

Thinking and Analyzing the Construction of Urban Ecological Network System of Territorial Spatial Planning

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Abstract: In the contemporary era of rapid urbanization, territorial spatial planning serves as a pivotal instrument guiding the sustainable development of cities, while the establishment of urban ecological networks emerges as a novel driving force for advancing ecological civilization. Commencing from the theoretical underpinnings of urban ecological network formation, this discourse elaborates on the essence and characteristics of urban ecosystems, the theory of ecological networks, its application in urban planning, and provides a comprehensive overview of modern methodologies and core principles in constructing urban ecological networks. Furthermore, the article delves into the determination and layout of ecological nodes, the design and linkage of ecological corridors, and the establishment and optimization of ecological service networks within the framework of territorial spatial planning. Through functional and efficacy analyses, it unveils the significant role of urban ecological networks in enhancing environmental quality, fostering sustainable urban development, and elevating residents' quality of life. Ultimately, it explores the challenges and opportunities confronting the construction of ecological network systems in the future urban development process, aiming to offer more targeted and forward-thinking planning recommendations and contribute theoretical and practical insights to the construction of urban ecological civilization.

1. Introduction

In the ongoing process of modern urbanization, the expanding boundaries of cities and the escalating ecological concerns accentuate the pressing need for the establishment of urban ecological networks. This framework not only necessitates the integration of various functions within urban ecosystems but also plays a crucial role in safeguarding biodiversity and maintaining ecological equilibrium. With a deepened understanding of urban ecological issues, ecological network theory has been widely employed in the realm of urban planning, aiding cities in sustaining ecological harmony amidst rapid development. The article aims to amalgamate theoretical inquiry with planning practices, scrutinizing viable approaches to constructing urban ecological networks and delineating specific implementation strategies within territorial spatial planning. Concurrently, by appraising the functions and benefits of urban ecological networks, it evaluates their positive

impact on environmental quality, urban sustainability, and residents' quality of life, furnishing practical guidance and insights for researchers and decision-makers in related fields.

2. Theoretical basis for the construction of urban ecological network system

2.1. Urban ecosystem concept and characteristics

The urban ecosystem is a highly complex and dynamic system, woven together by various factors such as natural environment, buildings, socioeconomic activities, and human behaviors. In this system, the components interact and depend on each other, collectively influencing the sustainable development of cities and the quality of life for residents. One of the most prominent features of urban ecosystems is their high degree of integration and openness. This implies that cities are not merely ecological deserts, but vibrant ecologies closely linked to the surrounding natural environment. Green spaces in cities, such as parks, green belts, lakes, as well as surrounding forests and fields, constitute the ecological infrastructure of urban ecosystems. These green spaces not only provide valuable leisure spaces for urban residents but also perform multiple ecological functions such as purifying air, regulating climate, maintaining water and soil, and providing biodiversity protection [1]. Therefore, in the construction of urban ecological networks, maintaining and enhancing the functions of these ecological infrastructures are key issues. On the other hand, the high degree of artificialization of urban ecosystems is also a significant characteristic. In the process of urbanization, a large amount of natural land is converted into construction land, which has caused considerable impact and damage to the original ecosystems. How to protect and restore urban ecosystems while developing cities, and how to construct a healthy and stable urban ecological network, are major challenges currently faced. This requires the adoption of scientific methods and advanced technologies, rational planning of urban spatial layout, increasing the area and quality of green spaces, and striving for harmonious coexistence between urban development and natural ecological protection. The theoretical foundation of constructing urban ecological networks also needs to consider the stability and disturbance resistance of urban ecosystems. This means that urban ecological networks should not only focus on the quantity and quality of ecological spaces but also consider the connectivity and overall functionality of these spaces. Measures such as constructing ecological corridors and green bridges to connect various ecological nodes, enhancing species exchange and energy flow between different ecological regions, can effectively enhance the overall stability and resilience of urban ecosystems. Based on this, the construction of urban ecological networks also needs to integrate the participation and needs of communities and residents. After all, cities are where humans live, and the construction and improvement of any ecosystem should fundamentally aim to improve human quality of life. By listening to the voices of communities, considering the needs of residents, strengthening environmental education and public participation, we can promote urban residents' understanding and respect for the ecological environment, and create a good social atmosphere for co-building and maintaining urban ecological networks.

2.2. Methods and Principles of Urban Ecological Network System Construction

Land spatial planning plays a pivotal role in urban development, particularly in the establishment of urban ecological network systems. The theoretical foundation of this system stems from the integrated application of various disciplines, including ecology, urban planning, geography, and others, aimed at upholding and restoring the stability and health of urban ecosystems through scientific methods and principles. The urban ecological network is not merely a layout of physical structures but rather an embodiment of ecological processes, encompassing aspects such as

biodiversity conservation, ecological process maintenance, and provision of ecosystem services. The approach and principles of constructing urban ecological network systems integrate the essence of ecological science and spatial planning, aiming to achieve the goal of sustainable urban development. Among these, the identification and preservation of ecological source areas as the core of the network are fundamental starting points. Ecological source areas refer to regions of high ecological value, such as forests, wetlands, etc., which serve as crucial carriers of biodiversity and play a key role in maintaining the balance of the overall ecosystem. Scientific assessment and identification of these ecological source areas, along with ensuring their effective protection and restoration in urban planning, form the basis for achieving urban ecological balance [2]. Furthermore, the construction of ecological corridors connecting these source areas should not be overlooked. Ecological corridors, as green pathways connecting dispersed ecological source areas, effectively facilitate species migration and gene exchange, enhancing the stability and resilience of ecosystems. These corridors not only need to consider the scientific layout of space but also balance the practical needs of urban development, such as pedestrian paths, green cycling lanes, etc., to achieve a win-win situation for ecological and social benefits. Additionally, the construction of urban ecological network systems should adhere to the principle of diversity. Maintaining and enhancing the diversity of urban ecological spaces helps improve the resilience of ecosystems against uncertain future environmental changes. This requires planners to comprehensively consider different types of green spaces, such as parks, community gardens, urban wetlands, etc., to ensure the functional and structural diversity of the ecological network. Throughout the entire construction process, public participation is also crucial. Public involvement not only enhances the transparency and credibility of planning but also increases community awareness and responsibility for environmental protection. Through effective communication and collaboration, planning schemes can be more aligned with actual needs, thereby improving the success rate and sustainability of implementation.

3. Construction of Urban Ecological Network System in Territorial Space Planning

3.1. Determination and layout of ecological nodes

Ecological nodes are pivotal components within the urban ecological network, their meticulous design serving as a linchpin for achieving sustainable urban development. They transcend mere green spaces or water bodies within the natural environment; rather, they embody the vital nexus of urban ecological functions, playing irreplaceable roles in preserving biodiversity, fostering ecological balance, and enhancing residents' quality of life. Determining ecological nodes necessitates a holistic approach, delving into various aspects such as the city's overall ecological system, natural geographical conditions, ecologically sensitive areas, biological habitats, and existing distribution of green spaces. Only through a comprehensive assessment of these crucial factors can the positions of ecological nodes be scientifically ascertained. These nodes may encompass pre-existing natural reserves, urban parks, or newly constructed ecological parks or green spaces meticulously planned and designed. Moreover, in their layout, ecological nodes should adhere to the connectivity principles of the ecological network, organically linking each node through greenways, water systems, and other ecological corridors. This fosters a multi-tiered, three-dimensional ecological network system, facilitating the migration and genetic exchange of organisms while promoting urban residents' leisure, recreation, and well-being. Furthermore, the layout of ecological nodes must fully consider future urban development trends, allocating space to address the ecological pressures arising from urban expansion, thereby ensuring the resilience and sustainability of the ecological network system. It is noteworthy that the determination and layout of ecological nodes are not immutable. With the acceleration of urbanization and the impacts of

climate change, regular evaluations and adjustments to ecological nodes and their network systems are imperative. This underscores the need for urban planners and decision-makers to possess foresight and flexibility, adjusting the layout strategies of ecological nodes and networks in response to environmental changes through environmental monitoring, data collection, and analysis. This adaptive approach enhances the resilience of urban ecosystems, effectively safeguarding and restoring them amidst the rapid urbanization process, thereby realizing the goals of ecological civilization and sustainable urban development. In summary, the determination and layout of ecological nodes represent a complex yet crucial task in constructing the urban ecological network system. It requires interdisciplinary knowledge spanning ecology, geography, urban planning, and the collective efforts and participation of society at large. Only through such endeavors can urban ecological systems be effectively protected and restored amid the rapid pace of urbanization, ultimately achieving the objectives of ecological civilization and sustainable urban development [3].

3.2. Design and connection of ecological corridors

Amidst the tide of modern urbanization, the significance of land spatial planning becomes particularly pronounced. This is especially true in the context of constructing urban ecological networks, as they not only pertain to the sustainable development of cities but also directly impact the quality of human life. When planning urban ecological networks, the design and connectivity of ecological corridors emerge as pivotal, for they serve as crucial links connecting ecological nodes, thus forming a cohesive ecological network. Ecological corridors essentially create a series of verdant pathways within cities, effectively linking various ecological nodes such as parks, green spaces, wetlands, and more. Through such connections, these green pathways not only provide urban residents with recreational spaces but, more importantly, establish migration routes for wildlife within the city, thereby significantly promoting biodiversity conservation. In designing ecological corridors, numerous factors need consideration. Firstly, the layout of ecological corridors should account for natural conditions such as topography, water systems, existing distribution of green spaces, as well as anthropogenic factors like urban traffic patterns and population distribution. This holistic approach ensures a win-win situation for ecological and socio-economic benefits. Secondly, meticulous planning is required for the width, structure, and functions of ecological corridors to effectively facilitate biological migration while mitigating adverse urban environmental impacts such as noise and light pollution. Within the process of constructing urban ecological networks, the design and connectivity of ecological corridors stand as a pivotal component. They not only impact the improvement of ecological environments but also play a critical role in enhancing urban living standards, thus fostering key elements for sustainable urban development. Hence, for urban planners and decision-makers, the scientific and rational planning of ecological corridors poses a profound and contemplative challenge. Looking ahead, with advancing technologies and heightened environmental awareness, the role of ecological corridors within urban ecological networks will increasingly shine, becoming a new highlight in the realm of urban green development.

3.3. Construction and optimization of ecological service network

In the discourse on the establishment of urban ecological networks within territorial spatial planning, the construction and optimization of ecological service networks emerge as pivotal tasks. This endeavor not only necessitates precise identification and evaluation of ecosystem services but also calls for a series of innovative measures aimed at enhancing the self-repair capability of urban ecosystems and augmenting their efficiency and efficacy in contributing to sustainable urban development. At the core of ecological service networks lies the formation of a multifunctional

network system conducive to biodiversity conservation while meeting human life needs, achieved through scientific planning and technological innovation. This encompasses not only the optimization of green infrastructure layout, such as parks and green corridors, but also the rational planning and management of urban water systems. Through such comprehensive construction, it becomes feasible to effectively realize ecological service functions like stormwater management and purification, air quality improvement, and alleviation of urban heat island effects, thereby creating a healthier and more comfortable living environment for urban residents. Furthermore, the optimization of ecological service networks necessitates the utilization of advanced technologies such as GIS and big data analysis to accurately identify and analyze the service functions of urban ecosystems, ensuring the scientificity and effectiveness of planning decisions [4].

4. Analysis of functions and benefits of urban ecological network system

4.1. Improvement and ecological protection of urban environment by ecological network

The urban ecological network system serves as a vital means of reconciling the tension between urban development and the preservation of the natural environment, assuming a pivotal role therein. Its functions and benefits, particularly its impacts on urban environmental enhancement and ecological preservation, manifest multidimensional values. The ecological network, by interconnecting natural habitats such as parks, green belts, and wetlands, weaves an organic, cohesive ecological fabric. This pattern not only optimizes the spatial structure of cities but also enhances biodiversity, bestowing upon cities the "green lungs" effect, effectively ameliorating urban climate and mitigating the heat island effect. The improvement of urban environment by the ecological network is also evident in the significant enhancement of air quality and the effective control of water pollution. Green spaces absorb carbon dioxide, release oxygen, purify the air, and concurrently provide comfortable leisure and recreational areas for urban residents, thus elevating their quality of life. The effective connection and preservation of urban water systems and wetlands augment the city's water storage and flood control capacities, acting as natural "sponges" and enhancing the city's resilience to extreme weather events. From the perspective of ecological conservation, establishing an ecological network system contributes to the protection and restoration of ecosystem services and the preservation of biodiversity. By safeguarding critical ecological areas and corridors, it ensures the survival space and migration pathways for wildlife, fostering natural exchanges among species and the maintenance of genetic diversity. Furthermore, the construction of urban ecological networks also promotes soil and water conservation, preventing land degradation, and safeguarding the city's sustainable development. Against the backdrop of rapid urbanization, the construction and refinement of urban ecological network systems not only represent a sense of responsibility for future sustainable development but also embody a concern for residents' quality of life. Through strategic planning and implementation, ecological networks can serve as bridges to promote harmonious coexistence between humans and nature, ushering in a brighter, healthier future for cities.

4.2. Promotion of sustainable urban development by ecological network

The urban ecological network, functioning as an ecological infrastructure, weaves together the green spaces within cities such as parks, wetlands, and gardens, creating a system that not only fosters biodiversity but also provides humans with recreational havens. Its establishment is pivotal not only for its contribution to the enhancement of urban landscapes but more importantly for its crucial role in maintaining ecological balance, elevating urban ecological quality, and bolstering urban resilience to climate change. By effectively linking fragmented natural environments within

cities, the urban ecological network reinforces ecological processes and the mobility of species, holding profound significance for biodiversity conservation. Biodiversity serves not only as the cornerstone of ecosystem health but also as a vital safeguard for urban sustainable development. On the other hand, these green spaces function as natural "cooling systems," playing indispensable roles in ameliorating the urban heat island effect, regulating microclimates, and filtering air pollution. This not only fosters a more pleasant living environment but also helps reduce urban residents' reliance on electricity cooling systems, thereby lowering energy consumption and carbon dioxide emissions, laying a solid foundation for urban sustainable development. Furthermore, the construction and maintenance of urban ecological networks promote harmonious coexistence between humans and nature. By offering citizens opportunities to connect with nature, it not only enhances residents' quality of life but also strengthens public awareness of and engagement in environmental protection. In the long term, this heightened public awareness will facilitate the implementation of more environmental conservation policies and measures, forming a virtuous cycle that further propels the process of urban sustainable development [5].

4.3. Impact of Ecological Network on Residents' Quality of Life

In confronting the manifold challenges of urbanization, the urban ecological network system emerges as paramount. It not only upholds the ecological equilibrium of cities but also intimately affects the quality of residents' lives. When ecological network strategies are deftly deployed, cities resemble intricate spider webs, where each thread serves as a lifeline. These interweaving strands form a safety net for inhabitants, furnishing a wholesome, harmonious, and sustainable living environment. The primary function of ecological networks lies in connecting urban green spaces, fostering diverse biotic habitats. This not only enhances urban biodiversity but also fortifies cities against natural calamities such as floods and storms. Yet, its benefits extend far beyond direct ecological effects. For instance, contiguous green spaces provide avenues for leisure and recreation, enhancing citizens' psychological well-being and alleviating the pressures of work and life. Consequently, residents' physical and mental health receives substantial promotion, nurturing robust community bonds and fostering a more harmonious social milieu. Furthermore, a well-designed urban ecological network can ameliorate air quality, mitigate noise pollution, and engender cooler microclimates, effectively alleviating the urban heat island effect. These directly influence residents' comfort and satisfaction with life, while laying the groundwork for sustainable urban development. The presence of green spaces also bridges the gap between residents and nature, providing opportunities for education and fostering environmental awareness, thereby imbuing the next generation with a deeper understanding of ecological preservation. Additionally, ecological networks exhibit a positive correlation with urban economic development. Enhancements in green spaces can augment property values, attract investments, stimulate tourism, and generate employment opportunities. Hence, the ecological network plays an indispensable role in enhancing the overall competitiveness of cities.

5. Conclusion

In summary, the urban ecological network system plays a pivotal role in territorial spatial planning, serving as a crucial guarantor for achieving sustainable urban development. The strategic arrangement of ecological nodes and corridors, along with the effective establishment of ecological service networks, not only facilitates the enhancement of urban ecological restoration capabilities but also fortifies urban resilience against ecological pressures, fostering harmonious coexistence between humanity and nature. Simultaneously, as a conduit linking nature with urban realms and fostering symbiosis between humans and the environment, the urban ecological network's

contributions to enhancing overall urban environments, safeguarding biodiversity, and elevating residents' quality of life are paramount and cannot be overlooked. Future planners and policymakers must deepen their understanding of the urban ecological network system, innovate planning and design principles, and integrate dual strategies of development and preservation comprehensively. It is imperative to steadfastly adhere to the guiding principles of ecological civilization construction, ensuring that territorial spatial planning progresses in tandem with ecological civilization construction, thereby jointly forging a bright future of harmonious development between humanity and nature.

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