A Case Study on Carbon Sequestration in and around Nagpur City

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***Abstract*: Carbon sequestration by trees and briefly reviews the physiology of carbon assimilation and likely carbon dynamics of future plantation forests.**

Forests are capable of effective sequestration and storage of atmospheric carbon in above-ground and below-ground biomass by way of processes of photosynthesis and tree growth.

Carbon sequestration potential has been measured for trees of urban areas like Nagpur city of Maharashtra state in India. The specific objective of present article was to estimate biomass of the trees in green pockets, various gardens, avenues in the urban areas like Nagpur city. The estimate based on the methodology used for the estimation of biomass in forest. In the present attempt biomass of the trees were estimated by random sampling in dense, moderate and spare plantation areas. Height and girth were recorded during survey of sampling sites and placed in particular height girth class which was made during the survey on the basis of range of height and girth of trees found in Nagpur city. From the recorded data total standing biomass and carbon sequestration was estimated and found to be 659328.4 tons and 55.52 tons/hector respectively.

***Keywords*: Biomass, Height & Girth, Sequestration, Bio-volume.**

I. INTRODUCTION

In today's world the Global warming is the most dreaded problem. Carbon Emission is the strongest causal factor for global warming. So, increasing carbon emission is one of today's major concerns, which is well addressed in Kyoto Protocol[1]. Trees are amongst the most significant elements of any landscape, both due to biomass and diversity. Their key role in ecosystem dynamics is well known. Trees are important sinks for atmospheric carbon i.e. carbon dioxide, since 50% of their standing biomass is carbon itself [2]. Importance of forested areas in carbon sequestration is already accepted, and well documented [3,4]. But hardly any attempts have been made to study the potential of trees in carbon sequestration from urban area.

In this study an attempt has been made to explore ecological conservation values of such areas in urban ecosystem. The study constitutes an assessment of standing biomass, carbon sequestration potential of tree flora in and around Nagpur City. Therefore, to evaluate the status of such green pockets, the present study was undertaken on vegetation in fringe forest Pockets and green areas in and around Nagpur city.

1.1 Carbon Sinks: A stock that is taking-up carbon is called a "sink". A sink is defined as a process or an activity that removes greenhouse gases from the atmosphere[5,6].

1.2 Carbon source: A stock that is releasing carbon is called as source. "source." Shifts or flows of carbon over time from one stock to another atmosphere to the forest are viewed as carbon "fluxes." Over time, carbon may be transferred from one stock to another. The amount of carbon stored in any stock may be large, even as the changes in that stock, fluxes, are small or zero. An old-growth forest, which is experiencing little net growth, would have this property. Also, the stock may be small while the fluxes may be significant. Young fast growing forests tend to be of this type[5]

1.3 Sequestration: **"**Carbon sequestration is the process of extraction of the atmospheric co_2 and its storage in terrestrial ecosystem for a very long period of time"[6]

The role of forests in carbon sequestration is probably best understood and appears to offer the greatest near-term potential for human management as a sink. Unlike many plants and most crops, which have short lives or release much of their carbon at the end of each season, forest biomass accumulates carbon over decades and centuries. Furthermore, carbon accumulation potential in forests is large enough that forests offer the possibility of sequestering significant amounts of additional carbon in relatively short periods – decades.

II. METHODOLOGY

2.1 Study Area: Nagpur-Wardha road , Nagpur-Bhandara road, , Nagpur-Katol road were selected as a study area. In the present attempt quadrate of 75x75 m^2 were laid in the selected areas. During survey variables considered were girth at breast height, height of the trees, wood density.

2.2 Biomass Estimation: The biomass of a tree is the sum of the biomass of its roots, trunk, branches, leaves and reproductive organs- flowers and fruits [7,8]. Biomass estimated in this study in the manner of -

2.3 Height of the tree: The height of the tree is measured. Height can be measured by ocular, non instrumental and instrumental method. For the present project ocular method is selected. The investigator marked the tree height at their height. From distance of about 3m from tree base, the number of 1.5m section from base to tree top were counted and

multiplied by 1.5 to get the height of tree in meter. Height classes were created for ease in calculation.

2.4 Girth of the tree: Girth of tree is measured at breast height of 1.5m.The trees with girth above 30cm are considered.

2.5 Wood density of the tree: Wood density is taken as 0.6 gm/ cm3

Biomass was estimated by multiplying the biovolume by the green wood density of tree species.[1]

Bio-volume = b = 0.4 x(GBH/∏)x H

Biomass = Specific gravity of wood x b

Where,

D = (GBH/∏), diameter calculated from GBH, assuming the trunk to be cylindrical.

H = Height

2.6 Present status of vehicle capacity in Nagpur city :

Vehicle category	No. of vehicle	No. of Vehicles in %
Two-wheelers	414955	85.4
Three-wheelers	10696	3.4
Cars	12003	3.4
Jeeps	2185	1.9
Omni Buses	935	0.2
Tractors	15025	3.0
Trailers	8511	1.86
Good Trucks	6595	0.96
Others	450	0.10
Total	471355	**100**

III. RESULT AND DISCUSSION

Table 1 gives the information about distribution classes of girth and height. In girth classes difference between two is 0.254 m and in height classes difference between two is 3.048 m.

Table 1 : Distribution classes on the basis of height and girth

Sr. No.	Classes	Average Girth in m	Average Height in m
01	I	0.254	3.048
02	II	0.571	6.858
03	III	0.952	11.43
04	IV	1.333	16.002
05	V	1.714	20.574

A) Nagpur-Wardha road , B) Nagpur-Bhandara road, C) Nagpur-Katol road

3.1 Biomass of Trees

Table 2 gives the information about the biovolume and biomass of per tree in selected height-girth classes. Table 3 gives the estimated values of total number of trees of Nagpur city. Results shows that with increase in girth and height of the trees Biovolume and biomass of tree also increases. Minimum value of biomass tree for minimum height girth class of present study was 4.78 kg/tree and maximum was 1469.77 kg/tree.

Information regarding total standing biomass in all height-girth classes and all selected wards is given in Table 4. Information regarding standing biomass & biomass/hector in classified plantation areas is given in Table 5.

Result shows that in dense areas standing biomass/hector was found to be 110.30 tons/hector. in moderate areas 69.70 tons/hector and in spare areas 25 tons/hector. Result shows that maximum biomass was present in dense areas than other two that is 110.30 tons/hectors. Minimum biomass was present in the areas like Borgaon road as this is commercial area and numbers of trees are less in this area.

Table 2: Estimated values of biovolume and biomass for selected height-girth classes.

Sr. No.	Girth and Height classes	Biovolume (m^3/tree)	Biomass (kg/tree)
1	I	0.0079	4.78
2	II	0.0906	54.37
3	III	0.4198	251.90
4	IV	1.1523	691.42
5	V	2.4496	1469.77

Table 3 Estimated values of Total number of trees in Nagpur City.

Sr. No.	Classified tree density	Name of Selected Wards	Area of selected sites (Sq.km)	Number of trees in wards	Number of trees under classified density	No. of trees / hector	Total area under classified tree density (Sq. km)	Total No. of trees in classified density areas	Total area of Nagpur city (Sq. km.)	Total No. of trees in city
1	Dense	Nagpur-Wardha Road	3.5	27050	27050	210	17.31	321580		
2	Moderate	Katol Road	8.3	20470	20470	180	30.45	602110	227.4 km^2	2143838
3	Spare	Bhandara Road	7.2	18400	18400	57	50.62	288534		

Table 4 : Estimated values of total standing biomass in all height-girth classes

Sr. No.	Height and girth classes	Total standing biomass (tons)		
		A	B	C
1	I	11.95	20.07	10.03
2	II	173.98	244.66	190.30
3	III	1891.76	1183.93	1763.30
4	IV	5213.30	2468.36	2212.54
5	V	9254.70	5144.20	3021.40
Total	5	16545.7	9061.22	7997.57

Table 5 : Estimated values of total standing biomass & biomass /hector

Sr. No.	Localities	Standing biomass (tons)	Biomass / hector
1	Nagpur- Wardha road	16545.7	110.30
2	Bhandara road	9061.22	69.70
3	Katol road	8997.57	28.00

3.2 Carbon Sequestration

Table 6 gives the carbon sequestration by total standing biomass in classified plantation areas. .The attempt estimated that total number of trees present in Nagpur city are 1081224 with total standing biomass as 529715.9 tons which sequestered total carbon of 264857.9 tons.(Refer Table No.8) Average Carbon sequestered by trees of Nagpur city per hectors found to be 2648.57 tons / yr. Most important carbon dioxide sequestration was 9710.4tons/year

Table 6 Total Carbon Sequestration by total standing biomass

Sr. No.	Localities	Area km^2	Standing biomass (tons)	Biomass / hector	Carbon sequestration / hector
1	Nagpur-Wardha road	3.5	16545.7	110.30	55.15
2	Bhandara road	3.3	9061.22	69.70	34.85
3	Katol road	4.0	8997.57	28.00	15.5

Table 7 Estimated values of total Carbon sequestration by total standing biomass in classified.

Sr. No.	Classified tree density	Total area in Hector	Total biomass in tons	Total carbon sequestration in tons	Carbon sequestration / year in tons	Carbon sequestration/ hector in tons
1	Dense	1731	190929.3	95464.65	954.64	55.15
2	Moderate	3045	212236.5	106118.25	1061.18	34.85
3	Spare	5062	126550	63275.00	632.75	15.57

Table 8. Estimated values of total no. of trees, and total Carbon sequestration by total standing biomass in Nagpur city.

Sr. No.	Tree Cover	Total area(km^2)	Total No. of trees	Total Biomass (tons)	Total Carbon sequestration (tons)	Carbon sequestration / year (tons)	Carbon sequestration tons/hector	CO_2 sequestration (tons)
1	Dense + Moderate + Spare	98.38	1081224	529715.8	264857.9	2648.57	26.92	9710.45

In present studies 50 year old plantation in area of the city like Nagpur wardha road sequestrate carbon was estimated 55.15 tons/hector, but since this area belongs to city and not to forest the estimated value is considerable as total area is not with trees. Results shows that, carbon sequestration by trees of Nagpur city is 2648.57 tons/year and 26.92 tons/hector. In this work, sequestration was concern with forest, in the present attempt address sequestration of cities with dense, moderate, and spare plantation areas which was not uniform throughout the city, hence the value is comparatively less. It is the average value that the plantation was not uniform throughout the city. But in dense areas carbon sequestration value was 55.15tons / hector.

IV. CONCLUSION

As in present study estimate CO_2 sequestration of the trees of Nagpur 9710.45tons/year and trees in city contribute for 0.18% sequestration of carbon dioxide. So it is necessary to plant more number of trees in the city. The estimate that reveals the magnitude of effect of urban trees and forest can have an atmospheric CO_2. Various attempt was made on the carbon sequestration by trees and their role in carbon credit. The role of green pocket in urban trees in ecosystem was not addressed up till now, which has important role in carbon credit and trees are contribute more as are perennial and their maintenance not expensive than herb and shrub which are annual. The cities like Nagpur sequestrate 2.5-3% of the total carbon sequestration of the total trees of India. Thus such studies quantify total carbon budget of trees planting, maintenance and removal, which includes CO_2 flux to the atmosphere from equipment and vehicles.

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