The Ways to Improve the Ecological Benefits of Carbon Sequestration of Garden Green Space

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Abstract. Carbon dioxide is one of the greenhouse gases responsible for global warming, and how to reduce the amount of carbon dioxide in the air is a major issue. Scholars have found that herbaceous flowers can fix 12.16 $g•m^{-2}• D^{-1}$ carbon dioxide per unit leaf area in green space, which has a good ecological benefit of carbon sequestration. Therefore, how to further improve the ecological benefits of carbon sequestration has become a concern of landscape architecture industry. This paper summarizes seven kinds of garden green land carbon ecological concrete approaches to improve, including selecting high carbon sequestration ability of plant species, increase high carbon sequestration ability of plant population, rich garden plant hierarchy, increase use native plants, increasing the vertical greening, choose low maintenance plants landscape, choose the appropriate maintenance management way, In order to deal with global warming phenomenon on the full play of green landscape fixed carbon dioxide capacity.

1 Introduction

Under the background of global warming, climate change has become a current hot topic[1]. The rapid urbanization process has brought some pressure to the reduction of greenhouse gas emissions, coupled with China's increasingly important position in the global climate governance, and the gradual deepening of the understanding of global climate change, it is urgent to actively explore various ways to deal with climate change[2-3].

Plants can absorb carbon dioxide and release oxygen through photosynthesis, which has the function of carbon fixation[4-5]. By improving the ecological benefits of carbon sequestration of garden green space plants and relying on vegetation to increase carbon sink, the greenhouse gas (carbon dioxide) content in the air can be effectively reduced. This article summarizes how to through the selection of plant species, plant population, plant community hierarchy, plant landscape design form and concept as well as the maintenance management method to improve the botanical garden green land vegetation to absorb carbon dioxide in the air (Fig. 1), in order to reduce the greenhouse gas content, and response to the global ecological crisis of climate warming.

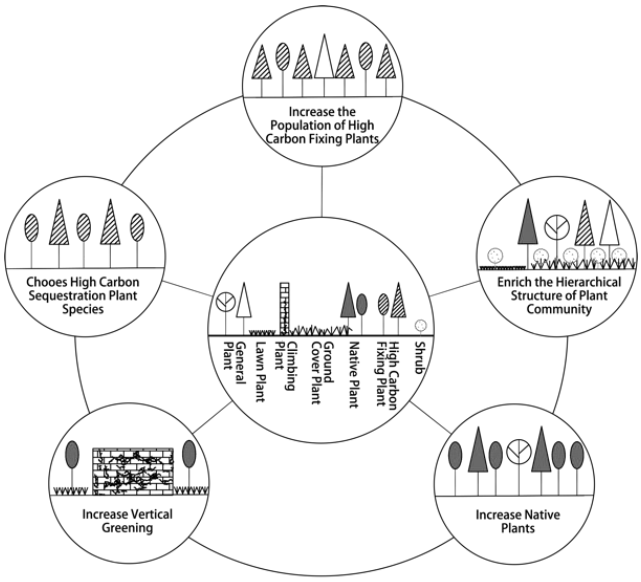

Fig. 1. Schematic diagram of improvement of Carbon Sequestration Capacity of Garden Green Space.

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2 Choose high carbon sequestration plant species

The ecological plant landscape of garden green space emphasizes ecology and diversity, and species, age and density of plant play a decisive role in their annual carbon sequestration capacity[6-7]. During the planning of urban green space system, the species of key trees and backbone trees are the main vegetation of garden green space, which not only reflect the vegetation characteristics of the city, but also can significantly improve the overall carbon sequestration benefit of urban garden green space if select the tree species with high carbon sequestration ability as the key tree and backbone tree species. Plants with different life forms have different carbon sequestration capacities. The research found that the order of daily carbon sequestration per unit leaf area from large to small was herbaceous flowers > deciduous shrubs > deciduous trees > evergreen shrubs > evergreen trees > lianas, and the order of daily carbon sequestration per unit cover area was herbaceous flowers > deciduous trees > evergreen shrubs > deciduous shrubs > evergreen trees > lianas (Table 1) [8]. Therefore, in addition to selecting trees with high carbon sequestration capacity for key trees and backbone trees, appropriately increasing the planting area of herbaceous flowers with low cost and strong adaptability can not only improve the value of the landscape, but also improve the ecological benefits of carbon sequestration of green space. For example, *Liriope spicata*, *Trifolium repens*, *Hemerocallis middendorffii* and *Iris tectorum* are herbacean flowers with high economizing index, which can maximize the ecological benefits of carbon sequestration under the premise of cost saving[9].

Table 1. Different daily carbon sequestration of different life forms [8].

Life form	Number of species	Average daily carbon sequestration per unit leaf area ($g•m^{-2}•d^{-1}$)	Average daily carbon sequestration per unit cover area ($g•m^{-2}•d^{-1}$)
Herbaceous flowers	81	12.16	83.12
Deciduous shrubs	56	10.05	36.24
Deciduous trees	118	9.75	53.84
Evergreen shrubs	80	7.99	37.10
Evergreen trees	77	7.81	31.72
Lianas	33	3.70	19.48

3 Increase the number of plants with high carbon sequestration capacity

Increasing the number of plant populations with high carbon sequestration ability and expanding the coverage area of plant populations with high carbon sequestration ability are helpful to increase the ecological benefits of carbon sequestration of garden green space. Key trees and backbone trees are the main vegetation landscape in urban garden green space, especially key trees, which have few species, large population and wide distribution range. Selecting tree species with high carbon sequestration ability will undoubtedly greatly improve the carbon sequestration ability of garden green space [8]. Forest landscape is a popular landscape at present, as well as an important part of "urban forest". It has a large population of dominant tree species, most of which are tall trees, with relatively strong carbon sequestration capacity and a long carbon fixation period[10-11]. If deliberately select trees with higher carbon sequestration ability, such as *Metasequoia glyptostroboides*, *Taxodium distichum* and *Glyptostrobus pensilis*, the per unit area of biomass and carbon sink are large, so they are used in many places [8-12].

4 Enrich the hierarchy of garden plant community

Create abundant hierarchy of garden plant community and improve the carbon sequestration ability of garden green space by increasing the ecological benefits of carbon sequestration of garden green scape. Related studies have shown that the ecological benefit of green space with multi-layer planting structure of tree, shrub and herb is the highest, which can significantly improve the carbon sequestration capacity of green space, followed by shrub and herb, and the single herb is the smallest [13-15]. For example, near natural plant community configuration, by protecting and induced natural more planted, to tree, shrub and herb cladding mode to enhance the complexity of the plant community, increase leaf area per unit area flora composite index, promote the plant photosynthesis, gradually to close to the natural state of community growth and development, so as to further enhance the comprehensive ability of carbon sequestration garden greenbelt [16]. It is the carbon density which is the carbon storage per unit area of the stand that the higher value, the stronger the carbon sequestration capacity per unit area of plant communities. Some scholars measured the carbon density of artificial plant communities in Gaojia manor in Shanghai and found that carbon density varies greatly between plant communities with different hierarchies [17]. The carbon density of evergreen deciduous broad-leaved mixed forest was 54.4 t/hm2, *Metasequoia glyptostroboides* forest was 31.4 t/hm2, bamboo forest was 13.2 t/hm2 and fruit-bearing forest was 9.2 t/hm2 [17] (Fig. 2). Carbon density is proportional to carbon sequestration capacity, so on the basis of rational use of various plants with high carbon sequestration ability, more tree-dominated composite vegetation cover structures are conducive to improving the ecological benefits of carbon sequestration of urban green space [18]. In addition, in

different hierarchical structures, the collocation of fast-growing and slow-growing trees and evergreen and deciduous trees can also improve the ecological benefits of carbon sequestration of plant communities [19].

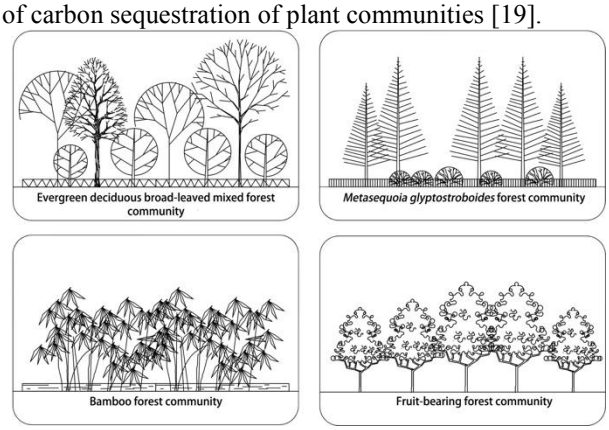

Fig. 2. Schematic diagram of plant community structures with different carbon densities.

5 Increase the use of native plants

Native plants have strong adaptability, are easy to survive, and are convenient for planting and maintenance, which is not only conducive to improving the environment, but also can reflect local cultural characteristics [20-21]. The construction of garden green space with native plants as the main body has gradually become one of the development directions in the industry [22]. In the study of the ecological benefits of carbon sequestration in green scape, relevant scholars concluded that native plants generally have high carbon sequestration ability through observation and analysis of portable photosynthetic apparatus [23-24]. Appropriately increasing the proportion and number of local dominant tree species in the planting planning and design of garden green space, and building a stable community structure with local plants as dominant species, not only has a strong ecological benefits of carbon sequestration, but also can improve the ecological service ability of green space and reduce carbon emissions [25].

6 Increase vertical greening

Vertical greening, as a supplementary form of green space, can effectively alleviate the problem of insufficient urban green space and increase the covered area of urban green space [26-27] (Fig. 3). Although the area of vertical greening is not large, the leaf area index of vertical greening plants is high and the carbon sequestration per unit area is considerable. Based on the improvement of carbon sequestration ability, different scholars have conducted in-depth studies on the plant species available for vertical greening, and found that some lianas used in vertical greening have higher leaf area index and higher ecological benefits of carbon sequestration, such as *Thunbergia laurifolia* (the leaf area index is 5.80 and the carbon sequestration per unit leaf area is 15.53 g•m-2•d-1), *Ficus pumila* (the leaf area index is 4.33 and the carbon sequestration per unit leaf area is 10.33 g•m-2•d-1), *Parthenocissus tricuspidat* (the leaf area index is 5.33 and the carbon sequestration per unit leaf area is 6.91 g•m-2•d-1)*a*, etc., which proves that vertical greening has good carbon sequestration potential [28-29]. There are also studies to establish a vertical greenery ecosystem carbon dioxide sequestration calculation model. Using *Zoysia Matrella*, *Salvia Nemorosa*, *Geranium Sanguineum* and other plant materials, the average annual carbon dioxide uptake of plant biomass was estimated to be 0.44-3.18 kg CO_2eq m^{-2}, demonstrating the advantages of vertical wall carbon fixation [30]. Therefore, increasing vertical greening becomes one of the ways to improve the ecological benefits of carbon sequestration of green space.

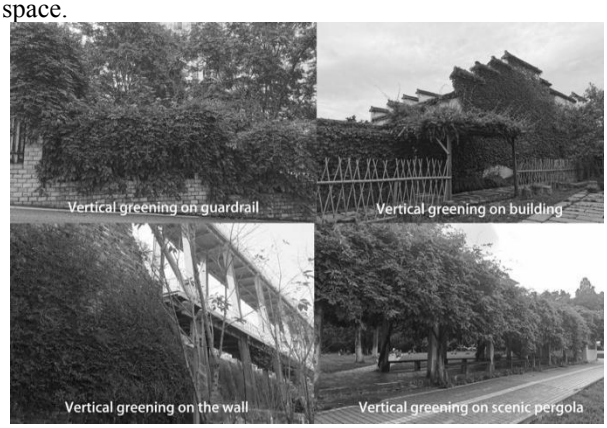

Fig. 3. Different forms of vertical greening.

7 Choose low-maintenance plant landscape

Urban green space is mostly constructed and managed manually, which requires a certain amount of maintenance input. Therefore, choosing low-maintenance or even self-maintenance plants can effectively reduce maintenance costs and reduce carbon dioxide emissions during maintenance, thereby indirectly improving the ecological benefits of carbon sequestration of green space [31]. Through fuzzy comprehensive evaluation and analysis, some scholars found that the herbaceous plants are arranged from high to low according to the conservation index: *Liriope spicata* > *Trifolium repens* > *Hemerocallis middendorffii* > *Iris tectorum* > *Poa pratensis*, indicating that the maintenance cost of *Poa pratensis* is too high and should not be used in a large area of green space from the perspective of reducing carbon dioxide [9]. In addition, some scholars said that the mosaic flower bed and other landscapes that need a lot of manual maintenance and management, especially the artificially cultivated annual and biennial herb, need to be replaced frequently. This kind of too exquisite plant landscape, even if the herb varieties have high ecological benefits of carbon sequestration, the high maintenance cost and high carbon emission will greatly offset the ecological benefits of carbon sequestration of green space. Therefore, it is not reasonable to consider from the perspective of increasing the ecological benefits of carbon sequestration [10].

8 Choose the appropriate cultivation, maintenance and management approach

In the maintenance and management stage in the later stage of garden green space planting, water and fertilizer management is the key point. In the soil environment with high water content, root respiration, litter and microbial decomposition will be inhibited, thus reducing the carbon emission of green space soil, which has an indirect effect on the improvement of the ecological benefits of carbon sequestration of garden green space [32]. Therefore, water-saving irrigation should be adopted to appropriately keep the soil moist, actively prevent diseases and insect pests in plants and soil, reduce the use of chemical fertilizers, recycle biological waste such as fallen leaves [33-34], and achieve low-carbon management to promote the building of high ecological benefits of carbon sequestration of garden green space. Pay regular attention to the growth dynamics of plants. According to different planting methods, reasonable pruning management is conducive to increasing the carbon sink efficiency. The artificial maintenance amount of natural plant landscape is generally lower than that of regular planting, so the carbon emission is relatively low and the ecological benefits of carbon sequestration is more lasting [35].

Due to the botanical garden green space carbon sequestration ability to corresponding contribution to slow global warming, so summarize the ways and methods to improve the ability of carbon sequestration, can design low-carbon landscape for the future provide a more scientific guidance, also let the landscape architecture profession in response to the global ecological crisis brought greenhouse gases play a proper role. In addition, although various approaches and methods to improve the ecological benefits of carbon sequestration have their own characteristics and functions, they are not isolated from each other in practice. Therefore, they should be rationally combined and comprehensively applied according to the specific situation of specific green space in order to improve the ecological benefits of carbon sequestration in green space more effectively. In the future, with the in-depth development of carbon sequestration research in the field of landscape architecture, new ways and methods will be explored to improve the ecological benefits of carbon sequestration in green space, so as to further develop and complete the research system of carbon sequestration benefit in green space, and contribute to improving the global ecological environment.

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