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Landscape Design Activism——The integration of public participation, urban equity, and spatial innovation

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SUMMARY: *As urban ecological civilization advances rapidly, equity issues in urban landscape planning—a public welfare endeavor—have become increasingly prominent. This study constructs a multidimensional framework for landscape design activism by integrating public participation, urban equity, and spatial innovation, and evaluates landscape design's spatial accessibility and urban equity. The evaluation of social equity in urban parks employs three metrics: the Gini coefficient, Lorenz curve, and locational entropy. Spatial accessibility is analyzed using spatial syntax. Case study findings reveal that green space service levels are highest in medium-density areas within Points of Interest (POI), followed by low-density zones. High-density and extremely high-density areas exhibit lower service levels, with overlapping service ranges and concurrent service blind spots. The study area exhibits significant inequity in landscape green space service distribution and spatial accessibility, with a Gini coefficient as high as 0.85.*

KEYWORDS: *Gini coefficient; Lorenz curve; locational entropy; spatial syntax; landscape design; activism*

1 Introduction

China is a nation with profound cultural heritage, possessing its own unique systems and philosophies in landscape design [1]. With the advancement of globalization and diversification, on one hand, this has further propelled theoretical knowledge in China's urban landscape design [2]. On the other hand, influenced by globalization, contemporary Chinese urban landscape design tends toward “homogenization,” with some cities' landscape designs lacking regional distinctiveness [3, 4]. The overall landscape design of a city serves as a crucial cultural vehicle for expressing its image. Therefore, in the construction and design of urban landscapes, it is essential to deeply consider regional uniqueness, particularly integrating local historical and cultural characteristics [5-7].

Currently, industry designers and government officials have begun to address this issue, seeking to explore and utilize local culture by incorporating it into urban landscape design. Cultivating distinctive cultural and landscape features not only heightens public awareness of traditional ethnic heritage but also ensures the sustainable and orderly transmission and development of indigenous cultures [8-11]. As early as 2001, the book Introduction to Human Settlements Science advocated leveraging the originality of regional cultures [12]. Can cities effectively harness their unique historical and civilizational characteristics, applying them appropriately in urban development—particularly in landscape design—to incorporate local cultural elements in this era of globalization [13-15]? It is crucial to allow their cultures to be

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fully expressed and developed.

The theoretical foundation of urban landscape design planning research serves as the basis for innovation and the core for implementation in urban landscape design planning [16]. Reference [17] integrates socio-economic dimensions into urban metabolism, utilizing landscape design to reconstruct sustainable resource management models. Using the Central Liberian region as a case study, it promotes interdisciplinary dialogue through landscape design. Reference [18] explores the application of environmental perception and virtual reality technologies in urban landscape design, aiming to enhance scientific rigor, interactivity, and coordination to achieve dual improvements in design quality and efficiency. Literature [19] examines the role of urban landscapes in supporting municipal, ecological, and social systems, noting that combinations of native and non-native plant species can adapt to climate change while enhancing biodiversity and aesthetic value. Literature [20] introduces the concept of “Landscape Urbanism” and its development and application in modern urban planning, emphasizing its focus on integrating natural and built environments and its contributions to constructing ecological patterns and addressing climate change.

“Landscape” belongs to the realm of aesthetics. Originally a painting term describing depictions of natural scenery, it later acquired connotations of natural vistas and pastoral scenes. By adopting natural landscapes and pastoral views as models for garden design, the concepts of ‘landscape’ and “garden creation” became intertwined. Reference [21] examines the latest trends in modern urban landscape design, focusing on sustainability and cultural heritage preservation. It proposes a landscape design philosophy that integrates natural and cultural elements to enhance urban spaces while safeguarding their distinctiveness. Literature [22] explores the increasingly vital role of landscape architecture and design research in addressing the environmental impacts of rapid urbanization on cities and their surrounding areas. It proposes that ecological planning methods based on suitability analysis transform traditional design approaches that relied on designers' creativity and human needs. Literature [23] examines the relationship between territory and urban space, positing that territorial structure is a prerequisite for urban landscape design. It proposes landscape form design solutions for reconnecting discontinuous areas in cities such as Rome, Boston, and Bari.

The landscape environment encompasses both natural and built environments, possessing dual spatial and ecological attributes. Beyond the inherent ambiguity of its meaning, academia currently lacks a precise definition. It broadly refers to the spatial relationships and ecological characteristics formed by various natural and cultural landscape resources, or the aggregate of material landscape environments such as urban and rural landscapes. Reference [24] explores the application of geographic urban morphology in urban landscape design and details its practical implementation in an Auckland, New Zealand, urban design studio project aimed at enhancing the urban living environment. Reference [25] conducted a quantitative analysis of the relationship between urban landscape and urban vitality at the street block level across 15 major Chinese cities. It identified urban planning patterns, land use, and architectural forms as key factors influencing urban vitality. Reference [26] comprehensively elaborates on the roles of urban design, planning, and landscape architecture in the creation and intelligent development of cities, aiming to establish principles for sustainable development and efficient growth in smart cities.

This paper integrates public participation, urban equity, and spatial innovation to construct a multidimensional framework for spatial justice in green landscape design planning. This framework is grounded in distributive spatial accessibility, participatory spatial diversity and inclusivity, and capacitative spatial availability. Taking City H as the research subject, this study evaluates the accessibility and urban equity of landscape design. Specifically, the assessment of urban equity employs three indicators: the Gini coefficient, Lorenz curve, and locational entropy. For evaluating urban spatial accessibility in landscape design, five quantitative metrics from spatial syntax are utilized: global integration, local integration, connectivity, depth value, and synergy.

2 Integrative Innovation in Landscape Design Activism

2.1 Integration of Public Participation, Urban Equity, and Spatial Innovation

2.1.1 Public Nature

Publicness implies being communal and open rather than private and secluded. Within public spaces, social activities among individuals mutually influence one another, forming public relations. Publicness represents the collective characteristics exhibited by groups composed of diverse individuals. Public landscapes, then, are various visual scenes that can be presented within public spaces accessible to many people for participation and shared enjoyment. These landscapes not only exist within public spaces but also inevitably connect with the broader public. Thus, publicness is one of their most fundamental characteristics.

2.1.2 Participatory

Both Arendt and Habermas emphasized the importance of public participation in the public sphere as individuals. They both believed that the public spirit and consciousness embodied in the public sphere require public engagement, rational discourse, and deliberative negotiation to ultimately achieve consensus. For cities, the public landscape is shared by the public living within them; their consciousness and spirit form the core of public consciousness and public spirit. Therefore, the public landscape must be connected to the masses inhabiting the city.

2.1.3 Spatial Artistry

The spatial artistry of urban public landscapes encompasses several key aspects: Public landscapes must possess aesthetic value, for without it, their artistic foundation is undermined. They should align with the city's regional and cultural characteristics, embodying its core spirit. Public landscapes should reflect contemporary and societal progress while maintaining connections to historical legacies. They must exhibit distinctive character traits and provide both visual and spiritual enjoyment for people.

2.2 A Multidimensional Framework for Landscape Designism from an Environmental Justice Perspective

2.2.1 Distributionalism: Landscape Spatial Accessibility

From the perspective of landscape spatial planning and design, accessibility serves as the key indicator for measuring whether landscape spaces are equitably distributed. Accessibility generally assesses the ease with which landscape spaces can be approached. It is not merely a reflection of a location's geographic attributes; rather, it is the fundamental prerequisite for ensuring residents have fair and convenient access to the benefits of landscape spaces. As the basic measure for determining whether landscape resources are distributed fairly, imbalances in accessibility reveal inequities in landscape space allocation. "Over the past two decades, as awareness of the importance of urban landscape spaces to public health has grown, the imbalance in accessibility to urban landscape spaces has emerged as a significant environmental justice issue. “On the surface, disparities in urban landscape accessibility primarily manifest as physical accessibility gaps—that is, uneven geographical distribution of landscape spaces. However, from the perspective of landscape utilization efficiency, accessibility disparities also reveal inequalities in residents' ability to conveniently use these spaces, reflecting imbalances in effective accessibility.”

2.2.2 Participatory Approach: Inclusive Landscape Spaces

Participatory justice is fundamentally procedural justice. Effective landscape spatial planning is an open and inclusive process, with the core of procedural fairness being substantive public engagement. As the most direct means of identifying landscape spatial needs, public participation in landscape spatial planning design enhances the scientific rigor, precision, and transparency of governmental landscape planning. This is particularly achieved through consultative interactions that comprehensively understand residents' preferences and genuine needs, thereby preventing mismatches between landscape supply and public demand. Simultaneously, public participation facilitates public oversight of landscape planning, achieving a relative balance of interests among all parties and ensuring landscape planning and design maximally serves the public good. Achieving effective public participation requires adherence to two principles: First, establishing democratic planning procedures for public engagement by creating community-centered participation platforms that enable all stakeholders to engage in the planning process, providing equal opportunities for deliberation, information exchange, and consensus-building. Second, addressing the tension between fairness and efficiency in public participation by prioritizing fairness.

2.2.3 Meritocracy: Accessibility of Landscape Spaces

Landscape spatial planning and design should not only meet accessibility requirements but also focus on enhancing the quality of landscape spaces through design interventions. This aims to attract more people to use these spaces, thereby promoting health and well-being. In this regard, the framework for improving landscape space quality, termed the “Star of Availability” and proposed by scholars such as Mick Lennon, is illustrated in Figure 1. Building upon the concept of affordance proposed by American ecological psychologist James Gibson, this framework explores the usability of landscape spaces across six dimensions: space (e.g., topography), scale, time, objects or features (e.g., trees, benches, bike lanes), activities (e.g., hiking, jogging, birdwatching), and the physiological and psychological states of people related to these dimensions. This approach offers valuable insights. In summary, environmental justice demands not only equitable distribution and accessibility of landscape resources but also prioritizes “usability” design that empowers the majority to engage effectively. Particular attention must be given to addressing the landscape needs of marginalized groups whose limited capabilities place them at a disadvantage.

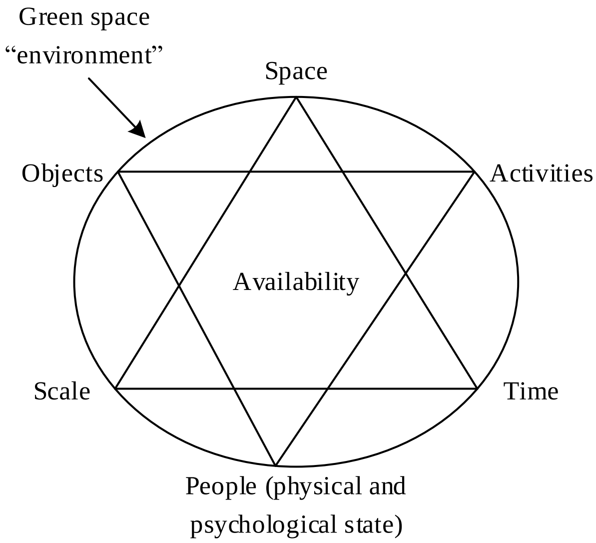


Figure 1: "Availability Star": Framework for improving the quality of green space

3 Quantitative Model for Landscape Design Activism

3.1 Urban Equity in Landscape Design

3.1.1 Buffer Analysis Method

Buffer zone analysis is a fundamental component of spatial analysis using GIS, serving as an effective method to describe the influence of specific objects on their surroundings and efficiently address spatial proximity issues. Simultaneously, buffer zone analysis is widely applied in fields such as meteorology, hydrology, fire analysis, and infrastructure development. This paper employs GIS technology to explore, on a quantitative level, the equity of park green space access among residents across different areas within the study region. Building upon buffer zone analysis, it integrates the Gini coefficient, Lorenz curve, and locational entropy analysis to provide a reliable foundation for subsequent research.

3.1.2 Gini Coefficient

The Gini coefficient is a commonly used indicator for measuring income equality. From the perspective of social equity, the fair and reasonable distribution of public resources shares certain similarities with income distribution. Consequently, in recent years, an increasing number of researchers have begun using the Gini coefficient to evaluate the fairness of public resource distribution among cities. It is primarily employed to quantitatively describe spatial variations in regional land use types. The formula for calculating the Gini coefficient is:

$$G = 1 - \sum_{k=1}^{n} (P_k - P_{k-1})(R_k + R_{k-1}) \tag{1}$$

Among these, P_k represents the cumulative proportion of population variables across residential areas, where $k = 0, \cdots, n$. $P_0 = 0$ and $P_n = 1$; R_k denotes the cumulative proportion of the effective service area for public green spaces, where $k = 0, \cdots, n$. $R_0 = 0$ and $R_n = 1$.

Taking the criteria of organizations such as the United Nations Development Programme as an example: a Gini coefficient below 0.2 indicates high equality; 0.2–0.29 indicates relatively equal; 0.3–0.39 indicates relatively reasonable; 0.4–0.59 indicates significant disparity; and above 0.6 indicates extreme disparity. Additionally, 0.4 serves as the “warning threshold” for income distribution inequality. According to the golden ratio principle, its precise value is 0.382.

3.1.3 Lorentz Curve

The Lorenz curve [27], like the Gini coefficient, is a commonly used indicator for measuring income equity. It provides a visual representation of fairness or inequity in distribution. It can quantify the proportion of park green space resources owned by a given percentage of the resident population and present this information graphically.

This study ranks all streets within the research area from highest to lowest based on their per capita park green space resources. Segmenting the data into 10% intervals, it calculates the proportion of park green space resources owned by each cumulative 10% of the resident population, thereby plotting the Lorenz curve.

In a Lorenz curve, the absolute equality line is a horizontal line at 45° where the XY-axis ratios are 1. Typically, the Lorenz curve exhibits an inward concavity; the closer it approaches the absolute equality line, the more equitable the resource distribution. Conversely, a deeper concavity indicates a more severe degree of inequality.

3.1.4 Location Entropy Analysis Method

Location entropy refers to the ratio of per capita park green space service resources available in different streets to the total per capita park green space service area within the entire study area. The calculation formula is:

$$LQ_i = (T_i / P_i) \div (T / P) \tag{2}$$

Here, LQ_i represents the locational entropy of a street, where i denotes the total number of streets within the study area; T_i indicates the total service area of various park and green space resources within street i; P_i signifies the resident population count in street i; T denotes the total park and green space service resources available across the five urban districts within the study area; and P represents the total population within the five urban districts under investigation.

In location entropy analysis, 1 is typically used as the standard value for comparison. If $LQ_i > 1$, it indicates that the per capita park green space service level within this spatial unit exceeds the overall average level of park green space services across all spatial units in the study area. If $LQ_i < 1$, it indicates that the per capita park green space service level in this spatial unit is below the overall level of park green space services available across all spatial units within the study area.

3.2 Spatial Innovation in Landscape Design

3.2.1 Spatial Syntax Concepts

Spatial syntax is a theory and methodology that studies the relationship between spatial organization and human society through quantitative descriptions of the structural patterns within human settlements, including buildings, villages, cities, and landscapes [28]. As an urban research paradigm, spatial syntax serves as a method for interpreting the unspoken laws embedded within space. The term “syntax” draws an analogy to “grammar” in language—meaning that spatial syntax refers to certain rules governing spatial composition. Just as the arrangement of words in a sentence is not random but follows grammatical rules to convey specific meaning, spatial syntax posits that space is also governed by logical relationships.

3.2.2 Spatial Syntax Model

Beyond serving as a theoretical framework, Spatial Syntax also offers a well-developed model analysis methodology. Grounded in graph theory and topology principles, Spatial Syntax constructs syntactic models using an entirely new spatial description approach, starting from human behavioral perception. It segments space into distinct regions based on spatial configuration forms, then integrates these topologically linked spaces to form Spatial Syntax models. The emergence of spatial syntax models has transformed traditional spatial modeling approaches by abstracting real spatial structures into topological frameworks. The advantage of spatial syntax models lies in their more intuitive results, facilitating easier comprehension of computational outcomes. To address diverse spatial configurations, spatial syntax theory proposes four distinct analytical models, enabling more precise descriptions of spatial structures.

3.2.3 Spatial Syntax Quantitative Indicators

Spatial syntax theory employs graph theory principles to conduct topological analysis of diverse spaces, transforming them into spatial syntax models through spatial configuration combinations. This process generates five quantitative indicators: integration, connectivity, depth, coordination, and control value. These five fundamental metrics have spawned syntax indicators such as average depth and global integration during spatial analysis and evaluation applications. Based on the research subject and spatial characteristics, the following five quantitative indicators were selected across the five research levels: Spatial Accessibility — Integration Spatial Connectivity — Permeability Spatial Penetration — Connectivity Spatial Hierarchy — Depth Value Spatial Perceptibility — Coordination Spatial Visibility — Line-of-Sight Integration

Global integration degree employs an infinite radius, examining spatial integration based on the city's entire spatial framework. It reflects the closeness of connections between spatial components and the overall space. Higher global integration indicates easier access to this space from other system components, signifying greater accessibility and stronger spatial integration. Local integration refers to the cohesive capacity among components within a defined range. Unlike global integration, local integration allows for varying study radii based on the research subject, thereby determining the degree of spatial clustering among nodes within different radius ranges. Higher local integration indicates stronger clustering capacity within that radius. Studies on spatial accessibility can be reflected through integration levels. Integration metrics are primarily used in subsequent research on accessibility at macro, meso, and micro levels.

$$Integration = \frac{n * n}{\sum_{i=1}^{n} d\theta(x,i)} \tag{3}$$

In the formula, Integration denotes the segment integration degree, n represents the total number of nodes within the search radius, and $d\theta(x,i)$ indicates the angular topological distance between space x and space i.

In spatial syntax theory, the depth value represents the minimum number of connections required for a given space to reach another space. In axis and segment models, the magnitude of the step distance within spatial groupings determines the depth value; in the field-of-view model, changes in human viewpoint within space and variations in viewing distance determine the depth value. A lower spatial depth value indicates fewer steps required for a node to reach all nodes within the same radius, signifying weaker spatial hierarchy. A higher depth value indicates more steps needed to reach all nodes within the same radius, corresponding to a more complex spatial structure, stronger spatial hierarchy, and lower accessibility of that space. The depth value is primarily used in subsequent studies at the meso-level. Its calculation formula is:

$$TD = \sum_{j=1}^{n} d_{ij} \tag{4}$$

In the formula: n denotes the number of node spaces, d_{ij} denotes the shortest number of steps from node space i to node space j.

The synergy coefficient is a correlation coefficient used to measure the relationship between global integration and local integration within spatial syntax parameters. In spatial organization, stronger spatial integrity indicates higher correlation between the overall space and its local components, resulting in higher synergy. Weak correlation between global and local integration—i.e., low synergy—signifies weak connections between the overall space and its local parts, indicating loose links between nodes and a disconnect between local and global elements. Synergy is primarily used in meso-level research as described below, calculated as follows:

$$R^2 \frac{\left[\sum (I_i - \overline{I}_\iota)(I_j - \overline{I}_J)\right]^2}{\sum (I_i - \overline{I}_\iota)^2 (I_j - \overline{I}_J)} \tag{5}$$

In the formula: I_i represents the global integration index, $\overline{I}_\iota$ represents the average global integration index, I_j represents the local integration index, and I_J represents the average local integration index.

In spatial syntax theory, connectivity denotes the number of spaces within a spatial configuration that intersect with the remaining spaces of the system. High connectivity indicates that a given space intersects with a larger number of other spaces, signifying higher permeability at that spatial node. Low connectivity indicates that a given space intersects with fewer other spaces, presenting a spatially isolated state. Connectivity is primarily used in the subsequent study at the meso-level. The formula for calculating connectivity is as follows:

$$C_i = k \tag{6}$$

In the formula, k denotes the number of connections associated with the i th spatial node.

4 Case Studies and Analysis

4.1 Case Study Area Selection

The study area encompasses the urban zone within the Fourth Ring Road of City H, covering a total area of 557.02 km². The overall distribution of green space exhibits a pattern of greater abundance in the east and lesser in the west. Green patches in the central urban area are small and scattered, while the eastern and western regions feature extensive park green spaces concentrated between the Third and Fourth Ring Roads, forming ring-shaped and strip-shaped distributions. Wedge-shaped protective green belts are located in the northeast and southwest areas of the Fourth Ring Road.

Urban green space data for the study area was extracted using October 2023 Amap as reference, with coordinate correction and other data processing applied. Combining street view image recognition with field surveys, and considering residents' green space needs for daily life and production, four categories were selected: park green spaces, plaza green spaces, protective green spaces, and ancillary green spaces. These comprise a total of 2,415 green space units covering 189.33 km².

POI data encompasses the geographic locations and attribute information of all spaces and facilities related to human production and daily life. Their spatial concentration is directly proportional to the production and living density of the surrounding area. Statistics show that within H City's Fourth Ring Road, there are 117,892 points of interest. Based on the city's diverse functions, these are categorized into: daily living services, business, education, public services, leisure and entertainment, and residential.

4.2 Analysis of Urban Equity

4.2.1 Spatial Distribution Characteristics of Landscape

(1) POI Density Distribution Characteristics

Points of interest within H City's Fourth Ring Road cluster in the urban core, as shown in Figure 2, exhibiting an overall density distribution that decreases in layers from the central urban area toward the outer ring districts. In the figure, dark green indicates extremely high-density zones, light green denotes high-density zones, pale green represents medium-density zones, and blank areas signify low-density zones. Their respective land areas are 17.28 km², 150.48 km², 86.34 km², and 50.17 km². Regarding the scale and density of POI clusters, areas beyond the Third Ring Road exhibit lower POI density, forming multiple small-scale hotspots. In terms of spatial distribution, eastern urban districts show higher POI density than southern districts, while northern districts have lower density than southern districts. Beyond the dense POI distribution in the city center, a multi-centered, concentric density pattern is gradually emerging in the outer ring districts.

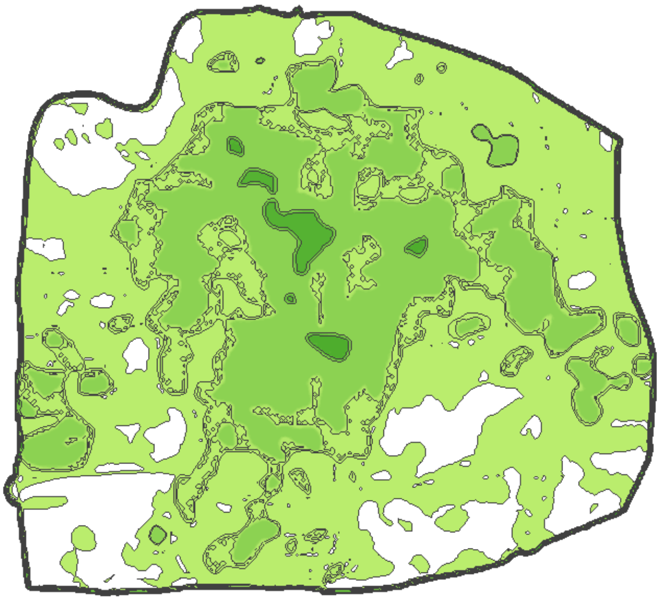


Figure 2: shows the density distribution of poi within the fourth ring road of H City

(2) Spatial Distribution Characteristics of Urban Green Space Recreation and Leisure Services

The spatial distribution characteristics of recreational services in H City's green spaces are shown in Table 1. Calculated at service radii of 410, 1120, and 2100 meters, the recreational service areas of urban parks cover 49.3, 83.06, and 143.65 km², respectively, encompassing 17.9%, 30.09%, and 52.04% of the study area. Additionally, 52.63 km² of green space service overlap exists, accounting for 21.17% of the total green space service area. Medium-density zones exhibit optimal park green space service levels, featuring moderately sized, evenly distributed green patches. Actual service coverage at different radii reaches 25.09%, 43.51%, and 69.82%, respectively, largely meeting the recreational needs of residents across diverse living spaces within these zones. In the ultra-high-density and high-density zones, the number of green patches is relatively low, primarily consisting of small-scale park green spaces, indicating lower accessibility to green spaces within these areas. Furthermore, within the 1120m service radius of urban parks and green spaces, the actual service coverage only extends to 19.52% of the extremely high-density zone and 19.26% of the high-density zone. Both density categories exhibit over 50% service blind spots. Consequently, there is a mismatch between the recreational and leisure service demands of residents in certain urban areas within Zhengzhou's Fourth Ring Road and the spatial distribution of park and green space.

Table 1: Statistical of recreation and entertainment service seope in POI density region

Then there's the heat type	410m		1120m		2100m	
	Service space /km	Occupying the proportion of the density area/%	Service space /km	Occupying the proportion of the density area/%	Service space /km	Occupying the proportion of the density area/%
High density area	3.15	13.22	4.17	24.85	8.24	47.09
High density area	14.57	7.81	28.54	19.16	59.61	41.33
Medium density area	22.84	25.09	37.07	43.51	60.77	69.82
Low density area	8.74	13.15	13.28	20.08	15.03	37.05
Amount to	49.3		83.06		143.65	

4.2.2 Overall Fairness Analysis

The Lorenz curve for park green space services is shown in Figure 3. The graph reveals significant disparities in the distribution of park green space services in City H, with pronounced polarization. Based on population segments, the top 10% of the population enjoys only 1.2% of park green space services. Even when the cumulative population reaches 90%, the cumulative share of park green space services reaches only 24.7%. The final decile (the top 10% of the population) commands a staggering 74.1% of park green space services, vastly exceeding the combined share enjoyed by the preceding 90% of the population. This reveals a pronounced disparity in access.

Using polynomial fitting, the Lorenz curve function for park green space services was obtained with the expression $y = 32.274x^5 - 66.11x^4 + 50.013x^3 - 13.154x^2 + 1.173x$, $p<0.01$, indicating good significance. Calculations show that the enclosed area of the Lorenz curve function for park green space services, i.e., Area II, is 0.1359. The sum of Areas I and II is 0.5, thus yielding a Gini coefficient of 0.85 for park green space services. Comparing this to the

United Nations classification standards for income distribution Gini coefficients, values exceeding 0.5 indicate a segment of resource distribution characterized by significant disparities. This indicates that the distribution of park green space resources across various subdistricts in City H is generally unfair.

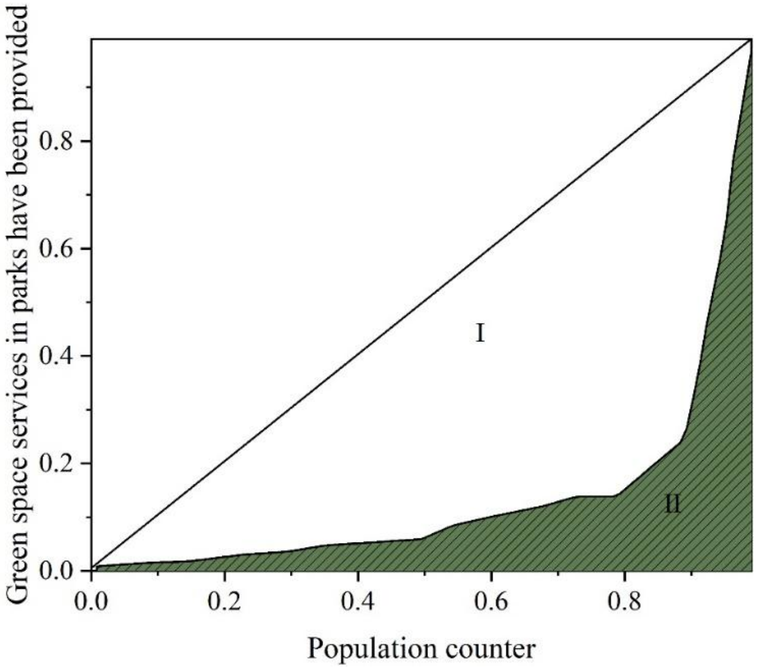


Figure 3: The Lorenz curve of park and green space services

4.2.3 Analysis of Overall Spatial Equity

Using the locational entropy calculation method, the locational entropy of park green space services for each subdistrict was computed and statistically analyzed, with results shown in Table 2. Jinshan Subdistrict recorded the highest locational entropy at 10.291, while the lowest subdistrict registered only 0.0317, indicating significant variation in park green space service locational entropy across H City's subdistricts. Subdistricts with park green space service location entropy below the standard value of 1 accounted for 77.23% of all subdistricts, indicating that the per capita access to park green space services in most subdistricts fell below the citywide average. Comparative analysis with statistical data on park green space service levels revealed that park green space service location entropy exhibited higher standard deviation and coefficient of variation, reflecting increased dispersion. This suggests greater disparity in park green space service location entropy across H City.

Table 2: Statistical results of location entropy of 14 street park green space

Least value	Crest value	Average value	Standard error	Coefficient of variation
0.0317	10.291	1.8736	2.7915	1.6925

The service location entropy of park green spaces across 43 subdistricts in City H is categorized as shown in Table 3. Among these, 16 subdistricts exhibit low or extremely low entropy, accounting for 37.21% of the total; 15 subdistricts show high or extremely high entropy, representing 34.88% of the total. The majority deviate from the normal range.

Table 3: Location entropy classification of green space service level in park

Grade	Location entropy	Number of units	the proportion of/%
Very low	<0.4	10	34.16
Lower	0.4-0.7	6	20.08
Secondary	0.7-1.3	12	15.12
Higher	1.3-2.0	7	6.93
Polar altitude	>2.0	8	23.71

4.3 Spatial Innovation Accessibility Analysis

4.3.1 Global Integration Analysis

Global integration refers to the relationship between a single axis and all other axes within a network. Its measurement requires traversing all linear elements in the network, as shown in Table 4. The global integration of Park A and Park C is relatively similar, but compared to Park B, both exceed Park B's global integration by more than double. The reason lies in their distinct layouts: Park A features a relatively regular overall design with strong local-to-global connections, high accessibility, balanced spatial tension, and relative homogeneity. Park C, as a memorial garden centered around a martyrs' shrine within the mausoleum complex, maintains a solemn and dignified atmosphere. Its formal layout exhibits symmetrical landscape nodes and a regular pattern. Park B, however, is naturally divided by urban roads into three distinct sections: East Garden, West Garden, and South Garden. Each section possesses its own unique character and exhibits flexible, varied organizational forms. Connections between key nodes require multiple spatial transitions, and the landscape features numerous winding paths. Consequently, the overall integration level is significantly reduced.

Table 4: Global integration of research object

Name of park	Average value	Crest value	Least value
Park a	115.64	181.12	50.16
Park b	79.21	122.33	46.77
Park c	160.37	248.57	76.33

4.3.2 Local Integration Analysis

Local integration refers to the relationship between an axis and other axes within a specific stride length. In geographical research, walking as a primary mode of transportation and its relationship with the built environment is a hot topic in urban geography. Jan Gehl's Human-Scale City proposes that a walking distance of approximately 500 meters is most acceptable to people, while the Manual on Traffic Engineering indicates that a walking distance within 1600 meters is optimal for pedestrians. Considering the study area's land coverage and boundary shape, four distance nodes—100m, 200m, 400m, and 800m—were selected for focused analysis within the local integration analysis radius, as shown in Table 5. It is evident that as the radius scale R in the line segment model increases, the park's local integration values rise and gradually approach the global integration level.

Table 5: Local integration of research object

Name of park	Value	R=100m	R=200m	R=400m	R=800m
Park a	Average value	24.21	36.63	62.95	97.08
	Crest value	50.71	91.64	124.01	180.23
	Least value	5.56	5.68	10.74	35.62
Park b	Average value	22.07	34.88	54.08	71.48
	Crest value	49.12	81.05	94.47	117.72
	Least value	5.23	6.67	18.65	35.89
Park c	Average value	22.18	46.73	102.38	155.73
	Crest value	45.23	98.62	231.15	246.82
	Least value	7.51	12.24	23.98	69.79

4.3.3 Connectivity Analysis

Connectivity refers to the number of intersecting axes along a given axis, reflecting the strength of spatial permeability. Higher values indicate tighter spatial connections. Axis connectivity is shown in Table 6. The table reveals relatively compact connectivity among paths within each park. Main thoroughfares exhibit higher connectivity values, while connections between clusters show lower values. Connectivity differences are minimal, with values distributed fairly uniformly. Connectivity peaks in Parks A, B, and C respectively.

Table 6: Connectivity of research object

Name of park	Average value	Crest value	Least value
Park a	3.92	12	1
Park b	3.67	11	1
Park c	3.82	9	2

4.3.4 Depth Value Analysis

The depth value refers to the number of steps from a local spatial unit to all other spatial units within the system, expressing the topological accessibility of the local space. A higher depth value indicates lower accessibility. Comparing the overall depth values of the three parks, as shown in Table 7, their average depth values exhibit a distinct gradient difference. Parks A and C both have lower depth values than Park B, indicating higher accessibility. Park B, due to its flexible overall layout and significant elevation differences within the park, has a relatively larger step depth.

Table 7: Depth value of research object

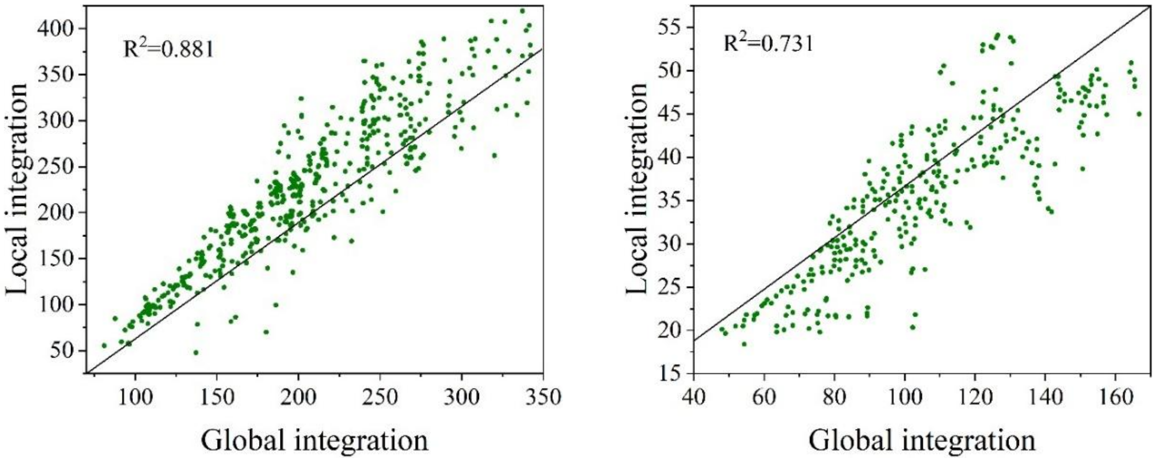
Name of park	Average value	Crest value	Least value
Park a	3628.69	7898.24	2151.28
Park b	4686.12	7727.91	2926.42
Park c	2878.12	5705.16	1733.59

4.3.5 Synergy Analysis

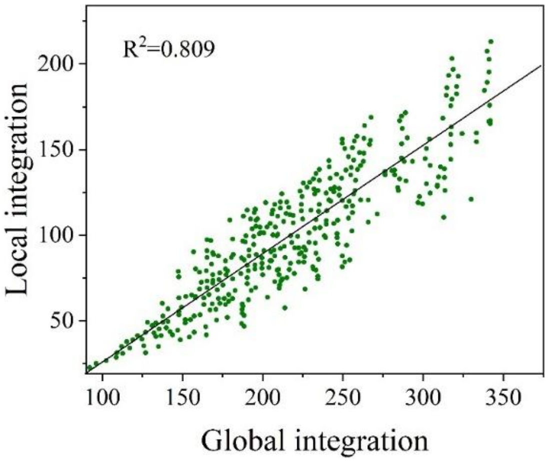
In spatial syntax theory, when R^2 is below 0.5, the horizontal axis is considered unrelated to the vertical axis. When R^2 exceeds 0.5, the horizontal axis is deemed related to the vertical axis. When R^2 reaches 0.7 or higher, a strong correlation exists between the horizontal and vertical axes, indicating a robust association between global integration and local integration.

Using global integration as the horizontal axis and local integration R=400m as the vertical axis, we analyze the coordination of spatial models.

The scatter plots for the three parks are shown in Figure 4. The figure indicates that Park A has a synergy coefficient of $R^2 = 0.881$, Park C has $R^2 = 0.731$, and Park B has $R^2 = 0.809$. It is evident that Park A's comprehensibility is comparable to Park C's, both exceeding that of Park B. The reason is clear: Parks A and C feature contiguous, integrated plots with relatively flat terrain, facilitating visitors' cognitive mapping. In contrast, Park B comprises three fragmented plots with significant elevation differences, making its local spaces difficult to recognize within the overall spatial context.



(a) Park a (b) Park b



(c) Park b

Figure 4: synergy of research object

5 Conclusion

This study uses City H as a case to construct a landscape spatial planning framework based on spatial accessibility for distributive justice, spatial diversity and inclusivity for participatory justice, and spatial availability for capability justice. It analyzes the scope of landscape services across different areas using POI data, Lorenz curves, and defined service radii, while also employing spatial syntax to quantify the accessibility of park spaces in City H. The results are as follows:

(1) Regarding the spatial distribution of urban green space services: medium-density areas > high-density areas > extremely high-density areas > low-density areas. Medium-density areas exhibit relatively reasonable distribution of green space services, with larger effective service areas for heat island mitigation, recreation, and disaster prevention. Other density zones show significant disparities in green space service distribution and insufficient service provision.

(2) The disparity in park green space service allocation in City H has decreased, with the Gini coefficient dropping to 0.85. While fairness has improved, it remains overall unequal, necessitating continued efforts to enhance equity.

(3) Park coordination ranks as Park A (0.881) > Park C (0.809) > Park B (0.731). Park A and Park B feature contiguous, integrated plots with relatively flat terrain, facilitating visitor spatial recognition. Park C comprises three fragmented plots with significant elevation differences, making localized spaces difficult to perceive within the overall spatial context.

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