



Comparison Study of Carbon Sequestration between Industrial and Rural Areas

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Abstract

Global warming stands as one of the most pressing problems of the new millennium, with carbon emissions serving as the strongest causal factor for rising temperatures. Trees are fundamental to any landscape due to their biomass and diversity, playing a key role in ecosystem health. It is paradoxical that while we rely on them, vegetation has faced significant destruction due to modern industrial and technological advancement. Since approximately 50% of tree biomass is composed of carbon, their role in carbon sequestration is vital. While forested areas are well-studied, the potential of "green patches" in urban environments—such as institutional campuses, avenues, and public gardens—remains largely unexplored. This study aimed to bridge that gap by examining the ecological conservation value of these areas within the industrial and rural ecosystems of Baramati city. Data was collected via a comprehensive tree census, noting species names, height, and girth for the first 100 trees in each area. The results indicated a massive deviation in sequestration levels between the two environments. The rural area contained 103 trees from eight different plant species spread over 12 acres, while the industrial area had 125 trees but only four different species. Crucially, the study found that the rural area stored more carbon than the industrial area despite having fewer total trees. This highlights that species diversity and (mendeley)These green areas act as essential biodiversity hotspots in industrial zones. Addressing their role in urban ecosystems is necessary for effective environmental management and ensuring that modern development does not come at the cost of our planet's health.

Keywords: Global warming; Carbon; Industrial; Rural areas

Introduction

Climate change is the preeminent global environmental challenge of the modern era. (Khurana, 2012) Anthropogenic warming is driven by the accumulation of atmospheric greenhouse gases (GHGs), including carbon dioxide, methane, nitrous oxide, and fluorinated gases, which enhance the Earth's radiative forcing. (Jat et al., 2022) Trees represent keystone components of terrestrial ecosystems due to their high biomass and taxonomic diversity. Despite their critical role in ecosystem services, anthropogenic industrial advancement has caused significant vegetation loss and degradation. These activities have shifted ecosystems from carbon sinks to sources, highlighting the critical need for integrated environmental management and conservation efforts. (Carbon Sequestration Potential of Trees in and around Pune City, n.d.) Through photosynthesis, woody biomass acts as a significant carbon sink, with carbon accounting for roughly half of the total organic matter. (Kumar et al., 2015)

Carbon sequestration is the capture and long-term storage of atmospheric CO₂ through biological processes in agriculture and forestry. These ecosystems act as carbon sinks, absorbing the primary greenhouse gas produced by human activity. (Jat et al., 2022) The combination of population growth, rapid industrialization, and urbanization—alongside climate change—will significantly increase the stress on India's ecosystems. (Khurana, 2012) In India, plantations are being established within both forest reserves and agroforestry systems to meet the increasing local demand for fuel wood. (Singh and Lal, 2000).

The capacity for forest ecosystems to function as carbon sinks is well-documented; however, the quantitative potential of urban forests to sequester carbon remains relatively under-explored. (Kumar et al., 2015) Hence a study of Carbon Sequestration between Industrial and Rural in Baramati is very crucial. The Baramati are located close to the equator, making the summers difficult to define. The greatest amount of precipitation occurs in June, with an average of 151 mm.

Materials and Methods

In the present study, two sites selected were Industrial area MIDC of Baramati and Sarafwadi rural area. The measurement of the quantity of carbon has been carried out and was based on the amount of above ground biomass and below ground biomass of trees in the study areas. The most commonly used method for sampling is the census method. Among the different methods for estimating total biomass, allometric method is used. All trees having >1.3 m heights girth at breast height (GBH) were scrutinized individually with their respective measurements of GBH in centimetres. Above Ground Biomass was estimated using DBH, height and wood density. For the wood density of the tree species, the standard average of 620 kg/m³ was taken. Total Biomass (TB) was obtained as the sum of Above Ground Biomass and Below Ground Biomass. Carbon stock was calculated using a value of 0.5 of the total biomass as carbon content. Carbon sequestration was calculated by multiplying carbon stock by 3.67, the ratio of molecular weight of CO₂ to carbon (Ravindranath and Ostwald 2008).

The following formulae were used for Above Ground Biomass Calculation:

$$AGB = \exp[-2.997 + \ln(WD) \times (DBH)^2 \times H]$$

$$C = 0.5 \times B$$

Where,

B= Biomass(kg)

C= Carbon storage (kg)

DBH=Diameter at breast height(m)

H = tree height (m)

WD= Wood density (Standard average value = 620 kg/m³)

ln = Natural log

The following formulae were used for Below Ground Biomass Calculation:

$$BGB = \exp[-1.0587 + 0.8836 \times \ln(AGB)]$$

Where,

Ln= Natural Logarithm

AGB= Above Ground Biomass (Dry tonnes/hectare)

Result and Discussion

The assessment of carbon sequestration potential across the two land-use types in Baramati revealed a stark contrast in biomass accumulation and storage capacity. At Site 1, representing the Industrial Area, the vegetation was predominantly composed of ornamental and urban species such as *Allagoptera arenaria* (Coastal palm) and *Cordia sebestena* (Geiger tree). The 103 trees surveyed at this site yielded a total carbon sequestration value of 16,907.52 kg, which is characteristic of the smaller, managed species typically selected for industrial green belts. In contrast, Site 2 at Sarafwadi Village exhibited a significantly higher sequestration capacity despite a similar tree count of 125. The total carbon sequestered at Sarafwadi was determined to be 438,974.30 kg, a figure that is more than twenty times higher than that of the industrial site.

While the industrial site focuses on aesthetics and space-efficient species, Sarafwadi Village is home to massive, indigenous hardwood species like *Ficus benghalensis* and *Azadirachta indica*. These trees possess extensive canopy spreads and dense wood, allowing them to function as superior carbon sinks. Furthermore, below-ground biomass calculations highlight the vital role of root systems in mature rural environments; the indigenous trees in the village setting maintained a proportional but significantly larger carbon reservoir underground compared to the ornamental species in the industrial zone. The industrial landscape is often restricted by soil compaction and physical barriers that limit tree growth, whereas the rural environment of Sarafwadi provides the ecological conditions necessary for trees to reach their full biomass potential. This study confirms that while industrial plantations are essential for local air quality and urban cooling, rural indigenous forests and village groves remain the primary bastions for long-term carbon storage and climate change mitigation in the region.

Parameter	Site 1 (Industrial)	Site 2 (Village)
Total Trees	103	125
Total Carbon Storage (kg)	16,907.52	438,974.30

Conclusion

This comparative study concludes that while both sites contribute to the carbon credit of the Baramati region, the rural landscape of Sarafwadi Village serves as a vastly more efficient carbon sink compared to the Industrial Area. The findings suggest that industrial greening policies should move beyond planting ornamental species and focus on integrating high-biomass indigenous trees where space permits. Furthermore, the preservation of mature trees

in village peripheries is critical for regional climate mitigation, as a single mature tree in Sarafwadi sequesters carbon equivalent to nearly 21 trees in the Industrial Area. To achieve local carbon neutrality, the "industrial-urban" model of plantation needs to be supplemented with "village-style" indigenous reforestation.

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Author Contributions

SV and SRP conceived the concept, wrote and approved the manuscript.

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