



Carbon Sequestration Potential of Woody Species in Thiagarajar College Campus, Madurai, India

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Abstract: Thiagarajar College Campus had 56 tree species and 5 shrub species with a total of 502 individuals during 2023. *Azadirachta indica* had a maximum number of 109 individuals. *Samanea saman* had the highest biomass (12923.72 kg/tree), Carbon storage (6461.80 kg/tree) and carbon sequestration (23456.56 kg/tree and 2148.70 kg/ha). The other potential tree species on the campus with high carbon sequestration were *Wrightia tinctoria*, *Parkia benghalensis*, *Ficus biglandulosa* and *Terminalia catappa*. The carbon level (497-538 ppm CO₂) in the surrounding environment was within the permissible limit due to the woody cover in the campus. The study recommends the potential tree species for disturbed and polluted urban space.

Keywords: *Azadirachta indica*, *Samanea saman*, Biomass, Carbon storage, CO₂ level

The heat-trapping gases released by human activities have become one of the great concerns of the world today as they cause global warming and its allied problems (<https://www.epa.gov/climatechange-science/causes-climate-change>). Carbon dioxide is the major greenhouse gas of global climate change (Dubal et al 2013). Around 87% of CO₂ is released from fossil fuel burning. The remaining is from forest clearing, industrial processes etc. Nearly 45% of CO₂ released during anthropogenic activities remains in the atmosphere. CO₂ trapping is essential for reducing our carbon footprint.

Plants act as a major sink of carbon as sequester carbon through photosynthesis. The forests, grasslands or rangelands play a significant role in carbon sequestration. They store 25% of carbon in their biomass. Aquatic systems store another 25% of CO₂. The bogs, peat and swamps can also store carbon as carbonate. Apart from that, carbon is sequestered in rocks through geological carbon sequestration (<https://www.nationalgrid.com/stories/energy-explained/what-carbon-sequestration>). The Kyoto Protocol and the United Nations Framework Convention on Climate Change gave directions to raise carbon sequestration. In the terrestrial landscape, trees play several important roles, especially carbon sequestration (Veeramani et al 2023). Trees offer several services for the sustenance of rural and urban ecosystems. They provide a significant contribution to climate change mitigation (Lahoti et al 2020). They trap heat and enable the purity of air, control the microclimate to regulate the urban heat island phenomenon (Jennings et al 2016). It is essential to maintain the urban green belt as it maintains air quality (Deshmukh et al 2020), ecosystem equilibrium (Anjali et al 2020) and to avoid climate change impact (Velasco and Chen 2019). Besides, they enhance socioeconomic and cultural values (Chaudhary and Tewari 2010).

The study by the Indian School of Mines, Dhanbad stated that the study of carbon sequestration in vegetation, litter and soil is important for eco-restoration of mining sites (https://bcclweb.in/files/2011/02/Eco_restoration2015.pdf). The short duration trees grown through agroforestry insist the significance of tree species in climate regulation (Singh and Gokhale 2024). Urban trees store carbon equal to that of tropical forest (<https://www.fastcompany.com/40589994/urban-trees-can-store-almost-as-much-carbon-as-tropical-rainforests>). The amount of carbon stored by tree species is influenced by the edaphic features and land use changes (Moussa et al 2018, Agarwal et al 2021a, Vineeta et al 2023).

In India, except in a few cities, studies on urban green cover are limited. The study conducted at Amity University Campus highlighted the need of urban green space for climate change mitigation (Sharma et al 2021). The study conducted near adjacent areas of Kolkata city pointed out the relationship between biomass and carbon sequestration and the importance of species selection as trees provide health security to urban residents (Agarwal et al 2021b). The present study was designed to assess the tree cover and its carbon sequestration potential in educational institution namely Thiagarajar College situated in the disturbed and polluted urban space of Madurai in Tamil Nadu, India.

MATERIAL AND METHODS

Study area: The study area, Thiagarajar college campus is in Teppakulam, Madurai, Tamil Nadu, India located at 9.90108 latitude and 78.151 longitudes (Fig. 1). The average rainfall in Madurai is 849 mm with a minimum of 28°C and a maximum of 42°C. The campus is 13.1 acres in size with 6.16 acres of built-up area. The study area is the connecting link between National Highway NH87 and the main part of

Madurai city. It is amidst a residential area with a dense population and heavy vehicular movement. The study was conducted from January 2023 to April 2023.

Enumeration of woody plant species: The trees and shrubs in the campus were documented. The number of individuals of each species was listed. The scientific name of the trees and shrubs along with the author's citation were verified using Gamble Flora (1921-1935) and Mathew Flora (1991), International Plant Name Index (<https://www.ipni.org/>) and Plants of the World Online of Kew Botanical Garden (<https://powo.science.kew.org/>).

Estimation of morphometric parameters: The biomass of woody species was calculated using a non-destructive method. An allometric model with tree diameter, height and wood specific gravity was used (Saral et al 2017). Wood specific gravity was used to reduce the error of biomass estimate (Beets et al 2012). The tree height was measured using a GLM40 Distometer. The girth was measured at 1.3 m from the base of the tree using measuring tape. The diameter and radius were calculated from the girth. Wood Density of the tree species was obtained from <http://db.worldagroforestry.org/wd>.

Above ground biomass of the woody species (AGB): The above ground biomass of a tree includes the whole shoot, branches, leaves, flowers and fruits.

$$\text{AGB (kg)} = \text{Volume of tree (m}^3\text{)} \times \text{Wood Density kg/m}^3.$$

$V = \pi R^2 H$, H = height of the tree in meters, R = radius of the tree in meters

Below ground Biomass (BGB): The below ground biomass (BGB) includes all biomass of live roots excluding fine roots. The BGB was calculated by using the following formula (Hangarge et al 2012)

$$\text{BGB} = \text{AGB} \times 0.26$$

Total biomass (TBM): The total biomass is the sum of the above and below ground biomass.

$$\text{Total biomass} = \text{AGB} + \text{BGB}$$

Estimation of carbon storage: Generally, for any plant species, 50% of its biomass is considered as carbon content.

$$\text{Carbon} = \text{Total biomass} \times 50\%$$

Estimation of carbon sequestration

$$\text{Weight of CO}_2 = \text{carbon content} \times 3.6663$$

$$\text{Weight of CO}_2 \text{ is } C + 2 \times O = 43.99915.$$

Hence, the ratio of CO₂ to C is calculated as: 43.99915/12.001118 = 3.6663.

In order to determine the weight of carbon dioxide sequestered in the tree, the weight of carbon in the tree was multiplied by 3.6663.

Estimation of CO₂ level in the atmosphere: CO₂ levels (ppm) within the campus and outside the campus were measured using a CO₂ detector (Gas Analyzer Monitor Air Quality Meter for Home Indoor Outdoor/ B08FCK4GB7) during April 2023.

RESULTS AND DISCUSSION

The study area, Thiagarajar College Campus had total of 61 woody species (Table 1). Among them, 56 were trees and the rest of the 5 were shrubs. The total number of trees in the college campus was 503. *Azadirachta indica* had maximum number of individuals (109) followed by *Polyalthia longifolia*. Seventeen species were being represented by a single individual. Among the 61 species, 34 species (56%) were native species and 27 (44%) were exotic species. The tallest tree in the campus was *Polyalthia longifolia* (14.6 m). The smallest tree species was *Punica granatum* (2m).

Samanea saman had the largest trunk with 1.43 m diameter and the highest biomass (12923.72 kg/tree) and carbon storage 6461.80 kg/tree (Table 2). It sequestered 18616.13 kg/tree carbon in its aboveground components and 4840.24 kg/tree carbon in belowground components with a total of 23456.56 kg/tree (Table 3). It sequestered about 31% of the carbon in a tree among all the other species. It was followed by *Wrightia tinctoria*, *Parkia biglandulosa* and *Ficus benghalensis*. All these species had tall trunk, large diameter and wood density. Height, diameter and wood density influence the biomass, carbon storage and sequestration potential (Chave et al 2014, Mensha et al 2016, Saral et al 2017, Prasad and Jithila 2018, Yumnam and Ronald 2022).

Besides the tree growth and morphometric parameters the relative abundance, tree cover and its diversity also influence the carbon storage in an area. Mouna et al (2019) observed correlation between carbon stock and number of individuals. High tree density could be one of the reasons for high carbon storage (Vineeta et al 2023). In the study site, *Azadirachta indica* had low biomass when compared to other species, due to its high density it sequestered 25.14 % of the total carbon. Channali et al (2022) observed that *Azadirachta indica* had high carbon sequestration capacity in Karnataka. *Azadirachta indica* and *Samanea saman* were the trees preferred to grow in urban environment due to their fast growth rate and wide range of adaptations to variety of soils (Rahman et al 2014). Besides



Fig. 1. Map showing the study area Thiagarajar College in Madurai, Tamil Nadu, India

Table 1. Woody species with their morphometric parameters at Thiagarajar College Campus in Madurai, Tamil Nadu, India

Name of the woody species	Family	No. of individuals	Habit/ origin status	Height (m)	Diameter (m)	Wood density** (g/cm ³)
<i>Adina cordifolia</i> (Roxb.) Brandis	Rubiaceae	1	Tree Native	3.37	0.18	0.61
<i>Aegle marmelos</i> (L.) Corrêa	Rutaceae	1	Tree Native	5.52	0.12	0.78
<i>Albizia lebeck</i> (L.) Benth.	Mimosaceae	7	Tree Native	11.18±2.17	0.19±0.02	0.59
<i>A. procera</i> (Roxb.) Benth.	Mimosaceae	17	Tree Native	10.39±2.06	0.36±0.1	0.68
<i>Ailanthus excelsa</i> Roxb.	Simaroubaceae	1	Tree Native	8.99	0.3	0.4
<i>Artocarpus heterophyllus</i> Lam.	Moraceae	1	Tree Native	5.02	0.16	0.59
<i>Azadirachta indica</i> A.Juss.	Meliaceae	109	Tree Native	8.87±2.88	0.36±0.23	0.72
<i>Bauhinia purpurea</i> L.	Caesalpinaceae	2	Tree Native	5.66±0.90	0.21±0.13	0.72
<i>B. tomentosa</i> L.	Caesalpinaceae	2	Tree Exotic	4.94±2.67	0.06±0.04	0.75
<i>B. variegata</i> L.	Caesalpinaceae	1	Tree Native	5.56	0.07	0.75
<i>B. rufescens</i> Lam.	Caesalpinaceae	1	Tree Exotic	3.75	0.05	0.75
<i>Bombax ceiba</i> L.	Bombacaceae	12	Tree Native	9.27±2.0	0.37±0.13	0.35
<i>Caesalpinia coriaria</i> (Jacq.) Willd.	Caesalpinaceae	14	Tree Exotic	6.53±1.33	0.36±0.14	1.13
<i>C. pulcherima</i> (L.) Sw.*	Caesalpinaceae	1	Shrub Exotic	4.16	0.05	0.84
<i>Cassia siamea</i> Lam.	Caesalpinaceae	6	Tree Exotic	9.22±1.72	0.33±0.97	0.74
<i>Casuarina equisetifolia</i> L.	Casuarinaceae	1	Tree Native	10.66	0.31	0.91
<i>Cocos nucifera</i> L.	Arecaceae	1	Tree Exotic	13.20	0.36	0.61
<i>Crateva religiosa</i> G.Forst.	Capparaceae	4	Tree Native	8.58±2.05	0.29±0.14	0.33
<i>Dalbergia latifolia</i> Roxb.	Fabaceae	3	Tree Native	8.57±2.95	0.16±0.01	0.75
<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Fabaceae	13	Tree Exotic	9.39±2.36	0.3±0.01	1.15
<i>Duranta versicolor</i> L.*	Verbenaceae	8	Shrub Exotic	2.12±0.03	0.09±0.02	0.56
<i>Elaeis guineensis</i> Jacq.	Palmae	1	Tree Native	11.84	0.27	0.33
<i>Ficus benghalensis</i> L.	Moraceae	4	Tree Exotic	8.83±5.30	0.69±0.41	0.49
<i>F. religiosa</i> L.	Moraceae	7	Tree Native	8.12±2.70	0.35±0.19	0.44
<i>Gliricidia sepium</i> (Jacq.) Kunth	Fabaceae	2	Tree Exotic	9.35±1.09	0.29±0.01	0.68
<i>Gmelina arborea</i> Roxb. ex Sm.	Verbenaceae	2	Tree Native	2.9±0.82	0.75±0.03	0.43
<i>Guazuma tomentosa</i> Kunth	Sterculiaceae	4	Tree Exotic	6.98±1.10	0.16±0.06	0.05
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	2	Tree Native	10.89±1.19	0.52±0.24	0.51
<i>Hibiscus rosa-sinensis</i> L.*	Malvaceae	1	Shrub Exotic	7.51	0.05	0.47
<i>Hypophorbe verschaffeltii</i> (W.Bull ex J.Dix) H.Wendl.	Arecaceae	20	Tree Exotic	6.57±1.06	0.38±0.08	0.64
<i>Lanea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	3	Tree Native	6.92±0.98	0.16±0.05	0.58
<i>Leucaena leucocephala</i> (Lam.) de Wit	Fabaceae	2	Tree Native	12.03±1.33	0.15±0.02	0.72
<i>Madhuca longifolia</i> (L.) J.F.Macbr.	Sapotaceae	5	Tree Native	9.01±5.95	0.37±0.23	0.79
<i>Mangifera indica</i> L.	Anacardiaceae	1	Tree Native	5.79	0.10	0.55
<i>Millingtonia hortensis</i> L.f	Bignoniaceae	16	Tree Exotic	8.66±3.33	0.22±0.12	0.48
<i>Mimusops elengi</i> L.	Sapotaceae	13	Tree Native	6.38±2.62	0.22±0.16	0.88
<i>Morinda tinctoria</i> Roxb.	Rubiaceae	3	Tree Native	7.00±1.04	0.19±0.04	0.54
<i>Manilkara zapota</i> (L.) P.Royen	Sapotaceae	1	Tree Exotic	6.28	0.06	0.95
<i>Muntingia calabura</i> L.	Muntingiaceae	3	Tree Native	5.50±1.04	0.11±0.04	0.3
<i>Parkia biglandulosa</i> Wight & Arn.	Mimosaceae	5	Tree Exotic	12.01±1.06	0.61±0.14	0.47
<i>Peltophorum pterocarpum</i> (DC.) Backer ex K.Heyne	Caesalpinaceae	9	Tree Exotic	10.54±1.48	0.39±0.04	0.63
<i>Pithecellobium dulce</i> (Roxb.) Benth.	Mimosaceae	2	Tree Exotic	9.97±2.16	0.41±0.22	0.66
<i>Plumeria rubra</i> L.	Apocynaceae	1	Tree Exotic	5.73	0.1	0.64
<i>Polyalthia longifolia</i> (Sonn.) Thwaites	Annonaceae	90	Tree Native	14.6±2.64	0.21±0.13	0.58
<i>Pongamia pinnata</i> (L.) Pierre	Fabaceae	17	Tree Native	7.18±2.45	0.2±0.12	0.61
<i>Psidium guajava</i> L.	Myrtaceae	2	Tree Exotic	6.22±2.32	0.12±0.02	0.85
<i>Punica granatum</i> L.	Lythraceae	1	Tree Exotic	2.00	0.006	0.7
<i>Samanea saman</i> (Jacq.) Merr.	Mimosaceae	3	Tree Exotic	12.82±2.16	1.43±0.05	0.52
<i>Santalum album</i> L.	Santalaceae	2	Tree Exotic	4.86±2.26	0.15±0.002	0.93
<i>Sapindus emarginatus</i> Vahl	Sapindaceae	5	Tree Native	8.14±1.55	0.18±0.11	0.71
<i>Simarouba glauca</i> DC.	Simaroubaceae	3	Tree Exotic	9.28±0.9	0.15±0.02	0.46
<i>Sterculia foetida</i> L.	Malvaceae	2	Tree Native	9.33±4.77	0.19±0.13	0.55
<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	7	Tree Native	5.88±1.83	0.19±0.07	0.7
<i>Tamrindus indica</i> L.	Caesalpinaceae	42	Tree Exotic	8.99±3.26	0.36±0.25	0.99
<i>Tabebuia rosea</i> (Bertol.) DC.	Bignoniaceae	1	Tree Exotic	8.36	0.64	0.53
<i>Tabernaemontana divaricata</i> (L.) R.Br. ex Roem. & Schult.*	Apocynaceae	4	Shrub Native	2.78±0.90	0.1±0.02	0.75
<i>Tecoma stans</i> (L.) Juss. ex Kunth*	Bignoniaceae	6	Shrub Exotic	3.79±0.73	0.08±0.05	0.46
<i>Tectona grandis</i> L.f.	Verbenaceae	2	Tree Native	8.56±1.71	0.18±0.02	0.61
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Combretaceae	1	Tree Native	10.17	0.19	0.8
<i>T. catappa</i> L.	Combretaceae	1	Tree Native	12.45	0.54	0.54
<i>Wrightia tinctoria</i> (Roxb.) R.Br.	Apocynaceae	1	Tree Native	8.11	0.64	0.77

Values – Mean±SD, n= 1 to 10 depends on the species; *Shrub **Wood Density Source: <http://db.worldagroforestry.org/wd>

Table 2. Biomass and carbon storage potential of woody species (kg/tree) in Thiagarajar College Campus in Madurai, Tamil Nadu, India

Name of the woody species	Above-ground biomass (kg/tree)	Below-ground biomass (kg/tree)	Total biomass (kg/tree)	Above-ground carbon storage (kg/tree)	Below-ground storage (kg/tree)	Total carbon storage (kg/tree)
<i>Adina cordifolia</i> (Roxb.) Brandis	52.28	6.79	59.08	26.14	3.39	29.54
<i>Aegle marmelos</i> (L.) Corrêa	46.99	6.11	53.1	23.50	3.06	26.55
<i>Albizia lebbek</i> (L.) Benth.	167.80	21.81	189.60	83.88	10.90	94.79
<i>A. procera</i> (Roxb.) Benth.	179.70	23.36	203.10	89.85	11.68	101.50
<i>Ailanthus excelsa</i> Roxb.	247.70	32.20	279.90	123.80	16.10	139.90
<i>Artocarpus heterophyllus</i> Lam.	45.57	5.924	51.49	22.79	2.96	25.75
<i>Azadirachta indica</i> A.Juss.	661.30	85.97	747.30	330.60	42.98	373.60
<i>Bauhinia purpurea</i> L.	128.00	16.63	144.6	63.98	8.32	72.30
<i>B. tomentosa</i> L.	10.47	1.36	11.83	5.24	0.68	5.91
<i>B. variegata</i> L.	11.78	1.53	13.32	5.89	0.77	6.66
<i>B. rufescens</i> Lam.	3.53	0.46	3.99	1.77	0.23	1.99
<i>Bombax ceiba</i> L.	353.80	46.00	399.80	176.90	23.00	199.90
<i>Caesalpinia coriaria</i> (Jacq.) Willd.	763.50	198.50	962.00	381.80	99.26	481.00
<i>C. pulcherima</i> (L.) Sw.	4.39	1.14	5.53	2.19	0.57	2.77
<i>Cassia siamea</i> Lam.	576.80	150.00	726.80	288.40	74.98	363.40
<i>Casuarina equisetifolia</i> L.	741.70	192.80	934.50	370.80	96.42	467.20
<i>Cocos nucifera</i> L.	818.60	212.80	1031.00	409.30	106.40	515.70
<i>Crateva religiosa</i> G.Forst.	191.00	49.66	240.70	95.50	24.83	120.30
<i>Dalbergia latifolia</i> Roxb.	128.00	33.29	161.30	64.01	16.64	80.66
<i>Delonix regia</i> (Bojer ex Hook.) Raf.	776.60	201.90	978.50	388.30	101.00	489.20
<i>Duranta versicolor</i> L.	5.96	1.55	7.52	2.98	0.78	3.76
<i>Elaeis guineensis</i> Jacq.	219.40	57.05	276.50	109.70	28.52	138.20
<i>Ficus benghalensis</i> L.	1623.00	421.90	2044.00	811.30	210.90	1022.00
<i>F. religiosa</i> L.	338.20	87.94	426.20	169.10	43.97	213.10
<i>Gliricidia sepium</i> (Jacq.) Kunth	410.00	106.60	516.60	205.00	53.30	258.30
<i>Gmelina arborea</i> Roxb. ex Sm.	536.00	139.40	675.40	268.00	69.69	337.70
<i>Guazuma tomentosa</i> Kunth	6.68	1.74	8.41	3.34	0.87	4.20
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	1189.00	309.10	1498.00	594.50	154.60	749.10
<i>Hibiscus rosa-sinensis</i> L.	4.43	1.15	5.59	2.22	0.58	2.79
<i>Hyophorbe verschaffeltii</i> (W.Bull ex J.Dix) H.Wendl.	482.30	125.40	607.70	241.10	62.69	303.80
<i>Lannea coromandelica</i> (Houtt.) Merr.	76.81	19.97	96.79	38.41	9.99	48.39
<i>Leucaena leucocephala</i> (Lam.) de Wit	158.90	41.31	200.20	79.44	20.66	100.10
<i>Madhuca longifolia</i> (L.) J.F.Macbr.	775.80	201.70	977.50	387.90	100.90	488.80
<i>Mangifera indica</i> L.	22.84	5.9	28.78	11.42	2.97	14.39
<i>Millingtonia hortensis</i> L.f	153.00	39.79	192.80	76.52	19.89	96.41
<i>Mimusops elengi</i> L.	219.00	56.95	276.00	109.50	28.47	138.00
<i>Morinda tinctoria</i> Roxb.	112.00	29.12	141.10	56.00	14.56	70.56
<i>Manilkara zapota</i> (L.) P.Royen	19.00	4.94	23.94	9.50	2.47	11.97
<i>Muntingia calabura</i> L.	16.11	4.19	20.29	8.05	2.09	10.15
<i>Parkia biglandulosa</i> Wight & Arn.	1674.00	435.20	2109.00	836.80	217.60	1054.00
<i>Peltophorum pterocarpum</i> (DC.) Backer ex K.Heyne	813.10	211.40	1025.00	406.60	105.70	512.30
<i>Pithecellobium dulce</i> (Roxb.) Benth.	871.80	226.70	1098.00	435.90	113.30	549.20
<i>Plumeria rubra</i> L.	28.06	7.29	35.35	14.03	3.65	17.68
<i>Polyalthia longifolia</i> (Sonn.) Thwaites	302.70	78.69	381.30	151.30	39.34	190.70
<i>Pongamia pinnata</i> (L.) Pierre	134.20	34.89	169.10	67.10	17.45	84.54
<i>Psidium guajava</i> L.	60.79	15.80	76.59	30.39	7.90	38.29
<i>Punica granatum</i> L.	0.04	0.01	0.05	0.02	0.06	0.03
<i>Samanea saman</i> (Jacq.) Merr.	10256.92	2666.80	12923.72	5128.46	1333.40	6461.80
<i>Santalum album</i> L.	76.25	19.82	96.07	38.12	9.91	48.04
<i>Sapindus emarginatus</i> Vahl	149.50	38.88	188.40	74.77	19.44	94.21
<i>Simarouba glauca</i> DC.	78.35	20.37	98.72	39.17	10.18	49.36
<i>Sterculia foetida</i> L.	147.20	38.27	185.50	73.59	19.13	92.73
<i>Syzygium cumini</i> (L.) Skeels	114.10	29.68	143.80	57.07	14.84	71.91
<i>Tamrindus indica</i> L.	889.00	231.10	1120.00	444.50	115.60	560.10
<i>Tabebuia rosea</i> (Bertol.) DC.	1413.00	367.30	1780.00	706.30	183.60	890.00
<i>Tabernaemontana divaricata</i> (L.) R.Br. ex	16.37	4.26	20.62	8.18	2.13	10.31
<i>Tecoma stans</i> (L.) Juss. ex Kunth	8.01	2.08	10.09	4.00	1.04	5.04
<i>Tectona grandis</i> L.f.	135.20	35.14	170.30	67.59	17.57	85.16
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	233.20	60.64	293.90	116.60	30.32	146.90
<i>T. catappa</i> L.	1547.00	402.30	1949.00	773.60	201.10	974.70
<i>Wrightia tinctoria</i> (Roxb.) R.Br.	1884.00	489.90	2374.00	942.20	245.00	1187.00
Total	33110.81	8360.65	41469.55	16554.45	4179.93	20734.54

Table 3. Carbon sequestration potential of woody species in Thiagarajar College Campus in Madurai, Tamil Nadu, India

Name of the woody species	Above-ground carbon sequestration (kg/tree)	Below-ground carbon sequestration (kg/tree)	Total carbon sequestration (kg/tree)	Total carbon sequestration of all the individuals of the species (kg/ha)
<i>Adina cordifolia</i> (Roxb.) Brandis	94.89	12.34	107.23	3.27
<i>Aegle marmelos</i> (L.) Corrêa	85.29	11.088	96.38	2.94
<i>Albizia lebbbeck</i> (L.) Benth.	304.49	39.58	344.08	73.54
<i>A. procera</i> (Roxb.) Benth.	326.14	42.39	368.55	191.31
<i>Ailanthus excelsa</i> Roxb.	449.56	58.44	508.00	93.07
<i>Artocarpus heterophyllus</i> Lam.	82.71	10.752	93.46	2.85
<i>Azadirachta indica</i> A.Juss.	1200.25	156.03	1356.29	4514.10
<i>Bauhinia purpurea</i> L.	232.25	30.19	262.44	16.02
<i>B. tomentosa</i> L.	19.00	2.47	21.47	1.31
<i>B. variegata</i> L.	21.39	2.78	24.16	0.74
<i>B. rufescens</i> Lam.	6.41	0.833	7.24	0.22
<i>Bombax ceiba</i> L.	642.20	83.48	725.68	265.90
<i>Caesalpinia coriaria</i> (Jacq.) Willd.	1385.76	360.29	1746.06	746.41
<i>C. pulcherima</i> (L.) Sw.	7.96	2.07	10.03	0.31
<i>Cassia siamea</i> Lam.	1046.88	272.19	1319.07	241.66
<i>Casuarina equisetifolia</i> L.	1346.12	349.99	1696.10	51.79
<i>Cocos nucifera</i> L.	1485.76	386.29	1872.05	57.16
<i>Crateva religiosa</i> G.Forst.	346.68	90.13	436.81	53.35
<i>Dalbergia latifolia</i> Roxb.	232.36	60.41	292.78	26.82
<i>Delonix regia</i> (Bojer ex Hook.) Raf.	1409.47	366.46	1775.97	704.95
<i>Duranta versicolor</i> L.	10.83	2.81	13.64	3.33
<i>Elaeis guineensis</i> Jacq.	398.22	103.54	501.77	15.32
<i>Ficus benghalensis</i> L.	2944.91	765.68	3710.59	453.20
<i>F. religiosa</i> L.	613.92	159.62	773.53	165.34
<i>Gliricidia sepium</i> (Jacq.) Kunth	744.19	193.49	937.68	57.26
<i>Gmelina arborea</i> Roxb. ex Sm.	972.92	252.96	1225.88	74.86
<i>Guazuma tomentosa</i> Kunth	12.12	3.15	15.27	1.87
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	2158.05	561.09	2719.15	166.05
<i>Hibiscus rosa-sinensis</i> L.	8.05	2.09	10.14	0.31
<i>Hyophorbe verschaffeltii</i> (W.Bull ex J.Dix) H.Wendl.	875.31	227.58	1102.89	673.52
<i>Lannea coromandelica</i> (Houtt.) Merr.	139.42	36.25	175.67	16.09
<i>Leucaena leucocephala</i> (Lam.) de Wit	288.38	74.98	363.37	22.19
<i>Madhuca longifolia</i> (L.) J.F.Macbr.	1408.11	366.11	1774.21	270.87
<i>Mangifera indica</i> L.	41.46	10.78	52.24	1.59
<i>Millingtonia hortensis</i> L.f	277.76	72.22	349.97	170.98
<i>Mimusops elengi</i> L.	397.55	103.36	500.91	198.83
<i>Morinda tinctoria</i> Roxb.	203.28	52.85	256.14	23.46
<i>Manilkara zapota</i> (L.) P.Royen	34.48	8.97	43.45	1.33
<i>Muntingia calabura</i> L.	29.23	7.60	36.83	3.37
<i>Parkia biglandulosa</i> Wight & Arn.	3037.76	789.82	3827.58	584.36
<i>Peltophorum pterocarpum</i> (DC.) Backer ex K.Heyne	1475.85	383.72	1859.57	511.03
<i>Pithecellobium dulce</i> (Roxb.) Benth.	1582.37	411.41	1993.78	121.76
<i>Plumeria rubra</i> L.	50.93	13.24	64.17	1.96
<i>Polyalthia longifolia</i> (Sonn.) Thwaites	549.31	142.82	692.13	1902.00
<i>Pongamia pinnata</i> (L.) Pierre	243.57	63.33	306.89	159.30
<i>Psidium guajava</i> L.	110.33	28.68	139.01	8.49
<i>Punica granatum</i> L.	0.07	0.01	0.09	0.002
<i>Samanea saman</i> (Jacq.) Merr.	18616.32	4840.24	23456.56	2148.70
<i>Santalum album</i> L.	138.39	35.98	174.37	10.64
<i>Sapindus emarginatus</i> Vahl	271.42	70.57	341.99	52.21
<i>Simarouba glauca</i> DC.	142.19	36.97	179.16	16.41
<i>Sterculia foetida</i> L.	267.14	69.45	336.59	20.55
<i>Syzygium cumini</i> (L.) Skeels	207.17	53.86	261.03	55.794
<i>Tamrindus indica</i> L.	1613.57	419.53	2033.10	2607.3
<i>Tabebuia rosea</i> (Bertol.) DC.	2563.99	666.64	3230.63	98.64
<i>Tabernaemontana divaricata</i> (L.) R.Br. ex	29.71	7.72	37.43	4.57
<i>Tecoma stans</i> (L.) Juss. ex Kunth	14.53	3.78	18.31	3.35
<i>Tectona grandis</i> L.f.	245.33	63.79	309.12	18.88
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	423.29	110.06	533.35	16.29
<i>T. catappa</i> L.	2808.20	730.13	3538.33	108.04
<i>Wrightia tinctoria</i> (Roxb.) R.Br.	3420.12	889.23	4309.35	131.58
Total	60095.38	15174.4	75269.78	17949.45

these two tree species the other species such as *Delonix regia*, *Tamarindus indica*, *Ficus religiosa*, *Peltophorum pterocarpum*, *Albizia lebeck*, *Terminalia catappa*, *Ficus benghalensis* and *Terminalia arjuna* growing in Thiagarajar College campus were observed as preferable species for road side plantation (Ragula and Chandra 2020). The outside environment of the college campus had an average of 537.87 ppm CO₂ and within the college campus 496.65 ppm CO₂ in the atmosphere. There was no large difference in the CO₂ level in and around the campus. From the study it was inferred that the CO₂ level was maintained within the permissible limit by the woody tree species, though the campus had high anthropogenic disturbances (<https://www.health.state.mn.us/communities/environment/air/toxins/co2.html>, Sharma et al 2021).

CONCLUSION

Samanea saman, *Wrightia tinctoria*, *Parkia biglandulosa*, *Ficus benghalensis*, and *Terminalia catappa* have high sequestration potential. *Azadirachta indica* is able to thrive well in all kinds of soil. The study suggests that these species are suitable for urban spaces with high anthropogenic disturbances and heavy vehicular movement.

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