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Compound Structures and Functions of Urban Forests

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ABSTRACT

As the core concept of forest urbanism, urban forest is of great importance for a city's sustainable development. It is a vital subsystem of urban compound ecosystem and evolve synergistically with other subsystems, as well as a significant landscape component to push forward realizing carbon peaking and carbon neutrality. This article proposes three approaches to improving the compound structures and functions of urban forests. First, enrich types and extend structures of urban forests to build forest cities. Second, move from constructing forests in the city towards integrating forests into the city to enhance compound ecological functions. Third, shift focus from forest ecosystems to urban ecosystems by a synergic construction of the urban forest and other types of ecosystems.

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KEYWORDS

Urban Forestry; Forest Urbanism; Urban Compound Ecosystems; Ecosystem Services; Green Infrastructure; Sustainable Urban Development

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As an important part of urban green infrastructure and the core concept of "forest urbanism," urban forest emphasizes organically integrating forest ecosystems with urban development and is attracting more attention from the global academia. Recent studies of forest urbanism focus mainly on urban planning and the sustainable management of urban and rural forest resources in temperate and tropical forest ecosystems, which inspect the "figure–ground" (or "armatures–tissues") relationship between forest ecosystems/trees and urban structures, exploring and promoting diverse ecological functions in cities[1].

Forest urbanism and water urbanism, similar to landscape urbanism and ecological urbanism, criticize the traditional views of urbanism from the lenses of landscape ecosystems and sustainable urban development. With the ideologically awakening of ecological protection globally, cities are increasingly attaching importance to the ecological and environmental construction, such as the emergence of "green cities" and "garden cities." However, the realization of forest urbanism is confronted with problems due to the compound structures and functions of forests in urban settings. For one thing, planted economic forests and seedlings for greening

predominate in most cities, which can hardly provide expected ecosystem services. For the other thing, greening around buildings and municipal infrastructure is burgeoning, which may create unconventional "urban forests." In this regard, questions are raised: what is the value of contemporary urban forests and how should they be constructed?

To probe into the contemporary value of urban forests, we should first investigate the compound structures and functions of the urban natural ecosystems and artificial infrastructure. First, urban forest is a vital natural subsystem of the urban compound ecosystem for its stability and resilience. Second, forest ecosystems, as crucial landscape elements to water urbanism and climate urbanism, can not only benefit a city's sustainability, but also adjust its water and thermal environments. Third, urban forest construction can push forward China's achievement of carbon peaking and carbon neutrality as forests can greatly contribute to sequestrating carbon and reducing carbon emission.

We can improve the compound structures and functions of urban forests in three main ways to realize its ecological value. Firstly, systematically enrich types and extend structures of urban forests towards the building of forest cities, because forests and urban fabrics are together developing and forming into a holistic ecosystem, covering parks, woodlands, and houses and infrastructure with innovative types of greening. Secondly, move from constructing forests in the city towards integrating forests into the city, to enhance their compound ecological functions as a whole—research has proved that the expansion of woodland patches would result in severer landscape fragmentation[2]. Thus, the construction of parks and woodlands simply inside and outside a city might not be an optimal path to improve its ecological and environmental benefits. Thirdly, shift focus from forest ecosystems onto urban ecosystems by a synergic construction of the urban forest and other types of ecosystems (like water bodies). Urban forests cannot be isolated from urban water systems, thermal environment, wind environment, biological habitats, or even viral transmission. Only when we regard it as an organic component of the larger urban compound ecosystem, can it realize synergy with all other systems.

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城市森林的复合结构与功能

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摘要

城市森林作为森林都市主义的核心概念，对城市的可持续发展有重要价值。城市森林是城市复合生态系统中一个不可或缺的子系统，它和城市水系等其他子系统之间存在共生演进的关系，也是中国城市实现“双碳”目标的景观要素。本文提出，可以从三个方面改善城市森林的复合结构和功能：首先，从城市森林到森林城市，系统拓展城市森林的类型和结构；其次，从建设森林到融合森林，注重提升城市森林的复合生态功能；最后，从森林生态系统到城市生态系统，统筹城市森林与其他类型生态系统的协同建设。

关键词

城市森林；
森林都市主义；
城市复合生态系统；
生态系统服务；
绿色基础设施；
城市可持续发展

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翻译
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“城市森林”（urban forest）作为一类重要的城市绿色基础设施，正日益引发全球学界的关注。作为“森林都市主义”（forest urbanism）的核心概念，城市森林一直强调森林生态系统与城市发展的有机融合。现有的森林都市主义研究案例也多涉及温带或热带森林生态系统中的都市规划和城乡林业资源的可持续管理，主要分析森林生态系统及树木与城市构成的“图底关系”和“骨肉关系”，讨论多样的生态功能[1]。

森林都市主义及水都市主义思想与景观都市主义、生态都市主义相关，都是从景观生态系统与城市可持续发展的角度对传统都市主义进行批判。随着全球生态保护思想的觉醒，当代城市发展过程中更加重视生态环境建设，“绿色城市”“园林城市”等都市主义方案层出不穷。然而，森林在城市中的结构和功能关系较为复杂。一方面，大部分城市内部和周边已经鲜有原生森林，人工种植的经济林和绿化苗木较多，它们提供的城市生态系统服务有限；另一方面，城市建筑和市政基础设施的绿化趋势方兴未艾，形成了区别于传统意义的新型“城市森林”。对此，我们不禁提出疑问，当代城市森林的价值体现在哪里？又应该如何建设？

我们有必要从城市自然生态系统与人工基础设施系统所具有的复合结构和功能的角度，审视当代城市森林的价值。首先，城市森林是城市复合生态系统中不可或缺的重要自然子系统类型，对维护整个系统的稳定和韧性有关键性作用。其次，森林生态系统不仅为城市可持续发展提供生态系统服务，更在很大程度上影响了城市水环境和热环境，是水都市主义和气候都市主义的重要景观因素。最后，建设城市森林是中国城市实现“双碳”（碳中和、碳达峰）目标的重要抓手之一：一方面，森林本身具有固碳的生态功能；另一方面，其作为主要的城市绿色基础设施能有效实现碳减排。

为实现城市森林的生态价值，可以从三个方面改善其复合结构和功能。第一，从城市森林到森林城市，系统拓展城市森林的类型和结构。森林与城市正在有机进化成一个完整的生态系统，不仅涵盖城市内外的公园绿地与林地，还包含以垂直绿化和城市森林花园为特征的“第四代住宅”，以及基于人工基础设施的绿化种植等。第二，从建设森林到融合森林，注重提升城市森林的复合生态功能。仅考虑建设城市内外的公园绿地和林地并不一定是改善城市生态环境的最佳途径。有研究证明，扩大某些城市的林地斑块反而在一定程度上加剧了城市的景观破碎化[2]。第三，从森林生态系统到城市生态系统，统筹城市森林与水体等其他类型生态系统的协同建设。城市森林和城市水系、城市热环境和风环境、生物栖息地乃至病毒传播等都密切相关，因此不能就森林论森林，要将森林建设视为城市复合生态系统这一耗散结构的有机组成部分，与其他组成部分协同发展。