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Carbon Sequestration Potential of Eight Tree Species Selected from the Golapbag Campus of Burdwan University, West Bengal (India).

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ABSTRACT

The present study works out the natural carbon reservoir potential of eight tree species selected from those growing in the Golapbag campus of Burdwan University, were evaluated by non- destructive method. Carbon sequestration is a mechanism for removal of carbon from the atmosphere fallen victim to increasing levels of atmospheric carbon dioxide (CO,) and other "greenhouse" gases. All the selected species, although not dominating in the campus, were found to have good carbon storage potential. The highest value of carbon sequestration was seen in case of *Pterospermum acerifolium* (1909.48 g) and the lowest in *Trema orientalis* (72.78 g).These Carbon sequestration values further correlate with height and grith of the concerned species could reveal positive relationship. Thus the Carbon sequestration values of all the species lying within this range indicate them to be gradationally ideal for planting in highly polluted areas for moderation of the environmental temperature. These species need further evaluation for their Anticipated Performance Index (API) so that they can be selected for 'green-belt' development.

Keywords: Golapbag campus, trees, natural carbon reservoir, "greenhouse", 'green-belt',

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INTRODUCTION

In the present scenario, continuous accumulation of CO_2 and other greenhouse gases in the atmosphere is expected to cause observable climatic changes in the coming century. Before the Industrial Era, atmospheric carbon dioxide (CO_2) concentration was 280 ppm for several thousand years. It has risen continuously since then, reaching 367 ppm in 1999 [8]. India's CO_2 emissions in 2014 continued to increase by 7.8%. The increase in CO_2 emissions in 2014 was mainly caused by an 11.1% increase in coal consumption. This growth rate was above the 10-year average of 7% [5].

Forest carbon flows have the potential to fight against greenhouse gases emissions and make a significant contribution in the effort to mitigate global warming. Thus, evaluating carbon offsetting abilities of trees is the need of the hour.

Carbon sequestration is the process by which atmospheric carbon dioxide is absorb by green plants through photosynthesis [13] and transform into oxygen and sugars (carbon). Oxygen is released into the air, and carbon is stored as biomass in different plant parts (trunks, branches, leaves and roots) and which become a part of the food chain and enters in soil. Subsequently the carbon reenters into the atmosphere through burning and decomposition.

The carbon sequestration capacity of tree species depends upon its age, height, girth, size, biomass accumulation rates, canopy diameter wood density [2, 3, 9] and rotation lengths [1]. Long lived, slow- growing and high density hardwood trees store more carbon than short- lived, low-density and fast growing trees [12]. The sink of carbon sequestration in forests and wood products helps to offset sources of carbon dioxide to the atmosphere, such as deforestation, forest fires, and fossil fuel emissions.

The significance of role of biomass of tree species in carbon sequestration had long been recognized, and many attempts have been made to estimate the biomass production of forests and their contribution for sequestration of carbon using non harvest techniques. Selection of ideal species for carbon sequestration is very important step for restoration of reduced ecosystem. These 8 species are most widely distributed and medicinally as well as commercially important timber species growing greater part of India. There is a lack of knowledge, awareness and research on their carbon sequestration and economical potential, which creating a lacuna about their use in various ongoing carbon forestry schemes and economic aspects from the farmers. The present work reveals the carbon sequestration of eight tree species raised in Golapbag campus of Burdwan University.

MATERIALS AND METHODS

STUDY AREA

The study area i.e Golapbag campus [Fig.1] having the latitudes 23.24°N and longitudes 87.86°E with the total area of 56.3 acres. It has an average elevation of 40 meters (131 ft) above the mean sea level. The city is situated 1100 km from New Delhi and almost 100 km north-west of Kolkata on the Grand Trunk Road (NH-2) and Eastern Railway. Average temperature in summer season is 30°C while at the winter season is 20°C. The yearly rainfall is about 1174.0 mm received during the rainy season from June to the end of September and Non monsoon rainfall (mm) is about 425.6 which reflect that District experiencing annual water deficit with respect to total average receipt of rain fall. The climate of the region supports the Northern tropical dry deciduous forest.

The Burdwan University's academic cluster is located in Golapbag, royal rose garden of pristine beauty. Planned and executed by a British botanist in the mid nineteenth century, the pleasure park of the olden days is surrounded by a canal with a beautiful island (Dār-ul-Bāhār) at the centre of it. With nearly 1200 trees, 154 rare centuries' old mahogany trees included, the historic Golapbag has been recently declared by the Botanical Survey of India as the Bio-diversity Heritage site. A number of factors such as variation in microhabitats, so much of land open to plantation, ornamentation and botanical studies, plenty of water bodies ,Diversity of microhabitats in the campus have led to the assemblage of variable plant species .

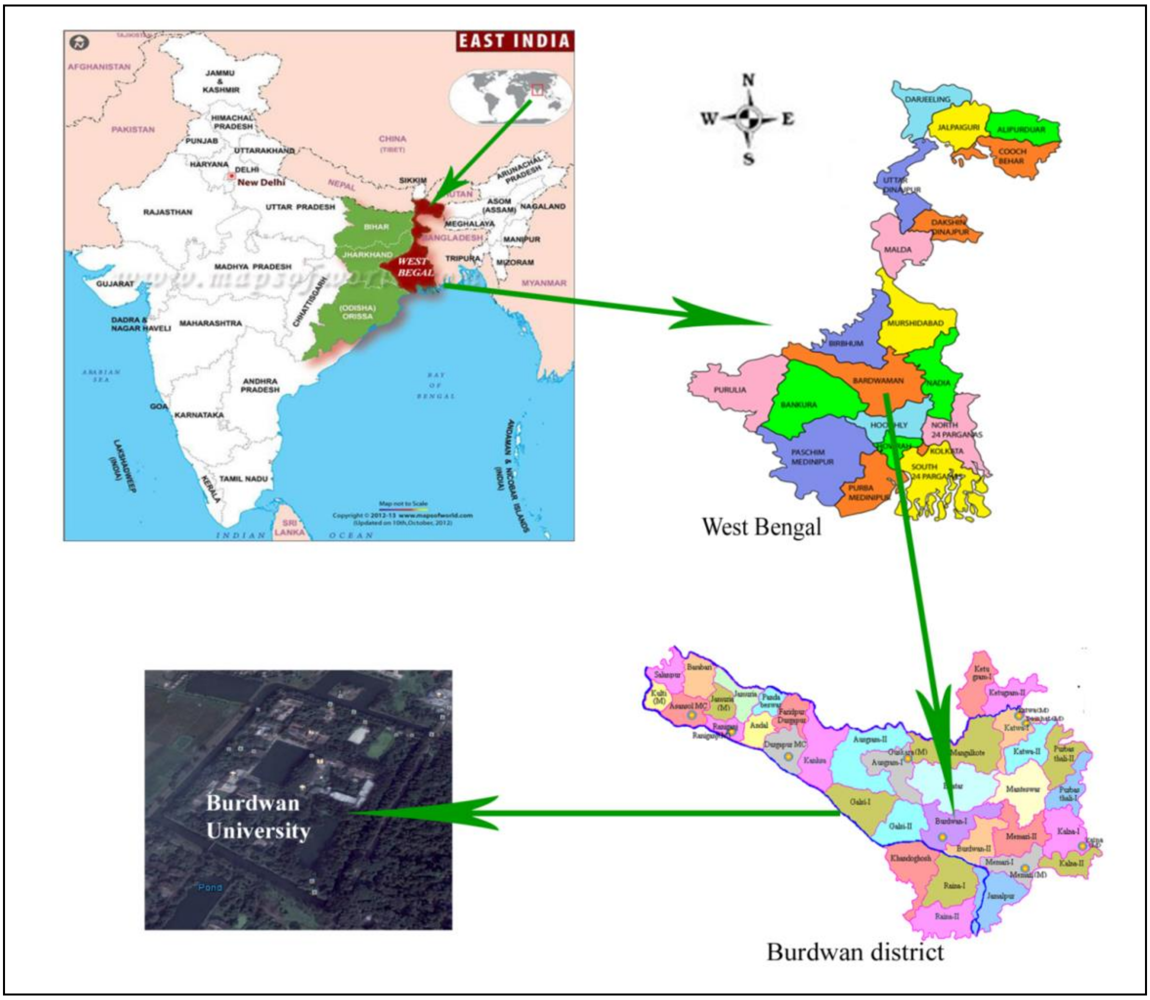

Figure 1: Map of study site located in Burdwan district of West Bengal, India

As many as eight species were selected. Non destructive allometric method was employed to estimate carbon stock in each plant species. The biomass of tree was estimated on the basis of different indicator parameters (e.g. tree DBH, height). The following parameters were measured for estimating biomass pool.

Measurement of DBH (Diameter at breast height):

DBH can be estimated by measuring tree Girth at Breast Height (GBH), approximately 1.3 meter from the ground [4]. The GBHs of trees were measured directly by measuring tape. Tree diameter (D) was calculated by dividing 3.14 to the marked girth of tree i.e. GBH/3.14

Measurement of tree height:

By using Theodolite instrument tree height was measured at DBH. Then height (H) of the tree is calculated by the following formula [10].

$$H = h + b \tan\theta$$

Here, h is height of horizontal plane of Theodolite. b is the distance in feet between tree and observer. θ is the angle between eye view at breast height and top of the tree.

Measurement of above ground biomass:

AGB include all living biomass above the soil. The aboveground biomass (AGB) has been calculated by multiplying volume of biomass and wood density. Tree bio-volume (TBV) value established by multiplying of diameter and height of tree species to factor 0.4[4].

$$\text{Tree Bio-volume (TBV)} = 0.4 \text{X} (D)^2 \text{ x H}$$

$$\text{AGB (kg)} = \text{Tree bio volume TBV (m3) x wood density (kg/m3}$$

Where; D = (GBH/π), diameter (meter) calculated from GBH, assuming the trunk to be cylindrical [6], H = Height (meter).

Wood density is used from Global wood density database [6, 14]. The standard average density of 0.6 gm/ cm is applied wherever the density value is not available for tree species [6].

Measurement of below ground biomass:

The belowground biomass (BGB) includes all biomass of roots .The belowground biomass has been calculated by multiplying the above ground biomass (AGB) by 0.26 factors as the root: shoot ratio [4,6].

Belowground biomass (BGB) kg/tree = aboveground biomass (AGB) kg/tree x 0.26

Total biomass:

Total biomass is the sum of the above and below ground biomass. [11]

Total Biomass (TB) = Above Ground Biomass + Below Ground Biomass

Carbon Estimation:

Generally, for any plant species 50% of its biomass is considered as carbon [7] i.e. Carbon Storage = Biomass x 50% or Biomass/2

On the basis of the Plants height Phanerophytes were categoriesed as follows [2]:

Mega- phanerophytes: - Over 30 meter high
Meso- phanerophytes:-8-30 meter high
Micro- phanerophytes:-2-8 meter high
Nano- phanerophytes: - Under 2 meter

On the basis of this classification the selected tree species are classified which are listed below (Table 1)

Table 1: Representing the tree species with their family and common name.

Serial no.	Scientific name	Family	Common name	Types of phanerophytes	Total no.[3] in site
1.	*Aegle marmelos* (L.) Corrêa	Rutaceae	Bel	Meso-phanerophytes	9
2.	*Aphanamixis polystachya* (wall.) R.Parker	Meliaceae	Pithraj Tree	Micro-phanerophytes	7
3.	*Grewia asiatica* L.	Urticaceae	phalsa	Micro-phanerophytes	5
4.	*Pterospermum*	Urticaceae	Muskanda,	Meso-	5

	acerifolium (l.) Willd.		kanak champa	phanerophytes	
5.	*Kavalama urens(* roxb.)Raf.	Malvaceae	Kulu	Meso-phanerophytes	5
6.	*Trema orientalis* (l.) Blume.	Cannabaceae	Chikan	Meso-phanerophytes	5
7.	*Artocarpus heterophyllus* lam.	Moraceae	Jackfruit	Micro-phanerophytes	4
8.	*Holarrhena pubescens* wall. Ex G. Don.	Apocynaceae	Indrajao	Meso-phanerophytes	3

RESULTS AND DISCUSSION

Table 2: List of Physiological Details of Selected Tree Species in study area

Name of the plant	Plant replica no.	GBH (in meter)	Diameter in meter	Height in meter	T_{bv} (meter^3)	AGB in kg	BGB(kg)	TB(kg)	Crbon storage (Gram)	carbon sequestration potential
Aegle marmelos	1	1.35	0.4295	14	1.0330	0.6198	0.1611	0.7809	390.45	
	2	0.63	0.2005	13.9	0.2235	0.1341	0.0349	0.169	84.5	
	3	2.85	0.9068	15.1	4.9666	2.9799	0.7748	3.7547	1877.35	784.1
Aphanamixis polystachya	1	1.15	0.3659	10.2	0.5462	0.3277	0.0852	0.4129	206.4	
	2	0.37	0.1177	7.3	0.0405	0.0243	0.0063	0.0306	15.3	
	3	0.74	0.2354	15	0.3325	0.1995	0.0519	0.2514	125.7	115.8
Grewia asiatica	1	0.88	0.28	6.8	0.2132	0.1279	0.0333	0.1612	80.6	
	2	0.91	0.2895	9.2	0.3084	0.1850	0.0481	0.2331	116.55	
	3	0.66	0.21	7.1	0.1252	0.0751	0.0195	0.0946	47.3	81.48
Pterospermum acerifolium	1	3.85	1.225	19.6	11.7649	7.0589	1.8353	8.8942	4447.1	
	2	0.8	0.2545	15.1	0.3912	0.2347	0.0610	0.2957	147.85	
	3	1.91	0.6077	20.3	2.9987	1.7992	0.4678	2.267	1133.5	1909.48
Kavalama urens	1	0.68	0.2164	12	0.2248	0.1349	0.0351	0.17	85	
	2	2.3	0.7318	20.6	4.4128	2.6477	0.6884	3.3361	1668.05	
	3	1.43	0.455	16.3	1.3498	0.8099	0.2106	1.0205	510.25	754.43
Trema orientalis	1	0.54	0.1718	11	0.1299	0.0779	0.0203	0.0982	49.1	
	2	0.7	0.2227	12.3	0.244	0.1464	0.0381	0.1845	92.25	
	3	0.65	0.2068	11.9	0.2036	0.1222	0.0318	0.154	77	72.78
Artocarpus heterophyllus	1	1.78	0.5664	16.1	2.066	1.2396	0.3223	1.5619	780.95	
	2	0.82	0.2609	7.9	0.2151	0.1291	0.0336	0.1627	81.35	
	3	1.49	0.4741	9.2	0.8272	0.4963	0.1290	0.6253	312.65	391.65
Holarrhena pubescens	1	0.87	0.2768	8.2	0.2513	0.1508	0.0392	0.19	95	
	2	1.95	0.6204	13.3	2.0476	1.2286	0.3194	1.548	774	
	3	0.76	0.2418	12	0.2806	0.1684	0.0438	0.2122	106.1	325.03

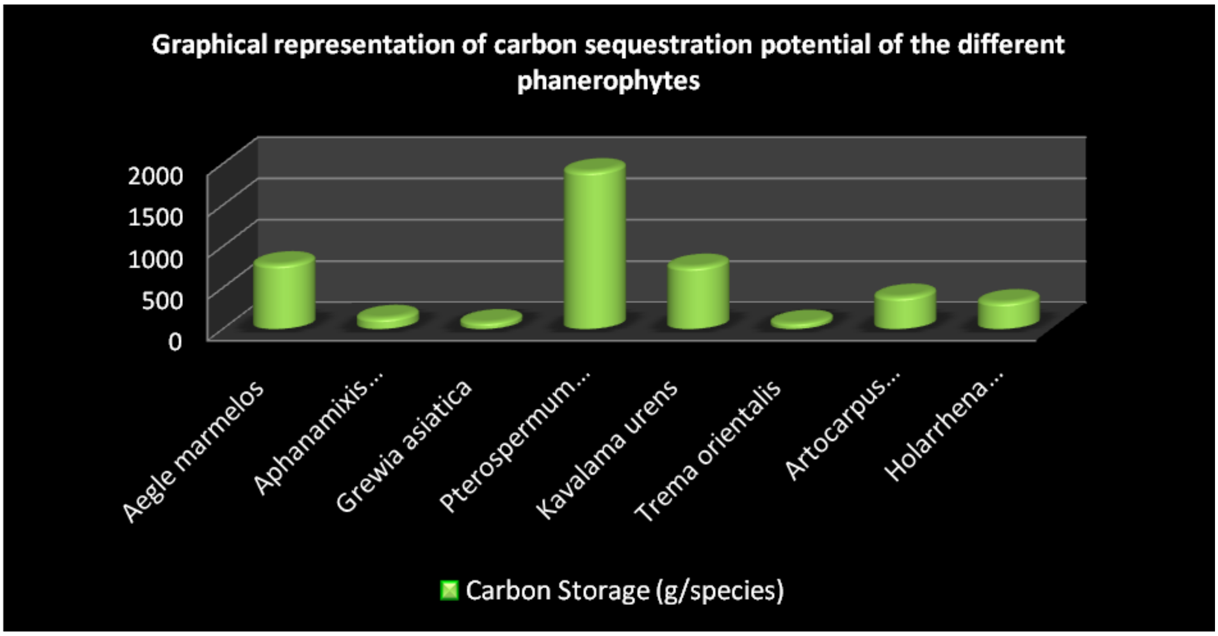

Table 3: Correlation between GBH and carbon sequestrational potential of different phanerophytes

Name of the plant	Correlation coefficient values(GBH)
Aegle marmelos	0.9839**
Aphanamixis polystachya	0.984**
Grewia asiatica	0.8873
Pterospermum acerifolium	0.9888**
Kavalama urens	0.9779**
Trema orientalis	1.1586
Artocarpus heterophyllus	0.9186*
Holarrhena pubescens	0.9923**

Table 4: Correlation between height and carbon sequestrational potential of different phanerophytes

Name of the plant	Correlation coefficient values(H)
Aegle marmelos	0.9945**
Aphanamixis polystachya	0.4543
Grewia asiatica	0.8159
Pterospermum acerifolium	0.5809
Kavalama urens	0.9661**
Trema orientalis	0.9973**
Artocarpus heterophyllus	0.9834**
Holarrhena pubescens	0.7072

* Significant at P 0.05 ** Significant at both P 0.05 and P 0.01

The data related to carbon sequestered by 8 different genera including 24 individuals phanerophytes were assessed from the Golapbag campus of Burdwan University. Table-1 demonstrates total number of trees of each species present in the area. Out of these eight genera five are mesophanerophytes and rest three are micro phanerophytes. Table 2 indicates the GBH in cm and tree height in meters. The above ground Biomass (AGB) per tree, below ground biomass (BGB) per tree, the total biomass of individual species and the total carbon sequestrated in each genera have been summarized. Among the eight selected species, major carbon sequestrating species were *Pterospermum acerifolium* (1909.48), followed by *Aegle marmelos* (784.1), *Kavalama urens* (754.43), *Artocarpus heterophyllus* (391.65), *Holarrhena pubescens* (325.03). *Aphanamixis* polystachya (115.8). The *Trema orientalis* has lowest carbon sequestration potential (72.78) and the second lowest carbon sequestrating species was *Grewia asiatica* having carbon content 81.48. From study we can concluded that out of 8 species *Pterospermum acerifolium* showed highest potential to maintain carbon stocks which harvest more CO_2 from atmosphere as well as *Pterospermum acerifolium, Aegle marmelos, Kavalama urens, Artocarpus heterophyllus, Holarrhena pubescens* has considerable contribution in managing the increase levels of CO_2. All the phanerophytes shows positive correlation between GBH and carbon storage potential, among them *Aegle marmelos*, Aphanamixis *polystachya*, *Pterospermum acerifolium*, *Kavalama urens* and *Holarrhena pubescens* coefficient values which is significant at both P 0.05 and P 0.01 level respectively and only *Artocarpus heterophyllus* is significant at P 0.05 level. If the GBH is increased then the carbon sequestration potential will be incresed in case of the 8 species (Table 3). Increasing height shows higher carbon sequestration potential. *Aegle marmelos*, *Kavalama urens*, *Trema orientalis*, *Artocarpus heterophyllus* possess positive correlation significant at both P 0.05 and P 0.01 level (Table 4).

CONCLUSION

From the present work it was observed that *Pterospermum acerifolium*, species was found to be dominant that sequestered (1909.48) of carbon followed by *Aegle marmelos* (784.1) (Table 2).

Looking to the serious concern of carbon management to mitigating the global warming problem the research can be useful for estimating capacity of the selected tree species in different place of Burdwan district for the purpose of obtaining carbon finance and assessing the contribution to reducing the carbon concentration in atmosphere. The rate of carbon sequestration potential increse with the enlargement of GBH and height of these tree species.

The greenery of the campus has been optimizing the environment by constituting a green patch in the peri-urban area of Bardhaman city to sustain a wide diversity of flora which is essential for Pollution abatement to control or eliminate pollution from a given environment.

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