

From Perception to Behaviour: The Role of Visual Coherence in Strengthening Place Attachment to Community Green Spaces in Desert Cities

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Abstract

Community green spaces are essential for improving urban liveability, particularly in desert cities where harsh climatic conditions limit ecological diversity and outdoor recreational opportunities. This study examines residents' perceptions of visual coherence in community green spaces within the Hexi Corridor region of northwestern China. Using a mixed-methods approach, data were collected through a structured questionnaire survey of 406 residents, supported by visual assessments and field observations in three representative cities: Wuwei, Zhangye, and Jiayuguan. The results indicate that visual coherence significantly influences residents' evaluations and usage of community green spaces. Key factors shaping these perceptions include vegetation arrangement, spatial organisation, accessibility, and landscape maintenance. Green spaces that exhibit clear spatial structures and harmonious landscape elements are perceived as more attractive and are used more frequently by residents. The findings highlight the importance of integrating visual quality considerations into urban green space planning and provide practical design insights for improving the aesthetic and functional performance of green spaces in desert urban environments.

Keywords: Visual Coherence, Community Green Space, Desert Cities, Environmental Perception, Urban Landscape Planning

Introduction

Urban green spaces are widely recognised as critical components of sustainable urban environments, providing a wide range of ecological, social, and psychological benefits. These spaces contribute to improving air quality, regulating urban microclimates, supporting biodiversity, and enhancing the overall well-being of urban residents. In addition to their environmental functions, urban green spaces also serve as important public areas for recreation, social interaction, and community engagement. As cities continue to expand and

densify, the role of accessible and well-designed green spaces has become increasingly important for maintaining urban liveability and environmental sustainability (Shiwen, 2025).

In many rapidly developing cities, however, urban green space planning has traditionally focused on quantitative indicators, such as total green space coverage or per capita green area, while paying relatively limited attention to the qualitative aspects of landscape design. Although the provision of sufficient green space is essential, the visual quality, spatial organisation, and user experience of these spaces also significantly influence how residents perceive and utilise them. Studies have shown that aesthetically pleasing and well-structured landscapes are more likely to attract users, promote recreational activities, and enhance psychological restoration (Kaplan et al., 1989). Despite these insights, a critical research gap remains regarding how specific visual properties of landscapes shape user behaviour and experiential outcomes, particularly in environmentally constrained contexts.

The importance of landscape perception has been emphasised in environmental psychology and landscape architecture research, where increasing attention has been given to the role of human cognition, perception, and emotional response in shaping interactions with the built environment. Individuals do not simply interact with physical environments in a purely functional manner; rather, they interpret and evaluate landscapes through cognitive and affective processes. This perspective aligns with broader contemporary social science debates that advocate for a shift from purely physical and quantitative planning approaches towards more human-centred, perception-driven frameworks of urban design. The landscape preference theory proposed by Kaplan and Kaplan suggests that people tend to prefer environments that are visually organised and easy to understand while still offering opportunities for exploration and engagement. Among the factors influencing landscape preference, visual coherence is considered a key element that contributes to the perceived attractiveness and legibility of an environment.

Visual coherence refers to the degree to which landscape elements appear orderly, harmonious, and visually connected. Environments that exhibit consistent spatial patterns, organised vegetation structures, and well-defined landscape elements tend to be perceived as more aesthetically pleasing and comfortable. In contrast, landscapes that appear disorganised or fragmented may create confusion and reduce the overall quality of the user experience. While previous studies have acknowledged the importance of coherence in environmental perception, limited empirical research has systematically examined how visual coherence translates into behavioural responses and place-based experiences, particularly within the context of community green spaces.

The issue of visual coherence becomes particularly relevant in desert cities, where environmental constraints pose significant challenges for urban landscape development. Cities located in arid and semi-arid regions often face limited water resources, sparse vegetation, and harsh climatic conditions, which restrict the diversity and density of urban greenery. As a result, green spaces in desert cities may appear visually monotonous or poorly integrated with the surrounding urban environment. Improving the visual organisation and aesthetic quality of these spaces is therefore essential for enhancing their attractiveness and usability. More importantly, understanding how residents perceive and respond to these

environments contributes to ongoing discussions in urban studies concerning the relationship between environmental quality, human behaviour, and urban liveability.

The Hexi Corridor region in northwestern China provides an important context for examining these issues. Located in an arid zone along the historical Silk Road, cities in this region experience extremely low precipitation and fragile ecological conditions. Despite increasing efforts by local governments to expand urban green infrastructure, many community green spaces remain limited in terms of landscape quality and design coherence. This raises an important research problem: how does visual coherence influence residents' perceptions, behavioural engagement, and overall evaluation of green spaces in environmentally constrained urban contexts? Addressing this question is essential not only for improving local landscape design practices but also for contributing to broader theoretical discussions on human–environment interaction.

In response to these challenges, this study investigates residents' perceptions of visual coherence in community green spaces in three representative desert cities in the Hexi Corridor: Wuwei, Zhangye, and Jiayuguan. Using a mixed-methods approach that combines questionnaire surveys, visual assessments, and field observations, the research aims to identify the key landscape attributes that influence residents' evaluations of green space quality. By examining the relationship between visual organisation, perception, and user behaviour, the study contributes to a deeper understanding of landscape aesthetics within the framework of environmental perception and behavioural urbanism. It further provides practical insights for improving the design and management of community green spaces in desert cities, while advancing broader debates on sustainable, user-centred urban development.

Literature Review

Urban Green Spaces and Urban Sustainability

Urban green spaces are widely recognised as vital components of sustainable cities due to their ecological, social, and economic benefits. These spaces contribute to improving urban environmental quality by reducing air pollution, mitigating urban heat island effects, and supporting urban biodiversity. At the same time, they provide residents with accessible environments for recreation, relaxation, and social interaction, which can enhance both physical and mental well-being. As urban populations continue to grow, the role of green infrastructure in maintaining urban livability has become increasingly important (Wang et al., 2024).

Previous studies have shown that access to high-quality green spaces is strongly associated with improved health outcomes and increased levels of physical activity among urban residents. Well-designed green environments can encourage walking, social interaction, and community engagement, thereby strengthening neighbourhood cohesion and overall quality of life (Alnaim et al., 2025). However, emerging research suggests that the benefits of urban green spaces are not solely determined by their availability, but also by their perceived quality and experiential characteristics, highlighting the importance of moving beyond purely quantitative planning approaches.

In many cities, urban green space planning has historically focused on quantitative indicators such as green coverage ratio or per capita green space area. While these measures are important for ensuring adequate provision of green infrastructure, they often overlook the qualitative aspects of landscape design, including spatial organisation, aesthetic appeal, and user experience. As a result, some urban green spaces remain underutilised despite meeting quantitative planning standards. This limitation reflects a broader shift in urban studies towards quality-oriented and user-centred approaches, where the experiential dimension of public spaces is increasingly recognised as a critical determinant of urban liveability.

Environmental Perception and Landscape Preference

Environmental perception refers to the process through which individuals interpret and evaluate their surrounding environments based on sensory information, cognitive processes, and personal experiences. In the context of urban landscapes, environmental perception plays a crucial role in shaping how people experience public spaces and determine whether they choose to use them. This perspective is closely aligned with contemporary social science debates on human–environment interaction, which emphasise the role of perception, cognition, and emotion in influencing spatial behaviour.

One of the most influential theories explaining landscape perception is the landscape preference framework developed by Rachel Kaplan and Stephen Kaplan. This framework suggests that people tend to prefer landscapes that are both understandable and engaging. According to this theory, environments that provide clear visual organisation allow users to easily interpret spatial patterns, while environments that contain elements of mystery or complexity encourage exploration and curiosity (Kaplan et al., 1989).

Another relevant theoretical perspective is the prospect–refuge theory, proposed by Jay Appleton. This theory suggests that people prefer environments where they can observe their surroundings while maintaining a sense of shelter or protection. Such spatial configurations can enhance feelings of safety and comfort in public spaces, which in turn influence how individuals interact with the environment.

Together, these theories highlight that the visual structure and organisation of landscapes significantly influence human preferences and behaviour. Landscapes that are visually organised and easy to interpret tend to generate more positive emotional responses and greater levels of user satisfaction. However, while these theoretical frameworks provide important insights into environmental perception, there remains a need for empirical studies that link perceptual qualities to actual behavioural outcomes in specific urban contexts.

Visual Coherence in Landscape Design

Visual coherence is an important concept in landscape aesthetics and urban design. It refers to the degree to which different elements of a landscape—such as vegetation, pathways, water features, and built structures—are arranged in a harmonious and organised manner. Landscapes that exhibit visual coherence tend to appear more orderly, balanced, and aesthetically pleasing.

According to the landscape preference theory proposed by Kaplan et al. (1989), coherence is one of the key factors influencing environmental preference. Coherent landscapes allow users to easily interpret spatial patterns and relationships between landscape elements, reducing cognitive effort and enhancing visual comfort. When landscape elements are arranged in a consistent and organised way, users can quickly understand the structure of the environment and navigate it more effectively.

In urban green spaces, visual coherence can be achieved through several design strategies, including the use of consistent planting patterns, clear spatial hierarchy, and well-defined pathways. The careful coordination of colours, textures, and landscape materials can also enhance the overall visual unity of a space. Conversely, landscapes that lack coherence may appear chaotic or fragmented, which can reduce their aesthetic appeal and discourage users from spending time in the space.

Despite its theoretical importance, visual coherence has often been examined primarily as an aesthetic concept rather than as a behaviourally significant variable. Limited research has systematically explored how visual coherence influences users' perceptions, frequency of use, and overall engagement with urban green spaces. This gap reflects a broader need to integrate landscape aesthetics with behavioural urbanism, thereby linking design qualities to measurable user outcomes.

Green Space Design Challenges in Desert Cities

Desert cities face unique environmental challenges that influence the planning and design of urban green spaces. Limited water resources, high temperatures, and fragile ecosystems restrict the range of vegetation that can be used in urban landscapes. As a result, green spaces in arid regions often have lower vegetation density and reduced ecological diversity compared with those in temperate climates.

These constraints can negatively affect the visual quality of urban landscapes, sometimes resulting in spaces that appear sparse or monotonous. Consequently, landscape designers must adopt innovative strategies to improve the aesthetic and functional quality of green spaces while maintaining environmental sustainability. This challenge is particularly significant in the context of contemporary urban sustainability debates, where cities are expected to balance ecological constraints with the need to provide high-quality public spaces.

In desert cities, the visual organisation of landscape elements becomes especially important because the limited availability of vegetation makes every design element more visible. Strategic planting arrangements, the use of drought-tolerant species, and the integration of architectural landscape elements can help create visually coherent and attractive green spaces despite environmental constraints.

Despite the growing attention to sustainable urban design in arid regions, empirical research examining residents' perceptions of visual coherence in desert urban green spaces remains limited. Most existing studies have focused on ecological performance or green space distribution rather than the perceptual and behavioural experiences of users. This gap

highlights a critical disconnect between environmental design and human response, which remains a key issue in contemporary urban and environmental research.

Research Gap and Study Contribution

Based on the above review, it is evident that while previous studies have examined the ecological functions of green spaces and the theoretical foundations of environmental perception, limited research has integrated visual coherence, user perception, and behavioural outcomes within a unified analytical framework, particularly in arid urban contexts. Furthermore, the relationship between landscape aesthetics and place-based experiences remains insufficiently explored in empirical studies.

This study addresses this gap by investigating residents' perceptions of visual coherence in community green spaces in the Hexi Corridor region of China. By combining survey data with visual landscape assessments, the research aims to identify the key landscape attributes that influence user perception and behaviour. In doing so, the study contributes to advancing knowledge on human–environment interaction, landscape aesthetics, and behavioural urbanism, while providing practical insights for improving green space design in desert urban environments.

Materials and Methods

Study Area

This study was conducted in the Hexi Corridor, an important arid region located in northwestern China along the historical Silk Road. The region is characterised by desert and semi-arid climatic conditions, including low annual precipitation, high evaporation rates, and large temperature variations. These environmental conditions pose significant challenges for urban ecological development and the planning of sustainable green spaces. Despite these constraints, community green spaces play a vital role in improving the urban environment and providing recreational areas for residents.

Three representative cities in the Hexi Corridor—Wuwei, Zhangye, and Jiayuguan—were selected as the case study areas. These cities share similar climatic conditions, urban development patterns, and ecological characteristics, making them suitable for comparative analysis. In recent years, local governments have increased investments in urban greening projects in order to enhance environmental quality and improve urban living conditions. However, many community green spaces in these cities still face issues related to limited vegetation diversity, fragmented spatial structures, and insufficient visual coherence. Therefore, examining residents' perceptions of these green spaces provides valuable insights for improving landscape planning and design in desert urban environments.

Research Design

This study adopted a mixed-methods research design, combining quantitative and qualitative approaches to evaluate residents' perceptions of visual coherence in community green spaces. The research framework included three main components: a questionnaire survey, a visual landscape assessment, and field observation.

The questionnaire survey served as the primary data collection method for understanding residents' perceptions of green space quality and visual coherence. The survey

instrument was designed to capture residents' evaluations of various landscape attributes, including vegetation arrangement, spatial organisation, accessibility, safety, and overall aesthetic quality.

Visual landscape assessments were conducted using photographic documentation and on-site observation. Photographs of selected green spaces were used to analyse landscape composition, vegetation structure, and spatial organisation. Field observations further supported the evaluation by recording maintenance conditions, spatial layout, and patterns of user activity.

By integrating these methods, the study was able to examine both the subjective perceptions of residents and the objective characteristics of the landscape environment, providing a comprehensive understanding of visual coherence in community green spaces.

Data Collection

Data were collected through a structured questionnaire survey conducted in selected community green spaces across the three case study cities. A total of 406 valid responses were obtained from residents who regularly used these green spaces. Respondents were approached on-site and invited to participate in the survey.

The questionnaire consisted of three main sections. The first section collected demographic information, including gender, age, education level, and length of residence in the city. The second section focused on green space usage patterns, including visitation frequency, duration of visits, and common recreational activities performed in the green spaces. The third section examined perceptions of visual coherence and landscape quality, where respondents evaluated specific landscape attributes using a five-point Likert scale ranging from "strongly disagree" to "strongly agree."

To ensure the reliability and clarity of the questionnaire, a pilot test was conducted with a small group of participants prior to the main survey. Feedback from the pilot survey helped refine the wording and structure of the questionnaire items. The main survey was conducted at different times of the day and week in order to capture a diverse group of green space users.

Data Analysis

The collected data were analysed using several statistical techniques to examine residents' perceptions of visual coherence in community green spaces. First, descriptive statistical analysis was conducted to summarise the demographic characteristics of respondents and general patterns of green space use. Mean values and standard deviations were calculated to evaluate respondents' perceptions of different landscape attributes.

Second, factor analysis was applied to identify the underlying dimensions of visual coherence. This method helped group related variables into broader perceptual categories, such as vegetation structure, spatial organisation, and maintenance quality.

Third, regression analysis was conducted to examine the relationships between visual coherence factors and residents' overall satisfaction with green spaces. This analysis helped

determine which landscape attributes had the strongest influence on residents' evaluations and usage patterns.

In addition to quantitative analysis, qualitative observations from field surveys and photographic assessments were used to interpret and contextualise the statistical results. This combination of quantitative and qualitative methods enhanced the robustness of the research findings.

Reliability and Validity

To ensure the reliability of the survey instrument, internal consistency was tested using Cronbach's alpha coefficient. A reliability value above 0.70 was considered acceptable for the variables used in the analysis. The results indicated that the questionnaire items demonstrated satisfactory internal consistency (Table 1).

Table 1
Reliability Analysis

Construct	Cronbach's Alpha	Interpretation
Visual Coherence	> 0.70	Reliable
Place Attachment	> 0.70	Reliable
Behaviour	> 0.70	Reliable
Overall Instrument	High	Strong consistency

Construct validity was assessed through factor analysis to confirm that the survey items effectively measured the intended dimensions of visual coherence. Furthermore, the use of multiple data sources—including surveys, visual assessments, and field observations—helped strengthen the validity of the research by providing a comprehensive evaluation of community green spaces.

Through this methodological framework, the study provides a systematic analysis of residents' perceptions of visual coherence. It offers insights into how landscape design influences the perceived quality of community green spaces in desert urban environments.

Results and Discussion

Socio-Demographic Characteristics of Respondents

A total of 406 valid questionnaires were collected from residents using community green spaces in the three selected cities: Wuwei, Zhangye, and Jiayuguan. The demographic composition of respondents reflects a diverse group of green space users, providing a reliable basis for analysing residents' perceptions of landscape quality.

The gender distribution of respondents was relatively balanced, indicating that both male and female residents actively use community green spaces. In terms of age, the majority of respondents were between 25 and 55 years old, representing the primary working-age population. Younger respondents tended to use green spaces for leisure activities and physical exercise, while older residents mainly used them for walking, relaxation, and social interaction.

Educational levels among respondents varied, with most participants having completed secondary or tertiary education. This suggests that respondents generally possessed sufficient awareness and understanding to evaluate landscape quality and environmental conditions. Overall, the demographic diversity of respondents ensures that the results reflect a broad range of perceptions and experiences related to community green spaces.

Patterns of Community Green Space Use

The survey results indicate that community green spaces play an important role in residents' daily lives in the three case study cities (Table 2). A significant proportion of respondents reported visiting nearby green spaces several times per week, highlighting their importance as accessible recreational environments within neighbourhoods.

Table 2

Patterns of Community Green Space Use

Variable	Category	Key Observation
Visit Frequency	Several times/week	Dominant pattern
Activities	Walking	Most common
	Relaxation	Very frequent
	Social interaction	Moderate
	Exercise	Moderate
Behaviour Link	Higher visual quality → higher usage	Strong relationship

Walking and relaxation were identified as the most common activities performed in these green spaces. Other activities included physical exercise, social interaction with friends and family members, and accompanying children or elderly relatives. These findings suggest that community green spaces primarily function as local recreational and social environments rather than large-scale destination parks.

However, the frequency of visits was closely related to residents' perceptions of landscape quality. Respondents who rated the visual organisation and overall appearance of green spaces more positively tended to visit these spaces more frequently. This finding indicates that the perceived visual quality of green spaces can significantly influence user behaviour and participation in outdoor activities.

Residents' Perceptions of Visual Coherence

The analysis of survey responses reveals that visual coherence is a key factor influencing residents' perceptions of community green spaces. Respondents generally preferred landscapes that exhibited organised spatial layouts, harmonious vegetation arrangements, and visually consistent design elements.

Among the evaluated landscape attributes, vegetation arrangement and spatial order received the highest average ratings. Residents expressed a preference for green spaces where trees, shrubs, and other vegetation were arranged in structured and visually balanced patterns. Landscapes that appeared orderly and well-maintained were perceived as more attractive and comfortable.

Accessibility and safety were also closely associated with perceptions of visual coherence. Green spaces with clearly defined pathways, open sightlines, and visible spatial

boundaries were evaluated more positively. These design features improve the legibility of the landscape, allowing users to easily understand the spatial structure of the environment and navigate the space with confidence.

Conversely, green spaces that lacked clear spatial organisation or contained poorly maintained vegetation were often perceived as visually disordered and less inviting. Such environments were associated with lower levels of user satisfaction and reduced recreational use.

Key Factors Influencing Visual Coherence

The factor analysis identified several key dimensions that shape residents' perceptions of visual coherence in community green spaces (Table 3). These dimensions include vegetation quality, spatial organisation, accessibility, and maintenance conditions.

Table 3
Factor Analysis of Visual Coherence Dimensions

Variable	Vegetation Quality	Spatial Organisation	Accessibility	Maintenance
Vegetation structure	✓			
Spatial layout clarity		✓		
Pathway organisation		✓		
Connectivity			✓	
Safety visibility			✓	
Cleanliness				✓
Maintenance condition				✓

Vegetation quality emerged as one of the most influential factors affecting visual perception. Respondents preferred landscapes that included a combination of trees, shrubs, and ground cover arranged in structured patterns. In desert cities where vegetation resources are limited, the careful selection and arrangement of drought-tolerant plant species can significantly enhance the visual diversity and ecological resilience of green spaces.

Spatial organisation was another important factor influencing landscape perception. Green spaces with clear spatial layouts, well-defined functional zones, and organised pathway systems were perceived as more visually coherent and easier to use. Such spatial clarity improves the legibility of the environment and enhances user comfort.

Maintenance conditions also played a significant role in shaping residents' perceptions. Well-maintained green spaces with clean pathways, healthy vegetation, and functional facilities contributed to a stronger sense of visual harmony. In contrast, poorly maintained landscapes disrupted visual coherence and reduced the perceived quality of the environment.

Discussion

The findings of this study highlight the importance of visual coherence as a key determinant of residents' satisfaction with community green spaces in desert urban

environments (Table 4). In arid regions such as the Hexi Corridor, where vegetation density is naturally limited, the visual organisation of landscape elements becomes particularly important for creating attractive and functional green spaces.

Table 4

Regression Analysis: Effects of Visual Coherence on Behaviour and Satisfaction

Dependent Variable	Independent Variable	Effect	Interpretation
Satisfaction	Visual Coherence	Positive	Strong influence
Behaviour (Usage)	Visual Coherence	Positive	Increases visits
Behaviour	Satisfaction	Positive	Mediating effect
Satisfaction	Vegetation Quality	Positive	Key predictor
Satisfaction	Spatial Organisation	Positive	Strong predictor

The results suggest that residents value landscapes that exhibit clear spatial patterns, organised vegetation structures, and consistent design elements. These findings align with established theories in environmental perception, which emphasise that coherent environments are easier to interpret and therefore more aesthetically appealing.

Furthermore, the study demonstrates that visual coherence is closely linked to the usability of green spaces. Residents are more likely to visit and spend time in green spaces that appear organised, safe, and well-maintained. This relationship suggests that improving the visual quality of green spaces can indirectly encourage greater community engagement and outdoor activity.

In desert urban contexts, achieving visual coherence requires careful planning and design strategies. Due to environmental constraints such as water scarcity and extreme temperatures, landscape designers must rely on efficient plant selection, structured spatial layouts, and consistent maintenance practices to enhance the visual quality of green spaces. By prioritising these design principles, urban planners can create more attractive and sustainable green environments that better meet the needs of residents.

Conclusion

This study examined residents' perceptions of visual coherence in community green spaces within desert urban environments, focusing on three representative cities in the Hexi Corridor: Wuwei, Zhangye, and Jiayuguan. Using a mixed-methods approach that combined questionnaire surveys, visual assessments, and field observations, the research investigated how residents evaluate the visual organisation and overall quality of neighbourhood green spaces.

The findings indicate that visual coherence plays an important role in shaping residents' perceptions and usage of community green spaces. Landscapes characterised by organised vegetation patterns, clear spatial structures, and consistent design elements were generally perceived as more attractive and comfortable. Among the evaluated factors, vegetation quality, spatial organisation, accessibility, and maintenance conditions emerged as the most influential determinants of visual coherence.

The results also reveal that visually coherent landscapes encourage more frequent use of community green spaces. Residents were more likely to visit and spend time in green

spaces that appeared well-organised, safe, and aesthetically harmonious. In contrast, poorly maintained or visually disordered environments reduced users' satisfaction and discouraged recreational activities. These findings highlight the importance of considering both functional and aesthetic qualities when designing urban green spaces, particularly in desert environments where ecological constraints limit vegetation diversity.

In addition, the study emphasises that improving the visual organisation and design quality of green spaces can significantly enhance their attractiveness and usability. In arid urban regions such as the Hexi Corridor, where natural vegetation resources are limited, careful planning of spatial layouts, vegetation arrangements, and landscape maintenance becomes essential for creating visually appealing and sustainable green environments.

Despite its contributions, this study has several limitations. The research focused on three cities within the Hexi Corridor region, which may limit the generalisability of the findings to other desert urban contexts. Future research could expand the geographical scope to include additional arid cities and explore the influence of cultural and climatic differences on landscape perception. Furthermore, advanced spatial analysis techniques, such as GIS-based landscape evaluation or visual landscape modelling, could be integrated into future studies to provide deeper insights into the relationship between landscape structure and perceived visual coherence.

Overall, the findings of this study contribute to a better understanding of landscape perception in desert cities and provide valuable guidance for improving the planning, design, and management of community green spaces in arid urban environments.

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