

Research Progress and Reflections on the Equity of Urban Green Space

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ABSTRACT

Green space equity development is a necessary pathway to achieve urban modernization and a crucial driving mechanism for enhancing urban resource utilization efficiency and resident life satisfaction. Green spaces are an essential component of urban ecosystems, not only mitigating the urban heat island effect but also playing a significant role in human comfort due to the ecological service value of vegetation. Equity is a core value persistently pursued in urban spatial and social development. This paper aims to further refine the theoretical research on urban green space equity from multidimensional perspectives by summarizing the development process of urban green space equity. It holds significant practical implications for improving urban ecological environment quality, promoting healthy urban living, and advancing urban green space development. Focusing on urban green spaces as the research subject, this study employs the literature review method to examine the main advancements in urban green space research over the past two decades, including the expansion of the connotation of urban green space and the diversification of its types. This contributes to understanding the context and value of urban green space research and refining the existing framework of urban green space studies.

KEYWORDS

Urban green space; Spatial equity; Fairness

1. INTRODUCTION

In the 21st century, with the global urbanization process, China's rapid urbanization has become a focal point of international academia. As ecological civilization construction and human-oriented urban development advance, the fairness of urban green space has become a crucial issue. Some cities in our country have gradually entered the stage of stock development, and continuous urban renewal actions have created opportunities for the secondary allocation and adjustment of urban green space. Exploring the diversity of content, form, and scale of urban green space provides possibilities for achieving fair distribution of urban green space under the current context [1]. Urban green space is a significant factor in promoting health and sustainable urban development. The fair distribution of urban green space helps promote urban healthy development, reduces health inequalities among people, and is an important component of environmental justice. The article reviews the important achievements of Chinese and foreign scholars on urban green space research over the past 20 years, summarizes some of its key contents, and looks forward to its development prospects [2].

2. CONCEPTS

Green space: refers to "land that is entirely or partially covered with grass, trees, shrubs, or other plants"; a broad definition of green space (green space) refers to "all open, undeveloped, and publicly

accessible land," including parks, community gardens, public green spaces, school playgrounds, playgrounds, public rest areas, squares, vacant areas, etc., which can beautify the environment, improve it, and provide citizens with a place for leisure and relaxation. Currently, there is no unified concept for the definition of urban green space [3]. Urban green space includes green space combined with the natural environment, special forms of urban green space (such as street greening), and green space containing water bodies in "blue space." Urban green space refers to a three-dimensional space with a living ecological effect, composed of urban forests, urban lawns, street trees, parks, and wetlands [4]. At the academic level, the traditional sociological research perspective of "space" has moved away from its material attributes and has transformed into a modernity of society and humanities.

Since the 1970s, social justice has become a central issue in Western political philosophy research. The concept of "fairness" has unique meanings in various aspects such as philosophy, economics, politics, law, and ethics. Summarizing, we can derive four relatively close concepts: fairness, justice, equality, and equity. Scholars' understanding of "fairness" primarily unfolds from two levels: "territorial fairness" and "human fairness." "Territorial fairness" is an ideal of absolute equality but carries a touch of egalitarianism; whereas "human fairness" focuses more on all social strata, especially the welfare issues of vulnerable groups. On this basis, it is necessary to balance both "territorial fairness" and "human fairness." Not only should fairness be reflected in spatial distribution, but the fairness perceptions of different social groups should also be fully considered.

3. LITERATURE REVIEW

3.1. Status Quo of Domestic Research

Our country's environmental justice research began in the early 20th century. Currently, there is still very little research on environmental justice issues in Chinese cities, but overall, the number of documents conducting research from the perspective of environmental justice is increasing. Research on the green space environmental equity in Chinese cities focuses on multiple themes, including factors such as green space equity, accessibility, and service area, as well as their measurement indicators and methods [5]. These studies indicate that the equity of urban green space is not only related to the improvement of urban ecological environment but is also closely linked to social equity. Professor Yang's research explores the urban green spaces in Guangzhou from the perspective of spatial fairness and justice, primarily considering the spatial heterogeneity of green space accessibility inequality for vulnerable groups. This aims to accurately identify and address the spatial disparities in urban green space in future urban green space system planning and related decision-making, making significant contributions to the equity of urban green space.

In practice, some cities like Shanghai and Chongqing have conducted analyses on the equity of green space, finding issues such as unequal distribution and mismatching of public green spaces. Additionally, by evaluating the index of unequal exposure to green space among residents, it can be seen that the availability and accessibility of urban green space in Shanghai show a declining trend, with the Gini coefficient also gradually decreasing, indicating the positive impact of urban greening policies [6]. Furthermore, although some studies have proposed improvement measures, such as the lack of specific spatial distribution planning for urban green space construction in China, focusing only on green space coverage and residential green space area, the equity of green space service functions has not been sufficiently addressed. This suggests that while there is research focused on improving green space equity, further planning and implementation efforts are still needed in practice.

3.2. Status Quo of Overseas Research

From the ecological justice perspective in Western urban green space planning, it can be concluded that the development of related research abroad over the past decade has a clear trajectory, diverse

thematic perspectives, and extensive cross-cutting content. Research hotspots are divided into five aspects: the fairness and accessibility assessment of urban green space distribution, the assessment of green space enjoyment for vulnerable groups, factors and strategies affecting the fairness of urban green space planning, green space compensation guided by ecological justice, and the promotion of residents' physical and mental health by ecological justice [7]. Research themes are concentrated on accessibility and environmental equity, green space spatial transformation and environmental gentrification, cultural equity and environmental equity issues in green space use, as well as green space environmental equity perception and local attachment. These studies mostly come from cities in developed countries, particularly the United States. Foreign literature scholars primarily focus on the current status, functions, usage conditions, accessibility, and environmental justice of urban green spaces [8]. The problems are that there are fewer representative author groups and a lack of collaboration among them.

In addition, in 2012, Western scholars proposed the concept of green gentrification. It is a result of the combination of traditional gentrification and environmental sociology theory. It refers to the phenomenon where environmental improvement leads to the replacement of original vulnerable residents by a new class in the context of newly built green infrastructure such as urban parks and ecological corridors, thus causing spatial reshaping and population restructuring in the surrounding areas of green spaces [9]. It is a dynamic process that exacerbates urban social spatial inequality. Currently, green gentrification has become an important branch of research in environmental justice and landscape equity both domestically and internationally. Currently, research on green gentrification is mainly focused on the following four aspects: the manifestations of green gentrification; the formation mechanisms of green gentrification; the influencing factors of green space characteristics on the degree of green gentrification; and the coping strategies for green gentrification. Early studies on the measurement of green gentrification mostly used qualitative research methods. With the development of GIS technology, quantitative methods have gradually increased in the study of gentrification phenomena, expanding the research scope and improving research accuracy.

4. RESEARCH ON THE DEVELOPMENT STAGE OF URBAN GREEN SPACE EQUITY

In recent years, many scholars at home and abroad have attempted to combine the actual green space needs, actual spatial layout, and actual green space functional utility of different groups to construct a new set of evaluation indicators, to conduct qualitative and quantitative analysis of the fairness of urban green spaces, aiming to supplement the existing methods of evaluating urban green spaces, thereby better reflecting the utilization of urban green resources by residents, and exploring what spatial allocation patterns can enable residents to equally and reasonably enjoy green space resources [10]. Therefore, in practice, the research on the fairness of urban green spaces in China has shown a trend of shifting from the initial "environmental equity" to "spatial justice" and "social justice."

4.1. The Stage of Environmental Equity

Since the 1960s and 1970s, the living standards of urban residents in Western and Eastern countries have gradually improved, and there has been increasing attention to the balanced distribution of public spaces, leading to their assessment and use as a measure. Subsequently, the "Regulations on Urban Planning and Construction Indicators" promulgated in China in 1993 also included commonly used indicators for evaluating urban green space services, which reflect the fairness of distribution in quantity [11]. At this stage of numerical equality, the fairness of green space layout both domestically and internationally is reflected and emphasized through egalitarianism. However, the existing evaluation indicators do not take into account the actual needs of residents, for example, the spatial distribution of some vulnerable groups is unbalanced, and the layout of green space does not align

with the service value it provides, highlighting the timeliness of current research on social fairness evaluation. But due to its operability and comparability, it is still widely used in China.

4.2. The Stage of Spatial Justice

After the 1990s, Western scholars began to realize that only by allocating space according to the needs of residents can public resources be allocated fairly. Due to uneven urban population distribution, the accessibility of some public service facilities (such as schools, parks, hospitals, etc.) is somewhat limited, that is, in reality, the number of residents in cities is not uniform, and simply using accessibility not considering residents' needs in the early stage to measure is one-sided. Chinese scholars have also thought about this. Overall, this stage incorporates the spatial distribution factors of residents, making the degree of fairness more credible, but it overlooks the differences in fair enjoyment between different groups.

4.3. The Stage of Social Equity

Academic research has shifted from focusing on "land" to focusing on "people." The study of urban public space fairness has also taken a "people-centered" approach, fully considering the needs of various social strata, income disparities, ethnic differences, and comprehensively analyzing the impact of various practical factors on the unfairness of green spaces. On this basis, research on the social justice of green space systems has been conducted. Currently, scholars in China have begun to evaluate the fairness of green spaces for different types of social groups and have achieved certain results [12]. For example, Professor Yang Wenyue has studied the spatial heterogeneity of urban green space unfairness in Guangzhou from the perspective of vulnerable groups and using the Geographically Weighted Regression (GWR) model, focusing on the spatial relationship between the accessibility of urban green space resources in Guangzhou and the community's vulnerable socio-economic variables. Currently, the development of green space systems in China is still at a quantitative and balanced level, while academic research is gradually shifting to the study of differences among social groups, and its research results will provide a theoretical basis for the future construction of urban green spaces in China.

5. CHARACTERIZATION AND MEASUREMENT OF URBAN GREEN SPACE EQUITY

5.1. The Representation of Urban Green Space Equity

Practical experience shows that different social groups enjoy varying degrees of urban greening, which is also known as "inequality," primarily manifested in "accessibility," "location," "residents' income," "age," and other factors leading to "green inequality."

5.1.1. Accessibility

In the urban green space system, distance and time are the main constraints restricting the fairness of urban green space [13]. Accessibility is mainly oriented to the users of green space. If a certain green space has strong accessibility, it will help improve the fairness rate of green space for different social groups and meet the needs of different social groups.

5.1.2. Location

Related studies indicate that suburban areas have less and smaller green spaces compared to urban areas, and there is an unfairness in the utilization and accessibility of green spaces in suburban regions. For groups living in the suburbs with inconvenient transportation, their opportunities to use green spaces are significantly reduced, which in turn affects their physical and physiological health. For

them, the level of happiness and satisfaction with living in the city decreases, which is not conducive to "people-oriented" urban development.

5.1.3. Income

High-income groups have more, higher quality, and more convenient green spaces compared to low-income groups. This situation is clearly related to the housing and transportation expenditures, green space choices, and the development and utilization of green spaces for low-income groups. Communities with higher economic levels usually have access to more park and green spaces; those with stronger economic capacity can choose urban green spaces over a larger area; and the vegetation and facility quality of green spaces around residential areas are generally higher. However, low-income groups, due to longer working hours and more leisure time, have less time and opportunity to access green spaces.

5.1.4. Age

Age is also an important factor affecting urban spatial equity, and the group most affected by this is the elderly. This is manifested in the following aspects: accessibility issues. Some elderly people may lack sufficient green spaces near their residential areas [14]. Due to limited mobility, they may not be able to easily reach parks or green spaces far from their homes, preventing them from enjoying the benefits of green spaces; inadequate green space facilities, some green spaces may lack facilities suitable for the elderly, such as accessible paths, sufficient resting seats, and safe walking paths. These factors limit the comfort and safety of the elderly when using green spaces; limited social interaction opportunities, urban green spaces are important places for social activities, but the elderly may face social isolation in these settings. For example, they may not be able to participate in activities organized within green spaces, or they may find it difficult to interact with other community members due to language and cultural barriers; economic factors, in some cases, the elderly may not be able to enjoy green spaces due to financial reasons. For example, some urban green spaces may require paid admission or offer paid services, which could be a burden for some elderly people with limited financial means.

5.2. Measurement Index and Measurement Method

5.2.1. Green space supply indicator in parks

The most commonly used indicators and methods to measure the fairness of urban green space environments domestically and internationally are accessibility, which can be divided into objective aspects (transportation accessibility) and subjective aspects (psychological accessibility), with current research primarily focusing on the objective aspect [15]. Over the past five years, research on park accessibility has advanced rapidly, mainly due to the progress in geographic spatial science and technology, with an increasing number of studies adopting GIS methods such as the nearest neighbor method, attractiveness index method, travel cost or expense method (travel cost method), etc. In terms of calculating the service area of parks, the buffer method is used relatively frequently. Sister et al. proposed that park service area analysis helps identify areas with higher park demand. Using the Los Angeles metropolitan area as a case study, they used Thiessen polygons to calculate the service area of each park and calculated its potential congestion or pressure, providing a practical method for studying the existing unfairness in park accessibility. The service radius of parks is related to factors such as the size of the park, the quality of green space, and the surrounding environment, forming a complex, edge-changing shape influenced by multiple factors. In practical applications, for ease of interpretation, it is often represented by regular shapes, where parks cover a certain range according to a specific buffer distance.

5.2.2. Comprehensive indicators of park green space supply and demand

Integrating the supply and demand perspectives has become a trend in the study of environmental equity in park green spaces. Urban planners should consider locating new parks in areas where

demand far exceeds park supply, rather than merely considering whether there are many parks nearby, because high-density populations, despite having numerous parks around them, may still be experiencing a lack of park services. Taleai et al. proposed an integrated spatial equity evaluation method to measure the balance between demand generated by residential areas and the supply of urban services at different spatial scales; Chen Wen et al. utilized indicators such as accessibility, park service coverage rate, service overlap rate, and the per capita area of accessible parks to propose a model for evaluating the equity of park location allocation; Tan et al. used park area ratio, per capita park area, per capita park area served, park service area, and the number of people per unit area of park regions in their park supply index, finding that park supply indicators tend to be skewed, especially at small scales; Łaskiewicz et al. applied an econometric model, combining data from 860 local resident quality of life questionnaires and objectively measured data on urban green space proximity, to study the impact of green space on residential time from an environmental equity perspective [16]. They proposed that if the availability of green space has a negative impact on residential time for residents in difficult living conditions, while it has a positive or neutral relationship for those with high socioeconomic status, we can assume an environmental unfairness. Germany, to determine whether the allocation of urban green space and population is unequal, conducted further analysis based on user preferences, while considering demographics and immigration status, using methods such as GIS, differential indices, and cluster analysis to calculate and analyze public land use and social statistics at the regional level.

6. FUTURE RESEARCH DIRECTION AND SUGGESTIONS

In the future, the research on the fairness of urban green space should be more in-depth and pay attention to practical application. The following points of deepening direction and suggestions can be used as a reference for researchers and decision makers.

6.1. The Development of Interdisciplinary Integration and Refined Evaluation Methods

The equity issue of urban green space is a complex socio-environmental system problem. Future research should continue to promote the deep integration of multiple disciplines such as environmental science, urban planning, sociology, and psychology to form a more comprehensive theoretical framework [17]. In terms of evaluation methods, more refined and context-specific indicators can be explored, such as using geographic information systems (GIS) and big data technology, combined with real-time location information and mobile trajectory data of residents, to dynamically evaluate the accessibility, usage preferences, and satisfaction of different groups with urban green spaces, thereby revealing the deep-seated socio-cultural factors of green space equity.

6.2. Precise Identification of Vulnerable Groups and Differentiated Strategy Formulation

For specific social groups such as the elderly, low-income populations, and people with disabilities, research should delve into understanding their unique needs and barriers in the use of green spaces, such as designing barrier-free facilities for the elderly, child-friendly play areas, and green space improvement projects in low-income communities. At the same time, adopt participatory planning and community governance models to involve these groups in the planning and management of green spaces, ensuring their voices are heard and their needs are met. Additionally, through statistical models such as geographically weighted regression, quantify the correlation between different socio-economic statuses and green space allocation to provide a scientific basis for the development of differentiated strategies.

6.3. Early Warning of the Green Gentleman Phenomenon and Countermeasures for Fairness

Addressing the issue of potential social spatial inequality exacerbated by the green gentrification, research should focus on establishing early warning systems to monitor the impact of green space improvement projects on surrounding community structures and housing prices, preventing green spaces from becoming tools that promote community exclusion. At the same time, explore effective policy and planning interventions, such as setting restrictions on land use around green spaces, implementing green space impact assessments, and establishing green space compensation mechanisms, to ensure that green space improvements can enhance environmental quality while promoting social equity.

6.4. Long-Term Tracking and Dynamic Adjustment Mechanism of Green Space Fairness

The equity of urban green space is a dynamic process influenced by multiple factors such as urban development, population mobility, and policy adjustments. Therefore, establishing a long-term monitoring and evaluation system is crucial. This system should include regular data collection, analysis of changes in green space layout and usage patterns, and tracking surveys on residents' satisfaction with green spaces. Based on monitoring results, governments and planning departments should be able to flexibly adjust green space planning and management strategies to ensure the fair distribution of green space resources can adapt to new urban development needs and continuously improve the quality of life and sense of environmental justice for all residents.

In summary, future research and practice on the equity of urban green space should place greater emphasis on interdisciplinary collaboration, refined evaluation, targeted support for vulnerable groups, effective control of green gentrification, and the establishment of long-term dynamic adjustment mechanisms to achieve the fair, efficient, and sustainable use of urban green space resources.

7. SUMMARY

Justice is an unchanging pursuit of human society, and space is the venue, carrier, and foundation for all human activities. When space acquires a social attribute, it also means it has a close relationship with the justice of society, and the two can no longer be separated. To achieve sustainable urbanization, it is necessary to correct issues from the perspective of "people," such as "seeking quick results," "focusing solely on political achievements," and "ignoring the actual interests of the people." Every city must formulate reasonable methods and systems for the distribution of interests to ensure social fairness, justice, and reasonableness, so that the main bodies of each city can enjoy the benefits of urbanization, and urbanization can develop in a direction of continuously narrowing the gap in interests rather than reversing it. Enhancing the fairness of urban green spaces can strengthen community cohesion and promote community integration and understanding. Developing green spaces can drive the appreciation of property values in surrounding areas, boost local commercial activities, and stimulate local economic growth. A reasonable distribution of economic benefits can help narrow the economic gap within cities. Urban greening can help cities adapt to climate change and mitigate its effects. Properly allocating these resources can ensure that all ethnic groups can improve their climate adaptability. The fairness of green spaces is a core component of urban planning and management, and it is the foundation for building a healthy, harmonious, and sustainable development. Only by allowing all citizens to enjoy the benefits of urban greening can we enhance the welfare and fairness of the people.

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