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Tree Biomass, Carbon Inventory and Annual Carbon Sequestration Potential of Different Tree Species in a Coastal District of West Bengal, India

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A study was conducted to assess tree biomass, carbon stock and annual carbon sequestration potential of avenue and plantation tree species in a coastal district of West Bengal, India, using a non-destructive allometric approach. The investigation was carried out within an institutional landscape located in South 24 Parganas district (22.259694° - 22.267877° N latitude and 88.195386° - 88.198760° E longitude), covering an area of 16 ha. A total of 1,052 trees belonging to 86 species, with ages ranging from 6 to 34 years, were inventoried and analysed for above-ground biomass, below-ground biomass, carbon stock and CO_2 sequestration. The total above-ground and below-ground biomass of the inventoried trees was estimated at 760.55 t and 152.11 t, respectively, resulting in a total carbon stock of 212.66 t. The cumulative CO_2 sequestration was estimated to be 779.60 t, with an annual sequestration rate of 34.36 t CO_2 yr^{-1}, equivalent to 2.15 t CO_2 ha^{-1} yr^{-1}. Among individual species, *Ceiba pentandra* exhibited the highest average annual CO_2 sequestration per tree (2.98 t $tree^{-1}$ yr^{-1}), whereas *Cascabela thevetia* showed the lowest sequestration potential (0.03 t $tree^{-1}$ yr^{-1}). At the species population level, *Roystonea regia* contributed the maximum share of total CO_2 sequestration, followed by *Delonix regia*, *Lagerstroemia speciosa*, *Neolamarckia cadamba* and *Spathodea campanulata*. The findings highlight the significant role of mixed plantations in carbon storage and sequestration within coastal institutional and peri-urban landscapes. Species-wise carbon sequestration estimates generated in this study can support informed tree selection and landscape planning strategies aimed at climate change mitigation in coastal regions of eastern India.

(***Key words:*** *Carbon stock, CO_2 sequestration, Coastal West Bengal, Non-destructive method, Tree biomass*)

With time, rapid industrialization, population growth, and increased human activities have led to higher greenhouse gas emissions, driving climate change across the world. This has resulted in profound and far-reaching effects on the environment and society, including rising temperatures, ocean acidification, melting glaciers, rising sea levels, extreme weather events, changes in precipitation patterns, biodiversity loss, and adverse impacts on agriculture, human livelihoods, health, and sustainability. Mitigating climate change requires actions such as transitioning to renewable energy, improving energy efficiency, promoting reforestation and conservation, and implementing sustainable agricultural practices through international agreements (IPCC Report, 2022).

These impacts are particularly severe in coastal regions, where low elevation, saline intrusion and high population density increase vulnerability to climate-induced stresses.

Deforestation, driven by agricultural expansion, timber and wood extraction, loss of fauna, wildfires, landscape fragmentation, the spread of second-growth forests, invasive species, and pathogens, has critical ecological consequences. These factors contribute to rising CO_2 levels and exacerbate climate change (Malhi *et al.*, 2014).

The transition to renewable energy involves shifting from fossil fuels like coal, oil, and natural gas to sustainable sources such as solar, wind, hydropower, geothermal, biomass, and biofuels. This shift is essential to reducing greenhouse gas emissions, combating climate change, and establishing a sustainable energy system (World Economic Forum, 2024). Environmental mitigation measures to address climate change include protecting and restoring ecosystems, afforestation, renewable energy adoption, energy efficiency improvements, and regenerative agriculture (The United Nations Framework Convention on Climate Change, 2024).

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Trees play a crucial role in managing atmospheric carbon through photosynthesis, a process in which they absorb CO_2 and store carbon in their wood, branches, leaves, bark, and roots. By converting CO_2 and water into sugars and oxygen, trees distribute the stored carbon throughout their tissues. This process, known as carbon sequestration, makes forests and trees the largest land-based carbon sinks on Earth. However, when trees decay, they release carbon dioxide back into the atmosphere. The carbon sequestration capacity of trees increases with age, as older trees are more efficient at absorbing CO_2. The amount of carbon stored depends on girth size, categorized as either below or above 12 inches in diameter.

Several studies have assessed carbon sequestration in various tree species and ecosystems. A study conducted between 2019 and 2022 in the dry deciduous forests of Uttar Kannada district, Karnataka, estimated tree carbon content. Results showed the highest carbon sequestration in *Tectona grandis*, followed by *Careya arborea* and *Lagerstroemia lanceolata*. However, deciduous forests are at high risk of degradation and deforestation due to natural and human-induced factors, leading to carbon release into the atmosphere (Banavasi and Koppad, 2022).

A comparative study in two cities in Gujarat used remote sensing technology to analyze carbon sequestration among three tree species, ranking *Azadirachta indica* highest, followed by *Acacia* sp. and *Cassia* sp. (Arya *et al.*, 2017). Similarly, a study in Thane city found that carbon sequestration was highest in *Azadirachta indica*, followed by *Ficus benghalensis*, *Tamarindus indica*, *Casuarina equisetifolia*, and *Pongamia pinnata*, highlighting the role of urban trees in reducing atmospheric CO_2 (Aasawari and Kakde, 2020).

The Council on Energy, Environment, and Water (CEEW) published a report emphasizing that Carbon Capture and Storage (CCS) can reduce emissions from key economic sectors without requiring major changes to existing fuels or technology (Bakshi *et al.*, 2023). Recent studies have further emphasized the importance of nature-based solutions, including urban and institutional tree plantations, as cost-effective and sustainable approaches for climate change mitigation (Priya *et al.*, 2023).

A study on tree carbon sequestration at Vinoba Bhave University assessed 25 tree species, identifying *Peltophorum* sp. as the highest CO_2-sequestering species, while *Carica papaya* had the lowest sequestration rate (Ranjan and Mishra, 2016). Additionally, research evaluating carbon sequestration based on tree trunk diameter, height, and canopy found that tree species with greater girth growth over shorter periods may be more suitable for selection in afforestation projects compared to forest-grown specimens (Chi *et al.*, 2020).

Despite the availability of such studies, species-wise information on tree biomass, carbon stock and annual carbon sequestration potential under coastal climatic conditions remains limited, particularly for non-forest land-use systems such as institutional campuses and avenue plantations in eastern India. These landscapes are often excluded from conventional forest carbon inventories, resulting in a lack of baseline data for regional carbon management.

Given the importance of carbon sequestration, this study aimed to collect data on various tree species, carbon stock, CO_2 sequestration levels, and the sequestration efficiency of individual species using a non-destructive method at an institutional landscape located in South 24 Parganas district, West Bengal. By expressing carbon stock and sequestration on a per species, per tree and per unit area basis, the study seeks to generate regionally relevant benchmarks applicable to coastal and peri-urban environments, rather than limiting the findings to a single campus.

MATERIALS AND METHODS

Study area

The study was conducted at The Neotia University (TNU) campus, a rural area located near Diamond Harbour Road, close to Jhinga and Sarisha, in the coastal district of South 24 Parganas, West Bengal, India. The geographical coordinates of the study area range between latitudes 22.267877°N and 22.259694°N, and longitudes 88.195386°E and 88.198760°E. Covering an area of 16 hectares, the campus is surrounded by three neighboring villages-Cheora, Amira, and Jhingasituated within the Diamond Harbour-II block of South 24 Parganas district in West Bengal, India.

The Ganges River flows approximately 16 km west of the study site, while the Bay of Bengal is about 80 km away, indicating its location within the coastal influence zone of eastern India. The region experiences a warm and humid climate, with summer temperatures ranging from 15°C to 35°C. The area receives an average annual rainfall of 1600 mm, and the soil is saline in nature, which is typical of coastal agro-ecological regions. The trees on campus were planted as part of landscape and environmental management programmes, with their ages ranging from 6 to 34 years. Only trees with a girth of at least one foot were included in this study.

The university campus comprises playgrounds, agricultural instructional fields, roadside plantations, gardens, and open green spaces. Based on field observation and visual interpretation of high-resolution satellite imagery (Google Earth, 2024), the land use land cover of the study area was classified into five major categories, namely built-up area (academic buildings and infrastructure), avenue plantations along roads, managed gardens and parks, agricultural instructional fields, and open grassland areas. Avenue and block plantations constitute the dominant tree-based land cover, representing the primary carbon-sequestering component of the landscape. This classification indicates that the study area represents a managed institutional green landscape under coastal peri-urban land use.

Materials used

For data collection, processing, and analysis, standard forestry and geospatial tools were used, including measuring tape for girth measurement, Ravi altimeter for tree height measurement, and a handheld Global Positioning System (GPS-Garmin Etrex 10) receiver for recording geographic coordinates. Spatial data processing and mapping were carried out using QGIS software.

Tree locations and inventory

To estimate the carbon stock of trees within the study area, the campus was divided into four zones based on infrastructure and plantation distribution. Each zone was further subdivided into sub-zones for systematic data collection. Tree selection followed a targeted approach, focusing on trees with a girth of at least 12 inches. Exact tree locations were determined by recording latitude and longitude using GPS. During the survey, each tree was identified and its botanical name, local name, and family were recorded.

Measurement of girth and tree height

Tree girth was measured at breast height (1.37 m above ground level), which is the standard reference height for forest biomass estimation. Tree height was measured using an altimeter based on the trigonometric method.

Biomass estimation using allometric equation

The carbon content and CO_2 sequestration of trees were estimated using a non-destructive method based on allometric equations (Chopra *et al.*, 2023). Field measurements of tree diameter and height were used for biomass estimation. Allometric equations are widely used and accepted for estimating tree biomass under Indian conditions and are recommended by IPCC (2006), Forest Survey of India (FSI, 2019), and Chave et al. (2005, 2014) for tropical tree species. These equations provide reliable biomass estimates without destructive sampling and have been validated for tropical and subtropical climatic regions similar to eastern India. Allometry refers to the proportional relationship between different parts of a plant and its overall size. Using this principle, tree biomass was estimated from measurable parameters such as diameter and height.

Calculation of above-ground and below-ground biomass

The carbon content and CO_2 sequestration of trees were estimated using a non-destructive method based on allometric equations. Field surveys were conducted to collect ground-based measurements, including stem diameter at girth and tree height. Measurements were taken in inches for tree trunk diameter, feet for tree height, and metric tons for weight. Tree biomass is divided into above-ground biomass (AGB) and below-ground biomass (BGB).

Above-ground biomass (Biomass in stems, branches, and leaves) was calculated using the following equation using the assumption that trees contain approximately 25% water by weight:

AGB = $(0.25 \times D^2 \times H)/2000$ in ton (Chi *et. al.*, 2020).

where: D = Diameter at breast height (DBH) in centimetre; H = Tree height in meter.

Below-ground biomass (Biomass in roots, assumed to be 20% of AGB) was calculated using the standard assumption:

BGB = $0.20 \times$ AGB

This root-to-shoot ratio is recommended by IPCC (2006) for tropical trees.

Total biomass was calculated as:

Total Biomass = AGB + BGB

Total dry biomass (TDB) was derived by multiplying TPB by 0.5, based on the assumption that dry matter constitutes 50% of total green biomass. The Total Carbon Stock was estimated by multiplying total dry biomass by 0.475, assuming that 47.5% of dry biomass consists of carbon.

Dry biomass was estimated as: Dry Biomass = $0.5 \times$ Total Biomass

Carbon stock was calculated as: Carbon Stock = $0.475 \times$ Dry Biomass

This carbon fraction value is widely used in forest carbon estimation studies in India and tropical regions.

Calculation of carbon sequestration

Total CO_2 sequestration was calculated using the conversion factor:

CO_2 sequestered = Carbon stock × 3.67; Annual CO_2 sequestration was calculated by dividing total CO_2 sequestration by tree age. Carbon sequestration was also expressed on per unit area basis ($t\ CO_2\ ha^{-1}\ yr^{-1}$) by dividing total annual sequestration by the total study area (16 ha), in order to enable comparison with other regional and national-level studies.

RESULTS AND DISCUSSION

Tree inventory

The study area, including zones, sub-zones of The Neotia University, and tree species distribution, is illustrated in Fig. 1.

Trees were dispersed throughout the campus, with a significant number lining both sides of the internal campus roads, forming avenue plantations. A total of 1,052 trees were recorded, representing 86 different species. The latitude and longitude of each tree species were collected and mapped using GIS platform.

Fig. 1 has been prepared to show the spatial distribution of carbon stock of trees across the study area. The map highlights variation in carbon storage potential among different plantation zones, indicating areas of relatively higher and lower biomass accumulation. Such spatial delineation helps in identifying priority areas for future plantation and carbon management planning.

Total carbon stock in trees

The total biomass, carbon stock, and sequestered CO_2, along with the yearly average carbon sequestration for each tree species, are presented in Table 1. The calculated total Above-ground biomass (AGB) was 760.55 tons, while the Below-ground biomass (BGB) was 152.11 tons. Consequently, the total green biomass amounted to 912.66 tons, and the total dry biomass was 456.33 tons. The total carbon stock of the trees in the study area was estimated at 212.66 tons, with a total CO_2 sequestration of 779.60 tons.

The overall annual carbon sequestration rate was calculated as 34.36 tons CO_2 per year. When expressed on per unit area basis, the annual carbon sequestration rate was estimated at 2.15 tons CO_2 per hectare per year, and the carbon stock was 13.29 tons per hectare. This allows comparison with similar studies conducted in other coastal and peri-urban landscapes. The observed carbon stock reflects the contribution of institutional plantations in enhancing carbon storage in non-forest land use systems, which are often not included in conventional forest carbon inventories.

Carbon sequestration potential of different tree species

The highest and lowest average CO_2 sequestration rates (tons $tree^{-1}$ $year^{-1}$) were observed in *Ceiba pentandra* (2.98 tons $tree^{-1}$ $year^{-1}$) and *Cascabela*

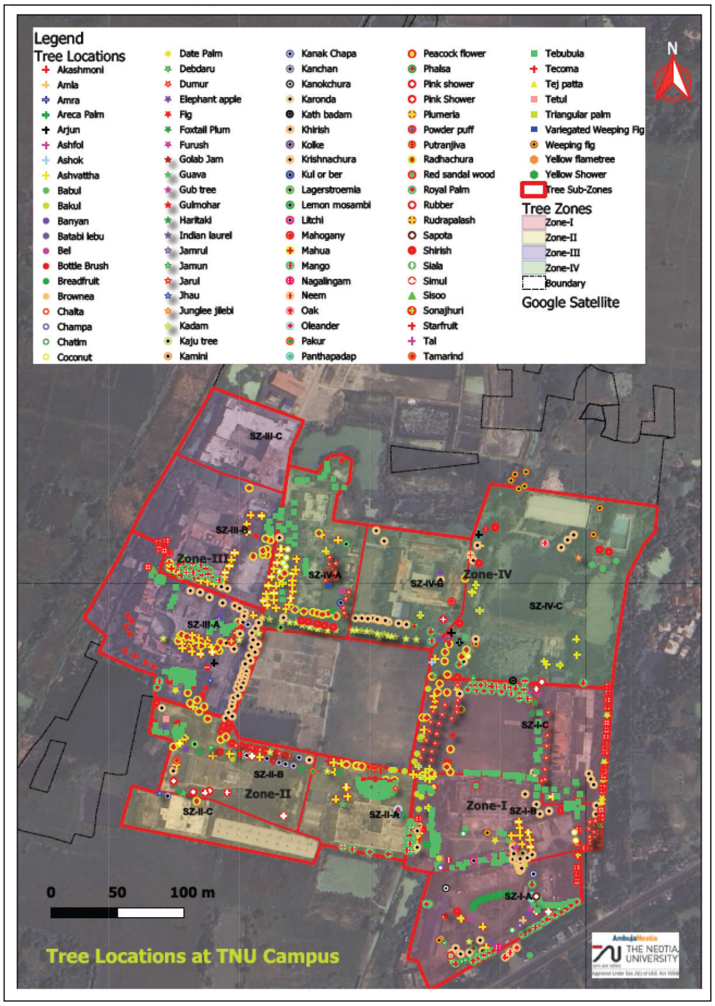

Fig. 1. *Tree Distribution Map in The Neotia University Campus*

thevetia (0.03 tons tree^{-1} year^{-1}), respectively. This variation is primarily due to differences in tree size, growth rate, wood density, and biomass accumulation capacity. Large, fast-growing species such as *Ceiba pentandra*, *Alstonia scholaris*, and *Neolamarckia cadamba* demonstrated higher carbon sequestration potential compared to smaller ornamental species. Species such as *Roystonea regia*, *Delonix regia*, *Lagerstroemia speciosa*, and *Neolamarckia cadamba* contributed significantly to the total carbon stock due to their higher population and biomass, highlighting their importance for carbon management in coastal landscapes.Comparable variations in carbon sequestration among tree species have also been reported in other institutional and urban ecosystems in India (Singh and Singh, 2012; Priya *et al.*, 2023), indicating that species selection plays a crucial role in maximizing carbon sequestration.

Spatial distribution of tree carbon stock and its ecological implications

The carbon stock shows that areas with dense plantation and mature trees exhibited higher carbon accumulation compared to sparsely vegetated zones. This spatial variation is influenced by tree age, species composition, and plantation density. The spatial distribution of tree carbon stock also has important implications for soil carbon sequestration. Trees contribute organic matter to soil through litter fall, root biomass, and decomposition, which enhances soil organic carbon over time. Therefore, areas with

Table 1. *Inventory of trees and calculation of sequestered CO_2 of trees in the The Neotia University (TNU) Campus*

Scientific name	No. of trees	Average age (Year)	Average height (ft)	Average girth (Inch)	Average diameter (Inch)	Average above ground biomass (tons tree^{-1})	Average below ground biomass (tons tree^{-1})	Average total biomass (tons tree^{-1})	Average total dry biomass (tons tree^{-1})	Average total carbon stock (tons tree^{-1})	Average Ttotal CO_2 sequestrated (tons tree^{-1})	Average annual sequestered CO_2 (tons year^{-1})	Total seques-tered CO_2 (tons)	Total se-questered carbon (tons)	Total se-questered CO_2 (tons year^{-1})
Acacia auriculiformis	7	16	42.46	42.4	13.5	0.82	0.16	0.98	0.49	0.23	0.84	0.05	5.91	1.61	0.37
Aegal marmelos	2	16	35.67	40.2	12.8	0.57	0.11	0.68	0.34	0.16	0.59	0.04	1.17	0.32	0.07
Albizia lebbeck (L.) Benth.	7	16	52.78	51.55	16.42	1.36	0.27	1.63	0.82	0.38	1.40	0.09	9.83	2.68	0.61
Albizia saman (Jacq.) Merr.	38	27	43.84	55.55	17.69	1.2	0.24	1.44	0.72	0.34	1.24	0.05	47.14	12.86	1.75
Alstonia scholaris (L.)	4	19	41.82	78.6	25.03	2.47	0.49	2.97	1.49	0.70	2.56	0.13	10.23	2.79	0.54
Anacardium occidentale	1	14	30.75	21	6.69	0.17	0.03	0.21	0.11	0.05	0.18	0.01	0.18	0.05	0.01
Artocarpus altilis (Parkinson) Fosberg	1	23	63.56	57.6	18.34	1.6	0.32	1.92	0.96	0.45	1.65	0.07	1.65	0.45	0.07
Averrhoa carambola	1	13	27.47	25.2	8.03	0.22	0.04	0.27	0.14	0.06	0.23	0.02	0.23	0.06	0.02
Azadirachta indica A. Juss.	5	18	29.57	24.24	7.72	0.18	0.04	0.22	0.11	0.05	0.19	0.01	0.95	0.26	0.05

Bauhinia variegata	8	24	35.67	33.15	10.56	0.33	0.07	0.39	0.20	0.09	0.34	0.01	2.69	0.73	0.11
Bombax ceiba L.	3	28	51.53	72.32	23.03	2.06	0.41	2.48	1.24	0.58	2.14	0.08	6.41	1.75	0.23
Borassus flabellifer	3	33	49.34	59.2	18.85	1.33	0.27	1.6	0.80	0.38	1.38	0.04	4.14	1.13	0.13
Brownea grandiceps	1	27	56.99	69.6	22.17	2.1	0.42	2.52	1.26	0.59	2.17	0.08	2.17	0.59	0.08
Caesalpinia pulcherrima	71	19	38.21	34.56	11.01	0.53	0.11	0.63	0.32	0.15	0.54	0.03	38.54	10.51	2.03
Calliandra haematocephala	1	18	20.9	18	5.73	0.09	0.02	0.1	0.05	0.02	0.09	0.00	0.09	0.02	0.00
Callistemon lanceolatus	11	22	29.11	33.38	10.63	0.3	0.06	0.36	0.18	0.08	0.31	0.01	3.41	0.93	0.16
Carissa carandas	1	24	37.31	30	9.55	0.26	0.05	0.31	0.16	0.07	0.27	0.01	0.27	0.07	0.01
Cascabela thevetia	1	24	14.34	12	3.82	0.03	0.01	0.03	0.02	0.01	0.03	0.00	0.03	0.01	0.00
Cassia fistula	1	31	47.15	48	15.29	0.83	0.17	0.99	0.50	0.23	0.85	0.03	0.85	0.23	0.03
Cassia javanica	6	18	41.68	56	17.83	1.08	0.22	1.3	0.65	0.31	1.12	0.06	6.72	1.83	0.37
Casuarina equisetifolia	1	19	53.71	48	15.29	0.94	0.19	1.13	0.57	0.27	0.97	0.05	0.97	0.27	0.05
Ceiba pentandra	1	34	53.71	84	26.75	2.88	0.58	3.46	1.73	0.81	2.98	0.09	2.98	0.81	0.09
Cinnamomum tamala	1	12	43.87	30	9.55	0.5	0.1	0.6	0.30	0.14	0.52	0.04	0.52	0.14	0.04

Citrus limetta	1	11	27.47	27.6	8.79	0.27	0.05	0.32	0.16	0.08	0.28	0.03	0.28	0.08	0.03
Citrus maxima	1	16	34.03	40.8	12.99	0.43	0.09	0.52	0.26	0.12	0.45	0.03	0.45	0.12	0.03
Cocos nucifera	9	26	47.52	38.53	12.27	0.57	0.11	0.69	0.35	0.16	0.59	0.02	5.35	1.46	0.21
Couroupita guianensis	1	21	37.31	54	17.2	0.83	0.17	0.99	0.50	0.23	0.85	0.04	0.85	0.23	0.04
Dalbergia sissoo	39	32	46.82	47.17	15.02	0.86	0.17	1.04	0.52	0.24	0.90	0.03	34.94	9.53	1.09
Delonix regia	96	24	41.54	52.24	16.64	1.02	0.2	1.22	0.61	0.29	1.05	0.04	100.90	27.52	4.20
Dillenia indica	3	21	34.57	40.8	12.99	0.52	0.1	0.63	0.32	0.15	0.54	0.03	1.63	0.44	0.08
Dimocarpus longan	1	31	53.71	72	22.93	2.12	0.42	2.54	1.27	0.60	2.19	0.07	2.19	0.60	0.07
Diospyros discolor	1	23	43.87	45	14.33	0.68	0.14	0.81	0.41	0.19	0.70	0.03	0.70	0.19	0.03
Dypsis decaryi	1	21	29.11	30	9.55	0.33	0.07	0.4	0.20	0.09	0.34	0.02	0.34	0.09	0.02
Dypsis lutescens	26	25	41.22	24.26	7.73	0.32	0.06	0.38	0.19	0.09	0.33	0.01	8.51	2.32	0.34
Ficus benghalensis	8	20	38.78	38.34	12.21	0.59	0.12	0.71	0.36	0.17	0.61	0.03	4.89	1.33	0.24
Ficus benjamina	11	26	35.52	39.71	12.65	0.43	0.09	0.52	0.26	0.12	0.45	0.02	4.93	1.34	0.19
Ficus carica	16	23	38.95	42.24	13.45	0.62	0.12	0.74	0.37	0.17	0.64	0.03	10.20	2.78	0.44
Ficus elastica	2	28	47.15	62.4	19.87	1.41	0.28	1.69	0.85	0.40	1.46	0.05	2.91	0.79	0.10

Ficus racemosa L.	1	28	63.56	45	14.33	0.98	0.2	1.17	0.59	0.27	1.01	0.04	1.01	0.27	0.04
Ficus religiosa	25	22	39.49	52.3	16.66	1.37	0.27	1.65	0.83	0.39	1.42	0.06	35.54	9.69	1.62
Ficus virens	1	24	37.31	38.4	12.23	0.42	0.08	0.5	0.25	0.12	0.43	0.02	0.43	0.12	0.02
Ficus benjamina starlight	1	30	37.31	24	7.64	0.27	0.05	0.33	0.17	0.08	0.28	0.01	0.28	0.08	0.01
Grewia asiatica	1	22	43.87	26.4	8.41	0.39	0.08	0.47	0.24	0.11	0.40	0.02	0.40	0.11	0.02
Lagerstroemia indica	3	13	29.65	21.89	6.97	0.16	0.03	0.2	0.10	0.05	0.17	0.01	0.52	0.14	0.04
Lagerstroemia speciosa	56	26	44.57	49.26	15.69	0.89	0.18	1.07	0.54	0.25	0.92	0.04	51.62	14.08	1.99
Laurus nobilis	1	16	26.81	18	5.73	0.11	0.02	0.13	0.07	0.03	0.11	0.01	0.11	0.03	0.01
Litchi chinensis	1	23	38.95	30	9.55	0.44	0.09	0.53	0.27	0.12	0.46	0.02	0.46	0.12	0.02
Madhuca longifolia	4	21	48.79	51.6	16.43	1.02	0.2	1.22	0.61	0.29	1.05	0.05	4.20	1.15	0.20
Magnolia champaca	1	30	50.43	45.6	14.52	0.8	0.16	0.96	0.48	0.23	0.83	0.03	0.83	0.23	0.03
Mangifera indica	24	25	36.62	37.6	11.97	0.48	0.1	0.58	0.29	0.14	0.50	0.02	11.99	3.27	0.48
Manilkara zapota	1	28	50.43	42	13.38	0.68	0.14	0.81	0.41	0.19	0.70	0.02	0.70	0.19	0.02
Markhamia lutea	1	27	43.87	68.4	21.78	1.56	0.31	1.87	0.94	0.44	1.61	0.06	1.61	0.44	0.06
Mimusops elengi	13	33	29.08	31.11	9.91	0.31	0.06	0.37	0.19	0.09	0.32	0.01	4.14	1.13	0.13

Murraya paniculata	1	12	27.47	14.4	4.59	0.07	0.01	0.09	0.05	0.02	0.08	0.01	0.08	0.02	0.01
Neolamarckia cadamba	32	20	43.67	67.18	21.39	1.55	0.31	1.86	0.93	0.44	1.60	0.08	51.28	13.99	2.56
Peltophorum pterocarpum	2	16	43.05	39.6	12.61	0.66	0.13	0.79	0.40	0.19	0.68	0.04	1.36	0.37	0.09
Phoenix dactylifera	13	25	35.16	38.31	12.2	0.43	0.09	0.52	0.26	0.12	0.45	0.02	5.82	1.59	0.23
Phyllanthus emblica	1	26	50.43	64.8	20.64	1.61	0.32	1.93	0.97	0.45	1.66	0.06	1.66	0.45	0.06
Pithecellobium dulce	1	21	42.23	52.44	16.7	0.88	0.18	1.06	0.53	0.25	0.91	0.04	0.91	0.25	0.04
Plumeria alba	1	10	24.19	14.4	4.59	0.06	0.01	0.08	0.04	0.02	0.07	0.01	0.07	0.02	0.01
Polyalthia longifolia	9	18	30.83	32.67	10.4	0.31	0.06	0.37	0.19	0.09	0.32	0.02	2.87	0.78	0.16
Psidium guajava	3	15	29.65	22	7.01	0.2	0.04	0.24	0.12	0.06	0.21	0.01	0.62	0.17	0.04
Pterocarpus santalinus	1	6	30.75	30	9.55	0.35	0.07	0.42	0.21	0.10	0.36	0.06	0.36	0.10	0.06
Pterospermum acerifolium	1	20	50.43	62.4	19.87	1.49	0.3	1.79	0.90	0.42	1.54	0.08	1.54	0.42	0.08
Putranjiva roxburghii	3	12	28.56	18.8	5.99	0.14	0.03	0.17	0.09	0.04	0.15	0.01	0.44	0.12	0.04
Quercus sp.	1	19	61.91	48	15.29	1.09	0.22	1.3	0.65	0.31	1.12	0.06	1.12	0.31	0.06

Ravenala madagascariensis	2	15	20.08	12	3.82	0.04	0.01	0.04	0.02	0.01	0.03	0.00	0.07	0.02	0.00
Roystonea regia	80	25	47.27	63.72	20.29	1.54	0.31	1.85	0.93	0.43	1.59	0.06	127.50	34.78	5.10
Saraca asoca	1	15	30.75	27.6	8.79	0.3	0.06	0.36	0.18	0.08	0.31	0.02	0.31	0.08	0.02
Spathodia campanulate	88	20	41.3	30	9.56	0.45	0.09	0.55	0.28	0.13	0.47	0.02	41.70	11.37	2.08
Spondias pinnata	1	20	43.87	55.2	17.58	1.02	0.2	1.22	0.61	0.29	1.05	0.05	1.05	0.29	0.05
Swietenia mahagoni	38	24	48.36	52.39	16.68	1.03	0.21	1.23	0.62	0.29	1.06	0.04	40.27	10.98	1.68
Syzygium cumini	10	23	37.96	47.1	15	0.77	0.15	0.92	0.46	0.22	0.79	0.03	7.93	2.16	0.34
Syzygium jambos	1	12	30.75	18	5.73	0.13	0.03	0.15	0.08	0.04	0.13	0.01	0.13	0.04	0.01
Syzygium samarangense	2	19	20.08	21.6	6.88	0.12	0.02	0.15	0.08	0.04	0.13	0.01	0.26	0.07	0.01
Tamarindus indica	2	23	47.15	64.98	20.69	1.91	0.38	2.29	1.15	0.54	1.97	0.09	3.95	1.08	0.17
Tamarix dioica	1	29	53.71	65.04	20.71	1.73	0.35	2.07	1.04	0.49	1.78	0.06	1.78	0.49	0.06
Tebubuia rosea	216	16	32.66	19.22	6.12	0.18	0.04	0.21	0.11	0.05	0.18	0.01	39.08	10.66	2.44
Tecoma stans	1	10	34.03	25.2	8.03	0.27	0.05	0.33	0.17	0.08	0.28	0.03	0.28	0.08	0.03
Terminalia arjuna	4	25	31.16	32.1	10.22	0.29	0.06	0.35	0.18	0.08	0.30	0.01	1.21	0.33	0.05
Terminalia catappa	1	22	43.87	54	17.2	0.97	0.19	1.17	0.59	0.27	1.01	0.05	1.01	0.27	0.05

Terminalia chebula	2	25	47.15	37.2	11.85	0.63	0.13	0.76	0.38	0.18	0.65	0.03	1.31	0.36	0.05
Thevetica peruviana	1	34	17.62	67.2	21.4	0.61	0.12	0.73	0.37	0.17	0.63	0.02	0.63	0.17	0.02
Vachellia/ Acacia nilotica	4	20	36.62	30	9.55	0.42	0.08	0.5	0.25	0.12	0.43	0.02	1.72	0.47	0.09
Wodyetia bifurcata	1	30	50.43	54	17.2	1.12	0.22	1.34	0.67	0.31	1.15	0.04	1.15	0.31	0.04
Ziziphus mauritians	1	10	30.75	18	5.73	0.13	0.03	0.15	0.08	0.04	0.13	0.01	0.13	0.04	0.01
Total	1052					65.23	13.04	78.27					779.60	212.66	34.36

higher tree carbon stock are likely to support higher soil carbon accumulation.

The Fig. 2. shows the variation in average total biomass and corresponding carbon stock per tree among different species recorded in the study area. Biomass values were highest in species such as *Cinnamomum tamala*, *Alstonia scholaris*, and *Dimocarpus longan*, indicating their greater carbon storage potential. Carbon stock followed a similar trend, as it is directly proportional to biomass. Species with higher biomass accumulation contribute more significantly to carbon sequestration and play an important role in climate change mitigation, particularly in coastal plantation ecosystems.This relationship is particularly important in coastal regions such as South 24 Parganas, where soils are often saline and low in organic carbon. Tree-based carbon inputs help improve soil structure, fertility, and long-term carbon storage capacity, contributing to overall ecosystem sustainability

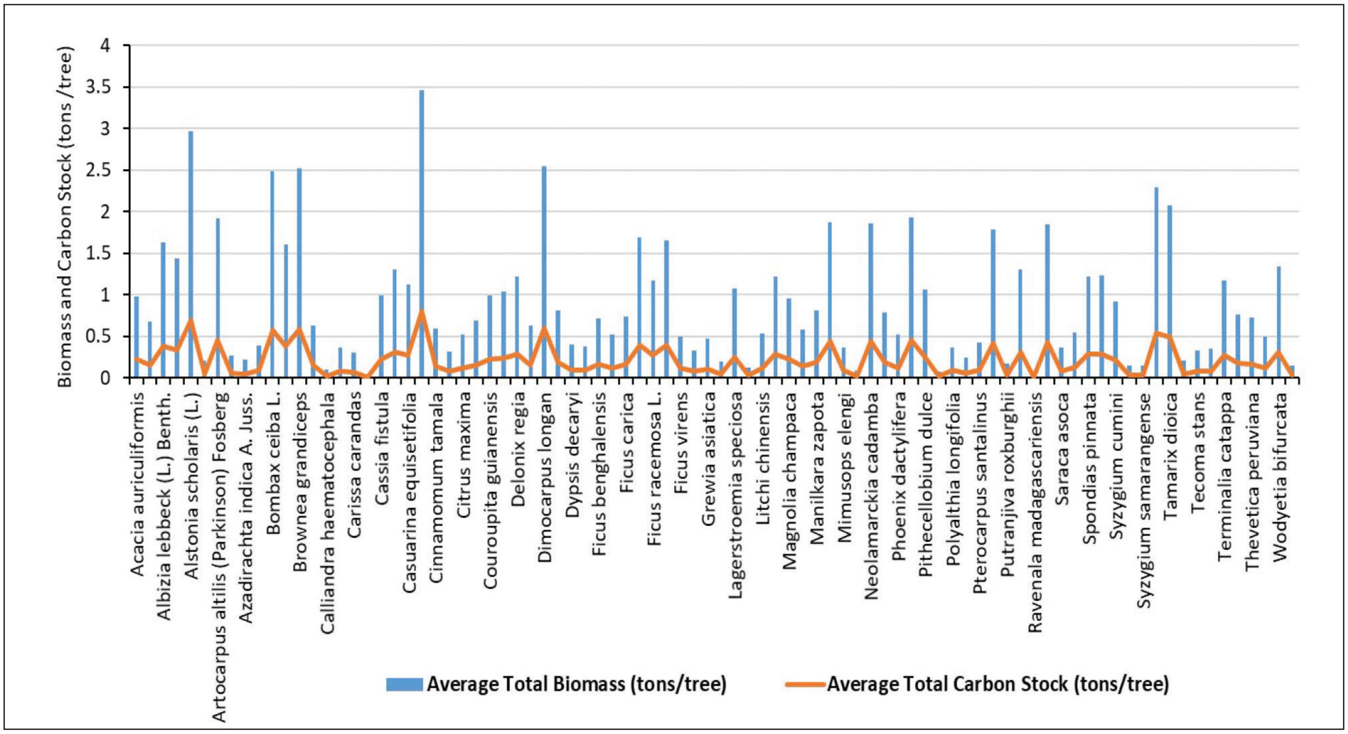

Fig. 2. *Species-wise variation in average total biomass and carbon stock of trees in the coastal study area of South 24 Parganas, West Bengal*

Top tree species for CO_2 sequestration

The most effective tree species in terms of high annual CO_2 sequestration potential are presented in Table 2. Among these, Alstoniascholaris showed the highest efficiency, requiring only 7 trees to sequester one ton of CO_2 per year, followed by *Ceiba pentandra*, *Tamarindus indica* and *Neolamarckia cadamba*.

The spatial distribution of tree carbon stock also has important implications for soil carbon sequestration in the study region. Trees contribute to soil organic carbon through litter fall, root turnover, and organic matter deposition. Areas with higher tree biomass and carbon stock generally enhance soil carbon accumulation over time, improving soil quality and ecosystem sustainability. In coastal regions such as South 24 Parganas, where soils are often saline and low in organic matter, tree-based carbon inputs play a significant role in improving soil carbon pools. Therefore, the delineated carbon stock map not only represents above-ground carbon

Table 2. *The estimated number of trees required to sequester one ton of CO_2 per year*

Sl. No.	Botanical name	CO_2 sequestration (ton year^{-1} tree^{-1})	Required No. of trees for one ton year^{-1} sequestration	Remark (based on fastest removal of CO_2 from environment
1	*Alstonia scholaris*	0.14	7.1	Rank 1
2	*Tamarindus indica, Albizia lebbeck* and *Ceiba pentandra*	0.09	11.1	Rank 2
3	*Bombax ceiba, Brownea grandiceps, Neolamarckia cadamba* and *Pterospermum acerifolium*	0.08	12.5	Rank 3
4	*Dimocarpus longan* and *Artocarpus altilis*	0.07	14.3	Rank 4

storage but also indicates potential zones of enhanced soil carbon sequestration.

These findings suggest that fast-growing, large-biomass tree species are more suitable for plantation programmes aimed at climate change mitigation and carbon sequestration in coastal regions.

CONCLUSION

The present study has revealed CO_2 sequestration potential of different tree species (86), along with estimation of total tree biomass and carbon stock, in 1052 trees of an institutional green landscape located in South 24 Parganas district of West Bengal, representing a coastal peri-urban ecosystem. The total carbon stock, total CO_2 sequestered (during entire tree life span) and total CO_2 sequestration potential per year corresponds to 220 tons, 808 tons and 33 tons year^{-1}, respectively.When expressed on per unit area basis, the annual carbon sequestration rate was estimated at 2.15 tons CO_2 ha^{-1} year^{-1}, indicating the significant role of avenue and plantation trees in carbon mitigation under non-forest land use systems. Further work is underway to calculate the total emission per year in the campus on account of various anthropogenic activities. The difference between yearly sequestered and emission value will help us to plan our future mitigation strategies for achieving goal of "Green Campus Tagline".The findings of this study highlight the importance of species selection and plantation planning for enhancing carbon sequestration in coastal regions. Tree species such as *Roystonea regia*, *Delonix regia*, *Neolamarckia cadamba* and *Ceiba pentandra* showed relatively higher carbon sequestration potential and may be considered suitable for plantation programmes aimed at climate change mitigation. Overall, the study provides baseline information on tree biomass and carbon sequestration potential in coastal institutional and peri-urban landscapes, which can support regional carbon management strategies, afforestation programmes, and climate change mitigation planning in coastal districts of eastern India.

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CONFLICTS OF INTEREST

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