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Carbon sequestration potential of Phanerophytes for environmental improvement to mitigate climate change

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Abstract

One of the most feared issues of the twenty-first century is global warming. According to some estimates, carbon emissions are the main cause of global warming. A landscape's most important components are trees because of their biomass and diversity. Furthermore, since 50% of their total biomass is carbon itself, they are significant sinks of atmospheric carbon dioxide. The goal of the current study is to determine the natural carbon storage potential of thirty the nine tree species using non-destructive methods. Carbon removing method from the earth's atmosphere that has been harmed by increasing amounts of dioxide in the atmosphere along with other "greenhouse" gases is known as carbon sequestration. The present study reported that *Celastrus robustus* (6114.079 kg), *Terminalia arjuna* (6002.236 kg), *Albizia lebbeck* (4931.837 kg), *Swietenia mahagoni* (4921.088 kg) are with high efficiency tosequ ester atmospheric CO_2. The growth of the plant, the unique traits of the particular tree species, wood density and the growing conditions all affect the rate of carbon sequestration. Because of their greater size, volume and long-lasting storage capabilities such as the branches, roots, leaves and the organic matter of the soil in which they grow, trees store the majority of the atmospheric carbon. All the listed plant has broad utilitarian value such as oxygen production, air quality maintenance and aesthetic value in addition to narrow utilitarian value (used as food, fodder and medicine). Therefore, the Carbon sequestration estimates for all the species falling within this range reveal that they are judiciously used in aesthetic rejuvenation since they are gradationally excellent for planting in areas that are polluted for landscape design and environmental optimization.

Key words : Global warming, Climate change, Carbon sequestration potential, utilitarian values of biodiversity, landscape design.

The prolonged retention of carbon within soils, plants, geological formations and the ocean is known as carbon sequestration. It happens naturally in addition to result of anthropogenic activity and it frequently involved to the storing of carbon which has the imminent potential to form carbon dioxide gas. In view of growing worries regarding climate change caused by higher levels of carbon dioxide in the atmosphere, there has been a lot of interest in increasing the amount of carbon sequestration by means of alterations to land use and forestrytogether with geoengineering techniques like capturing and storing carbon[46,62]. Carbon sequestration can be biological, geological and technological.Carbon dioxide gas is a fundamental component of the cycle of carbon and a primary source of photosynthesis, atmospheric CO_2 levels have risen dramatically from 250 to 418 ppm because of excessive use of fossil fuels. The greenhouse gas effect accelerated CO_2 release is a major source of climatic change, leading to global warming and also melting of ice caps at the poles, changes in biogeochemical processes, acidification of the oceans, altered precipitation, nutrient enrichment of lakes, imbalance in biological communities, extinction of certain animals and plants, changes in metabolism, effects on fertility of the soil and more at the molecular level[16,51,71,77]. By reducing deforestation, employing green energy as a substitute to fossil fuels, reusing atmospheric CO_2, the reduce, reuse, and recycle (RRR) technique can be used to regulate high CO_2 levels. Carbon capture and storage *i.e* CCS, and carbon capture primarily utilization *i.e* CCU are two technologies designed to capture atmospheric CO_2 and emphasis on long-term storage in geological places. Captured CO_2 is utilized to make a variety of value-added goods including biofuels, polymers and reactants. Natural CO_2 filters are plants and microbes[32,36]. The biological fixation of carbon process which uses photosynthesis occurred inmany species of both plants and microbes including bacteria, fungi, yeast, algae, and others, produces a variety of biomolecules such as proteins, carbohydrates, and lipids, six different photosynthetic routes along with certain non-photosynthetic pathways that fix carbon dioxide from the atmosphere have been documented[20]. In comparison to other microbes, algae are the most potent in utilization of CO_2 and biological carbon fixation, and they are frequently exploited on a huge industrial scale for biofuels generation. The most productive way of recycling and reducing atmospheric CO_2 is algal biofuel production utilizing captured CO_2 [19]. The carbon dioxide storing technique in subsurface geologic formations and rocks is termed as geological carbon sequestration. Carbon dioxide is typically extracted and entered through porous rocks as long-term storage from an industrial source example steel or cement manufacture, or a related to energy source, such as a power station and natural gas processing facility[1]. Geologic capture of carbon dioxide (GCS) is a viable alternative for mitigating the negative consequences of climate change in the face of rising energy needs. To assure the ecological long-term viability of this alternative, we need to first comprehend the rates including mechanisms that underlie essential geochemical reactions, as well as their effects on GCS performance, multiphase reactive CO_2 transport, and risk management. To reduce environmental impacts and enhance GCS operations, strong interdisciplinary interactions are required[24]. As in the graphene sector, technological carbon sequestration includes a variety of innovative methods for removing carbon and redirection to make it a viable resource for production[40]. Global warming is one of the most feared issues of the twenty-first century. Carbon emissions are thought to be the primary cause of global warming. Because of biomass and diversity of trees are among the most important aspects of every landscape. Not only that, but they are also major sinks for atmospheric carbon or carbon dioxide because 50% of the standing biomass is carbon. A plant's carbon sequestration potential is also one of the criteria for its selection in green belt development[3,17]. The importance of tree species biomass in carbon sequestration has long been known, and numerous attempts have been made to quantify forest biomass production and its contribution to carbon sequestration using non-harvest methodologies[12,65,78]. So, the current study calculates the organic carbon reservoir capacity of thirty nine plant species chosen from the greeneries of Krishna SayerPark, Burdwan and analysed using a non-destructive manner. Carbon sequestration being a technique for removing carbon from the environment as the amount of environmental carbon dioxide together with other greenhouse gases (CH_4, CO_2, N_2O) rise.

Study site :

The Krishna SayerPark of Barddhaman (Burdwan) is part of The University of Burdwan (Fig. 1), and is located at23.2324° N, 87.8615° E with an average elevation of 37 meters (131 feet) above mean sea level. It is a little less around 100km north-west beyond Kolkata.Bardhaman is a town and municipality within the Indian state of West Bengal. It is the district headquarters of PurbaBardhaman, which served as a district capital during the British occupation. Burdwananother name for this town has been in used since then. A variety of factors, including diversity in microhabitats, aesthetic and botanical studies, abundant water bodies, and diversification of microhabitats in the ecopark, have resulted in the assemblage of variable vegetation taxa.KrishnasayerPark also known as Krishnasayer Eco Park due to its self-sustaining systems that produce their own energy, harvest and purify their own water, and grow their own food.

Fig. 1. Study site

Thirty-nine species were chosen among the dominant species of the study site, and their girths were measured conventionally at breast height (GBH), which is approximately 1.32m above ground surface.Simply using bio-statistics employing allometric equations, the total biomass of the list plants was estimated. AGB was calculated by multiplying it's by the wood densityof different tree species. The value of the tree bio-volume (BV) was calculated by multiplying the diameter of the tree by the height of the plants by a factor of 0.33.Theodolite is a measurement tool used to determine height. The world Agroforestry database (http://db.worldagroforestry.org/wd) is used to calculate wood density. The AGB was multiplied by 0.26 factorsrepresenting the root: shoot ratio, to determine the BGB.

Basal area (BAin m^2)= $(GBH)^2$ / 4π
Tree Bio-Volume (BVin m^3)=BA X Height X Form factor (0.33)
Above ground Biomass (AGB in Kg)= BV X wood density(kg/m^3)
Below ground mass (BGB in Kg)= AGBX 0.26
Total Biomass (TB in Kg)= AGB+BGB

Calculating carbon in general, 50% of any plant species' biomass is regarded as carbon. So, Carbon Storage/Carbon Sequestration Potential (Kg)= TB/2

The findings show that the research site has a higher plant diversity that increases its capacity to sequester carbon, with *Celastrus robustus* ranking top followed by *Terminalia arjuna, Albizia lebbeck*, and *Swietenia mahagoni*. The ability of the plants to store carbon represented in Table-1 and Fig. 2. Basal area (BA), and biomass (TB) varied depending on the type of plant species. About 1 trillion tons of CO_2 are stored in terrestrial ecosystems in the biomass produced by growing trees and plants. Numerous studies show that species have different levels of carbon storage and sequestration[17,46].

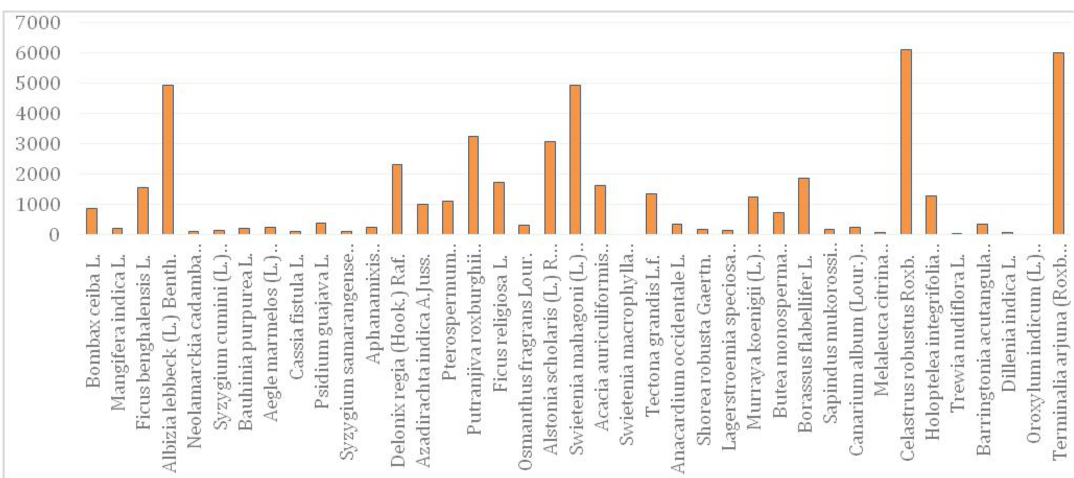

Fig. 2. Graphical representation of Carbon Sequestration Potential of listed plants

Table-1. Showing the listed plant species with Carbon Sequestration Potential

Scientific name	GBH in M	Height in Meter	Basal area BA= $(GBH)^2 / 4\pi (m^2)$	(Bio Volume BV) = BA X Height X Form factor (0.33)(m^3)	wood density WD (kg/m^3)	Above ground Biomass (AGB) = BV X wood density (kg)	Below ground mass (BGB)= AGBX 0.26(kg)	Total Biomass (TB)= AGB+ BGB(kg)	Carbon seques-tration potential = TB/ 2(kg)
Bombax ceiba L.	2.745	21.3	0.5999 22373	4.2168 54357	320.5	1351.501 821	351.390 4736	1702.89 2295	851.446
Mangifera indica L.	1.1285	17.8	0.1013 94287	0.59559	597.7	355.9841 695	92.5558 8407	448.540 0535	224.270
Ficus benghalensis L.	3.233	18.3	0.8321 88615	5.0255 87	490.3	2464.045 328	640.651 7852	3104.69 7113	1552.348
Albizia lebbeck (L.) Benth.	4.27	27.4	1.4516 64013	13.125 95	596.4	7828.314 196	2035.36 1691	9863.67 5887	4931.837
Neolamarckia cadamba (Roxb.) Bosser	0.823	22	0.0539 27468	0.391513	480.0	187.9264 41	48.8608 7466	236.787 3157	118.393
Syzygium cumini (L.) Skeels	0.762	22.3	0.0462 29618	0.3402 03758	701.1	238.5169	62.01438	300.5312	150.265
Bauhinia purpurea L.	0.915	21.8	0.0666 58041	0.4795 3795	720.0	345.2673	89.7695	435.0368	217.518
Aegle marmelos (L.) Corrêa	0.945	22	0.0711 00717	0.5161 91202	782.7	404.0229	105.0459	509.0688	254.534
Cassia fistula L.	0.549	24.3	0.0239 96895	0.1924 311	829.3	159.5831	41.49161	201.0747	100.537
Psidium guajava L.	1.128	20.2	0.1013 04459	0.6752 95521	858.7	579.8763	150.7678	730.6441	365.322
Syzygium samarangense (Blume) Merr. & L.M. Perry	0.701	17.3	0.0391 24283	0.2233 60534	712.0	159.0327 003	41.3485 0208	200.381 2024	100.191
Aphanamixis polystachya (Wall.) R.Parker	0.976	23.3	0.0758 42038	0.5831 49432	620.0	361.5526 477	94.0036 8841	455.556 3362	227.778

Delonix regia (Hook.) Raf.	2.44	46.1	0.474012739	7.211155796	510.0	3677.689456	956.1992586	4633.888715	2316.944
Azadirachta indica A. Juss.	1.55	35	0.191281847	2.209305334	727.5	1607.269631	417.890104	2025.159735	1012.579
Pterospermum canescens Roxb.	1.92	35	0.293503185	3.389961783	519.8	1762.102135	458.1465551	2220.24869	1110.124
Putranjiva roxburghii Wall.	2.74	36.7	0.597738854	7.239215255	707.5	5121.744793	1331.653646	6453.398439	3226.699
Ficus religiosa L.	2.44	40	0.474012739	6.256968153	441.0	2759.322955	717.4239684	3476.746924	1738.373
Osmanthus fragrans Lour.	1.22	15	0.118503185	0.586590764	841.5	493.6161282	128.3401933	621.9563215	310.978
Alstonia scholaris (L.) R. Br.	3.05	50	0.740644904	12.22064092	397.3	4855.260639	1262.367766	6117.628405	3058.814
Swietenia mahagoni (L.) Jacq.	2.74	60	0.597738854	11.8352293	660.0	7811.251338	2030.925348	9842.176685	4921.088
Acacia auriculiformis Benth.	1.83	50	0.266632166	4.399430732	581.0	2556.069256	664.5780064	3220.647262	1610.323
Swietenia macrophylla King	0.152	12	0.00183949	0.007284382	533.4	3.885489447	1.010227256	4.895716703	2.447
Tectona grandis L.f.	1.83	40	0.266632166	3.519544586	612.7	2156.424968	560.6704916	2717.095459	1358.547
Anacardium occidentale L.	1.52	20	0.183949045	1.214063694	454.1	551.3063236	143.3396441	694.6459677	347.322
Shorea robusta Gaertn.	0.61	35	0.029625796	0.342177946	776.7	265.7696105	69.10009874	334.8697093	167.434
Lagerstroemia parviflora Roxb.	0.762	25	0.046229618	0.381394347	530.0	202.139004	52.55614104	254.695145	127.347
Murraya koenigii (L.) Spreng.	2.44	20	0.474012739	3.128484076	636.0	1989.715873	517.3261269	2507.041999	1253.521
Butea monosperma (Lam.) Taub.	1.83	30	0.266632166	2.639658439	440.0	1161.449713	301.9769255	1463.426639	731.713

Borassus flabellifer L.	1.52	50	0.183949045	3.035159236	975.0	2959.280255	769.4128662	3728.693121	1864.346
Sapindus mukorossi Gaertn.	0.915	20	0.066658041	0.439943073	679.0	298.7213467	77.66755015	376.3888969	188.194
Canarium album (Lour.) DC.	1.52	15	0.183949045	0.910547771	432.5	393.8119108	102.3910968	496.2030076	248.101
Melaleuca citrina (Curtis) Dum. Cours.	0.61	15	0.029625796	0.146647691	740.5	108.5926152	28.23407996	136.8266952	68.413
Celastrus robustus Roxb.	2.74	60	0.597738854	11.8352293	820.0	9704.888025	2523.270887	12228.15891	6114.079
Holoptelea integrifolia Planch.	2.44	25	0.474012739	3.910605096	515.5	2015.916927	524.138401	2540.055328	1270.027
Trewia nudiflora L.	0.61	12	0.029625796	0.117318153	440.8	51.71384178	13.44559886	65.15944065	32.579
Barringtonia acutangula (L.) Gaertn.	1.22	25	0.118503185	0.977651274	580.4	567.4287994	147.5314878	714.9602872	357.480
Dillenia indica L.	0.61	18	0.029625796	0.175977229	682.2	120.0516658	31.21343312	151.2650989	75.632
Oroxylum indicum (L.) Kurz	0.305	11	0.007406449	0.02688541	396.6	10.66275362	2.772315941	13.43506956	6.71753
Terminalia arjuna (Roxb. ex DC.) Wight &Arn.	2.74	60	0.597738854	11.8352293	805.0	9527.359586	2477.113492	12004.47308	6002.236

The economic as well utilitarian values for biological diversity are based on the reality that man depends on biological variability for the products that nature can give such as resins, wood, paper-making fibers, food, biochemical natural products, genes and also information for biotechnology, which includes the production of pharmaceutics and cosmetics[2]. Narrowly utilitarian refers to justifications for biodiversity preservation based on the fact that nature provides innumerable direct economic benefits to humanity, such as natural sources of food, fuel, fiber, construction materials, industrial goods, and pharmaceuticals. Broadly utilitarian

Table-2. Showing the listed plant species with their family and their utilitarian value

Scientific name	Family	Category of Narrow utilitarian (NU) (Food, Fodder, Pharmaceutics)	Ref
Bombax ceiba L.	Malvaceae	Pharmaceutics	Kumari *et al.*,[29].
Mangifera indica L.	Anacardiaceae	Food Pharmaceutics	Baloch *et al.*,[10]; Shah *et al.*,[57].
Ficus benghalensis L.	Moraceae	Pharmaceutics	Panday and Rauniar[47]; Iltaf *et al.*,[21].
Albizia lebbeck (L.) Benth.	Leguminosae	Pharmaceutics Fodder	Balkrishna *et al.*,[8]; Kurdi *et al.*, 1996.
Neolamarckia cadamba (Roxb.) Bosser	Rubiaceae	Pharmaceutics	Wang *et al.*,[75].
Syzygium cumini (L.) Skeels	Myrtaceae	Food Pharmaceutics	Qamar *et al.*,[52].
Bauhinia purpurea L.	Leguminosae	Pharmaceutics	T. Kumar and K.S. Chandrashekar, 2011. Zakaria *et al.*,[80].
Aegle marmelos (L.) Corrêa	Rutaceae	Food Pharmaceutics	Venthodika *et al.*,[74]; Sharma *et al.*,[60].
Cassia fistula L.	Leguminosae	Pharmaceutics	Siddiqua *et al.*,[66].; Mwangi *et al.*,[45].
Psidium guajava L.	Myrtaceae	Food Pharmaceutics	Tousif *et al.*,[72].
Syzygium samarangense (Blume) Merr. & L.M. Perry	Myrtaceae	Food Pharmaceutics	Banadka *et al.*,[11].
Aphanamixis polystachya (Wall.) R.Parker	Meliaceae	Pharmaceutics	Paul *et al.*,[50].
Delonix regia (Hook.) Raf.	Leguminosae	Pharmaceutics	Sharma, S., & Arora, S. [61].
Azadirachta indica A. Juss.	Meliaceae	Pharmaceutics	Baby *et al.*,[6].
Pterospermum canescens Roxb.	Malvaceae	Pharmaceutics	Jaiganesh K.P. and Aunachalam G[22].
Putranjiva roxburghii Wall.	Putranjivaceae	Pharmaceutics	Mishra *et al.*,[41].
Ficus religiosa L.	Moraceae	Pharmaceutics	Mussarat *et al.*,[43].
Osmanthus fragrans Lour.	Oleaceae	Pharmaceutics	Wang *et al.*, [76].
Alstonia scholaris (L.) R. Br.	Apocynaceae	Pharmaceutics	Khyade *et al.*,[28].

Swietenia mahagoni (L.) Jacq.	Meliaceae	Pharmaceutics	Sukardiman *et al*.,[68].
Acacia auriculiformis Benth.	Leguminosae	Pharmaceutics Fodder	Sharma *et al*.,[58]; Mathew *et al*.,[39] .
Swietenia macrophylla King	Meliaceae	Pharmaceutics	Moghadamtousi *et al*.,[42].
Tectona grandis L.f.	Lamiaceae	Pharmaceutics	Asdaq *et al*.,[5].
Anacardium occidentale L.	Anacardiaceae	Pharmaceutics Food	Salehi *et al*.,[54].
Shorea robusta Gaertn.	Dipteroc-arpaceae	Pharmaceutics	Soni *et al*.,[67].
Lagerstroemia parviflora Roxb.	Lythraceae	Pharmaceutics	Sharmin *et al*.,[63].
Murraya koenigii (L.) Spreng.	Rutaceae	Pharmaceutics	Balakrishnan *et al*.,[9].
Butea monosperma (Lam.) Taub.	Leguminosae	Pharmaceutics	Muthuswamy *et al*.,[44].
Borassus flabellifer L.	Arecaceae	PharmaceuticsFood	Thi Le *et al*.,[70].
Sapindus mukorossi Gaertn.	Sapindaceae	Pharmaceutics	Upadhyay *et al*.,[73].
Canarium album (Lour.) DC.	Burseraceae	Pharmaceutics	Yeh YT *et al*.,[79].
Melaleuca citrina (Curtis) Dum.Cours.	Myrtaceae	Pharmaceutics	Manikandan *et al*.,[37].
Celastrus robustus Roxb.	Celastraceae	Pharmaceutics	Shen *et al*.,[64].
Holoptelea integrifolia Planch.	Ulmaceae	Pharmaceutics	Ganie *et al*.,[18].
Trewia nudiflora L.	Euphorbiaceae	Pharmaceutics	Kang *et al*.,[25].
Barringtonia acutangula (L.) Gaertn.	Lecythidaceae	Pharmaceutics	Kaur *et al*.,[27].
Dillenia indica L.	Dilleniaceae	PharmaceuticsFood	Kviecinski *et al*.,[31].; Das *et al*.,[13].
Oroxylum indicum (L.) Kurz	Bignoniaceae	Pharmaceutics	Dinda *et al*.,[14].
Terminalia arjuna (Roxb. ex DC.) Wight &Arn.	Combretaceae	Pharmaceutics	Amalraj *et al*.,[4].

implies to biodiversity's broad and all-encompassing benefits, which are not exclusive to any one species and include pollination, oxygen production, air quality maintenance and aesthetic value[34]. Among the listed plants 2 and 8 plants used as fodder and food respectively where all the plants possess pharmaceuticals potential (Table-2).

Carbon sequestration potential reported at Tropical Forest Reserve and Benue State of Nigeria records *Delonix regia*, *Albizia lebbeck*, *Azadirachta indica, Mangifera indica* are respectively 3,611.3 kg, 26.1 kg,221 kg, 2755.8 kg [15]. Due to 20 years of limestone mine for the cement manufacture, *Bombax ceiba* native species can be used for regeneration in restoring a 0.2 km^2 significantly degraded tropical monsoon rainforest at Baopoling Mountain (BPL), Sanya, China. In a pristine tropical rainforest in BPL stomatal closure assisted *Bombax ceiba* in developing higher tolerance to drought stress than the most prevalent native plant like *Bridelia tomentosa*, hence better adjusting to drought stress in the dry season[35]. *Swietenia mahagoni* (18.08ton/tree) of Gujrat forest[48], *Albizia lebbeck* (2.419 ton/tree)of North Maharashtra University Jalgaon[69], *Holoptelea integrifolia* (0.02-ton/tree) and *Terminalia arjuna* (2.2ton/tree) of Pushkar valley, Aravali region Rajasthan[59], *Alstonia scholaris* (190.36 ton/tree) and *Delonix regia* (16.84ton/tree) of Shuats Campus *i.e.* Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad[38] are the example of plant having high carbon sequester potential. AGB and carbon stock are respectively reported *Alstonia scholaris* (20.97 t/ha and 9.44 t/ha), *Acacia auriculiformis* (5.84t/ha and 2.63t/ha), *Swietenia macrophylla* (2.08t/ha and 0.93t/ha), *Syzygium cumini* (0.20t/ha and 0.08t/ha), *Azadirachta indica* (0.19t/ha and 0.06t/ha) at Isabela State University Wildlife Sanctuary (ISUWS), Cabagan, Isabela, Philippines[49]. Study based on Plantation in North Kalimantan, Indonesia, 8 years age of *Neolamarckia cadamba* forest produced 81.90 tons ha^{-1} of biomass and 39.31 tons ha^{-1} of carbon sequestration, respectively. However, a different plot for *N. cadamba* trees had 96.85 tons ha^{-1} of biomass and 46.49 tons ha^{-1} of carbon, While the third plot had values of 116.84 and 56.08 tons per hectare, respectively[56]. Urban forests of Universitas Indonesia in Depok contain *Bauhinia purpurea*, which stores 2.079 tons of carbon per hectare[55] whereas at Ratanpur, Nepal value is 1.47 kg/tree[26]. *Azadirachta indica* (39.138 tons), *Ficus benghalensis* (1.619 tons), *Delonix regia* (1.366 tons), *Albizia lebbeck* (1.112 tons), *Murraya koenigii* (1.019 tons), *Ficus religiosa* (0.851 tons), *Syzygium cumini* (0.804 tons), *Mangifera indica* (0.143 tons), *Lagerstroemia parviflora* (0.137 tons), *Holoptelea integrifolia* (0.128 tons), *Aegle marmelos* (0.112 tons), *Alstonia scholaris* (0.064 tons), *Butea monosperma* (0.057 tons) are the potent carbon sequesters present at Kamareddy Municipality road side of Telangana state of southern India[53].

Sustainable utilization of natural resources may serve as a successful conservation solution for plants with medicinal properties with diminishing stocks. *Swietenia mahagoni*[68], *Holoptelea integrifolia*[18], *Terminalia arjuna*[4], *Alstonia scholaris*[28], are the example of some angiospermic genera can be used as potent phytoresources for ecological optimization through CO_2 sequestration as they are commonly grow in different parts of Asian continent.

Global carbon sequestration programme has the potential to make a particularly significant contribution to controlling the rise in CO_2 emissions in the next few decades. However, even the highest quantity of carbon that could be sequestered over the course of a century will be swamped by the enormity of fossil-fuel emissions. Carbon sequestration by plants should be seen as a component of a mitigation strategy not as a replacement for the changes in energy supply, consumption and technology that will be required to stabilize atmospheric CO2 concentrations. The current study found that *Celastrus robustus* (6114.079 kg), *Terminalia arjuna* (6002.236 kg), *Albizia lebbeck* (4931.837 kg), and *Swietenia mahagoni* (4921.088 kg) sequester atmospheric CO_2 with remarkable efficiency. In the final analysis, it can be claimed that the current research can open the door to aesthetic renewal through landscape design in conjunction with ecological optimization through CO_2 sequestration using suitable trees.

Conflict of Interest

It is certified that the authors have no conflict of interest regarding the publishing of this paper and has authorized the final manuscript.

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