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Carbon sequestration in Bhubaneswar City of Odisha, India

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ABSTRACT: Stored carbon in dominant trees of Bhubaneswar city was assessed during 2015. Twelve dominant trees were identified in the heart of the city. Both the Above Ground Biomass (AGB) and Above Ground Carbon (AGC) followed the order *Delonix regia* > *Pistacia vera* > *Azadirachta indica* > *Peltoforum pterocarpum* > *Ficus religiosa* > *Albizia saman* > *Simarouba glauca* > *Grewia asiatica* > *Alstonia scholaris* > *Mimusops elengi* > *Cassia fistula* > *Lagerstroemia speciosa* during premonsoon and monsoon. The carbon dioxide equivalents assessed for the species reveal considerable potential of the trees in off-setting atmospheric carbon dioxide.

KEYWORDS: Bhubaneswar city, Above Ground Biomass, Above Ground Carbon, Carbon dioxide

I. INTRODUCTION

Trees have immense role in regulating the carbon dioxide budget in the atmosphere. However, this particular ecosystem service is poorly understood or quantified although trees act as the major 'sink' of carbon dioxide by fixing carbon during photosynthesis and storing carbon as biomass. It is to be noted at this point that the volume of carbon sink is highly elastic in nature as the stored carbon in forest/plantation is a direct function of growth, decay and death of the trees. Even the edaphic factors and soil management also influence the biomass and stored carbon in forest/plantation. All trees irrespective of species store carbon in organic form which are emitted back to the atmosphere after their death and decay (through microbial decomposition) and during the entire phase of growth sequestration of carbon occurs depending on the growth pattern.

Carbon storage data vary substantially amongst sites, which illustrate the importance of relative abundance of tree species, type of species, age of the tree species and edaphic factors.

The present study was undertaken in the Bhubaneswar city in the maritime state of Odisha during 2015. Some management practices have also been discussed in context to the efficiencies of carbon sequestration as various maintenance activities emit carbon back to the atmosphere *via* fossil-fuel combustion (*e.g.*, from chain saws, trucks, chippers) [1].

II. MATERIALS AND METHODS

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Study Area: The present study was conducted in the Infosys area of the Bhubaneswar city of Odisha (20°20'41.6"N/85°48'25.4"E). We selected 12 dominant tree species in the area based on the relative abundance of the trees. The study was undertaken during two seasons (premonsoon and monsoon) in 2015.

Above Ground Biomass (AGB) Estimation: The biomass of above ground structures (stems, branches and leaves) were estimated as per the standard procedure [2].

Above Ground Carbon (AGC) Estimation: The fresh samples of stem, branch and leaf were collected for each species and oven dried at 70°C. Direct estimation of percent carbon were carried out by Vario MACRO elemental make CHN analyzer, after grinding and random mixing the oven dried stems, branches and leaves separately.

III. RESULT

A total of 12 trees species were documented from the study site (Table 1) few of which were fruit bearing trees.

Above Ground Biomass (AGB)

The present study shows the AGB is more in monsoon compared to premonsoon season. The value of AGB ranges from 3.24 tonnes ha⁻¹ (in *Lagerstroemia speciosa* during premonsoon) to 2376.29 tonnes ha⁻¹ (in *Delonix regia* during monsoon) (Figure 1, Table 1) in the study site. The relatively more value of AGB in the monsoon may be the growth of the tree in course of time or profuse ability of fresh water during rainy season.

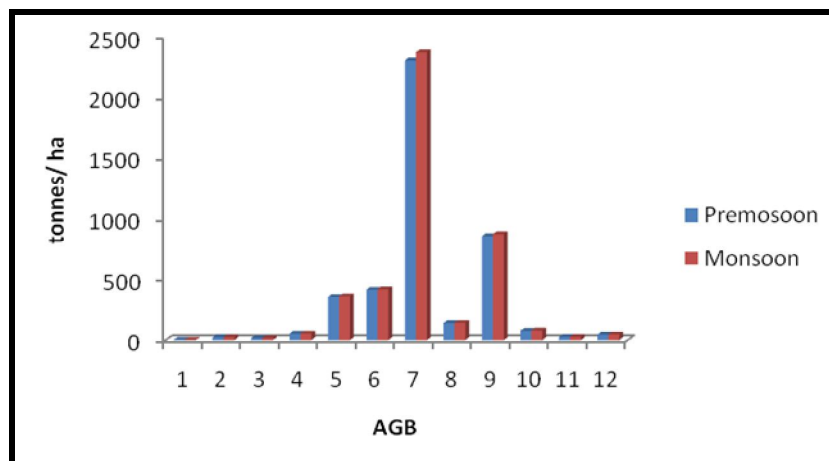


Figure 1: AGB in dominant trees species in the study site during premonsoon and monsoon

Above Ground Carbon (AGC)

The stored carbon in the tree is found to increase with the growth of species (documented in the present study in terms of biomass). Thus the AGC ranges from 1.51 tonnes ha⁻¹ (in *Lagerstroemia speciosa* during premonsoon) to 1128.74 tonnes ha⁻¹ (in *Delonix regia* during monsoon) (Figure 2, Table 1) in the study site.

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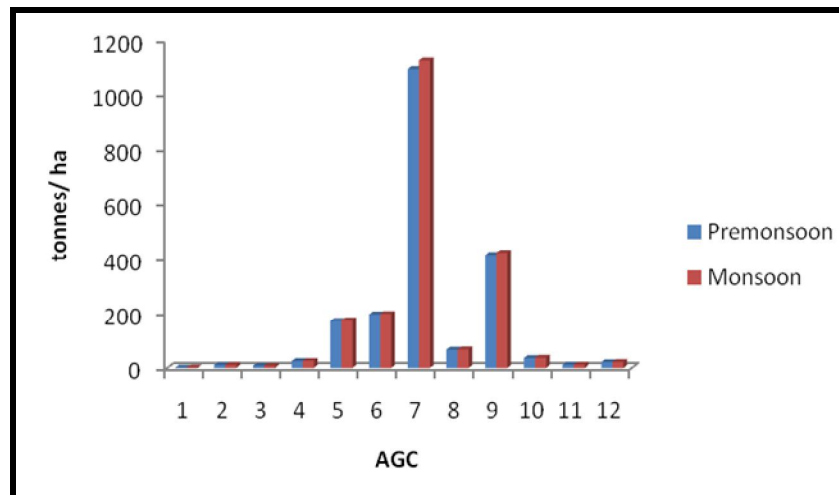


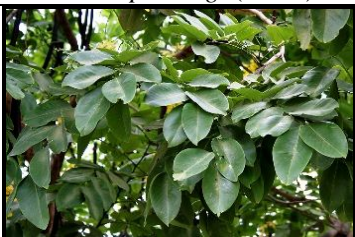


Figure 2: AGC in dominant trees species in the study site during premonsoon and monsoon

Table 1: Seasonal variation of AGB and AGC in the dominant trees species in the study site

Trees species	Premonsoon		Monsoon	
	A	B	A	B
 <i>Lagerstroemia speciosa</i> (Pride of India)	3.24	1.51	3.47	1.62
 <i>Mimusops elengi</i> (Bakul)	22.86	10.72	23.68	11.11
 <i>Cassia fistula</i> (Amaltas)	16.34	7.70	16.45	7.75

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Vol. 4, Issue 8, August 2015

 <p><i>Simarouba glauca</i> (Aceituna)</p>	52.13	25.13	53.08	25.58
 <p><i>Peltoforum pterocarpum</i> (Radhachura)</p>	359.38	172.14	364.23	174.47
 <p><i>Azadirachta indica</i> (Neem)</p>	419.31	196.66	423.04	198.41
 <p><i>Delonix regia</i> (Gulmohar)</p>	2311.18	1097.81	2376.29	1128.74
 <p><i>Ficus religiosa</i> (Peepal)</p>	138.96	66.98	140.68	67.81

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 <i>Pistacia vera</i> (Pista)	861.24	413.40	877.65	421.27
 <i>Albizia saman</i> (Rain tree / Shirish)	76.06	35.98	78.56	37.16
 <i>Alstonia scholaris</i> (Chatim)	25.40	11.94	26.13	12.28
 <i>Grewia asiatica</i> (Phalsa)	45.23	21.17	46.09	21.57

A: Above Ground Biomass (tonnes ha⁻¹); B: Above Ground Carbon (tonnes ha⁻¹)

IV. DISCUSSION

The city of Bhubaneswar is the capital of the maritime state of Odisha, which is situated in the North East coast of India. In recent times, high rises, shopping malls, national highways and luxurious apartments have grabbed a major portion of the city space. This has hiked up the city carbon dioxide concentration. The safe level of carbon dioxide concentration in the atmosphere is 350 ppm [3]. Apart from these, there are iron and steel, paper and cement industries in Bhubaneswar, which also emit considerable carbon dioxide in the atmosphere. Our team members documented a mean value of 407 ppm (mean of 24 hours) in the study site, which is 16.29 % higher than normal level (Figure 3).

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Figure 3: CO₂ analyser monitoring atmospheric carbon dioxide in the heart of the Bhubaneswar city

The trees, being the sink of CO₂ can regulate the CO₂ concentration in the atmosphere. However, the storage of carbon is species-specific in nature and depends on growth of the species, biomass of the species, soil quality and other environmental parameters. From the stored carbon values we observed the CO₂ - equivalent of *Delonix regia* (4028.97 tonnes ha⁻¹) > *Pistacia vera* (1517.17 tonnes ha⁻¹) > *Azadirachta indica* (721.73 tonnes ha⁻¹) > *Peltoforum pterocarpum* (631.77 tonnes ha⁻¹) > *Ficus religiosa* (245.81 tonnes ha⁻¹) > *Albizia saman* (132.04 tonnes ha⁻¹) > *Simarouba glauca* (92.21 tonnes ha⁻¹) > *Grewia asiatica* (77.69 tonnes ha⁻¹) > *Alstonia scholaris* (43.82 tonnes ha⁻¹) > *Mimusops elengi* (39.34 tonnes ha⁻¹) > *Cassia fistula* (28.24 tonnes ha⁻¹) > *Lagerstroemia speciosa* (5.55 tonnes ha⁻¹) in premonsoon and during monsoon the values were *Delonix regia* (4142.46 tonnes ha⁻¹) > *Pistacia vera* (1546.06 tonnes ha⁻¹) > *Azadirachta indica* (728.15 tonnes ha⁻¹) > *Peltoforum pterocarpum* (640.30 tonnes ha⁻¹) > *Ficus religiosa* (248.85 tonnes ha⁻¹) > *Albizia saman* (136.37 tonnes ha⁻¹) > *Simarouba glauca* (93.89 tonnes ha⁻¹) > *Grewia asiatica* (79.15 tonnes ha⁻¹) > *Alstonia scholaris* (45.07 tonnes ha⁻¹) > *Mimusops elengi* (40.77 tonnes ha⁻¹) > *Cassia fistula* (28.44 tonnes ha⁻¹) > *Lagerstroemia speciosa* (5.94 tonnes ha⁻¹). Such study has considerable implications not only in terms of prioritizing the species during afforestation (considering the CO₂ – equivalent values of the species), but it may also serve as a road map for planners to select those species for felling/cutting that has the least ecosystem service in terms of carbon storage.

V. CONCLUSION

The stored carbon in urban trees is regulated by abundance and biomass of the species. Considering the best suited species in the area in terms of AGB, it is needed to increase their abundance through plantation/ afforestation programme.

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