



Carbon Sequestration Potential of Landscape Plants

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As global climate change intensifies, the urgent need to reduce atmospheric carbon dioxide (CO₂) levels grows more critical. One of the most natural, cost-effective, and sustainable strategies to combat climate change is carbon sequestration—the process by which carbon is captured and stored. Landscape plants play an essential role in this by absorbing CO₂ and storing carbon in their biomass and the soil. This article explores the mechanisms, factors, species, design considerations, benefits, and challenges related to carbon sequestration in landscape plants.

What Is Carbon Sequestration?

Carbon sequestration is the process of capturing and storing atmospheric CO₂ to reduce global warming. Plants sequester carbon through photosynthesis, building organic molecules in their tissues, and through contributing organic matter to soils. Unlike temporary carbon storage, sequestration implies a long-term carbon sink that prevents CO₂ re-release into the atmosphere, vital for mitigating greenhouse gas accumulation.

Landscape Plants and Carbon Capture

Landscape plants include trees, shrubs, groundcovers, and vines used in urban, suburban, and rural green spaces. Each type contributes differently to carbon capture:

Trees: Large biomass and long lifespans mean trees like *Populus* (poplar) and *Eucalyptus* species are among the top carbon sequesters.

Shrubs: Denser plantings of shrubs contribute actively to above-ground and soil carbon.

Groundcovers and Grasses: While having lower biomass, they enhance soil carbon through root systems and organic litter.

How Plants Sequester Carbon

Plants capture atmospheric CO₂ through photosynthesis, converting it to sugars and other organic compounds used to build tissues. Carbon is sequestered mainly in:

Above-ground Biomass: Leaves, stems, and branches.

Below-ground Biomass: Roots which contribute to soil organic carbon upon decomposition.

Soil Organic Carbon: Decomposed plant material enhances soil carbon storage, detectable for decades or longer under favourable conditions.

Especially important are root systems and their symbiotic relationships with soil microbes such as mycorrhizal fungi, which efficiently cycle carbon into stable soil pools.

Factors Affecting Carbon Sequestration Potential

Several interrelated factors determine how much carbon landscape plants can sequester:

Species Characteristics: Growth rate, biomass accumulation, and photosynthetic capacity differ widely. For example, *Populus* species show high daily net carbon uptake.

Plant Age and Size: Young plants sequester carbon fast during growth phases; mature plants store large carbon stocks over time.

Plant Density and Arrangement: Dense and layered plantings increase total carbon input.

Soil Quality and Management: Healthy soils with minimal disturbance and good organic matter promote greater carbon retention.

Climate and Environmental Conditions: Temperature, moisture, and sunlight influence photosynthesis and growth rates.

Quantitative Findings from Research

Recent studies evaluating commonly used landscape tree species in urban areas highlight varying carbon sequestration capacities, emphasizing the importance of species selection:

- Top tree species for sequestration include *Populus*, *P. stenoptera*, *P. acerifolia*, among large arbors.
- Small arbors and shrubs such as *P. serratifolia* and *B. megistophylla* also make important contributions.
- Typical sequestration rates range between 10 to 80+ kg CO₂ per tree annually, depending on conditions.
- Dense urban green spaces with multi-layered planting can sequester up to 320 kg CO₂ per 400 m² yearly.

Shrubs and groundcovers typically have lower individual sequestration but cover larger areas, cumulatively adding carbon stock, especially in managed landscapes like parks and gardens.

Designing Carbon-Sequestering Landscapes

Maximizing sequestration potential requires intentional landscape design based on these principles:

- **Select High-Biomass Species:** Focus on fast-growing, long-lived trees and shrubs with high leaf area index and photosynthetic rates.
- **Use Diverse Plant Communities:** Species diversity enhances ecosystem resilience and carbon cycling.
- **Implement Layered Planting Schemes:** Combine trees, understory shrubs, and groundcovers to maximize biomass vertically and horizontally.
- **Apply Sustainable Soil Practices:** Reduce soil disturbance, incorporate organic mulches and amendments, and promote microbial health.
- **Consider Planting Density and Spatial Arrangement:** Increase carbon input by optimizing spacing to maximize canopy cover and root overlap.

Additional Benefits of Landscape Carbon Sequestration

Besides carbon storage, landscape plants offer multiple ecosystem services:

- **Cooling Urban Heat Islands:** Plants regulate microclimates, reducing energy consumption.
- **Improving Air and Water Quality:** Vegetation filters pollutants and supports cleaner environments.
- **Supporting Biodiversity:** Diverse landscapes provide habitat for birds, insects, and other wildlife.
- **Enhancing Aesthetic, Social, and Recreational Values:** Attractive green spaces contribute to human well-being.

Challenges and Practical Considerations

While promising, carbon sequestration through landscapes faces challenges:

- **Maintenance Needs:** Requires watering, pruning, pest management, and protection from urban stress.
- **Space Constraints:** Urban areas often lack space for dense or large-scale planting.
- **Verification Difficulties:** Monitoring carbon stocks accurately requires specialized methods and resources.

- **Longevity and Mortality:** Trees and shrubs have finite lifespans; replacement and sustained management are necessary.

Emerging Trends and Technologies

Innovations aiming to optimize landscape carbon sequestration include:

- **Urban Forestry Programs:** Integrating large-scale tree planting with city planning.
- **Remote Sensing and GIS:** Advanced tools for monitoring vegetation health and carbon storage.
- **Climate-Adaptive Species Selection:** Using drought- and heat-tolerant plants to future-proof landscapes.
- **Soil Microbiome Enhancement:** Leveraging beneficial soil fungi and microbes to stabilize carbon pools.

Case Studies in Carbon Sequestration Landscapes

- Urban green spaces in cities like Zhengzhou, China, have successfully integrated high-sequestration species driving measurable carbon capture.
- Community-led projects globally focus on reforestation and urban greening to create carbon sinks.
- Institutional landscaping now increasingly incorporates carbon accounting into design and management planning.

Conclusion

Landscape plants are vital tools in the fight against climate change, with significant carbon sequestration capacity when strategically managed. Combining species diversity, sustainable practices, and innovative design unlocks their full potential. Harnessing these natural systems not only captures carbon but also improves urban livability, biodiversity, and resilience—making carbon-smart landscaping a cornerstone of sustainable futures.