can further affect CO_2 source dynamics of urban forests through such components as fossil fuel emissions and harvesting of biomass [3].

2. MATERIALS AND METHODS

2.1 Location

The study area comprises of 2126 hectares of area which is mainly from B.A.M. University campus and Jaisingpura, Pahadsingpura etc. The district is from 19 to 20 degrees north longitude and 74 to 76 degrees east latitude. Aurangabad city is situated on the river bank Kham a tributary of the Godavari river. The entire city is situated at the latitude of 19°53'50" N and longitude of 75°22'46" E. Aurangabad District is located mainly in the Godavari river basin and partly in the Tapi river basin. The city is surrounded by the hills of the Vindhya ranges and the river Kham passes through it.

2.2 Measurement of diameter at breast height (DBH) and tree height:

To estimate the biomass of different trees, non-destructive method was used. The biomass of the tree was estimated on the basis of diameter at breast height (DBH) and tree height. DBH can be determined by measuring tree Girth at Breast Height (GBH), approximately 1.3 meter above the ground. The GBH of trees having the diameter greater than 10 cm were measured directly by the measuring tape [21]. The tree height measured by the Theodolite instrument.

2.3 Above ground biomass (AGB) of trees:

The above ground biomass of the tree includes whole shoot, branches, flowers, leaves and fruits. It is calculated using the following formula.[22].

AGB kg = volume of tree (m3) x wood density Kg/m3

$V = \pi r^2 H$

Where H = Height of the tree in meter, V= volume of the cylindrical shaped tree in m3, r = radius of the tree in meter, Radius of the tree is calculated from GBH of tree. Height was measured with the help of the instrument Theodolite. The wood densities were obtained from the website www.worldagroforestycentre.org. The standard average density of 0.6 gm/cm was applied wherever the density value is not available for tree species [20].

2.4 Estimation of the Below Ground Biomass (BGB)

The Below Ground Biomass (BGB) includes all biomass of live roots excluding fine roots having < 2 mm diameter. The below ground biomass was calculated by multiplying AGB by 0.26 factors as the root: shoot ratio. BGB is calculated by following formula [21,20, 23].

BGB (Kg/tree) = AGB (Kg/tree) or (ton/tree) x 0.26

Table 1: Wood densities of tree species

Sr. No.	Tree Species (Scientific Name)	Local name	Wood density in g/cm³
1	*Pithecellobium dulce*	Vilayati chinch	0.6657
2	*Polyalthia longifolia*	Ashok	0.5635
3	*Pongamia pinnata*	Karanj	0.6198
4	*Psidium guajava*	Peru	0.6713
5	*Punica granatum*	Dalimb	0.771
6	*Roystonea regia*	palm tree	0.66
7	*Santalum album*	Chandan	0.9367
8	*Sesbania sesban*	Shevari	0.43
9	*Spathodea campanulata*	Pichkari	0.3303
10	*Swietenia mahagoni*	Mohogony	0.66

3. RESULTS AND DISCUSSION

Humans constantly interact with the natural environment to create some differences in the tree cover. Costs of maintaining the cover of vegetation and attitudes toward the trees in urban landscape, both related to ambient environmental factors, alter the desire and ability of individuals to incorporate trees in the urban landscape. Tree cover can be increased by allowing space for the vegetation cover, planting, and inspiring natural regeneration. Measurements of the tree cover provide important basic structural data used to model urban tree cover functions such as air pollution control and carbon dioxide capture [19]. Understanding the relationship among the urban trees, people, and environment can facilitate probable urban designs that might increase the environmental and social benefits from trees. Large trees also preserve approximately 1000 times maximum carbon than smaller trees [19,20]. It may be one of the crucial green region in the urban and industrial sectors. Carbon capture rates vary by species, soil, climate, topography and most important is management practice [13]. Environmentalists have highlighted the role of urban forests as a place of social integration as they provide recreation and relief to the urban population from their hectic life.

More research work is required on the overall effects of trees, soils and its proper management in the urban areas. Carbon storage by tree species in woodlands at national level was 20.2 billion tonnes in 2008 [20].

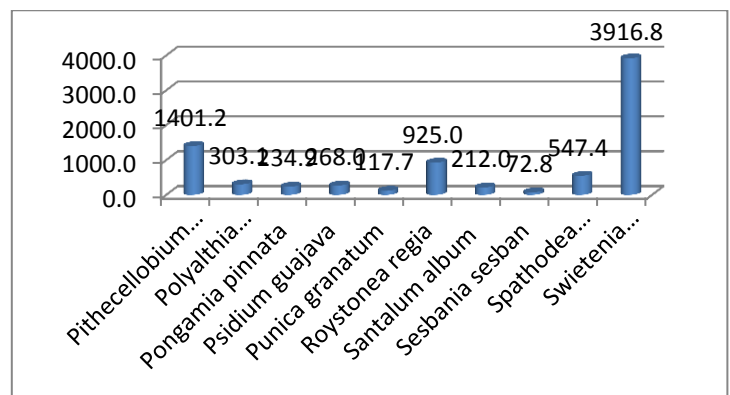**Table 2: Shows Biophysical measurements with AGB and BGB**

Sr. No.	Scientific name	DBH (Meters)	Height (Meters)	Volume (m³)	AGB (kg/tree)	BGB (kg/tree)
1	*Pithecellobium dulce*	0.363	8.79	0.91	606.64	157.73
2	*Polyalthia longifolia*	0.194	7.88	0.23	131.22	34.12
3	*Pongamia pinnata*	0.189	5.88	0.16	101.70	26.44
4	*Psidium guajava*	0.192	5.99	0.17	116.05	30.17
5	*Punica granatum*	0.142	4.19	0.07	50.97	13.25
6	*Roystonea regia*	0.317	8.46	0.67	400.47	104.12

	Scientific name					
7	*Santalum album*	0.17	4.49	0.10	91.79	23.86
8	*Sesbania sesban*	0.148	4.25	0.07	31.50	8.19
9	*Spathodea campanulata*	0.295	10.50	0.72	237.00	61.62
10	*Swietenia mahagoni*	0.464	15.22	2.57	1695.76	440.90
	Average	0.247	7.56	0.56	346.30	90.04
	Total	2.474	75.64	5.67	3463.10	900.40

Table 3: Shows TB, C, CO_2, Tree count, Total CO_2

Sr. No.	Scientific name	TB (kg/tree)	C (kg/tree)	CO_2 (kg/tree)	Tree count	Total CO_2 (Tonnes)
1	*Pithecellobium dulce*	764.36	382.18	1401.19	156	218.586
2	*Polyalthia longifolia*	165.34	82.67	303.10	40	12.124
3	*Pongamia pinnata*	128.14	64.07	234.91	205	48.156
4	*Psidium guajava*	146.22	73.11	268.05	156	41.815
5	*Punica granatum*	64.22	32.11	117.72	40	4.709
6	*Roystonea regia*	504.60	252.30	925.00	206	190.550
7	*Santalum album*	115.65	57.83	212.01	7	1.484
8	*Sesbania sesban*	39.69	19.85	72.76	6	0.437
9	*Spathodea campanulata*	298.62	149.31	547.42	8	4.379
10	*Swietenia mahagoni*	2136.66	1068.33	3916.82	11	43.085
	Average	436.35	218.17	799.89	83.5	56.530
	Total	4363.50	2181.75	7998.96	835	565.320

Carbon capture and sequestration is a theoretical approach to control and mitigate the contribution of emissions of fossil fuels to global warming, based on capturing carbon dioxide from large point sources such as the fossil fuel power plants. The carbon dioxide might then be stored away from the atmosphere permanently. As urban areas discharge maximum amount of emissions of carbon, tree creates an impact on carbon emissions through changing in climates at micro level, albedo, use of energy, and maintenance of emissions which require to be added with tree storage and capture estimates to improve a more complete evaluation of the role of trees of the urban area on climate change [20].

Graph showing CO_2 sequestration

The study was conducted in the Aurangabad city to estimate the above ground biomass, below ground biomass, total biomass, carbon dioxide, carbon from selective ten tree species. *Swietenia mahagoni* has sequestered 3916.81 kg/tree of CO_2 which is highest compared to other tree species from the study area. It is due to high DBH and height of the tree. At the same time AGB 1695.76, BGB 440.89, total biomass 2136.65, carbon 1068.32 which is highest in the *Swietenia mahagoni* which has only 11 tree count. *Sesbania sesban* sequestered lowest CO_2 72.75 kg/tree compared to other trees which is may be due to lowest DBH i.e. 0.148 meters, total biomass sequestered 39.69 kg/tree. Total tree count of the study area is 835. Maximum 206 trees found of *Roystonea regia* and only 6 trees found of *Sesbania sesban* from the study area. Total AGB 3463.10, total BGB 900, Total biomass 4363.50, Total carbon 2181.75, total CO2 sequestered is 7998.96kg/tree and total CO2 from all tree species from the study area is 565.32 tonnes. Large healthy trees having the diameter more than 77 cm sequester approximately 90 times more carbon as compared to the small healthy trees species which have the diameter less than 8 cm [19]. Large trees also store nearly 1000 times maximum carbon than smaller trees [20, 19].

REGRESSION ANALYSIS

To estimate the closeness and relationships various parameters a regression analysis was performed with the help of SPSS 16.0 software.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.949a	.900	.871	.27519

a. Predictors: (Constant), Height, DBH

Coefficients a

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-1.097	.229		-4.791	.002
	DBH	3.169	2.321	.443	1.366	.214
	Height	.116	.072	.522	1.610	.152

a. Dependent Variable: Volume

Where,

t = Statistics R= Multiple correlation coefficient; R^2 and adjusted R^2 = Coefficient determination of variablesB= Regression coefficient

Above table shows that strong correlation coefficient between DBH with volume and the height whereas adjusted R^2 shows 87 % variability between the Volume with DBH and Height. Above statistical table shows that volume is significant with DBH. As increase in DBH its metabolic and the growth necessities would also increase.

4. CONCLUSION

Trees from urban area play crucial roles in reduction of the atmospheric carbon dioxide levels. In the present research work calculation of AGB, BGB, TB, carbon and carbon dioxide sequestration potential rate often tree species was done by nondestructive method. Theodolite instrument was used for height measurement. Wood densities were obtained from the World Agroforestry Centre for the measurement of carbon sequestered by trees. Carbon stock was determined for *Pithecellobium dulce, Polyalthia longifolia, Pongamia pinnata, Psidium guajava, Punica granatum, Roystonea regia, Santalum album, Sesbania sesban, Spathodea campanulata, Swietenia mahagoni* tree species in and around university campus of Aurangabad city. Results show that *Swietenia mahagoni* has the better carbon sequestration potential rate which sequestered 3916.81 kg/tree of CO_2 whereas *Sesbania sesban* has the least sequestration rate which sequestered 72.75 kg/tree of CO_2 as compared to other species. Total tree count is 835. Total carbon sequestered 2181.75. Total carbon dioxide from all the tree species sequestered 7998.96 kg/tree. Carbon dioxide sequestered by the trees 565.32 tonnes. More field measurements are needed in urban regions to help improve carbon accounting and other functions of urban forest ecosystems. Before applying the approach of urban tree management, quantification of organic carbon in the urban region by nondestructive method will be helpful.

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