

Article

Urban Parks and Native Trees: A Profitable Strategy for Carbon Sequestration and Climate Resilience

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Abstract: Urban green spaces are increasingly recognized for their potential to mitigate climate change by reducing atmospheric concentrations of greenhouse gases, especially carbon dioxide (CO₂). However, enhancing carbon sequestration efficiency in limited urban green areas remains a significant challenge for sustainable urban planning. Trees are among the most cost-effective and efficient natural carbon sinks, surpassing other types of land cover in terms CO₂ absorption and storage. The present study aimed to evaluate the carbon sequestration potential of four native tree species, *Pongamia pinnata*, *Azadirachta indica*, *Melia azedarach*, and *Dalbergia sissoo*, in urban parks across Multan City, Pakistan. A total of 456 trees of selected species within six parks of Multan City were inventoried to estimate the biomass and carbon stock using species-specific allometric equations. Soil organic carbon at two soil depths beneath the canopy of each tree was also estimated using Walkley–Black method. The findings revealed that the highest mean tree biomass (2.16 Mg ha^{−1}), carbon stock (1.04 Mg ha^{−1}) and carbon sequestration (3.80 Mg ha^{−1}) were estimated for *Dalbergia sissoo*, while *Melia azedarach* exhibited the lowest (0.12 Mg ha^{−1}, 0.06 Mg ha^{−1} & 0.23 Mg ha^{−1}, respectively) across all six parks. The soil carbon stocks ranged from 48.86 Mg ha^{−1} to 61.68 Mg ha^{−1} across all study sites. These findings emphasize the importance of species selection in urban green planning for carbon sequestration. Strategic planting of effective native trees like *Dalbergia sissoo* can mitigate climate change and provide urban forest ecosystem services.

Keywords: carbon stock; CO₂ sequestration; climate change; *Dalbergia sissoo*; ecosystem services; urban parks



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1. Introduction

Industrialization and urbanization have increased fossil fuel consumption and the degradation of green spaces, raising the average global CO₂ concentration from pre-industrial levels [1,2]. This rise in greenhouse emissions has led to severe environmental challenges, such as climate change, which has significant implications for global ecology and socioeconomic systems. In response to this challenge, the international community has proposed a number of international agreements, with the Paris Climate Change Agreement

being the most prominent. This agreement aims to restrict the average global temperature rise to below 1.5 °C compared to pre-industrial levels [3]. The Intergovernmental Panel on Climate Change (IPCC) has emphasized that all nations must pursue carbon neutrality by 2050 [4]. Aligning with this global directive, Pakistan has established its primary policy to attain zero-carbon emissions by 2050 [5]. Trees planted in urban parks provide an effective carbon reduction strategy that contributes to the global carbon neutrality objectives. Trees mitigate carbon emissions by providing shade, protecting against wind, and promoting evapotranspiration [6–8]. In addition to carbon sequestration, urban trees provide other benefits, such as air purification, improved microclimates, increased rainfall, and reductions in noise pollution [9–11]. In order to establish the national greenhouse gas reduction targets, it is important to understand the carbon offset potential of urban trees. Urban forestry can contribute to the mitigation of climate change by sequestering high CO₂ emissions in cities. Research has shown that tree cover in urban areas has the potential to bend the rising carbon curve below the 2 °C threshold, thereby contributing to a reduction in the rate of global warming [12]. Trees absorb carbon through their biomass and can help to achieve carbon neutrality [13]. Although there has been debate on the extent of CO₂ offset that urban trees can provide [14], their potential to reduce CO₂ emissions remains significant and cannot be neglected [15,16].

Urban parks play a critical role in carbon sequestration, providing essential environmental benefits amid rising global emissions. Multiple studies have shown the significance of spatial planning and strategic species selection in improving the efficiency of carbon sequestration in urban green spaces. For example, in Xi'an, China, optimizing plant selection and green space distribution significantly enhanced carbon sequestration efficiency, with *Styphnolobium japonicum* and *Salix babylonica* have high sequestration potential [17]. Research conducted on 25 public parks in Bangkok, Thailand, estimated a sequestration capacity of 11,112.2 tons of carbon, which accounted for only 0.1% of the city's emissions, thereby highlighting the need for improved urban greening strategies [18]. Similarly, a study of four historical parks in Rome, Italy, revealed their significant role in carbon sequestration, with an annual capacity of 3197 MgCO₂ ha⁻¹, offsetting approximately 3.6% of the city's 2010 greenhouse gas emissions. Larger parks like Villa Pamphili and Villa Ada, with extensive woodland areas, had higher sequestration rates (780–998 MgCO₂ ha⁻¹ year⁻¹), while smaller parks showed lower efficiency [19]. Urban trees in Tehran, Iran, sequester approximately 60,102 tons of carbon annually, with species like *Cupressus arizonica* playing a key role in offsetting pollution in the semiarid environment [20]. These findings show that species selection is crucial for urban carbon sequestration. In recent years, there has been a growing focus on the role of land use in mitigating climate change by absorbing atmospheric carbon dioxide through the accumulation of carbon in vegetation and soil. Among the vegetation, native and endangered species have been preferred for urban planting schemes over the past decade [21–23], while others recommend the selection of species based on their ecosystem services, such as air pollution, soil stabilization, and microclimate regulation [24,25]. Native species are generally regarded as more effective in providing better ecosystem services and conservation of regional biodiversity compared to introduced species [21,26].

However, there are not enough region-specific data available to draw relevant conclusions about how native species are vital in sequestering carbon in trees growing in urban parks. This knowledge gap hinders the development of green space planning strategies that seek to maximize climate benefits. Therefore, the present study aimed to address this gap by assessing the biomass and identification of native species with high carbon sequestration potential, thereby contributing to reducing carbon footprints in urban green spaces. Pakistan, like many other developing countries, is facing severe environmental

challenges, due to its expanding population, pollution, and rapid urbanization. Multan, one of the most densely populated cities and seventh-largest city in Pakistan, exemplifies these challenges. This research aimed to evaluate the potential of four native tree species found in urban parks in Multan City, Pakistan, to sequester carbon dioxide (CO₂). In addition to calculating the CO₂ sequestration [27,28], this study also aims to determine the monetary value of sequestered carbon.

2. Materials and Methods

2.1. Study Area

The present study was conducted in Multan, the biggest city in Southern Punjab, Pakistan (Figure 1). Geographically, the city is located at latitude 30.2° N and longitude 71.47824° E, with an altitude of about 215 m above sea level. Multan is characterized by an arid climate with hot summers and mild winters, with an average rainfall of 200 mm. The city has extreme temperature variations, ranging from 1 °C in winter to 52 °C in summer [29]. It covers an area of 3720 km² with a population of around 3.1 million, of which 42% reside within the urban core. Despite the presence of many urban spaces, the urban parks of Multan have not been investigated for their ecosystem services, particularly their potential for carbon sequestration. This region has been particularly vulnerable to climate change impacts such as floods and heat waves [30], making it an ideal region to investigate this problem.

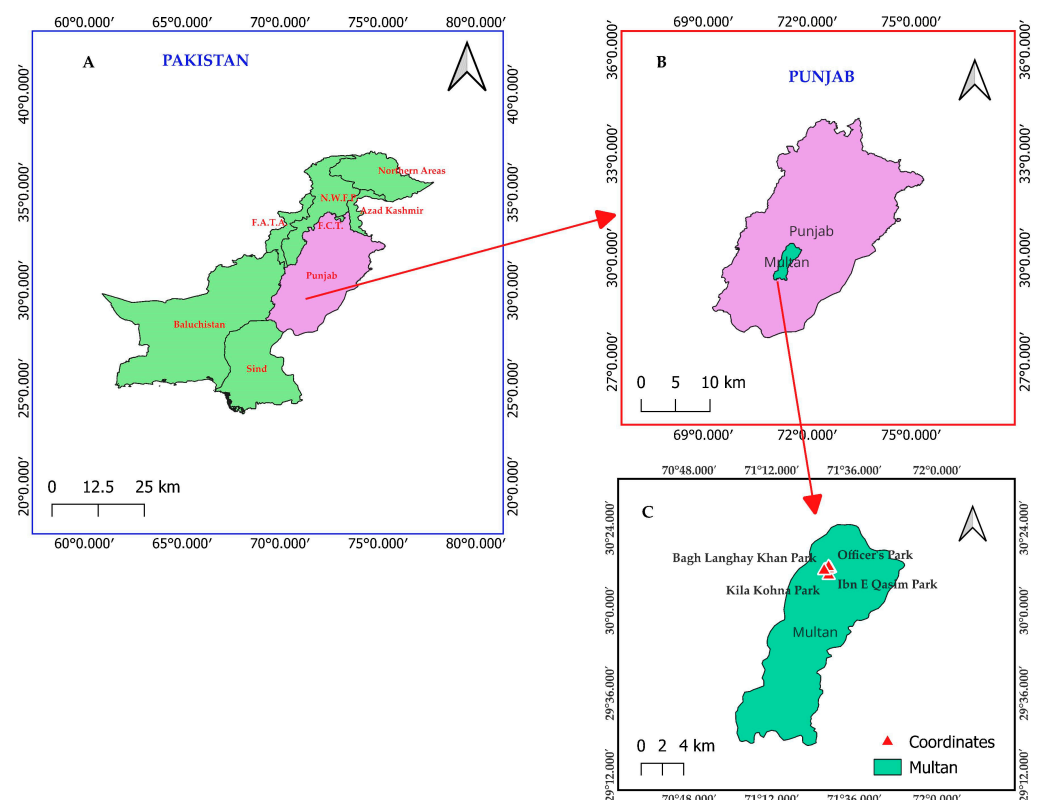


Figure 1. Study area showing map of (A) Pakistan, (B) Punjab province of Pakistan and (C) sampling sites of Multan City (Southern Punjab).

2.2. Sampling Methodology

The sampling method and sample size were determined depending on the area and vegetation composition to ensure the overall accuracy of the sampling [31]. In Multan City, the Parks and Horticultural Authority (PHA) is responsible for the maintenance of urban parks. Currently, the city has 59 parks, which are divided into three distinct zones: A, B,

and C. The average park size is 3.36 acres, and the median is 1.58 acres. Only three parks exceed 10 acres in size, while the rest range from 0.1 to 6 acres. For this study, parks in each zone were further subdivided into three size classes depending on their size: large parks (>10 acres), medium parks (5–10 acres), and small parks (<5 acres). The parks were selected using a random sampling technique, while the quantitative evaluation of tree coverage composition was conducted using a stratified random sampling approach. A total of six urban parks, two from each class category, were selected in the study area. Details of the selected urban parks are presented in Table 1.

Table 1. Details of the six selected urban parks.

Park Category	Park Name	Park Location	Park Area
Large Parks	Shashams Park	71.48228° E, 30.20402° N	39.80 acres
	Kila Kohna Park	71.47557° E, 30.19935° N	25.00 acres
Medium Parks	Bagh Langhay Khan Park	71.45944° E, 30.19651° N	6.00 acres
	Ibn E Qasim Park	71.47503° E, 30.19984° N	10.00 acres
Small Parks	Officer's Colony Park	71.47501° E, 30.21092° N	2.10 acres
	Allama Iqbal Park	71.45359° E, 30.19327° N	2.00 acres

A field survey was carried out during March and April 2024 across six selected urban parks to inventory trees and collect soil samples. Four native species, viz. *Dalbergia sissoo* Roxb. ex DC., *Azadirachta indica* A.Juss., *Melia Azedarach* L. and *Pongamia pinnata* (L.) Pierre, were selected for this study. A total of 456 trees (76 from each park, with 19 individuals per species) were sampled. For each tree, diameter at breast height (DBH) and total height were measured to estimate biomass and carbon stock.

For soil analysis, soil sampling was performed underneath the canopy of selected tree species at two depths: 0–20 cm and 20–40 cm. Using a soil auger, a total of 192 soil samples (96 per depth, 32 per urban park and 48 per tree species) were collected. All samples were properly labeled and stored at 4 °C before being subjected to further analysis.

2.3. Above- and Belowground Biomass and Carbon Estimation

For the estimation of tree biomass, a non-destructive approach was employed. For this, initially, the girth of each individual tree was measured at a height of 1.37 m by using the tailor's inches tape, which was then converted to DBH. Tree height was estimated with the help of Sunnto Clinometer. The aboveground biomass for each species was estimated utilizing species-specific allometric equations sourced from the scientific literature (Table 2) and adjusted for log bias as necessary. For all the trees, it was assumed that belowground biomass constituted 26% of the aboveground biomass [32–34]. The carbon content was taken as 48% of the total biomass of each species [35]. Later, individual trees' carbon was converted to carbon per park, carbon per hectare, and total carbon stock per hectare. The carbon contents were multiplied by a factor of 3.663 to calculate the CO₂ sequestration, as described by Yasin et al. [36].

Table 2. Allometric equations are used for the calculation of tree biomass.

Species	Biomass Equations	Reference
<i>Pongamia pinnata</i> (L.) Pierre	$Exp (+1.230 (\ln(D2)) - 2.308$	[37]
<i>Azadirachta indica</i> A.Juss.	$Exp (-0.456 + 1.673x \ln(DBH))$	[38]
<i>Melia azedarach</i> L.	$Exp (-5.7225 + 2.0365 \times \ln(DBH \times TH)$	[39]
<i>Dalbergia sissoo</i> Roxb. ex DC.	$Exp (+1.113 (\ln(D2)) - 0.891$	[37]

2.4. Soil Sampling and Carbon Estimation

For the estimation of soil carbon, soil samples were collected at two different depths (0–20 and 20–40 cm) underneath the canopy of each tree species. A total of 192 samples, 76 for each depth and 48 for each tree species, were collected using a soil auger. After collection, the samples were immediately sealed in ziplocked polythene bags and transported to the laboratory under temperature-controlled conditions. A metal core sampler with dimensions of 6 cm in height and 4 cm in internal diameter was used to estimate the soil bulk density at the specified depths. The samples were air-dried and sieved through a 2 mm sieve. Soil organic carbon (%) was determined by using the method explained by Walkley and Black [40]. Soil organic carbon stocks (SOCs) on per-hectare basis were then calculated by multiplying the values of soil depth, bulk density, and percentage of organic carbon [41].

$$SOC = OC\% \times Bulk\ density\ (g\ cm^{-3}) \times sampling\ depth\ (cm)$$

2.5. Statistical Analysis

Descriptive statistical analysis was performed using the Statistics 8.1 version. To evaluate the variability among the native tree species and study sites (urban parks), a one-way analysis of variance (ANOVA) was conducted using the Statistics 8.1 version software. Upon significance, mean values were compared by the least significant difference (LSD) using the Statistics 8.1 version software package. The study map including geographic site coordinates of the investigated sites, was created using QGIS version 3.34.12. Data visualization, including graphs, was generated utilizing Microsoft Office software (version 2019; Microsoft Corporation, Albuquerque, NM, USA).

3. Results

3.1. Growth Parameters

The growth parameters, including diameter at breast height (DBH cm) and height (m) of various tree species from the studied urban parks, are presented in Table A1, with significant differences observed ($p < 0.05$). Among all the species, greater diameter (61.88 cm) and height (28.93 m) were observed for *A. indica* trees present in Shahshams Park, while lower diameter (25.48 cm) and height (7.40 m) were found in Bagh Langhay Khan Parkas compared to other parks. For *P. pinnata*, the greater DBH (28.04 cm) and height (11.86 m) were observed in Qila Kohna Qasim Park, whereas the lowest DBH (20.54 cm) and height (7.18 m) were found in Bagh Langhay Khan Park. In the case of *M. azedarach*, trees in Qila Kohna Qasim Park had greater DBH (22.45 cm) and height (13.45 m), while lower values of DBH (13.84 cm) and height (4.85 m) were recorded in Officer's Colony Park. Similarly, *D. sissoo* attained greater DBH (40.18 cm) and height (19.69 m) in Qila Kohna Qasim Park, while the lowest DBH (24.18 cm) and height (9.08 m) were observed in Officer's Colony Park (Table A1). These variations demonstrate the site-specific effects on tree growth across different urban parks.

The results of DBH and height show a significant difference ($p < 0.05$) among the four native species, as shown in Figure 2A,B. The maximum DBH (32.65 cm) and height (14.41 m)

were recorded for *A. indica*, while the minimum DBH (8.38 cm) and height (18.63 m) were recorded in *M. azedarach*, as compared to other species.

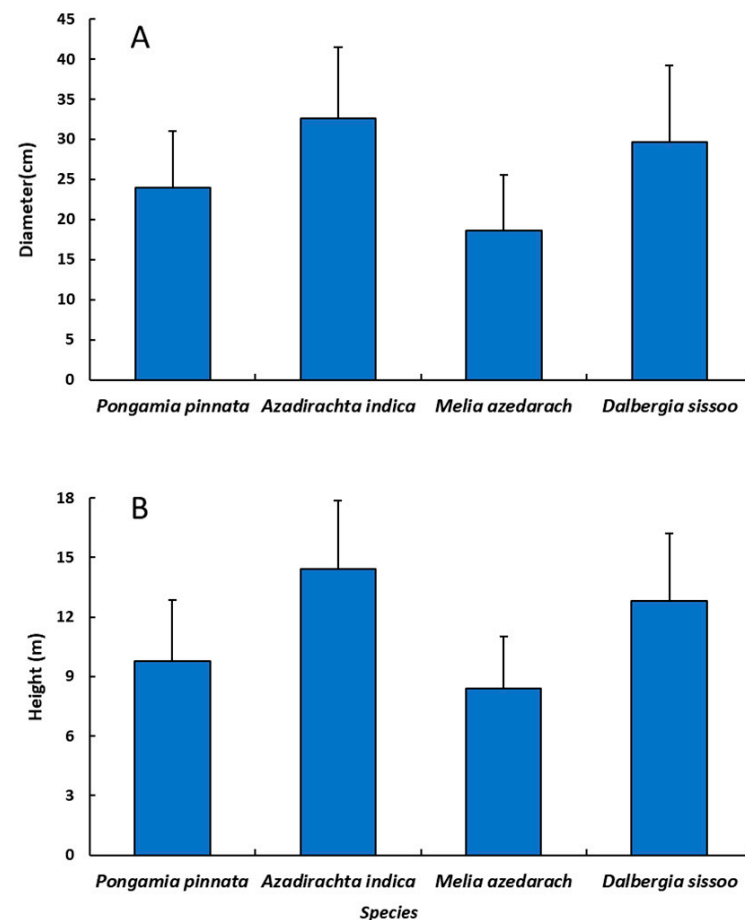


Figure 2. Showing comparison of (A) diameter and (B) height among selected native species in urban parks of Multan City.

3.2. Biomass Carbon and CO₂ Sequestration Rate

The overall mean biomass exhibited considerable variation and was significantly ($p \leq 0.05$) distinct among the tree species and across urban parks (Table A2). In the case of *P. pinnata*, the highest total biomass (0.41 Mg ha^{-1}) was recorded in Jinnah Park, while the lowest (0.12 Mg ha^{-1}) was recorded in Bagh Langhay Khan Park. For *A. indica*, the maximum total biomass (2.63 Mg ha^{-1}) was recorded in Shahshams Park, while the minimum (0.12 Mg ha^{-1}) was recorded in Bagh Langhay Khan Park. Similarly, *M. azedarach* recorded the maximum total biomass (0.27 Mg ha^{-1}) in Shahshams Park and the minimum (0.04 Mg ha^{-1}) in Bagh Langhay Khan Park. In the case of *D. sissoo*, the highest total biomass (5.05 Mg ha^{-1}) was recorded in Qila Kohna Qasim Park, while the lowest (0.82 Mg ha^{-1}) was recorded in Officer's Colony Park (Table A2).

The results of aboveground biomass (AGB), belowground biomass (BGB) and total biomass (TB) showed significant differences ($p < 0.05$) among the four native species (Figure 3). *D. sissoo* showed the maximum mean of AGB (1.71 Mg ha^{-1}), BGB (0.45 Mg ha^{-1}), and TB (2.16 Mg ha^{-1}), suggesting its excellent carbon accumulation potential. In contrast, the minimum AGB (0.10 Mg ha^{-1}), BGB (0.03 Mg ha^{-1}) and TB (0.12 Mg ha^{-1}) were recorded in *M. azedarach*, as compared to other species. These findings highlight the potential of *D. sissoo* to optimize carbon sequestration in urban green spaces and emphasize the species-specific variations in biomass productivity.

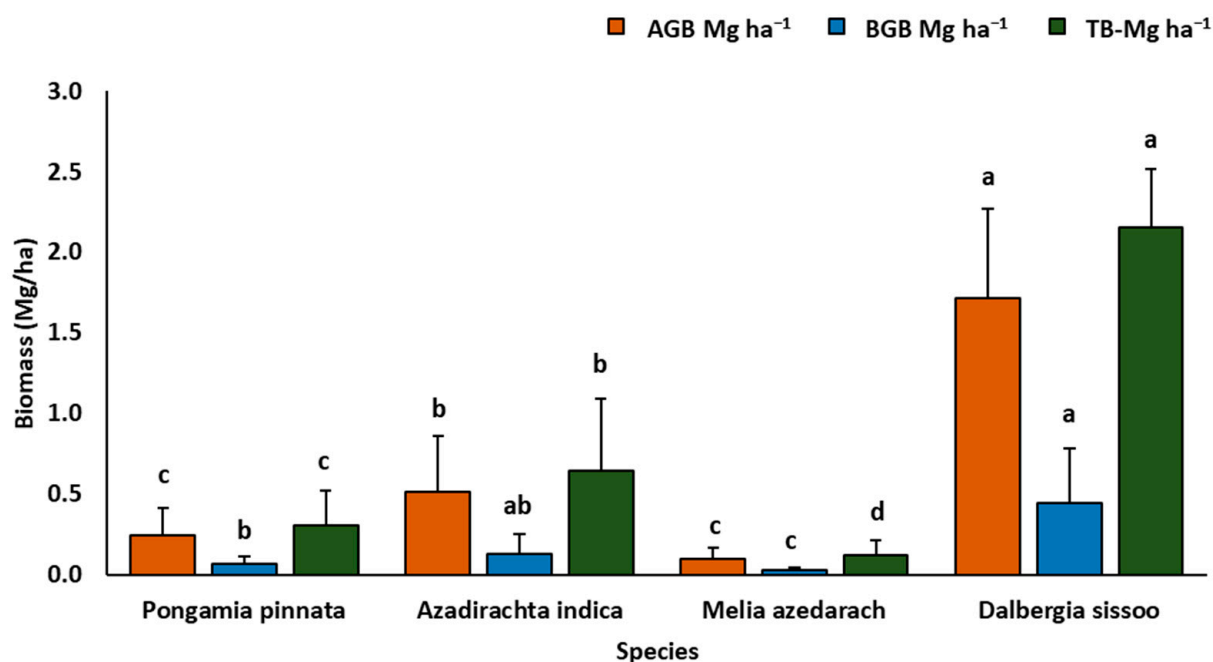


Figure 3. Aboveground, belowground and total biomass of the studied tree species in urban parks of Multan City. Different letters above the error bars indicate statistically significant differences at $p < 0.05$ based on Least Significant Difference (LSD).

Similar to tree biomass, highly significant variations in tree carbon stock and CO₂ sequestration were observed among the tree species and the studied urban parks. The measured aboveground, belowground, and total carbon stock varied significantly ($p \leq 0.05$) by tree species and site (Table A3). For *P. pinnata*, the highest total carbon (0.20 Mg ha⁻¹) was recorded in Jinnah Park, while the lowest (0.06 Mg ha⁻¹) was recorded in Bagh Langhay Khan Park. In the case of *A. indica*, the maximum total carbon (1.27 Mg ha⁻¹) was recorded in Shahshams Park and the minimum (0.06 Mg ha⁻¹) again in Bagh Langhay Khan. *M. azedarach* recorded the maximum total carbon (0.13 Mg ha⁻¹) in Shahshams Park and the minimum (0.03 Mg ha⁻¹) in Officer's Colony Park. For *D. sissoo*, the highest total carbon (2.43 Mg ha⁻¹) was recorded in Shahshams Park, whereas the lowest (0.27 Mg ha⁻¹) was recorded in Qila Kohna Qasim Park.

Also, carbon sequestration showed significant variation among the tree species and studied sites. For *P. pinnata*, the maximum carbon sequestration (0.71 Mg ha⁻¹) was recorded in Officer's Colony Park and the minimum (0.21 Mg ha⁻¹) in Bagh Langhay Khan Park. *A. indica* showed maximum carbon sequestration (4.64 Mg ha⁻¹) in Shahshams Park and the minimum (0.22 Mg ha⁻¹) in Bagh Langhay Khan Park. In the case of *M. azedarach*, the maximum carbon sequestration (0.48 Mg ha⁻¹) was recorded in Shahshams Park while the minimum (0.07 Mg ha⁻¹) in Allama Iqbal Park. *D. sissoo* exhibited the greatest carbon sequestration potential, with a maximum value of (8.89 Mg ha⁻¹) in Qila Kohna Qasim Park and the minimum (0.97 Mg ha⁻¹) in Jinnah

Overall, the results of carbon stock (TC) and carbon sequestration (SC) showed a significant difference ($p < 0.05$) among the four native species (Figure 4). The maximum TC (1.04 Mg ha⁻¹) and CS (3.80 Mg ha⁻¹) were recorded in the case of *Dalbergia sissoo*, thereby indicating its excellent capacity for carbon storage and sequestration. In contrast, *M. azedarach* showed the lowest TC (0.06 Mg ha⁻¹) and CS (0.23 Mg ha⁻¹) compared to other native species, indicating a relatively lower contribution to ecosystem carbon services among the studied sites.

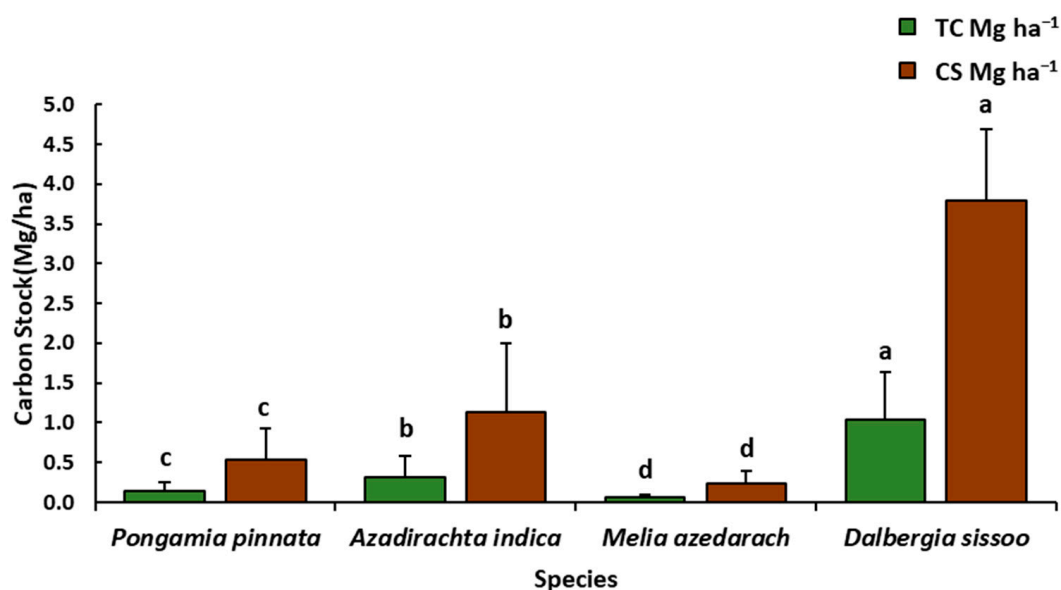


Figure 4. Total carbon stock and carbon sequestration potential among studied tree species in urban parks of Multan City. Different letters above the error bars indicate statistically significant differences at $p < 0.05$ based on Least Significant Difference (LSD).

3.3. Soil Carbon Stock

Across all tree species and studied sites, organic carbon (OC%) and soil carbon stock (SOC Mg ha⁻¹) demonstrated a decreased trend with increasing soil depth (0–20 cm > 20–40 cm). In the case of *P. pinnata*, the maximum SOC (15.71 Mg ha⁻¹) was recorded in Officer's Colony Park, while the minimum (11.33 Mg ha⁻¹) was found in Bagh Langhay Khan Park. For *A. indica*, the highest SOC (17.42 Mg ha⁻¹) was recorded in Shahshams Park, while the lowest (10.20 Mg ha⁻¹) was in Jinnah Park. *M. azedarach* showed the maximum SOC (15.13 Mg ha⁻¹) in Bagh Langhay Khan Park and the minimum SOC (10.75 Mg ha⁻¹) in Qila Kohna Qasim Park. Similarly, for *D. sissoo*, the SOC ranged from the highest (16.42 Mg ha⁻¹) in Officer's Colony Park to the lowest (11.94 Mg ha⁻¹) in Qila Kohna Qasim Park.

Statistical analysis showed no significant variation in SOC (Mg ha⁻¹) data among the tree species (Figure 5). The other parameters of soil samples are shown in Table A5.

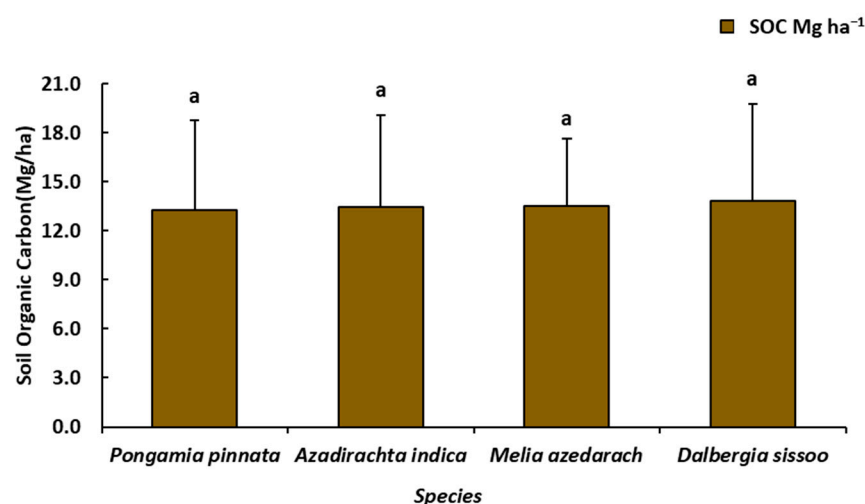


Figure 5. Soil organic carbon stocks among studied tree species in urban parks of Multan City. Error bars marked with same lowercase letters indicate no significant difference among the trees with respect to Soil Organic Carbon at $p < 0.05$ based on LSD.

4. Discussion

The current study aimed to investigate the capacity of native tree species in urban parks in Multan City, Pakistan, as a strategy to regulate and sequester carbon for mitigating CO₂ emissions. The findings revealed that native species have great potential to absorb carbon released from various sources. Moreover, these native species can tolerate high levels of CO₂ and intercept pollutants, thereby contributing to improved air quality and a reduction in greenhouse gas emissions, particularly CO₂. These findings are consistent with previous studies [26,42], which support the importance of native urban vegetation in mitigating climate change.

A significant variation ($p < 0.05$) in growth parameters, including DBH and height, was observed among the four native tree species (Figure 2). The highest DBH (32.65 cm) and height (14.41 m) were recorded for *A. indica*, while the lowest DBH (8.38 cm) and height (18.63 m) were recorded in *M. azedarach*. Our results indicate that there is a strong correlation between the DBH and height of the tree with biomass and carbon sequestration. Our findings support prior research indicating that, for the majority of species, the rate of mass growth increases as the size of the tree increases. This implies that larger, mature trees are actively capturing large amounts of carbon in comparison to smaller trees. In fact, a single large tree can accumulate as much carbon in one year as is stored in an entire medium-sized tree [34,43].

Growth and biomass accumulation are heavily influenced by many factors, such as the quality of the site, the type of soil, tree age, management practices, and their relationship with the belowground components [41,44]. In the current study, growth parameters along with above- and belowground biomass accumulation were quantified among various trees and urban parks, demonstrating significant variation ($p < 0.05$) (Figure 3) among four native tree species. The highest AGB (1.71 Mg ha⁻¹), BGB (0.45 Mg ha⁻¹), and TB (2.16 Mg ha⁻¹) were recorded in *D. sissoo*, while the lowest AGB (0.10 Mg ha⁻¹), BGB (0.03 Mg ha⁻¹) and TB (0.12 Mg ha⁻¹) were found for *M. azedarach*. These findings highlight the importance of *D. sissoo* species for carbon storage and biomass accumulation in urban environments.

The quantity of carbon in a given area is termed its carbon stock. The carbon sequestration rate refers to the process of capturing atmospheric carbon and storing it in a designated reservoir. Trees, as perennial plants, serve as long-term carbon sinks and can sequester significant quantities of carbon in both their aerial and subterranean structures. This study assessed the aboveground and belowground carbon stocks of four native tree species, along with the rate of CO₂ sequestration, in several urban parks. The carbon stock of the four native species exhibited a significant difference among them ($p < 0.05$; Figure 4). The maximum total carbon (TC) of 1.04 Mg ha⁻¹ and carbon stock (CS) of 3.80 Mg ha⁻¹ were recorded in *D. sissoo*, while the minimum TC of 0.06 Mg ha⁻¹ and CS of 0.23 Mg ha⁻¹ were found in *M. azedarach*. These findings underscore the importance of species selection in the optimization of urban carbon sequestration.

In addition to the carbon storage provided by the trees, soil plays an essential role in terrestrial ecosystems. Soil carbon stocks are influenced by a variety of factors, such as soil type, topography, climate, vegetation cover, and agricultural and forestry management practices [45]. Our study revealed a clear trend that soil carbon decreased with increasing depth, with the highest levels found at the upper depth (0–20 cm) across all six urban parks. This observation is likely due to the accumulation of organic matter (leaf litter and fine roots) near the surface of the soil, which adds to the increased carbon input to the soil [26,46].

This study, despite its valuable contributions, is subject to certain limitations, providing opportunities for future research to overcome such limitations. This study did not take into account the environmental consequences of seasonal maintenance activities in the park, such as pruning, mowing, or irrigation, which could influence carbon dynamics. Another important limitation in this study is the exclusion of all vegetation groups existing in the park, i.e., herbs, grasses, and shrubs, that also affect the overall carbon sink of the park.

This research also provides valuable practical implications. The method and analysis of urban parks provide insight into the strategies that can be replicable under similar environmental conditions for measurements of carbon sequestration. Moreover, this research identifies species having good carbon sequestration potential that can be used in the future planning of urban parks with effective carbon sinks in the country.

5. Conclusions

Green spaces in cities, particularly trees, can store carbon from the atmosphere and alleviate the effects of climate change. The current findings show that native tree species found in urban green spaces have high potential for reducing carbon emissions. To preserve the world from global warming and climate change, metropolitan areas must be managed sustainably with the goal of carbon sequestration. In addition to maintaining the current design, planting more carefully picked (native) urban trees can increase the amount of atmospheric carbon that urban parks absorb. Urban residents must understand the value of urban trees as an essential element of the urban landscape. The current trend in urban tree diversity exhibits the dominance of exotic species over native species, which frequently results in the neglect of the ecological and sustainable advantages of native species. Greater emphasis is required in the selection of trees for urban landscapes, not only for ease of maintenance but also to ensure an ecologically balanced mix of species. Therefore, promoting native biodiversity is a significant challenge, but it is critical for creating environmentally friendly and sustainable urban ecosystems. Therefore, a move towards building up native biodiversity is needed as it may bring about eco-friendly changes. Native trees such as *Dalbergia sissoo* (Sheesham) and *Azadirachta indica* (Neem) are considered ecologically beneficial due to their comparatively high carbon fixation efficiency; these species may be excellent for reducing urban pollution and may provide a viable option for maximum carbon fixation. According to the current findings, *Dalbergia sissoo* (Sheesham) and *Azadirachta indica* (Neem) can be planted in greater numbers to enhance the carbon stock in green spaces and help combat climate change. Moving forward, further research is needed to strengthen the implementation of urban green spaces as climate solutions. Key areas for future investigation include the following: assessing the long-term carbon storage potential of native versus exotic tree species in urban environments; identifying socioeconomic and cultural barriers to the adoption of native species in urban planning; and developing policy frameworks that incentivize biodiversity-friendly urban forestry practices. Additionally, studies should explore the synergistic benefits of urban trees, such as their role in reducing heat island effects, improving air quality, and enhancing urban biodiversity. By addressing these research gaps, cities can optimize green space management strategies, ensuring that urban forestry contributes effectively to climate resilience and sustainable development.

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Appendix A

Table A1. Summary of growth parameters and age classes of different tree species in urban parks in Multan City. Values are means $\pm$ SD.

Park Name	Tree Species	Diameter (cm)	Height (m)	Estimated Age Class
Shahshams Park	<i>Pongamia pinnata</i>	27.11 $\pm$ 6.36	11.48 $\pm$ 4.66	11–15 yrs.
	<i>Azadirachta indica</i>	61.88 $\pm$ 6.29	28.93 $\pm$ 1.25	25–30 yrs.
	<i>Melia azedarach</i>	22.03 $\pm$ 7.79	9.71 $\pm$ 3.74	7–12 yrs.
	<i>Dalbergia sissoo</i>	34.14 $\pm$ 8.67	16.15 $\pm$ 7.00	15–20 yrs.
Qila Kohna Qasim Park	<i>Pongamia pinnata</i>	28.04 $\pm$ 3.37	11.86 $\pm$ 3.01	12–15 yrs.
	<i>Azadirachta indica</i>	33.51 $\pm$ 13.56	20.91 $\pm$ 6.47	9–14 yrs.
	<i>Melia azedarach</i>	22.45 $\pm$ 5.34	13.45 $\pm$ 3.70	7–12 yrs.
	<i>Dalbergia sissoo</i>	40.18 $\pm$ 15.74	19.69 $\pm$ 7.22	17–22 yrs.
Bagh Langhay Khan Park	<i>Pongamia pinnata</i>	20.54 $\pm$ 5.42	7.18 $\pm$ 1.54	5–10 yrs.
	<i>Azadirachta indica</i>	25.48 $\pm$ 5.87	7.40 $\pm$ 2.06	8–12 yrs.
	<i>Melia azedarach</i>	20.07 $\pm$ 3.68	6.46 $\pm$ 1.52	6–11 yrs.
	<i>Dalbergia sissoo</i>	25.79 $\pm$ 14.25	8.72 $\pm$ 5.22	10–15 yrs.
Jinnah Park	<i>Pongamia pinnata</i>	22.86 $\pm$ 9.63	11.42 $\pm$ 3.36	7–12 yrs.
	<i>Azadirachta indica</i>	27.41 $\pm$ 11.08	9.11 $\pm$ 4.01	9–13 yrs.
	<i>Melia azedarach</i>	15.98 $\pm$ 5.81	8.64 $\pm$ 2.49	4–9 yrs.
	<i>Dalbergia sissoo</i>	20.22 $\pm$ 11.64	12.68 $\pm$ 4.10	5–10 yrs.
Allama Iqbal Park	<i>Pongamia pinnata</i>	21.77 $\pm$ 6.62	8.84 $\pm$ 3.12	6–11 yrs.
	<i>Azadirachta indica</i>	26.63 $\pm$ 9.98	11.23 $\pm$ 4.47	9–13 yrs.
	<i>Melia azedarach</i>	17.39 $\pm$ 5.67	7.19 $\pm$ 1.82	5–9 yrs.
	<i>Dalbergia sissoo</i>	33.22 $\pm$ 13.82	10.61 $\pm$ 3.66	15–20 yrs.
Officer’s Colony Park	<i>Pongamia pinnata</i>	23.33 $\pm$ 10.74	7.80 $\pm$ 2.75	8–13 yrs.
	<i>Azadirachta indica</i>	25.98 $\pm$ 8.82	8.85 $\pm$ 2.61	8–13 yrs.
	<i>Melia azedarach</i>	13.84 $\pm$ 3.80	4.85 $\pm$ 1.43	4–9 yrs.
	<i>Dalbergia sissoo</i>	24.18 $\pm$ 11.52	9.08 $\pm$ 5.07	9–14 yrs.

Table A2. Biomass distribution among different tree species in urban parks in Multan City. Values are means $\pm$ SD.

Park Name	Species	AGB Mg ha ⁻¹	BGB Mg ha ⁻¹	TB Mg ha ⁻¹
Shahshams Park	<i>Pongamia pinnata</i>	0.30 $\pm$ 0.04	0.08 $\pm$ 0.01	0.38 $\pm$ 0.13
	<i>Azadirachta indica</i>	2.09 $\pm$ 0.76	0.54 $\pm$ 0.20	2.63 $\pm$ 0.46
	<i>Melia azedarach</i>	0.22 $\pm$ 0.09	0.06 $\pm$ 0.00	0.27 $\pm$ 0.22
	<i>Dalbergia sissoo</i>	1.56 $\pm$ 0.40	0.41 $\pm$ 0.15	1.96 $\pm$ 0.65
Qila Kohna Qasim Park	<i>Pongamia pinnata</i>	0.26 $\pm$ 0.12	0.07 $\pm$ 0.03	0.33 $\pm$ 0.15
	<i>Azadirachta indica</i>	0.40 $\pm$ 0.14	0.10 $\pm$ 0.03	0.50 $\pm$ 0.05
	<i>Melia azedarach</i>	0.18 $\pm$ 0.03	0.05 $\pm$ 0.00	0.22 $\pm$ 0.02
	<i>Dalbergia sissoo</i>	4.01 $\pm$ 1.75	1.04 $\pm$ 0.23	5.05 $\pm$ 1.98
Bagh Langhay Khan Park	<i>Pongamia pinnata</i>	0.10 $\pm$ 0.02	0.03 $\pm$ 0.00	0.12 $\pm$ 0.06
	<i>Azadirachta indica</i>	0.10 $\pm$ 0.02	0.03 $\pm$ 0.00	0.12 $\pm$ 0.02
	<i>Melia azedarach</i>	0.03 $\pm$ 0.00	0.01 $\pm$ 0.00	0.04 $\pm$ 0.01
	<i>Dalbergia sissoo</i>	1.28 $\pm$ 0.30	0.33 $\pm$ 0.10	1.61 $\pm$ 0.90
Jinnah Park	<i>Pongamia pinnata</i>	0.33 $\pm$ 0.15	0.09 $\pm$ 0.00	0.41 $\pm$ 0.07
	<i>Azadirachta indica</i>	0.20 $\pm$ 0.13	0.05 $\pm$ 0.00	0.25 $\pm$ 0.02
	<i>Melia azedarach</i>	0.09 $\pm$ 0.01	0.02 $\pm$ 0.00	0.12 $\pm$ 0.01
	<i>Dalbergia sissoo</i>	0.44 $\pm$ 0.16	0.11 $\pm$ 0.03	0.55 $\pm$ 0.08
Allama Iqbal Park	<i>Pongamia pinnata</i>	0.14 $\pm$ 0.01	0.04 $\pm$ 0.01	0.18 $\pm$ 0.07
	<i>Azadirachta indica</i>	0.16 $\pm$ 0.08	0.04 $\pm$ 0.01	0.20 $\pm$ 0.08
	<i>Melia azedarach</i>	0.04 $\pm$ 0.00	0.01 $\pm$ 0.00	0.05 $\pm$ 0.01
	<i>Dalbergia sissoo</i>	2.34 $\pm$ 0.49	0.61 $\pm$ 0.17	2.95 $\pm$ 0.66
Officer's Colony Park	<i>Pongamia pinnata</i>	0.32 $\pm$ 0.05	0.08 $\pm$ 0.2	0.40 $\pm$ 0.09
	<i>Azadirachta indica</i>	0.13 $\pm$ 0.03	0.03 $\pm$ 0.00	0.16 $\pm$ 0.03
	<i>Melia azedarach</i>	0.01 $\pm$ 0.00	0.00 $\pm$ 0.00	0.01 $\pm$ 0.00
	<i>Dalbergia sissoo</i>	0.65 $\pm$ 0.27	0.17 $\pm$ 0.05	0.82 $\pm$ 0.22

AGB: Aboveground biomass; BGB: belowground biomass; TB: total biomass.

Table A3. Total carbon and carbon sequestration potential of different tree species in urban parks in Multan City. Values are means $\pm$ SD.

Park Name	Species	TC Mg ha ⁻¹	CS Mg ha ⁻¹
Shahshams Park	<i>Pongamia pinnata</i>	0.18 $\pm$ 0.05	0.68 $\pm$ 0.15
	<i>Azadirachta indica</i>	1.27 $\pm$ 0.46	4.64 $\pm$ 1.70
	<i>Melia azedarach</i>	0.13 $\pm$ 0.03	0.48 $\pm$ 0.09
	<i>Dalbergia sissoo</i>	0.94 $\pm$ 0.27	3.46 $\pm$ 1.66
Qila Kohna Qasim Park	<i>Pongamia pinnata</i>	0.16 $\pm$ 0.04	0.57 $\pm$ 0.17
	<i>Azadirachta indica</i>	0.24 $\pm$ 0.07	0.88 $\pm$ 0.25
	<i>Melia azedarach</i>	0.11 $\pm$ 0.03	0.39 $\pm$ 0.18
	<i>Dalbergia sissoo</i>	2.43 $\pm$ 0.88	8.89 $\pm$ 3.53
Bagh Langhay Khan Park	<i>Pongamia pinnata</i>	0.06 $\pm$ 0.01	0.21 $\pm$ 0.08
	<i>Azadirachta indica</i>	0.06 $\pm$ 0.01	0.22 $\pm$ 0.11
	<i>Melia azedarach</i>	0.02 $\pm$ 0.01	0.08 $\pm$ 0.02
	<i>Dalbergia sissoo</i>	0.78 $\pm$ 0.40	2.84 $\pm$ 1.11
Jinnah Park	<i>Pongamia pinnata</i>	0.20 $\pm$ 0.05	0.73 $\pm$ 0.19
	<i>Azadirachta indica</i>	0.12 $\pm$ 0.03	0.43 $\pm$ 0.13
	<i>Melia azedarach</i>	0.06 $\pm$ 0.01	0.21 $\pm$ 0.05
	<i>Dalbergia sissoo</i>	0.27 $\pm$ 0.12	0.97 $\pm$ 0.30

Table A3. Cont.

Park Name	Species	TC Mg ha ⁻¹	CS Mg ha ⁻¹
Allama Iqbal Park	<i>Pongamia pinnata</i>	0.09 ± 0.02	0.32 ± 0.17
	<i>Azadirachta indica</i>	0.09 ± 0.02	0.34 ± 0.10
	<i>Melia azedarach</i>	0.02 ± 0.01	0.07 ± 0.02
	<i>Dalbergia sissoo</i>	1.42 ± 0.72	5.19 ± 2.97
Officer's Colony Park	<i>Pongamia pinnata</i>	0.19 ± 0.09	0.71 ± 0.22
	<i>Azadirachta indica</i>	0.08 ± 0.02	0.29 ± 0.14
	<i>Melia azedarach</i>	0.03 ± 0.01	0.15 ± 0.02
	<i>Dalbergia sissoo</i>	0.40 ± 0.19	1.45 ± 0.75

Table A4. Showing soil organic carbon of different tree species in the studied parks in Multan City. The first and second values represent the mean values and standard deviation. Distribution of organic carbon and soil organic carbon stocks in urban parks in Multan City. Values are means ± SD.

Park Name	Species	OC (%)	SOCS Mg ha ⁻¹
Shahshams Park	<i>Pongamia pinnata</i>	0.29 ± 0.02	11.73 ± 4.89
	<i>Azadirachta indica</i>	0.35 ± 0.02	17.42 ± 10.55
	<i>Melia azedarach</i>	0.31 ± 0.03	13.20 ± 5.19
	<i>Dalbergia sissoo</i>	0.31 ± 0.05	13.59 ± 7.09
Qila Kohna Qasim Park	<i>Pongamia pinnata</i>	0.32 ± 0.02	13.61 ± 7.11
	<i>Azadirachta indica</i>	0.30 ± 0.01	12.56 ± 5.84
	<i>Melia azedarach</i>	0.27 ± 0.01	10.75 ± 4.43
	<i>Dalbergia sissoo</i>	0.26 ± 0.02	11.94 ± 6.35
Bagh Langhay Khan Park	<i>Pongamia pinnata</i>	0.26 ± 0.01	11.33 ± 5.93
	<i>Azadirachta indica</i>	0.24 ± 0.02	10.30 ± 3.47
	<i>Melia azedarach</i>	0.35 ± 0.01	15.13 ± 7.01
	<i>Dalbergia sissoo</i>	0.34 ± 0.01	14.00 ± 6.13
Jinnah Park	<i>Pongamia pinnata</i>	0.34 ± 0.08	12.98 ± 3.39
	<i>Azadirachta indica</i>	0.24 ± 0.01	10.20 ± 5.85
	<i>Melia azedarach</i>	0.31 ± 0.01	13.23 ± 6.93
	<i>Dalbergia sissoo</i>	0.32 ± 0.01	12.87 ± 6.24
Allama Iqbal Park	<i>Pongamia pinnata</i>	0.33 ± 0.09	14.18 ± 10.19
	<i>Azadirachta indica</i>	0.38 ± 0.01	15.05 ± 7.29
	<i>Melia azedarach</i>	0.33 ± 0.02	14.28 ± 5.98
	<i>Dalbergia sissoo</i>	0.36 ± 0.01	14.33 ± 7.22
Officer's Colony Park	<i>Pongamia pinnata</i>	0.39 ± 0.01	15.71 ± 7.60
	<i>Azadirachta indica</i>	0.38 ± 0.03	15.07 ± 6.28
	<i>Melia azedarach</i>	0.34 ± 0.02	14.48 ± 7.36
	<i>Dalbergia sissoo</i>	0.40 ± 0.02	16.42 ± 8.62

OC: Organic carbon; SOC: soil organic carbon.

Table A5. Summary of soil physico-chemical properties under different tree species of urban parks in Multan City. Values are means $\pm$ SD.

Park Name	Species	EC	pH	AP(ppm)	OM (%)	AK (ppm)	S (%)	BD (g cm ⁻³)
Shahshams Park	<i>P. pinnata</i>	2.52 $\pm$ 0.38	8.15 $\pm$ 0.07	15.00 $\pm$ 0.71	0.50 $\pm$ 0.04	214.00 $\pm$ 7.07	37.00 $\pm$ 1.41	1.38 $\pm$ 0.01
	<i>A. indica</i>	3.59 $\pm$ 0.48	8.05 $\pm$ 0.07	13.85 $\pm$ 0.21	0.60 $\pm$ 0.04	209.00 $\pm$ 7.07	38.00 $\pm$ 0.00	1.61 $\pm$ 0.16
	<i>M. azedarach</i>	1.86 $\pm$ 0.19	8.20 $\pm$ 0.00	14.95 $\pm$ 0.64	0.54 $\pm$ 0.05	216.50 $\pm$ 10.61	37.00 $\pm$ 1.41	1.44 $\pm$ 0.01
	<i>D. sissoo</i>	2.36 $\pm$ 0.46	8.40 $\pm$ 0.00	13.40 $\pm$ 0.57	0.54 $\pm$ 0.08	209.00 $\pm$ 14.14	37.00 $\pm$ 1.41	1.45 $\pm$ 0.13
Qila Kohna Qasim Park	<i>P. pinnata</i>	2.40 $\pm$ 0.14	8.35 $\pm$ 0.07	14.80 $\pm$ 0.14	0.55 $\pm$ 0.04	206.50 $\pm$ 3.54	35.00 $\pm$ 1.41	1.41 $\pm$ 0.01
	<i>A. indica</i>	9.35 $\pm$ 3.48	8.00 $\pm$ 0.00	16.30 $\pm$ 0.42	0.51 $\pm$ 0.01	221.50 $\pm$ 3.54	34.00 $\pm$ 0.00	1.41 $\pm$ 0.03
	<i>M. azedarach</i>	2.30 $\pm$ 0.37	8.30 $\pm$ 0.14	17.40 $\pm$ 0.57	0.47 $\pm$ 0.02	206.50 $\pm$ 3.54	36.00 $\pm$ 0.00	1.35 $\pm$ 0.03
	<i>D. sissoo</i>	2.11 $\pm$ 0.08	8.40 $\pm$ 0.14	16.15 $\pm$ 0.78	0.45 $\pm$ 0.03	196.50 $\pm$ 3.54	34.00 $\pm$ 0.00	1.50 $\pm$ 0.01
Bagh Langhay Khan Park	<i>P. pinnata</i>	1.66 $\pm$ 0.11	8.30 $\pm$ 0.00	15.65 $\pm$ 1.34	0.44 $\pm$ 0.01	211.50 $\pm$ 10.61	32.00 $\pm$ 0.00	1.46 $\pm$ 0.13
	<i>A. indica</i>	1.45 $\pm$ 0.16	8.55 $\pm$ 0.07	15.35 $\pm$ 0.21	0.41 $\pm$ 0.04	221.00 $\pm$ 4.24	36.00 $\pm$ 0.00	1.49 $\pm$ 0.06
	<i>M. azedarach</i>	1.58 $\pm$ 0.06	8.15 $\pm$ 0.07	14.10 $\pm$ 0.99	0.61 $\pm$ 0.02	219.00 $\pm$ 7.07	34.00 $\pm$ 0.00	1.44 $\pm$ 0.06
	<i>D. sissoo</i>	1.77 $\pm$ 0.01	8.10 $\pm$ 0.00	14.55 $\pm$ 0.35	0.58 $\pm$ 0.01	224.00 $\pm$ 7.07	36.00 $\pm$ 0.00	1.40 $\pm$ 0.02
Jinnah Park	<i>P.pinnata</i>	2.09 $\pm$ 0.08	8.40 $\pm$ 0.14	15.20 $\pm$ 0.42	0.58 $\pm$ 0.14	211.50 $\pm$ 3.54	37.00 $\pm$ 1.41	1.36 $\pm$ 0.03
	<i>A. indica</i>	1.78 $\pm$ 0.04	8.35 $\pm$ 0.07	13.80 $\pm$ 0.28	0.42 $\pm$ 0.02	216.50 $\pm$ 10.61	37.00 $\pm$ 1.41	1.39 $\pm$ 0.08
	<i>M. azedarach</i>	1.97 $\pm$ 0.01	8.30 $\pm$ 0.00	15.80 $\pm$ 0.42	0.53 $\pm$ 0.01	204.00 $\pm$ 7.07	36.00 $\pm$ 0.00	1.41 $\pm$ 0.05
	<i>D. sissoo</i>	1.86 $\pm$ 0.10	8.00 $\pm$ 0.14	14.65 $\pm$ 0.35	0.56 $\pm$ 0.02	214.00 $\pm$ 7.07	34.00 $\pm$ 0.00	1.33 $\pm$ 0.03
Allama Iqbal Park	<i>P. pinnata</i>	2.43 $\pm$ 0.95	8.05 $\pm$ 0.07	15.20 $\pm$ 0.99	0.57 $\pm$ 0.16	201.50 $\pm$ 10.61	35.00 $\pm$ 1.41	1.33 $\pm$ 0.03
	<i>A. indica</i>	2.07 $\pm$ 0.98	8.10 $\pm$ 0.14	13.70 $\pm$ 0.14	0.65 $\pm$ 0.01	216.50 $\pm$ 3.54	38.00 $\pm$ 0.00	1.32 $\pm$ 0.01
	<i>M. azedarach</i>	1.39 $\pm$ 0.12	8.25 $\pm$ 0.07	14.95 $\pm$ 0.64	0.58 $\pm$ 0.04	201.50 $\pm$ 10.61	38.00 $\pm$ 0.00	1.45 $\pm$ 0.17
	<i>D. sissoo</i>	4.54 $\pm$ 1.01	8.05 $\pm$ 0.07	13.30 $\pm$ 0.99	0.63 $\pm$ 0.02	224.00 $\pm$ 7.07	37.00 $\pm$ 1.41	1.30 $\pm$ 0.00
Officer's Colony Park	<i>P. pinnata</i>	1.75 $\pm$ 0.01	8.50 $\pm$ 0.14	14.80 $\pm$ 0.42	0.68 $\pm$ 0.02	201.50 $\pm$ 17.68	35.00 $\pm$ 1.41	1.33 $\pm$ 0.06
	<i>A. indica</i>	1.42 $\pm$ 0.01	7.85 $\pm$ 0.07	15.75 $\pm$ 0.64	0.65 $\pm$ 0.05	196.50 $\pm$ 3.54	34.00 $\pm$ 0.00	1.36 $\pm$ 0.02
	<i>M. azedarach</i>	1.92 $\pm$ 0.18	8.45 $\pm$ 0.07	14.60 $\pm$ 0.28	0.59 $\pm$ 0.03	204.00 $\pm$ 0.00	35.00 $\pm$ 1.41	1.39 $\pm$ 0.01
	<i>D. sissoo</i>	1.77 $\pm$ 0.08	8.65 $\pm$ 0.07	15.35 $\pm$ 0.35	0.69 $\pm$ 0.04	219.00 $\pm$ 7.07	35.00 $\pm$ 1.41	1.35 $\pm$ 0.00

EC: Electrical conductivity; AP: available phosphorus; OM: organic matter; AK: available potassium; S: saturation; BD: bulk density.

References

- McGee, J.A.; York, R. Asymmetric relationship of urbanization and CO₂ emissions in less developed countries. *PLoS ONE* **2018**, *13*, e0208388. [CrossRef] [PubMed]
- Gyamfi, B.A.; Onifade, S.T.; Nwani, C.; Bekun, F.V. Accounting for the combined impacts of natural resources rent, income level, and energy consumption on environmental quality of G7 economies: A panel quantile regression approach. *Environ. Sci. Pollut. Res.* **2021**, *29*, 2806–2818. [CrossRef] [PubMed]
- Gao, Y.; Gao, X.; Zhang, X. The 2 °C global temperature target and the evolution of the long-term goal of addressing climate change—From the United Nations framework convention on climate change to the Paris agreement. *Engineering* **2017**, *3*, 272–278. [CrossRef]
- Masson-Delmotte, V.; Zhai, P.; Pörtner, H.; Roberts, D.; Skea, J.; Shukla, P.; Pirani, A.; Moufouma-Okia, W.; Péan, C.; Pidcock, R. GIEC, 2018: Résumé à L'intention des Décideurs, Réchauffement Planétaire de 1, 5 °C. 2019. Available online: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/09/SR15_Summary_Volume_french.pdf (accessed on 5 March 2025).
- Tamoor, M.; Samak, N.A.; Xing, J. Pakistan toward achieving net-zero emissions: Policy and roadmap. *ACS Sustain. Chem. Eng.* **2022**, *11*, 368–380. [CrossRef]
- Jo, H.-K.; Kim, J.-Y.; Park, H.-M. Carbon reduction and planning strategies for urban parks in Seoul. *Urban For. Urban Green.* **2019**, *41*, 48–54. [CrossRef]
- Shadman, S.; Khalid, P.A.; Hanafiah, M.M.; Koyande, A.K.; Islam, M.A.; Bhuiyan, S.A.; Woon, K.S.; Show, P.-L. The carbon sequestration potential of urban public parks of densely populated cities to improve environmental sustainability. *Sustain. Energy Technol. Assess.* **2022**, *52*, 102064. [CrossRef]
- Chen, M.; Jia, W.; Du, C.; Shi, M.; Henebry, G.M.; Wang, K. Carbon saving potential of urban parks due to heat mitigation in Yangtze River Economic Belt. *J. Clean. Prod.* **2023**, *385*, 135713. [CrossRef]
- Mexia, T.; Vieira, J.; Príncipe, A.; Anjos, A.; Silva, P.; Lopes, N.; Freitas, C.; Santos-Reis, M.; Correia, O.; Branquinho, C. Ecosystem services: Urban parks under a magnifying glass. *Environ. Res.* **2018**, *160*, 469–478. [CrossRef]
- Liu, O.Y.; Russo, A. Assessing the contribution of urban green spaces in green infrastructure strategy planning for urban ecosystem conditions and services. *Sustain. Cities Soc.* **2021**, *68*, 102772. [CrossRef]
- Pinto, L.V.; Inácio, M.; Ferreira, C.S.S.; Ferreira, A.D.; Pereira, P. Ecosystem services and well-being dimensions related to urban green spaces—A systematic review. *Sustain. Cities Soc.* **2022**, *85*, 104072. [CrossRef]
- Hecht, S.B.; Pezzoli, K.; Saatchi, S.J.C. Trees have already been invented: Carbon in woodlands. *Collabra* **2016**, *2*, 24. [CrossRef]
- Bastin, J.-F.; Finegold, Y.; Garcia, C.; Mollicone, D.; Rezende, M.; Routh, D.; Zohner, C.M.; Crowther, T.W. The global tree restoration potential. *Science* **2019**, *365*, 76–79. [CrossRef]
- Marshall, M. Reforestation is Seen as a Way to Help Cool the Climate, Sucking Excess Warming Carbon Out of the Atmosphere. But it's not always that simple. BBC Future. 26 May 2020. Available online: <https://www.bbc.com/future/article/20200521-planting-trees-doesnt-always-help-with-climate-change> (accessed on 5 March 2025).
- Sharma, R.; Pradhan, L.; Kumari, M.; Bhattacharya, P. Assessment of carbon sequestration potential of tree species in Amity University Campus Noida. *Environ. Sci. Proc.* **2020**, *3*, 52. [CrossRef]
- Shahzad, L.; Tahir, A.; Sharif, F.; Haq, I.U.; Mukhtar, H. Assessing the impacts of changing climate on forest ecosystem services and livelihood of Balakot mountainous communities. *Pak. J. Bot.* **2019**, *51*, 1405–1414. [CrossRef] [PubMed]
- Fan, L.; Wang, J.; Han, D.; Gao, J.; Yao, Y.J.S. Research on promoting carbon sequestration of urban green space distribution characteristics and planting design models in Xi'an. *Sustainability* **2022**, *15*, 572. [CrossRef]
- Singkran, N. Carbon sink capacity of public parks and carbon sequestration efficiency improvements in a dense urban landscape. *Environ. Monit. Assess.* **2022**, *194*, 750. [CrossRef]
- Gratani, L.; Varone, L.; Bonito, A. Carbon sequestration of four urban parks in Rome. *Urban For. Urban Green.* **2016**, *19*, 184–193. [CrossRef]
- Rasoolzadeh, R.; Mobarghaee Dinan, N.; Esmaeilzadeh, H.; Rashidi, Y.; Marcu, M.V.; Sadeghi, S.M.M. Carbon sequestration and storage of urban trees in a polluted semiarid city. *Forests* **2024**, *15*, 1488. [CrossRef]
- Conway, T.M.; Almas, A.D.; Coore, D. Ecosystem services, ecological integrity, and native species planting: How to balance these ideas in urban forest management? *Urban For. Urban Green.* **2019**, *41*, 1–5. [CrossRef]
- Sagoff, M. The quantification and valuation of ecosystem services. *Ecol. Econ.* **2011**, *70*, 497–502. [CrossRef]
- Arcos-LeBert, G.; Aravena-Hidalgo, T.; Figueroa, J.A.; Jaksic, F.M.; Castro, S.A. Native trees provide more benefits than exotic trees when ecosystem services are weighted in Santiago, Chile. *Trees* **2021**, *35*, 1663–1672. [CrossRef]
- Riley, C.B.; Herms, D.A.; Gardiner, M.M. Exotic trees contribute to urban forest diversity and ecosystem services in inner-city Cleveland, OH. *Urban For. Urban Green.* **2018**, *29*, 367–376. [CrossRef]
- Potgieter, L.J.; Gaertner, M.; Kueffer, C.; Larson, B.M.; Livingstone, S.W.; O'Farrell, P.J.; Richardson, D.M. Alien plants as mediators of ecosystem services and disservices in urban systems: A global review. *Biol. Invasions* **2017**, *19*, 3571–3588. [CrossRef]

26. Zubair, M.; Yasin, G.; Qazlbash, S.K.; Ul Haq, A.; Jamil, A.; Yaseen, M.; Rahman, S.U.; Guo, W. Carbon Sequestration by Native Tree Species around the Industrial Areas of Southern Punjab, Pakistan. *Land* **2022**, *11*, 1577. [\[CrossRef\]](#)
27. Nowak, D.J.; Crane, D.E.J.E.p. Carbon storage and sequestration by urban trees in the USA. *Environ. Pollut.* **2002**, *116*, 381–389. [\[CrossRef\]](#)
28. McPherson, E.G.; Nowak, D.; Heisler, G.; Grimmond, S.; Souch, C.; Grant, R.; Rowntree, R. Quantifying urban forest structure, function, and value: The Chicago Urban Forest Climate Project. *Urban Ecosyst.* **1997**, *1*, 49–61. [\[CrossRef\]](#)
29. Hussain, S.; Mubeen, M.; Nasim, W.; Fahad, S.; Ali, M.; Ehsan, M.A.; Raza, A. Investigation of irrigation water requirement and evapotranspiration for water resource management in Southern Punjab, Pakistan. *Sustainability* **2023**, *15*, 1768. [\[CrossRef\]](#)
30. Manzoor, S.A.; Malik, A.; Zubair, M.; Griffiths, G.; Lukac, M. Linking social perception and provision of ecosystem services in a sprawling urban landscape: A case study of Multan, Pakistan. *Sustainability* **2019**, *11*, 654. [\[CrossRef\]](#)
31. Lei, X.; Tang, M.; Lu, Y.; Hong, L.; Tian, D. Forest inventory in China: Status and challenges. *Int. For. Rev.* **2009**, *11*, 52–63. [\[CrossRef\]](#)
32. Cairns, M.A.; Brown, S.; Helmer, E.H.; Baumgardner, G.A. Root biomass allocation in the world's upland forests. *Oecologia* **1997**, *111*, 1–11. [\[CrossRef\]](#)
33. Akbar, K.; Ashraf, I.; Shakoor, S. Analysis of urban forest structure, distribution and amenity value: A case study. *J. Anim. Plant Sci.* **2014**, *24*, 1636–1642.
34. Yasin, G.; Ur Rahman, S.; Farrakh Nawaz, M.; Qadir, I.; Zubair, M.; Gul, S.; Safdar Hussain, M.; Zain, M.; Athar Khaliq, M. Estimating carbon stocks and biomass accumulation in three different agroforestry patterns in the semi-arid region of Pakistan. *Carbon Manag.* **2021**, *12*, 593–602. [\[CrossRef\]](#)
35. Thomas, S.C.; Martin, A.R. Carbon content of tree tissues: A synthesis. *Forests* **2012**, *3*, 332–352. [\[CrossRef\]](#)
36. Yasin, G.; Nawaz, M.F.; Zubair, M.; Azhar, M.F.; Mohsin Gilani, M.; Ashraf, M.N.; Qin, A.; Ur Rahman, S. Role of traditional agroforestry systems in climate change mitigation through carbon sequestration: An investigation from the semi-arid region of Pakistan. *Land* **2023**, *12*, 513. [\[CrossRef\]](#)
37. Pati, P.K.; Kaushik, P.; Khan, M.; Khare, P. Allometric equations for biomass and carbon stock estimation of small diameter woody species from tropical dry deciduous forests: Support to REDD+. *Trees For. People* **2022**, *9*, 100289. [\[CrossRef\]](#)
38. Djomo, A.N.; Ibrahima, A.; Saborowski, J.; Gravenhorst, G. Allometric equations for biomass estimations in Cameroon and pan moist tropical equations including biomass data from Africa. *For. Ecol. Manag.* **2010**, *260*, 1873–1885. [\[CrossRef\]](#)
39. Miah, M.D.; Islam, K.N.; Kabir, M.H.; Koike, M. Allometric models for estimating aboveground biomass of selected homestead tree species in the plain land Narsingdi district of Bangladesh. *Trees For. People* **2020**, *2*, 100035. [\[CrossRef\]](#)
40. Walkley, A.; Black, I.A. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Sci.* **1934**, *37*, 29–38. [\[CrossRef\]](#)
41. de, M. Sá, J.C.; Cerri, C.C.; Dick, W.A.; Lal, R.; Filho, S.P.V.; Piccolo, M.C.; Feigl, B.E. Organic matter dynamics and carbon sequestration rates for a tillage chronosequence in a Brazilian Oxisol. *Soil Sci. Soc. Am. J.* **2001**, *65*, 1486–1499.
42. Hussain, S.B.; Khan, S.; Zubair, M. Carbon Sequestration Potential of Roadside Trees in Southern Punjab, Pakistan. *Asian J. Res. Agric. For.* **2022**, *8*, 155–161.
43. Stephenson, N.L.; Das, A.; Condit, R.; Russo, S.; Baker, P.; Beckman, N.G.; Coomes, D.; Lines, E.; Morris, W.; Rüger, N. Rate of tree carbon accumulation increases continuously with tree size. *Nature* **2014**, *507*, 90–93. [\[CrossRef\]](#) [\[PubMed\]](#)
44. JHA, K.K. Root carbon sequestration and its efficacy in forestry and agroforestry systems: A case of *Populus euramericana* I-214 cultivated in Mediterranean condition. *Not. Sci. Biol.* **2018**, *10*, 68–78. [\[CrossRef\]](#)
45. Takimoto, A.; Nair, P.R.; Nair, V.D. Carbon stock and sequestration potential of traditional and improved agroforestry systems in the West African Sahel. *Agric. Ecosyst. Environ.* **2008**, *125*, 159–166. [\[CrossRef\]](#)
46. Komal, N.; Zaman, Q.u.; Yasin, G.; Nazir, S.; Ashraf, K.; Waqas, M.; Ahmad, M.; Batool, A.; Talib, I.; Chen, Y. Carbon storage potential of agroforestry system near Brick Kilns in irrigated agro-ecosystem. *Agriculture* **2022**, *12*, 295. [\[CrossRef\]](#)

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