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Research on the Optimization Layout Strategy of Urban Green Spaces Based on Carbon Sequestration Benefits

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Abstract: Against the backdrop of increasingly severe global climate change, the carbon sequestration benefits of urban green spaces are receiving more attention. This paper thoroughly explores the optimization layout strategy of urban green spaces based on carbon sequestration benefits. Through a detailed analysis of the close relationship between carbon sequestration benefits and urban green spaces, a series of specific and professional optimization suggestions are proposed. The aim is to provide strong theoretical support and practical guidance for the planning and design of urban green spaces in the future.

Keywords: carbon sequestration benefits; urban green spaces; optimization layout; ecological environment; climate change

Introduction

With the exacerbation of global climate warming, reducing greenhouse gas emissions and increasing carbon sequestration have become urgent priorities. Urban green spaces, as a key component of urban ecosystems, are increasingly prominent in their roles in regulating urban microclimates, improving air quality, and enhancing urban carbon sequestration capacity. Therefore, how to optimize the layout of urban green spaces based on carbon sequestration benefits has become an important research topic in the current field of urban planning and construction.

1. Carbon Sequestration Benefits and the Close Relationship with Urban Green Spaces

1.1 Importance of Carbon Sequestration Benefits

Carbon sequestration benefits refer to the absorption and fixation of atmospheric carbon dioxide by vegetation in green spaces through photosynthesis, thereby reducing the concentration of greenhouse gases in the atmosphere. This ecological benefit is particularly important against the backdrop of global

climate change, as it not only helps to slow down the rate of climate warming but also provides a more livable environment for urban residents.

1.2 Role of Urban Green Spaces in Enhancing Carbon Sequestration Benefits

Urban green spaces, with their high vegetation coverage and rich biodiversity, play a crucial role in urban ecosystems. These green spaces are not only important components of urban landscapes but also key carbon sinks. Through scientific and reasonable planning and layout, urban green spaces can significantly improve the overall greenery level of cities and enhance their carbon sequestration capacity. Specifically, plants in green spaces efficiently absorb atmospheric carbon dioxide through photosynthesis and fix it in their tissues and soil. This process not only helps to reduce the concentration of greenhouse gases in the atmosphere, thereby alleviating the pressure of global climate warming but also provides urban residents with fresher air and a pleasant living environment. Therefore, urban green spaces play an irreplaceable role in enhancing carbon sequestration benefits and are an important support for urban sustainable development.

2. Principles of Urban Green Space Layout Based on Carbon Sequestration Benefits

2.1 Ecological Priority Principle

The ecological priority principle should permeate the planning and design of urban green spaces. This principle emphasizes that in any layout decision, protecting and enhancing the ecological functions of green spaces must take precedence. Specifically, when planning green spaces, planners should prioritize schemes that maximize the carbon sequestration benefits of green spaces[1]. This not only includes selecting plant species with strong carbon absorption capabilities but also involves the rational configuration of green space spatial structures to ensure the efficient operation of ecosystems. Through this ecologically prioritized layout strategy, the overall ecological benefits of urban green spaces can be significantly enhanced, thereby making a positive contribution to addressing climate change and improving urban environmental quality. The implementation of this principle requires planners to possess profound ecological knowledge and forward-thinking planning concepts to ensure that urban green spaces play a crucial role in promoting sustainable urban development.

2.2 Balance Layout Principle

The balance layout principle plays a crucial role in urban green space planning. This principle emphasizes the balanced distribution of green space resources in various urban areas, aiming to avoid green spaces being overly concentrated in certain areas or experiencing obvious green space deficiencies. By implementing balanced layout, every corner of the city can enjoy the many ecological benefits brought by green spaces, such as improving air quality, reducing the urban heat island effect, and providing leisure and recreational spaces. More importantly, a balanced green space layout also helps enhance the overall carbon sequestration capacity of the city because widely distributed green spaces can more effectively absorb carbon dioxide from the atmosphere, thereby assisting cities in addressing the challenges of climate change. The implementation of this principle not only requires planners to have a global perspective but also needs to fully consider the specific needs and characteristics of different urban areas to ensure the scientific and rational layout of green spaces.

2.3 Multifunctionality Principle

The multifunctionality principle is an indispensable design concept in the planning and layout of urban green spaces. This principle emphasizes that green spaces should not be limited to their carbon sequestration function but should also become comprehensive spaces that meet the diverse needs of urban residents. In addition to being important carbon sinks to help improve the environment, green spaces should also provide places for leisure and recreation for citizens, becoming oases for people to relax and get close to nature. At the same time, green spaces are also ideal places for environmental education and ecological popularization. By showcasing the mysteries of natural ecology, green spaces can enhance public environmental awareness and scientific literacy. Therefore, when planning green spaces, it is necessary to fully consider and carefully design their multifunctionality, ensuring that green spaces not only enhance ecological benefits but also maximize their social benefits, achieving a harmonious coexistence and win-win situation between ecological and social

benefits.

3. Specific Strategies for Optimizing the Layout of Urban Green Spaces Based on Carbon Sequestration Benefits

3.1 Increasing Green Space Area and Density

In the strategy for optimizing the layout of urban green spaces, increasing green space area and density is a crucial measure. By significantly increasing the proportion of urban greenery and expanding the area of green space, it is possible to effectively promote the improvement of urban greening levels and enhance the city's ecological functions and carbon sequestration capacity. Specifically, the land resources on the periphery and outskirts of the city provide ample space for expanding green spaces. These areas often have lower levels of development, relatively lower land costs, and relatively better ecological environments, making them ideal choices for expanding green space and increasing the area of large parks and forests. Through scientifically rational planning, large ecological parks or forest parks can be built in these areas to provide more leisure and recreational places for urban residents, while effectively enhancing the city's carbon sequestration benefits. Additionally, establishing green belts between residential and commercial areas is also an important measure. These green belts not only form a continuous green network, improving the overall greening level of the city but also effectively isolate noise and pollution, improving the living environment of urban residents. Moreover, green belts can serve as places for daily leisure activities for residents, promoting interaction and communication within communities, enhancing community cohesion in the city. In the process of increasing green space area and density, it is also necessary to focus on the multifunctional development of green spaces. In addition to basic ecological and recreational functions, green spaces can also accommodate diversified functions such as education and culture[2]. For example, setting up environmental education areas in green spaces can enhance residents' environmental awareness by showcasing various ecological knowledge and environmental protection technologies. Or establishing cultural squares can provide a platform for residents to display and exchange local culture. At the same time, to ensure the sustainable development of green spaces, it is necessary to establish a comprehensive green space management system. This includes formulating scientific green space maintenance plans, strengthening daily maintenance and cleaning of green spaces, and establishing norms for green space use. Through these measures, it is possible to ensure the long-term stable operation of green spaces, continuously providing high-quality ecological services for urban residents.

3.2 Scientific Planning of Green Space Morphology and Structure

In the optimization of the layout of urban green spaces, the planning of green space morphology and structure is a key link in enhancing its carbon sequestration benefits. Reasonable green space morphology and structure not only optimize the urban landscape but also effectively promote the health and stability of ecosystems. To achieve this goal, the "patch-corridor-matrix" theory from ecology can be used to construct the ecological network of urban green spaces. In this model, "patches" represent green spaces of various sizes and types, such as parks and street green spaces; "corridors" are green corridors connecting these green spaces, such as tree-lined paths and green belts; and "matrix" is the overall environment in which urban green spaces are located. Through the planning of this ecological network model, the connectivity and integrity between green spaces can be ensured, forming an organic and coherent urban green space system. This connectivity not only helps the migration and exchange of animal and plant populations but also promotes the material circulation and energy flow of urban ecosystems, thereby enhancing their carbon sequestration capacity. At the same time, balanced layout is also an important principle in green space planning. To avoid uneven distribution of green space resources, planners need to consider various urban areas comprehensively to ensure that each area can enjoy the ecological benefits brought by green spaces. This requires planners to focus not only on the construction of large green spaces but also on the layout of dispersed green spaces such as street green spaces and small parks, providing residents with more convenient and accessible green spaces[3]. When implementing this strategy, it is also necessary to consider the city's natural conditions such as climate, soil, and hydrology, as well as its social, economic, and

cultural characteristics, to develop targeted planning schemes. Additionally, planners should pay attention to the long-term sustainability of green spaces, ensuring that green spaces can continuously and stably provide ecological services to the city through scientific and rational maintenance and management.

3.3 Introducing Low-Carbon Design Principles

In the planning and design of urban green spaces, the introduction of low-carbon design principles is of paramount importance for enhancing the carbon sequestration benefits of green spaces. Low-carbon design not only focuses on the aesthetics and functionality of green spaces but also emphasizes their environmental impact and carbon emissions throughout their entire lifecycle. When selecting plant species, prioritizing native plants is both environmentally friendly and economical. Native plants have already adapted to local climate and soil conditions, resulting in relatively lower maintenance costs and higher survival rates. This not only reduces the management costs of green spaces but also helps maintain ecological balance, as native plants typically have better compatibility with the local ecosystem. In addition to plant selection, the rational configuration of plant community structure is also crucial. Through carefully designed plant communities, biodiversity in green spaces can be increased, thereby enhancing their carbon sequestration capacity. A diverse range of plant species and layers can more effectively utilize solar energy, water, and nutrients, thus increasing the productivity and stability of ecosystems. This diversity in design also helps resist pests and diseases, reducing the use of chemical pesticides and further lowering environmental burdens. In the daily management of green spaces, irrigation and lighting are two major energy-consuming processes. To reduce energy consumption and carbon emissions, energy-efficient and environmentally friendly technologies and equipment should be utilized. For example, water-saving irrigation techniques such as drip irrigation or micro-spraying can be employed to avoid water wastage. In terms of lighting, low-energy consumption fixtures like LEDs can be used, equipped with light-sensitive controllers to automatically turn off lights when not needed. Additionally, green space design can incorporate more natural elements such as rainwater collection systems and solar energy utilization to achieve energy self-sufficiency. These measures not only help reduce the reliance of green spaces on external energy sources but also enhance their sustainability and environmental performance.

3.4 Diversification of Green Space Functions

As an integral part of urban ecosystems, the diversification of green space functions is crucial for meeting the diverse needs of urban residents. To achieve multifunctionality in green spaces, various activities and facilities can be ingeniously incorporated to create comprehensive green spaces that integrate leisure, entertainment, education, and ecology. To meet the needs of residents of all ages, especially children and teenagers, carefully designed children's play areas can be set up within green spaces. These play areas not only feature various play equipment such as slides, swings, and sand pits but also prioritize safety design to ensure the safety of children during play. Surrounding the play areas, colorful flowers and visually appealing plants can be planted to create a vibrant and enjoyable play environment for children. For residents who enjoy sports, the construction of sports facilities is particularly important. In urban green spaces, various sports facilities such as basketball courts, badminton courts, and fitness trails can be planned to meet the diverse sporting needs of different residents. The design of these sports facilities should emphasize practicality and comfort, such as using non-slip and wear-resistant flooring materials, providing ample seating and lighting facilities to ensure the comfort and safety of residents during sports activities. Additionally, urban green spaces should also take on the responsibility of protecting the ecological environment and enhancing urban biodiversity. By creating natural ecological spaces such as wetlands and woodlands, suitable habitats can be provided for wildlife.[4] These ecological spaces not only enrich urban biodiversity but also help regulate urban climate, purify air, and reduce noise. In the design of ecological spaces, attention should be paid to ecological balance and sustainability, avoiding overdevelopment and human interference to protect the stability and integrity of ecosystems.

Conclusion

The optimization of urban green space layout based on carbon sequestration benefits is one of the important approaches to improving urban ecological

environment quality, addressing global climate change, and achieving sustainable urban development. By implementing strategies such as increasing green space area and density, diversifying green space functions, and scientifically planning the form and structure of green spaces, the carbon sequestration benefits of urban green spaces can be effectively enhanced, providing residents with a more livable living environment and promoting the green and sustainable development of cities. Looking ahead, with the increasingly severe global climate change and the continuous pursuit of high-quality living environments by urban residents, the optimization of urban green space layout based on carbon sequestration benefits will be more widely applied and promoted in the future.

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