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Exploration of Factors That Reduce Residents' Willingness to Use Different Types of Urban Parks in Beijing

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Abstract

Urban parks are vital for enhancing residents' quality of life. With ongoing urban expansion, park visitation and quality expectations have risen, yet research on ecosystem disservices—i.e., the negative impacts of parks—remains limited compared with studies on ecosystem services. This study addresses this gap by investigating why residents may avoid parks, focusing on how negative perceptions vary across different park types. Through questionnaire surveys conducted in 68 parks across five categories in central Beijing, residents' concerns were analyzed. Findings show significant differences among park type: users of small neighborhood parks emphasized internal noise, infrastructure, and cleanliness; while users of medium and large regional park users prioritized safety risks, followed by landscape and infrastructure issues. Users of historically significant parks raised concerns related to overcrowding and plant emissions, while those of special theme parks highlighted issues related to the cultural or natural atmosphere. Accordingly, park renovation should adopt type-specific strategies rather than uniform approaches. Drawing on successful Beijing cases, targeted improvements and a sustainable business operation model are proposed to address funding limitations. These results align with China's park classification framework and offer insights for international urban park management, ultimately contributing to improved resident well-being and reduced urban inequality.

Keywords: urban parks; ecosystem services; ecosystem disservices; improvement measures

1. Introduction

The accelerating pace of global urbanization and continuous population growth are intensifying urban congestion. According to UN-Habitat, in 2021, over 56% of the global population resided in cities [1]. In megacities such as Beijing, the population density in 2025 has reached 1330 people per square kilometer [2]. Within such densely populated environments, there is an urgent need to enhance living standards and alleviate urban pressures.

Urban parks, characterized by extensive green spaces and recreational facilities, provide residents with venues for social interaction and physical activity while serving as vital spaces for connecting with nature [3]. They play a crucial role in stress reduction and mental restoration. However, over time, various factors can diminish their usability: plants may release pollen or damage infrastructure through root growth [4]; facilities deteriorate due to overuse; and overcrowding can increase interpersonal conflicts [5]. These issues collectively discourage park visits, reducing utilization rates and adversely affecting residents' well-being [6].

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In academic research, such adverse effects are referred to as ecosystem disservices (EDS) [7]. Contrary to the original purpose of parks—to promote happiness and relaxation among residents—these negative impacts hinder improvements in human well-being [8]. Vulnerable populations, including the elderly, children, and individuals with disabilities, are particularly affected, thereby exacerbating social inequality and impeding progress toward UN-Habitat's Sustainable Development Goals [9].

Given the limited availability of land for constructing new urban parks, it is crucial to upgrade existing parks by mitigating negative impacts and enhancing service capacity. Urban parks vary considerably in their functions and design focus [10]—some emphasize neighborhood amenities with abundant infrastructure, while others feature expansive landscapes and open squares for large-scale activities. Classification systems also differ internationally [11] (e.g., pocket parks and comprehensive parks in China; neighborhood and regional green spaces in the United States). Therefore, distinct park types are likely to exhibit different negative effects. Identifying the most significant issues associated with each type is essential for implementing targeted and effective improvements.

Against this background, the central thesis of this study is that ecosystem disservices in urban parks are not uniformly distributed but vary systematically according to park type, and that identifying these differences through empirical investigation can support more targeted and effective improvement strategies.

To test this proposition, the study addresses the following research questions:

RQ1: What are the major ecosystem disservices perceived by residents in different types of urban parks?

RQ2: Do significant differences exist in the intensity and structure of EDS across park categories?

RQ3: How can targeted management and renovation strategies be formulated based on these differentiated patterns?

RQ4: How can sustainable funding mechanisms support long-term improvement of urban parks?

To answer these questions, this study investigates 68 parks located in the central urban area of Beijing. First, existing EDS literature is reviewed to establish a conceptual framework. Second, park types closely associated with residents' recreational experiences are identified, forming the basis for questionnaire design. Surveys are widely distributed to collect residents' evaluations, and the data are analyzed using online SPSS analysis platform (https://spssau.net) to identify statistically significant differences among park categories. Finally, practical recommendations are proposed in accordance with the empirical findings.

By empirically examining EDS across multiple park types, this study contributes to the literature in three ways. First, it advances the operationalization of EDS from a predominantly theoretical concept toward a perception-based comparative analysis. Second, it provides evidence-based insights for improving existing parks in land-constrained megacities such as Beijing. Third, it offers a transferable analytical framework that may inform the management of government-led urban parks in other contexts, subject to local adaptation. Ultimately, the findings aim to enhance urban park performance, promote equitable access to high-quality green spaces, and improve residents' overall well-being.

2. Literature Review

EDS refer to the negative impacts of ecosystem functions or processes on human well-being, encompassing actual or perceived hazards, discomfort, or economic losses [12]. In contrast to ecosystem services, which highlight the benefits of natural systems, EDS emphasize the complex and sometimes detrimental interactions between humans and nature. These impacts may arise from inherent ecological characteristics or from human

management and utilization of the natural environment [13]. For instance, in urban contexts, tree roots can damage infrastructure [14], and certain plants may trigger allergic reactions [15]—both representing specific manifestations of EDS.

EDS occur in multiple forms, commonly categorized as health risks, economic costs, and aesthetic discomfort [16]. Additional categories include infrastructure damage, noise pollution, and elevated crime risk. Such impacts are influenced not only by ecological attributes but also by the quality of human management practices. Most academic frameworks classify EDS into four categories: ecological, health, economic, and social [16]. Some scholars have expanded this to six categories by including aesthetic impacts and constraints on urban planning [17].

2.1. Ecosystem Disservices Related to Ecosystem Properties and Human Health

One important category of EDS relates to the ecological characteristics of vegetation and biodiversity. Invasive species can threaten urban ecosystem stability and create management challenges. Some non-native plants spread rapidly, outcompete native vegetation, and disrupt ecological balance in urban green spaces. They may also trigger allergies or produce toxic substances affecting human health [18]. Consequently, invasive species can reduce biodiversity and influence residents' perceptions of safety and comfort.

Trees, a highly visible component of urban parks, can also generate ecosystem disservices. Large roots may damage sidewalks, underground infrastructure, and buildings, creating hazards and raising maintenance costs [19]. During extreme weather, falling branches or tree lodging pose risks, while accumulated leaves, fruits, and branches increase cleaning demands. Although natural, these processes may reduce park usability and perceived safety if unmanaged.

Biological emissions from vegetation are another concern. Certain plants release pollen, volatile organic compounds, or airborne particles that can cause allergies, respiratory issues, or other health problems [20]. Seasonal pollen emissions are particularly problematic in densely populated urban areas, making plant selection and vegetation management crucial for park design.

Water-related ecological issues can also contribute to EDS. Urban ponds, lakes, and wetlands may experience eutrophication from nutrient accumulation, causing water quality deterioration, odors, and harmful microorganisms [21]. Severe nutrient overload may trigger harmful algal blooms, degrading aquatic ecosystems and posing public health and recreational risks [22]. Such conditions reduce park attractiveness and discourage use.

Ecosystem disservices may also directly affect human health and safety. Wildlife such as insects, [23] snakes, or aggressive birds may pose risks [24]. Poorly maintained green spaces can increase crime opportunities, reducing residents' sense of security. [25] Stagnant water and dense vegetation can breed mosquitoes, increasing bites and vector-borne disease risks [26]. These examples show that human-ecosystem interactions are complex and require careful management.

Overall, ecosystem processes can provide benefits while causing negative impacts. Understanding these dual effects is essential for assessing residents' perceptions and designing strategies that minimize disservices while maintaining ecological functions.

2.2. Restrictions on Urban Aesthetic, Planning and Development

In addition to ecological and health-related impacts, ecosystem disservices may also influence the aesthetic quality and spatial functionality of urban environments. Urban parks are expected to provide visually pleasant landscapes and comfortable recreational spaces; however, certain ecological or environmental conditions may reduce their aesthetic appeal or limit their usability.

One common issue involves the deterioration of landscape quality. Poorly maintained vegetation, damaged facilities, or disorganized spatial layouts may create an unpleasant visual environment for visitors [27].

Noise pollution is another factor that may reduce the perceived environmental quality of urban parks. Although natural sounds such as birdsong or flowing water are generally considered beneficial, excessive or uncontrolled noise generated by wildlife, park facilities, or nearby traffic can cause discomfort to visitors and nearby residents [28]. Such conditions can reduce residents' satisfaction with park environments and negatively affect their willingness to spend time in these spaces. Similarly, excessive vegetation density or poorly planned plant arrangements may obstruct views and limit visual openness, making certain areas feel enclosed or unsafe [29]. When such disturbances become frequent, they may negatively affect the recreational experience and reduce the attractiveness of green spaces.

Ecosystem characteristics may also impose certain constraints on urban planning and development. For example, the presence of protected habitats or wetland ecosystems may restrict infrastructure construction or urban expansion in specific areas [30]. While such ecological protection measures are essential for environmental conservation, they may create conflicts between urban development needs and ecological preservation.

In some cases, environmental conditions within urban green spaces may also contribute to social problems. Poorly maintained or inadequately monitored green areas may become gathering places for illegal or antisocial activities, reducing residents' perceptions of safety [31]. In addition, strict conservation regulations implemented in certain parks may limit public access or restrict recreational activities, which may reduce residents' opportunities for leisure and outdoor exercise [32]. These planning and management constraints illustrate how ecosystem disservices can affect both spatial design and social use of urban parks.

2.3. Ecosystem Disservices Related to Economic, Social and Cultural Factors

Beyond ecological and spatial impacts, ecosystem disservices may also have economic, social, and cultural implications. The management and maintenance of urban green spaces require substantial financial resources, and ecological processes may increase the costs associated with park operation and infrastructure maintenance.

One significant economic concern involves the cost of maintaining urban green infrastructure. Activities such as tree pruning, pest control, landscape maintenance, and waste removal require continuous investment from municipal governments or park management agencies [33]. In addition, natural events such as storms or plant diseases may cause damage to park facilities and vegetation, further increasing maintenance expenditures.

Property damage caused by ecological processes also represents a potential economic burden. For example, falling branches, tree root expansion, or soil erosion may damage nearby buildings, vehicles, or public infrastructure [34]. Conservation-oriented green spaces may limit commercial development or tourism-related operations [35]. These incidents not only create financial losses but may also lead to legal disputes and compensation claims.

Ecosystem disservices may also influence social and cultural aspects of urban life. Cultural conflicts may arise when certain landscape elements or ecological features conflict with local beliefs, traditions, or aesthetic preferences [36]. For instance, some plant species or animal habitats may be perceived negatively due to cultural associations or superstitions. Furthermore, unequal distribution of high-quality green spaces across urban areas may exacerbate social inequality, as residents in disadvantaged neighborhoods often have limited access to safe and well-maintained parks [37].

Psychological responses to environmental conditions also play an important role in shaping residents' perceptions of ecosystem disservices. Certain spatial characteristics, such as overly dense vegetation, poorly lit pathways, or isolated park areas, may create feelings of discomfort, anxiety, or insecurity among visitors [38]. These psychological effects may discourage residents from using parks, even when the physical environment is otherwise suitable for recreational activities.

In summary, ecosystem disservices extend beyond ecological and environmental impacts, influencing economic costs, social interactions, and cultural perceptions. Recognizing these broader dimensions is essential for developing comprehensive urban park management strategies that balance ecological protection with human well-being.

2.4. Ecosystem Disservices Existing Research Methods

Research on EDS primarily employs qualitative analysis, remote sensing and geographic information system (GIS) techniques, and sampling-based approaches [39]. Each method offers distinct advantages and is suited to specific research contexts.

Qualitative analysis is one of the most frequently used approaches in EDS studies [40]. It typically involves collecting data through questionnaires, interviews, and literature reviews, allowing for an in-depth understanding of residents' perceptions and preferences regarding the urban natural environment. Remote sensing and GIS techniques are widely applied to evaluate and map the spatial distribution of EDS [30]. These methods enable researchers to identify the distribution of various tree species across cities and assess their influence on air quality with high spatial precision. Sampling analysis is mainly used to assess particular types of EDS [41], such as pollen allergies or noise pollution. For example, pollen concentrations can be measured using air sampling, whereas noise levels can be quantified through acoustic sampling.

Although existing research methods have contributed significantly to the assessment of EDS, several limitations persist [42]. First, while qualitative analysis provides valuable socio-cultural insights, it often lacks quantitative data, making large-scale comparison and generalization difficult [43]. Second, although remote sensing and GIS methods can accurately depict spatial patterns, they remain limited in their ability to evaluate complex ecosystem processes and functions comprehensively.

The study of EDS holds considerable importance for urban planning and residents' well-being. It enables a more holistic understanding of the relationship between urban ecosystems and human health. By identifying and evaluating EDS, urban planners can better balance the delivery of ecosystem services with the management of potential risks. Moreover, EDS research offers a scientific foundation for policy development, supporting decision-makers in formulating more effective strategies for urban greening and environmental protection. In addition, it contributes to promoting social equity by ensuring that planning and management initiatives address the needs and interests of diverse social groups [37].

3. Research Methods

3.1. Research Object

The central area of Beijing serves as the core functional zone of the capital, encompassing its political, cultural, international exchange, and scientific and technological innovation centers. It is also a key area for the protection of the city's historical and cultural heritage [44]. Due to its high population density and limited spatial resources, parks in this region face significant usage pressure. Their ability to maintain efficient public service delivery is closely linked to the health and well-being of a large portion of residents in the central urban area [45].

The study area focuses on the central urban region of Beijing, excluding the eastern and western districts, which are strongly influenced by political activities and subject to risk management and event control. During such periods, residents' park use is often restricted. Therefore, the specific research scope includes Haidian District, Chaoyang District, Shijingshan District, and Fengtai District, as illustrated in Figure 1.

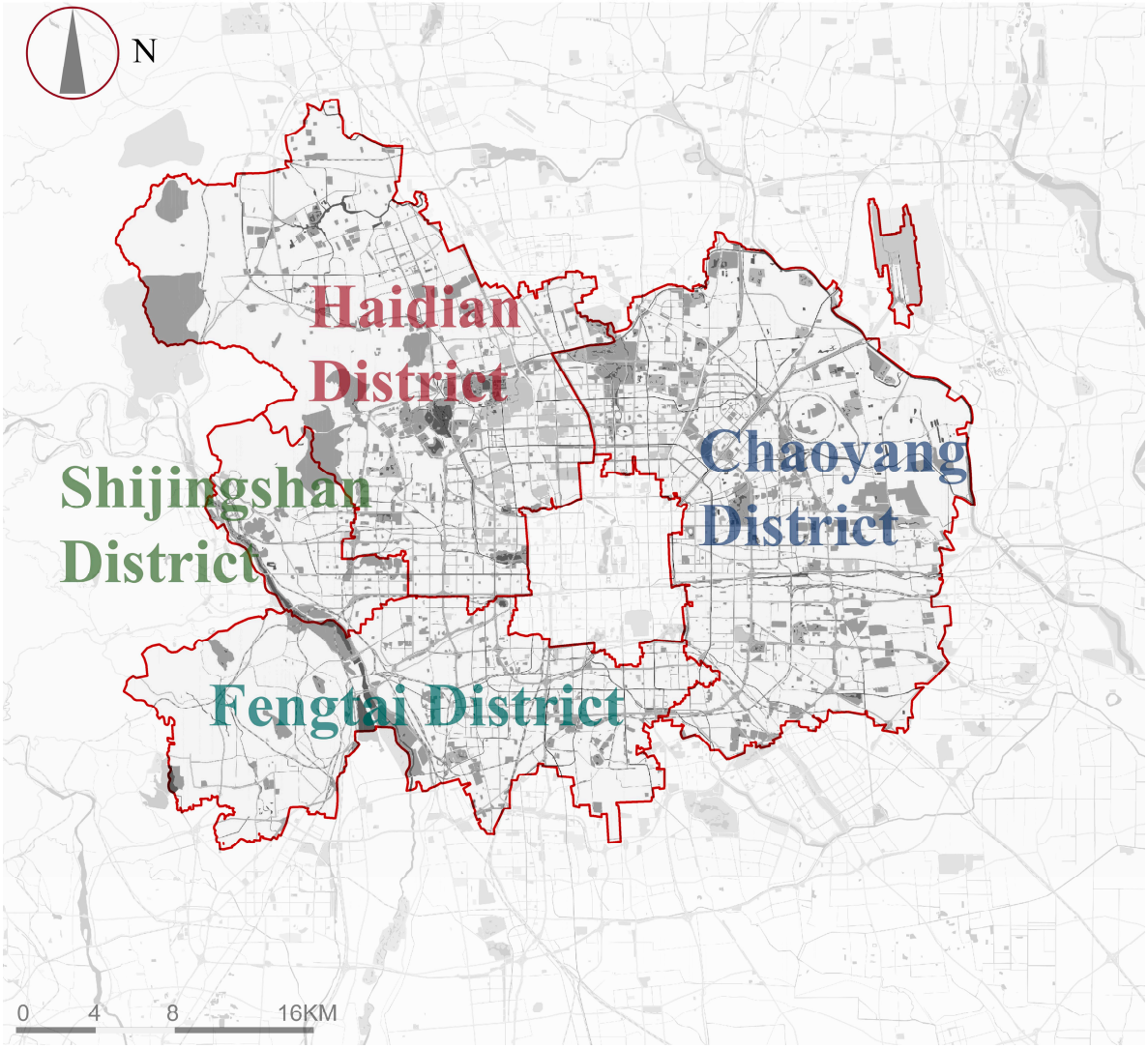


Figure 1. Study area.

To ensure representativeness and relevance to the research objectives, the following selection criteria were applied.

First, street green spaces and pocket parks were excluded due to their limited development scale and service capacity. Second, natural parks situated in remote locations, which are inconvenient for daily visits, were also omitted. Third, parks with significant political importance, such as the Olympic Forest Park and the Summer Palace, were excluded to avoid bias associated with restricted accessibility. Finally, only parks classified as Grade I or II [46] were included. These encompass comprehensive parks, community parks, historic parks, and specialized parks—types that are well-known, frequently used, and effectively reflect typical urban park challenges.

Baseline park information was obtained from the official website of the Beijing Municipal Bureau of Landscape and Greening [46]. Grade I and II parks are recognized for their exemplary functionality and high construction standards. Historic parks refer to gardens

with exceptional historical, cultural, ecological, or scientific value that have influenced urban development or artistic culture. Community parks are equipped with essential service facilities and activity spaces, primarily serving nearby residents for everyday recreation, emphasizing children's play and elderly fitness. Comprehensive parks offer multifunctional facilities and diverse content, supporting activities such as sightseeing, recreation, education, and sports. Specialized parks feature distinctive themes or notable cultural or natural value, with corresponding recreational and service facilities. For this study, specialized parks were further subdivided into *humanities-type* and *nature-type* to enhance the generalizability of findings across different park classification systems.

The specific parks and their locations are listed in Tables 1–4, and their spatial distribution is shown in Figure 2.

Table 1. Research sites in Chaoyang district.

Serial Number	Type	Park Name
1	Historic Garden	Ritan Park
2	Community Park	Wangjing Park
3		Wangcheng Park
4		Lishuiqiao Park
5		Sun Palace Garden
6		Wangjing Sports Park
7		Yangshan Park
8		Dongyichu Park
9		Rosewater Park
10	Special Park (Humanities)	Dongba Park
11		Sun Palace Park
12	Special Park (Natural)	Beijing Pear Garden
13		Sophora Japonica Garden in Beijing
14		Changying Park
15		Guanzhuang Park
16		Beijing Forest Park
17	Comprehensive Park	Dawangjing Park
18		Wanghe Park
19		Guta Park
20		Chaoyang Park
21		Tuanjie Lake Park
22		Side Park
23		Qingfeng Park
24		Beixiaohe Park
25		Xinglong Park

Table 2. Research sites in Fengtai district.

Serial Number	Type	Park Name
26	Historic Garden	Lotus Park
27	Community Park	Fengtai Science Park Ecological Theme Park
28		Shiliuzhuang Park
29		Fengyi Park
30	Special Park (Humanities)	Nangong World Geothermal Expo Park
31		Beijing World Park
32	Special Park (Natural)	Yukang Country Park
33		Beijing World Flower Garden
34		Green Causeway Country Park
35	Comprehensive Park	Fengtai Garden
36		Nanyuan Park

Table 3. Research sites in Haidian district.

Serial Number	Type	Park Name
37	Historic Garden	Yuyuantan Park
38		Zizhuyuan Park
39	Community Park	Shangdi Park
40		Sunshine Sunday Park
41		Changchun Fitness Park
42		BAGOU Landscape Garden
43		Yinghulou Park
44		Nanchanghe Park
45		Dinghui Park
46		Wangzhuang Park
47	Special Park (Humanities)	Beijing Zhangjiakou Railway Ruins Park
48		Zhongwu Park
49		Wukesong Olympic Cultural Park
50		Yuandadu Ruins Park
51	Special Park (Natural)	Dongsheng Bajia Country Park
52		Tayuan Urban Forest Park
53		Baiwangshan Forest Park
54		Danqingpu Country Park
55	Comprehensive Park	Haidian Park
56		Beiwu Park
57		Madian Park
58		Linglong Park

Table 4. Research sites in the Shijingshan district.

Serial Number	Type	Park Name
59	Historic Garden	Badachu Park
60	Community Park	Gucheng Park
61	Special Park (Humanities)	Beijing International Sculpture Park
62		Shijingshan Sculpture Park
63		Beijing Shijingshan Amusement Park
64		Laoshan City Leisure Park
65	Special Park (Natural)	Yongding River Leisure Forest Park
66		Yamenkou Urban Forest Park
67	Comprehensive Park	Xiaoqingshan Park
68		Xin'an Park

According to the official statistics published by the Beijing Municipal Bureau of Landscape and Greening, Beijing currently contains a large number of public parks with diverse functions and spatial scales. However, only a portion of these parks meet the criteria of Grade I or Grade II classification and are widely used by residents for daily recreational activities.

In this study, 68 parks located in the central urban districts were selected based on the criteria described above. These parks represent the major functional categories defined in Beijing's park classification system, including comprehensive parks, community parks, historic parks, and specialized parks. By covering multiple park types with varying spatial scales, functional orientations, and visitor characteristics, the selected sample captures a substantial portion of the variability within the urban park system of central Beijing.

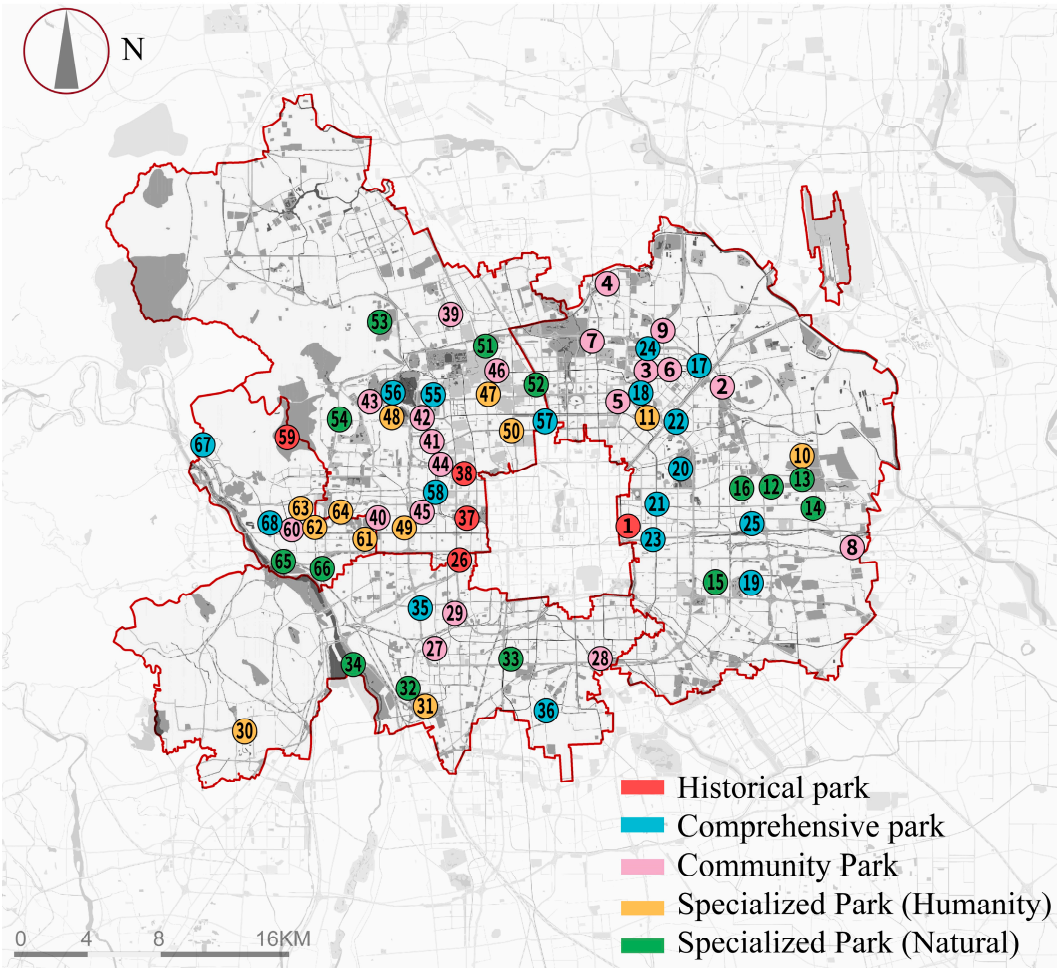


Figure 2. Distribution of research objects.

Although the selected parks do not represent the entirety of Beijing's park system, they include the most frequently used and publicly accessible parks in densely populated urban districts. Therefore, the sample provides a meaningful basis for analyzing residents' perceptions of ecosystem disservices associated with different types of urban parks.

3.2. Research Methods

This study employs a combination of questionnaire survey and literature review methods. By systematically reviewing and analyzing existing literature, we preliminarily identified the potential types of EDS that may occur in urban parks, as well as the applicable contexts of current research methodologies. When selecting EDS indicators, only those directly related to residents' on-site experiences—such as noise, water pollution, and pollen exposure—were included. Indicators that are less perceptible to park users, such as species invasion or economic loss, were excluded, as these have minimal influence on residents' willingness to continue using the park. The selected indicators were then refined and clearly redefined to ensure conceptual independence and comprehensive coverage of all possible negative experiences encountered by residents during park visits. Each indicator was designed to be distinct and non-overlapping, collectively encompassing the full range of negative impacts likely to affect park users.

The final set of indicators used for the questionnaire analysis is presented in Table 5.

Table 5. Literature-based ecosystem disservice indicators affecting residents' park use.

Analysis Index	Index Connotation	Literature source
Noise impact	Noise from vehicles, creatures, or equipment causing public annoyance	Yildirim et al., 2022 [28]
Psychological oppression	Inadequate nighttime lighting, enclosed spaces, or visual clutter creating nervousness or depression	Hui et al., 2022 [38]
Potential environmental harm	Physical hazards, such as sharp edges, thorny plants, or uneven ground leading to injuries	Veibiakkim et al., 2025 [16]; Azmy et al., 2016 [24]; Elmqvist et al., 2013 [25]
Unpleasant smell	Pungent odors from garbage, sewage, or animal waste affecting psychological well-being	Cariñanos et al., 2020 [20]
Water pollution	Turbid, foul-smelling water with debris, breeding mosquitoes and posing disease risks.	Wood, L.E. et al., 2022 [21]
Insect bite	Mosquito gatherings and bites in the evening, causing discomfort and potential disease	Barnes et al., 2020 [26]
Biological metabolite emissions	Pollen and catkins from plants causing allergies, diseases, and air pollution	von Döhren et al., 2022 [15]
Visual field limitation	Stained grounds or obstructed views, weakening aesthetic value and attraction	Oosterbroek et al., 2023 [29]
Personal behavior restricted	Unreasonable regulations or closures restricting free activities and flexibility of use	Baumeister et al., 2022 [32]
Unsatisfactory landscape	Monotonous and obsolete landscapes failing to meet aesthetic and leisure needs	Drillet et al., 2020 [27]
Lack of Infrastructure	Lack of essential service facilities (e.g., benches, trash cans, and signs) leading to a poor experience	Ala-Hulkko et al., 2019 [30]; Duinker et al., 2015 [33]
Infrastructure damage	Damaged service facilities not being repaired promptly, preventing normal use	Drew-Smythe et al., 2023 [19]
Cultural conflict	Spiritual meaning of landscapes or structures conflicting with residents' thoughts or beliefs	Skryhan et al., 2021 [36]
Crowd crowding	Overcrowding, narrow passages, and insufficient emergency evacuation capacity during peak hours	Zhou et al., 2023 [5]; Pistón et al., 2022 [37]

The evaluation indicators used in this study were derived from the ecosystem disservices (EDS) identified in the literature review. Previous studies have documented a wide range of negative ecosystem impacts associated with urban green spaces, including ecological disturbances, environmental pollution, safety risks, and management-related problems (citations remain as in the literature review).

However, not all ecosystem disservices directly affect residents' recreational experiences in urban parks. Therefore, this study focuses specifically on those EDS that can be directly perceived by park users during their visits. Indicators that primarily affect macro-level urban development (e.g., broader economic or institutional impacts) were not included in the questionnaire design.

Based on this principle, the indicators presented in Table 5 were selected from the literature and adapted to reflect the perceptible negative impacts experienced by park visitors. Each indicator represents a specific type of ecosystem disservice that can influence residents' willingness to use urban parks, such as noise disturbance, poor environmental quality, safety concerns, or management-related issues.

To ensure clarity and consistency in the questionnaire, each indicator was accompanied by a concise explanation (index connotation), describing the specific phenomenon represented by the indicator. These descriptions were designed to help respondents understand the meaning of each item and provide consistent evaluations.

As shown in the literature review, quantitative research on EDS remains relatively underdeveloped; therefore, a qualitative questionnaire approach was adopted [47]. Through

concise questions and large-scale data collection, this method enables an objective reflection of the issues perceived by residents in different parks. The questionnaire items were derived from the types of disservices summarized in prior research.

3.3. Research Steps

3.3.1. Questionnaire Design

The questionnaire was designed in two sections. The first section gathered basic demographic information, while the second focused on specific negative effects associated with park use. The specific questions and option settings of the questionnaire are shown in Appendix A.

The first section included only general demographic variables without collecting any personal or sensitive information. It comprised five questions related to gender, age, education level, occupational status, and the park most frequently visited or known by the respondent. This ensured that the final dataset represented a diverse range of age groups, professions, and educational backgrounds.

The second section investigated residents' perceptions of 14 types of negative effects identified through an extensive literature review. The aim was to identify prominent EDS patterns across different urban park types in central Beijing, based on residents' collective feedback. These 14 perception dimensions are listed in Table 6.

Table 6. Survey design for negative impact perception.

Title Number	Corresponding Number	Negative Effect	Questioning Methods
1	D1	Noise impact	Can you feel the noise in the park you often use?
2	D2	Psychological oppression	Do you feel psychological oppression in the park you often use?
3	D3	Potential environmental harm	Are there any safety hazards in the park you often use?
4	D4	Unpleasant smell	Can you smell the pungent smell in the park you often use?
5	D5	Water pollution	Is the water in the park you often use clean?
6	D6	Insect bite	Will you be bitten by mosquitoes in the park you often use?
7	D7	Biological metabolite emissions	Are there any plants scattered with pollen or catkins in the park you often use?
8	D8	Visual field limitation	Does the park you often use restrict personal behavior?
9	D9	Personal behavior Restricted	Is there any visual obstruction in the park you often use?
10	D10	Unsatisfactory landscape	Is the park scenery you often use in line with public aesthetics?
11	D11	Lack of Infrastructure	Is the infrastructure in the park you often use complete?
12	D12	Infrastructure damage	Is the infrastructure in the park you often use maintained in time?
13	D13	Cultural conflict	What is the cultural conflict in the park you often use?
14	D14	Crowd crowding	How crowded is the park you often use?

The questionnaire was designed to measure residents' perceived intensity of different ecosystem disservices in urban parks. Each indicator was evaluated using a Likert-type rating scale, allowing respondents to rate the perceived severity of each negative impact. [48], where 1 = slight or none, 2 = small, 3 = average, 4 = large, and 5 = serious. Respondents evaluated each indicator according to their personal experience. The mean score of each item (i.e., the total score divided by the number of respondents) was later used to analyze the relative impact of different EDS categories across parks. To ensure clarity and ease of understanding, the phrasing of each question and response option was adjusted for context during questionnaire preparation. For instance, when assessing noise pollution, the response options were expressed as: "cannot hear", "occasional noise", "moderate noise", "often hear noise", and "frequent noise". Similar contextual refinements were made for other indicators.

The questions presented in Table 6 were directly derived from the indicator framework shown in Table 5. Each question corresponds to one evaluation indicator and translates the conceptual indicator into a measurable survey item.

This approach ensures consistency between the theoretical framework (ecosystem disservices identified in the literature) and the empirical data collected through the questionnaire.

3.3.2. Questionnaire Distribution and Collection

The questionnaire was distributed via the online platform *Questionnaire Star* from 2 August 2025, to 17 September 2025, using shared links circulated through social media and chat applications. All responses were collected in real time to ensure data quality. To enhance sample diversity and reach, students, colleagues, and volunteers were invited to share the questionnaire link within their social circles.

A total of 1785 responses were received through the online system. After quality screening, 1673 valid samples were retained (112 random or incomplete questionnaires were excluded), achieving an overall valid response rate of 93.4%. The resulting dataset provides a comprehensive, multi-dimensional reflection of residents' perceptions and establishes a solid foundation for subsequent empirical analysis.

It should be noted that the questionnaire was distributed primarily through online platforms and social networks, which may introduce a degree of self-selection bias. Individuals who are more active on digital platforms are more likely to participate in such surveys, which may result in the overrepresentation of younger respondents and students. This tendency is reflected in the demographic structure of the sample, where students constitute a relatively large proportion of participants.

Nevertheless, the survey still includes respondents from a wide range of age groups and occupational backgrounds. While the potential bias should be acknowledged, the sample size and diversity provide a valuable overview of residents' perceptions regarding ecosystem disservices in urban parks.

Given that ecosystem disservices are often experienced subjectively by park users, perception-based survey methods are widely used to evaluate their impacts on residents' park use.

Due to the complexity and context-specific nature of ecosystem disservices, existing quantitative models for evaluating such impacts remain relatively limited. Therefore, this study adopts a perception-based quantitative approach using large-sample survey data to improve the reliability of the results.

The collected responses were aggregated using a weighted average method to calculate the perceived intensity of different ecosystem disservices across park categories. This approach allows the study to identify the relative strength of different negative impacts based on residents' evaluations.

3.3.3. Data Aggregation

To evaluate the perceived intensity of ecosystem disservices (EDS) across different urban parks, a two-level aggregation procedure was applied.

At the individual park level, the intensity score of each ecosystem disservice indicator was calculated as the arithmetic mean of all responses collected in that park. Respondents rated each indicator using a Likert-type scale. The park-level score was obtained by summing all individual responses and dividing by the total number of respondents in that park:

$$\bar{x}_i = \frac{\sum_{j=1}^{N_i} x_{ij}}{N_i}$$

where

$\bar{x}_i$ represents the mean score of a specific indicator in park i

x_{ij} is the score given by respondent j

N_i is the number of valid questionnaires collected in park i

This value represents the perceived intensity of a given ecosystem disservice in each park.

Because the number of respondents differed among parks, a weighted average method was applied to calculate representative scores for each park category. In this approach, the park-level mean score was weighted by the number of respondents in that park. The category-level score was calculated as:

$$EDS_c = \frac{\sum_{i=1}^{n}(\bar{x}_i \times N_i)}{\sum_{i=1}^{n} N_i}$$

where

EDS_c represents the overall intensity score of a given ecosystem disservice for park category c

$\bar{x}_i$ is the mean score for park i

N_i is the number of respondents in park i

n is the number of parks belonging to category c

This weighted aggregation ensures that parks with larger sample sizes contribute proportionally to the category-level score, thereby minimizing distortions caused by unequal respondent distributions.

The primary objective of the analysis is to identify and compare the perceived intensity of ecosystem disservices across different types of urban parks. The results therefore focus on descriptive comparisons of weighted mean scores across park categories. Given the perception-based nature of the questionnaire and the large sample size (1673 valid responses), the study aims to characterize overall patterns of perceived ecosystem disservices rather than to test causal relationships or statistically significant differences between park categories. Consequently, inferential statistical tests such as MANOVA or cluster analysis were not applied. The analytical framework prioritizes the interpretation of perception intensity and relative differences across park types.

The number of valid questionnaires collected in each park varied depending on visitor flow and on-site participation willingness. As a result, the number of respondents per park ranged from 3 to 5 in parks with limited visitation to as many as 187 in highly frequented parks. This variability reflects the actual distribution of park users during the survey period rather than a predetermined quota sampling design.

3.3.4. Variability Calculation

To assess variability among parks within the same category, the standard deviation of park-level mean scores was calculated. This measure reflects the dispersion of indicator values across different parks and provides additional information beyond aggregated mean values. The standard deviation was calculated as:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(\bar{x}_i - \mu)^2}{n-1}}$$

where

SD represents the variability among parks

$\bar{x}_i$ is the mean score for park i

μ is the aggregated mean score for the corresponding park category i

n is the number of parks within that category

The calculated standard deviations were used to visualize variability in the results, presented as error bars in the figures. This approach enables comparison of dispersion patterns across park categories while maintaining consistency in data aggregation.

Given the use of a 5-point Likert scale, the observed standard deviation values indicate moderate variability across parks and suggest a stable distribution of responses. This level of variability is considered appropriate for perception-based data and supports the reliability of the aggregated results. The results will be presented in the following figures.

4. Results and Discussion

4.1. Results

1. Gender distribution characteristics

The gender composition of the valid sample indicates that female participants accounted for 52.4%, while male participants represented 47.6%, as shown in Figure 3a. This near-equitable distribution demonstrates a balanced gender ratio, with a slight predominance of female respondents but no significant structural deviation.

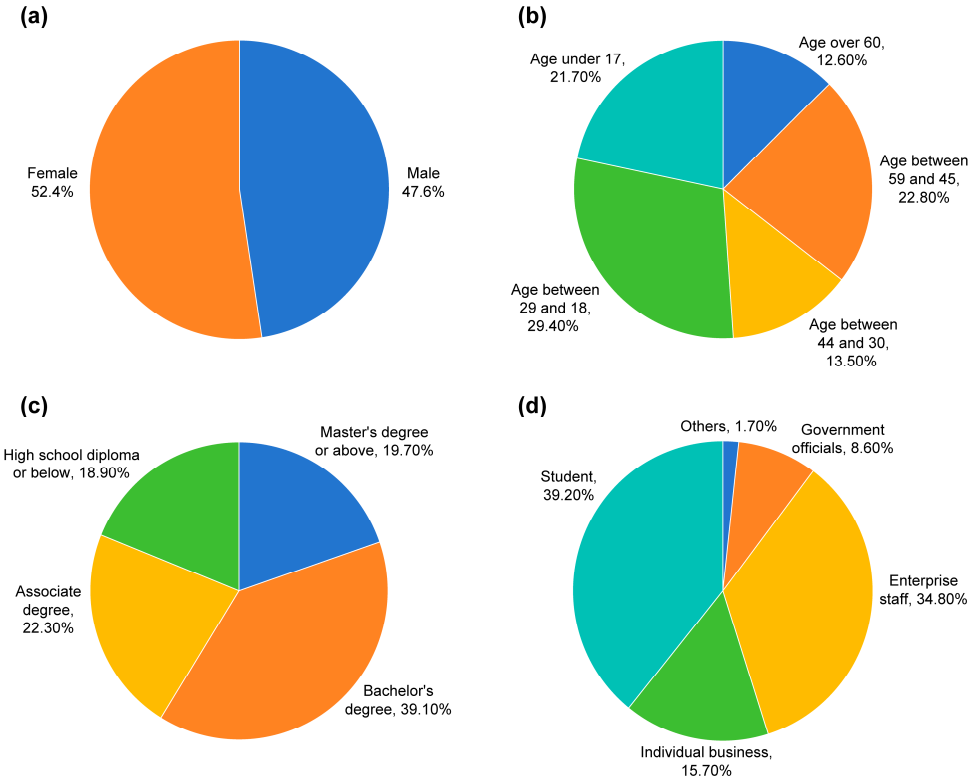


Figure 3. Basic information on respondents: (**a**) Gender distribution of respondents; (**b**) Age distribution of respondents; (**c**) Educational distribution of respondents; (**d**) Occupational distribution of respondents.

2. Age structure analysis

The survey encompassed all age groups: 29.4% were aged 18–29, 22.8% aged 45–59, 21.7% were under 17, 13.5% aged 30–44, and 12.6% were over 60, as presented in Figure 3b. This distribution ensures broad demographic representation across different life stages.

3. Educational level composition

Regarding education, 39.1% of respondents held a bachelor's degree, 22.3% had completed junior college, 19.7% held master's or doctoral degrees, and 18.9% had education levels below secondary school, as shown in Figure 3c. The data reflect a well-diversified educational structure among participants.

4. Occupational type distribution

Occupational statistics reveal that enterprise employees comprised 34.8%, students 39.2%, government personnel 8.6%, self-employed workers 11%, and other occupations 1.7%, as shown in Figure 3d. Retired participants reported their previous occupations.

5. Distribution of questionnaire responses by park

Each respondent-selected park was tallied to determine the number of questionnaires corresponding to each site (see Table 7). When calculating scores for individual negative impacts, the total scores from all respondents for a specific park were summed and then divided by the number of respondents for that park. For example, to determine the noise impact score for Chaoyang Park, the total score assigned by 45 respondents was divided by 45. The resulting averages for all indicators are presented in subsequent tables and histograms.

Table 7. Number of completed questionnaires for each park.

Type	Name	Number
Comprehensive Park	Chaoyang Park	45
	Haidian Park	41
	Tuanjie Lake Park	36
	Dawangjing Park	29
	Side Park	25
	Guta Park	22
	Qingfeng Park	22
	Beiwu Park	21
	Xinglong Park	19
	Wanghe Park	17
	Madian Park	17
	Beixiaohe Park	16
	Linglong Park	15
	Fengtai Garden	14
	Xin'an Park	13
	Xiaoqingshan Park	11
	Nanyuan Park	9
Community Park	Wangcheng Park	15
	Yangshan Park	13
	BAGOU Landscape Garden	12
	Fengtai Science Park Ecological Theme Park	11
	Nanchanghe Park	10
	Gucheng Park	10
	Dongyichu Park	9
	Shangdi Park	9
	Sunshine Sunday Park	9
	Rosewater Park	8
	Dinghui Park	8
	Wangjing Park	7
	Sun Palace Garden	7
	Fengyi Park	7
	Changchun Fitness Park	7
	Wangzhuang Park	7
	Lishuiqiao Park	6
	Wangjing Sports Park	6
	Yinghulou Park	5
	Shiliuzhuang Park	3

Table 7. *Cont.*

Type	Name	Number
Historic Garden	Yuyuantan Park	187
	Zizhuyuan Park	133
	Lotus Park	103
	Badachu Park	96
	Ritan Park	94
Special Park (Humanities)	Beijing International Sculpture Park	52
	Beijing Zhangjiakou Railway Ruins Park	42
	Dongba Park	32
	Zhongwu Park	28
	Yuandadu Ruins Park	25
	Nangong World Geothermal Expo Park	21
	Shijingshan Sculpture Park	21
	Sun Palace Park	17
	Wukesong Olympic Cultural Park	17
	Beijing Shijingshan Amusement Park	15
	Laoshan City Leisure Park	14
	Beijing World Park	13
Special Park (Natural)	Baiwangshan Forest Park	26
	Dongsheng Bajia Country Park	23
	Sophora Japonica Garden in Beijing	22
	Beijing Pear Garden	21
	Guanzhuang Park	20
	Beijing World Flower Garden	19
	Changying Park	16
	Yongding River Leisure Forest Park	16
	Beijing Forest Park	14
	Yamenkou Urban Forest Park	11
	Danqingpu Country Park	10
	Tayuan Urban Forest Park	9
	Yukang Country Park	8
	Green Causeway Country Park	7

4.1.1. Comprehensive Park Results

The evaluation results for comprehensive parks are shown in Table 8 and Figure 4. Overall, several types of ecosystem disservices received relatively high scores, indicating that they represent the main factors reducing residents' satisfaction when visiting these parks.

Table 8. Scores for various negative impacts in comprehensive parks.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Chaoyang Park	2.23	2.15	3.63	3.08	3.11	3.61	2.82	2.57	3.31	3.42	3.26	4.03	2.73	3.31
Haidian Park	2.01	2.18	3.51	2.52	2.66	3.38	2.74	3.32	3.12	3.23	3.21	3.86	2.93	3.46
Tuanjie Lake Park	2.37	2.55	3.87	2.91	3.17	3.22	3.33	3.24	3.79	3.91	3.57	4.32	2.68	2.91
Dawangjing Park	3.08	2.21	4.18	2.83	2.89	3.69	3.24	2.98	3.43	3.87	3.97	4.21	2.87	3.86
Side Park	3.25	2.03	4.05	3.18	3.26	3.44	2.86	2.42	2.83	3.94	4.04	4.23	3.04	3.15
Guta Park	3.02	2.68	3.52	2.37	2.75	3.06	2.61	3.11	3.36	3.47	3.57	3.71	2.27	2.96
Qingfeng Park	3.14	2.17	3.64	2.94	3.23	2.81	3.17	2.58	3.05	3.76	3.86	4.12	3.34	2.75
Beiwu Park	2.19	2.04	3.69	2.72	2.69	3.37	3.51	2.62	3.12	2.93	3.63	4.02	2.72	2.63
Xinglong Park	3.24	2.73	3.74	3.21	2.48	3.76	3.08	2.75	3.46	3.61	3.71	3.97	2.85	3.42
Wanghe Park	2.42	2.19	3.92	2.68	2.36	4.02	3.31	2.86	4.07	3.88	4.18	3.26	2.67	2.99
Madian Park	2.79	2.43	3.36	2.82	3.15	3.46	3.02	2.49	3.45	3.86	3.56	4.13	3.34	3.18
Beixiaohe Park	2.25	2.16	3.75	2.85	2.72	3.73	3.49	2.81	3.53	3.54	3.64	3.91	3.27	2.93
Linglong Park	2.17	2.84	3.67	2.96	2.64	3.92	2.76	2.73	2.81	3.79	3.89	4.37	2.13	3.02
Fengtai Garden	3.12	2.65	3.62	2.79	3.59	3.67	2.95	3.08	3.26	3.77	3.87	3.87	3.02	3.15
Xin'an Park	2.41	2.68	2.91	2.67	2.88	3.08	2.68	2.27	2.97	3.41	3.52	3.99	2.42	3.44
Xiaoqingshan Park	2.28	2.92	3.78	3.53	3.12	3.79	3.41	2.84	3.28	2.96	3.81	3.94	2.37	3.16
Nanyuan Park	3.06	1.98	3.56	3.34	3.29	3.62	3.18	2.62	3.51	3.52	3.98	3.98	2.79	3.53
Average	2.598	2.343	3.706	2.871	2.934	3.477	3.041	2.827	3.318	3.605	3.651	4.017	2.809	3.182

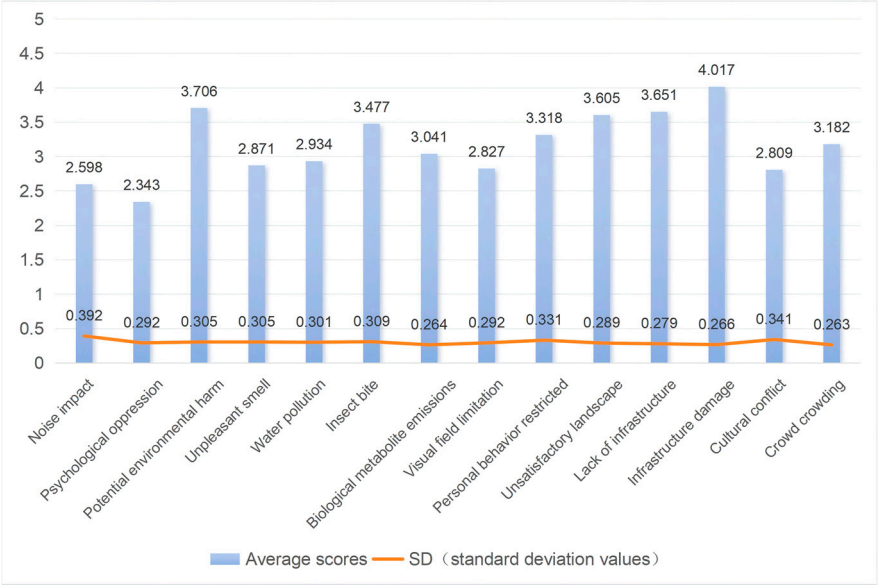


Figure 4. Statistical scores for negative impacts in comprehensive parks.

Among all indicators, infrastructure damage received the highest score, followed by potential environmental harm, inadequate infrastructure, and unsatisfactory landscape quality. These issues appear to be the most prominent negative factors perceived by visitors in comprehensive parks. In addition, mosquito bites also received a relatively high score, suggesting that biological disturbances remain an important factor affecting user comfort. Several other indicators, including restricted personal activities, crowding, and biological emissions, showed moderate scores. These results indicate that although these issues are noticeable, their impact on overall park experience is comparatively less severe. In contrast, factors such as visual obstruction, cultural conflict, noise disturbance, and psychological pressure received relatively low scores, suggesting that these issues are less influential in shaping visitors' perceptions of comprehensive parks.

Overall, the results suggest that the main ecosystem disservices in comprehensive parks are primarily associated with facility conditions, environmental quality, and biological disturbances.

4.1.2. Community Park Results

The results for community parks are presented in Table 9 and Figure 5. Compared with comprehensive parks, the distribution of ecosystem disservices in community parks reflects stronger influences from daily neighborhood use and local environmental conditions.

The highest scores were observed for inadequate infrastructure, mosquito bites, infrastructure damage, and noise disturbance. These findings indicate that problems related to facility availability, maintenance conditions, and environmental disturbances represent the most significant negative factors affecting visitors in community parks. A second group of indicators, including unpleasant odors, visual obstruction, potential environmental harm, and biological emissions, showed moderate scores. These impacts are noticeable but appear to be less critical than infrastructure-related issues. Meanwhile, indicators such as psychological pressure, cultural conflict, unsatisfactory landscape quality, crowding, restricted personal behavior, and water pollution received relatively low scores. This suggests that these factors are perceived as less important concerns within community park environments.

Table 9. Scores for various negative impacts in community parks.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Wangcheng Park	3.43	2.69	2.53	3.12	2.04	3.79	2.34	2.17	2.42	2.21	3.86	3.76	1.96	1.84
Yangshan Park	3.86	2.53	3.14	3.37	2.19	3.81	2.47	2.69	2.33	2.16	3.77	4.02	3.15	2.08
BAGOU Landscape Garden	3.06	2.38	2.41	2.95	2.24	3.94	3.09	3.04	2.11	2.72	3.68	3.83	2.86	2.24
Fengtai Science Park Ecological Theme Park	3.87	2.37	2.66	3.08	2.36	3.89	3.12	3.02	2.21	2.15	4.03	4.05	2.79	2.42
Nanchanghe Park	3.41	3.08	2.26	3.34	1.97	3.27	2.62	2.33	2.12	2.12	3.79	3.97	2.75	2.32
Gucheng Park	3.78	3.12	2.54	3.27	2.08	3.81	2.43	2.93	2.35	2.57	3.71	3.63	2.53	2.16
Dongyichu Park	3.42	2.67	3.13	2.77	1.98	4.13	2.22	3.27	1.96	2.34	3.94	3.44	3.07	2.02
Shangdi Park	3.61	2.37	3.05	3.48	2.08	3.63	2.94	3.03	2.45	3.08	3.89	3.92	3.18	2.81
Sunshine Sunday Park	3.81	3.21	2.36	3.09	2.24	4.03	2.69	3.35	2.42	3.24	3.87	3.67	2.42	2.86
Rosewater Park	3.88	2.27	2.67	3.21	2.43	4.04	3.23	2.73	2.44	2.42	4.01	3.38	3.11	2.75
Dinghui Park	3.53	3.05	2.52	3.26	2.13	3.91	3.16	2.83	2.21	3.32	3.83	3.93	2.44	2.43
Wangjing Park	3.33	2.32	3.26	2.81	2.65	4.12	2.36	2.27	2.86	3.16	3.81	3.69	2.51	2.48
Sun Palace Garden	3.92	2.23	2.31	3.58	2.14	4.34	2.25	3.34	2.47	2.82	4.03	4.02	2.18	2.11
Fengyi Park	3.54	3.14	2.35	3.56	2.81	3.26	3.15	3.05	2.33	2.81	4.11	3.62	1.99	2.15
Changchun Fitness Park	2.93	2.22	3.12	3.88	2.92	4.02	2.43	2.87	2.06	2.36	3.81	2.81	2.73	2.58
Wangzhuang Park	3.69	2.42	3.01	3.04	2.61	3.35	3.18	2.87	2.37	2.75	4.12	3.69	2.43	2.49
Lishuiqiao Park	3.79	2.28	2.68	3.65	2.24	4.01	2.81	2.67	2.03	2.74	4.34	3.24	2.16	3.07
Wangjing Sports Park	3.86	2.79	2.98	3.62	2.16	3.73	2.51	2.68	2.45	2.48	3.26	3.08	2.14	2.84
Yinghulou Park	3.54	3.03	3.08	3.64	2.03	4.21	2.31	2.85	2.78	3.21	4.02	4.12	3.15	1.98
Shiliuzhuang Park	3.98	2.75	2.87	3.75	1.93	3.61	2.28	2.93	2.39	2.63	3.35	3.74	2.31	2.33
Average	3.598	2.643	2.716	3.271	2.249	3.839	2.691	2.827	2.318	2.605	3.851	3.715	2.609	2.359

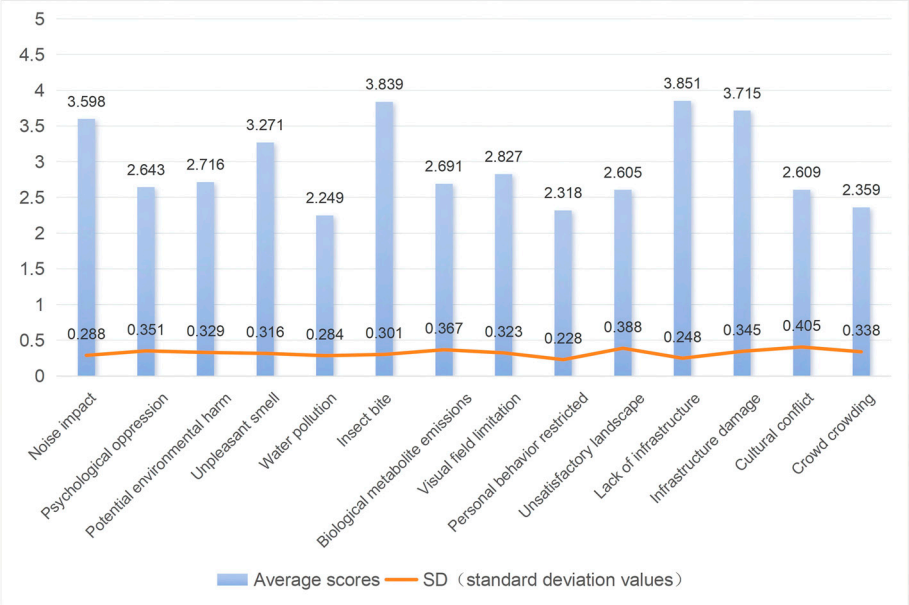


Figure 5. Statistical scores for negative impacts in community parks.

Overall, the results indicate that ecosystem disservices in community parks are primarily related to infrastructure deficiencies, environmental disturbances, and everyday neighborhood activities.

4.1.3. Historical Park Results

The results for historical parks are summarized in Table 10 and Figure 6. Compared with other park categories, historical parks show a different distribution pattern of ecosystem disservices.

Table 10. Scores for various negative impacts in historical parks.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Yuyuantan Park	2.59	2.53	3.13	2.93	3.06	2.61	3.65	2.81	2.92	2.85	3.25	3.42	3.61	4.47
Zizhuyuan Park	2.75	2.65	3.25	2.71	2.85	2.74	3.89	2.78	3.58	2.29	3.19	3.19	3.63	4.02
Lotus Park	3.27	2.88	2.91	2.33	3.43	2.96	4.08	2.75	2.53	2.38	3.55	3.73	3.87	4.26
Badachu Park	3.02	2.92	3.47	2.84	3.32	3.38	4.13	2.61	3.26	2.63	3.92	3.81	3.49	3.95
Ritan Park	2.92	2.81	3.06	2.35	3.02	2.66	3.47	3.35	3.08	2.79	3.03	3.48	2.92	4.18
Average	2.856	2.628	3.219	2.671	3.107	2.819	3.816	2.836	3.078	2.607	3.351	3.483	3.524	4.216

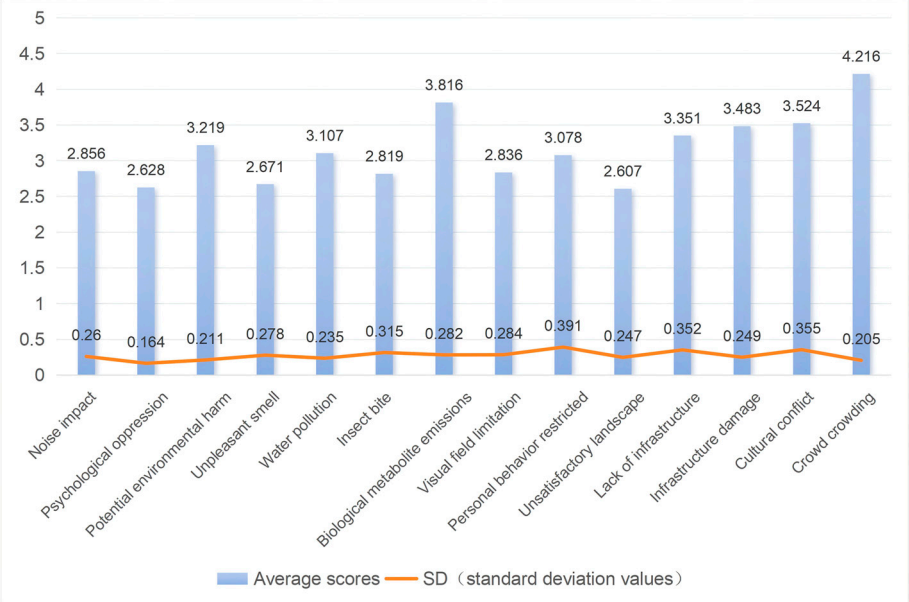


Figure 6. Statistical scores for negative impacts in historical parks.

The most prominent issue identified by respondents is crowding, which received the highest score among all indicators. In addition, plant physiological emissions and cultural conflict also received relatively high scores, indicating that these factors significantly influence visitors' experiences in historical parks. Moderate scores were observed for indicators such as infrastructure damage, inadequate infrastructure, potential environmental harm, water pollution, and restricted personal activities. These issues appear to affect visitor experiences to some extent but are less dominant than crowding-related impacts. Other indicators, including noise disturbance, visual obstruction, mosquito bites, unpleasant odors, psychological pressure, and unsatisfactory landscapes, received comparatively lower scores. These results suggest that these factors are perceived as less influential within historical park environments.

Overall, the results indicate that the main ecosystem disservices affecting historical parks are primarily associated with visitor density, cultural interaction, and biological factors.

4.1.4. Specialized Park (Humanities) Results

The evaluation results for humanities-type specialized parks are presented in Table 11 and Figure 7. The distribution of ecosystem disservices in this park category reflects a combination of visitor density, cultural characteristics, and environmental conditions.

Table 11. Scores for various negative impacts in specialized (Humanities) parks.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Beijing International Sculpture Park	2.54	2.29	3.12	2.94	2.98	3.87	3.04	2.34	3.12	3.21	3.57	3.59	3.85	3.89
Beijing Zhangjiakou Railway Ruins Park	2.75	2.74	3.08	2.83	2.78	3.93	2.66	2.71	3.25	3.04	3.46	3.88	4.18	3.75
Dongba Park	2.83	2.21	3.34	2.53	3.2	3.88	2.91	2.47	2.79	3.19	2.76	4.12	4.22	3.88
Zhongwu Park	3.01	2.07	3.23	3.43	2.32	3.63	3.27	3.02	2.53	2.97	3.46	3.63	4.13	4.15
Yuandadu Ruins Park	2.69	2.82	3.18	3	2.96	3.86	3.51	2.52	3.16	3.08	3.02	3.85	3.61	4.01
Nangong World Geothermal Expo Park	2.15	2.25	3.43	3.28	2.64	3.13	3.08	2.15	3.35	2.79	3.21	3.54	4.16	3.61
Shijingshan Sculpture Park	3.13	2.37	3.86	3.02	3.27	3.46	3.31	3.27	3.01	3.13	3.48	3.63	3.96	3.97
Sun Palace Park	2.51	2.17	2.83	2.96	2.74	3.81	3.02	2.51	3.21	2.93	3.89	4.08	3.91	3.75
Wukesong Olympic Cultural Park	2.75	2.78	3.66	3.23	2.84	3.92	3.49	2.75	3.08	2.35	3.42	3.47	3.36	3.76
Beijing Shijingshan Amusement Park	2.28	2.74	3.81	3.35	2.77	3.28	2.36	2.28	3.45	2.88	3.44	3.61	4.03	4.05
Laoshan City Leisure Park	2.28	2.77	3.22	3.23	3.05	3.75	2.95	2.08	2.68	3.23	2.75	3.79	3.68	3.29
Beijing World Park	3.16	3.07	3.58	3.58	2.8	3.74	2.68	3.16	3.11	2.47	3.28	3.83	3.76	3.79
Average	2.674	2.445	3.258	3.084	2.892	3.768	3.014	2.568	3.047	2.994	3.308	3.742	3.951	3.878

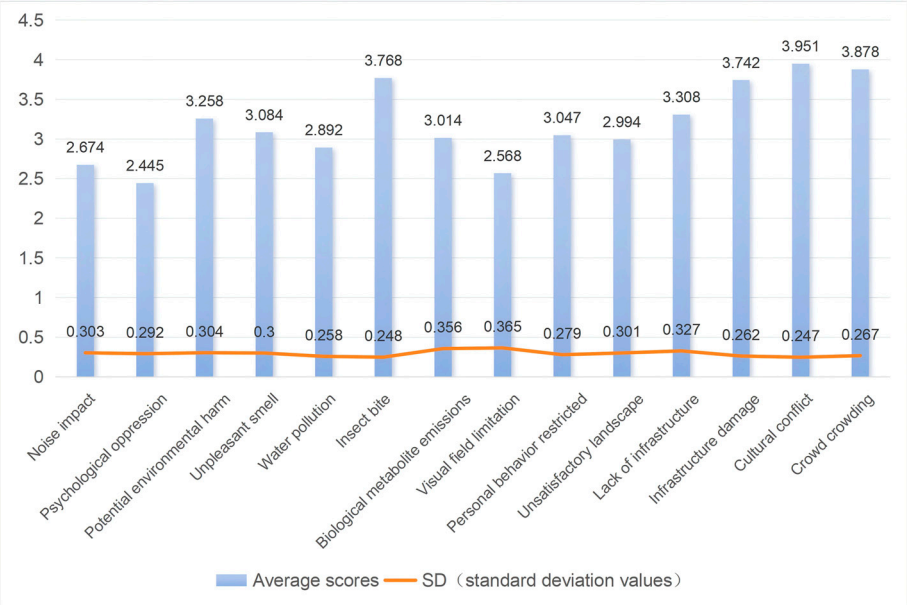


Figure 7. Statistical scores for negative impacts in specialized (Humanities) parks.

The indicators with the highest scores were cultural conflict, crowding, mosquito bites, and infrastructure damage. These factors appear to represent the most significant negative influences on visitor experience in humanities-type parks. Several other indicators, including potential environmental harm, inadequate infrastructure, unpleasant odors, biological emissions, restricted personal behavior, and unsatisfactory landscape quality, showed moderate scores. These results suggest that these issues are present but do not dominate visitor perceptions. By contrast, water pollution, noise disturbance, psychological pressure, and visual obstruction received comparatively lower scores, indicating that these factors have relatively limited influence in humanities-type specialized parks.

Overall, the results suggest that ecosystem disservices in this park category are mainly related to visitor interactions, cultural context, and biological disturbances.

4.1.5. Specialized Park (Natural) Results

The results for natural-type specialized parks are shown in Table 12 and Figure 8. Compared with other park categories, ecosystem disservices in natural parks appear to be more strongly associated with environmental and ecological conditions.

Table 12. Scores for various negative impacts in specialized (Natural) parks.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Baiwangshan Forest Park	2.09	3.82	3.28	2.19	3.38	3.54	2.74	3.21	3.36	3.85	3.29	3.61	2.32	2.51
Dongsheng Bajia Country Park	2.56	3.32	3.23	2.34	3.69	3.51	2.52	3.34	3.09	3.71	3.63	3.35	2.43	2.63
Sophora Japonica Garden in Beijing	2.15	3.03	3.84	2.38	3.71	3.72	2.78	3.16	3.27	4.16	3.41	3.22	2.71	3.09
Beijing Pear Garden	3.05	2.78	3.44	2.61	3.37	3.32	2.71	3.08	2.75	4.03	3.28	3.53	2.23	2.38
Guanzhuang Park	2.51	3.46	2.6	2.85	4.01	4.02	2.34	2.72	3.31	4.23	3.07	3.09	3.13	2.84
Beijing World Flower Garden	2.17	3.08	3.49	2.23	3.53	3.32	3.02	3.42	2.97	3.32	3.69	3.55	2.56	2.89
Changying Park	2.16	2.78	3.01	3.14	3.83	3.53	2.96	3.63	3.23	3.94	3.64	3.87	2.71	2.82
Yongding River Leisure Forest Park	2.53	3.13	3.19	3.03	3.83	3.75	3.54	3.98	2.85	3.72	3.32	3.96	2.43	2.05
Beijing Forest Park	2.21	3.01	3.35	2.49	3.71	3.88	3.51	3.27	2.79	3.74	3.25	3.46	3.05	2.67
Yamenkou Urban Forest Park	2.38	3.06	4.13	2.67	4.03	4.09	3.15	3.69	2.58	3.51	3.61	3.28	2.96	2.73
Danqingpu Country Park	2.13	3.16	3.44	2.27	3.11	3.55	2.93	4.08	3.43	4.03	3.08	3.75	2.25	3.08
Tayuan Urban Forest Park	2.76	3.42	3.42	3.15	3.24	3.52	2.43	3.73	2.96	4.13	3.17	3.39	1.92	2.31
Yukang Country Park	2.63	3.14	2.9	2.31	4.05	3.53	3.21	3.51	2.63	3.71	2.53	3.08	2.36	2.76
Green Causeway Country Park	2.27	3.64	3.33	2.88	3.81	3.51	2.66	3.56	3.66	3.64	2.91	3.63	2.31	2.72
Average	2.361	3.206	3.279	2.527	3.705	3.619	2.852	3.279	3.078	3.845	3.351	3.483	2.542	2.671

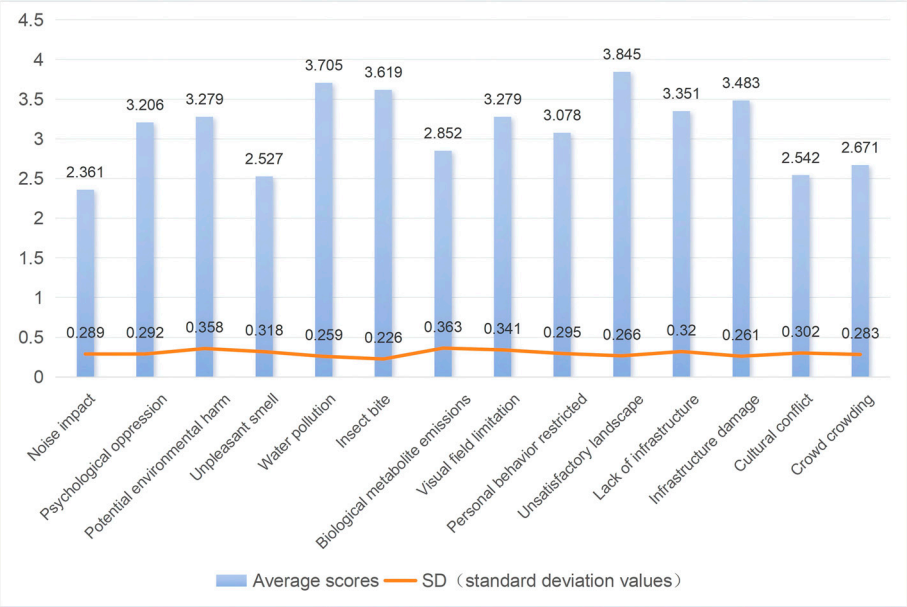


Figure 8. Statistical scores for negative impacts in specialized (Natural) parks.

The highest scores were observed for unsatisfactory landscape quality, water pollution, mosquito bites, and infrastructure damage. These indicators represent the most noticeable negative factors perceived by visitors in natural parks. Moderate scores were recorded for lack of infrastructure, potential environmental harm, visual obstruction, and psychological pressure. These issues create some inconvenience for visitors but do not appear to significantly reduce overall park usage. Finally, indicators such as restricted personal behavior, biological emissions, crowding, cultural conflict, unpleasant odors, and noise disturbance received relatively low scores. These factors are therefore perceived as less significant within natural park environments.

Overall, the results suggest that ecosystem disservices in natural parks are primarily related to ecological conditions, environmental quality, and biological disturbances, rather than to social or cultural factors.

4.2. Discussion

4.2.1. Analysis and Improvement Measures for Comprehensive Parks

Comprehensive parks generally refer to large urban green spaces with multiple integrated functions, including sightseeing, leisure, physical exercise, and children's play.

These parks are typically surrounded by mixed land uses such as commercial zones, residential neighborhoods, public service facilities, and educational or medical institutions. The user base is diverse—primarily composed of residents and employees, followed by tourists, students, and patients. On weekends and holidays, these parks experience high visitor density, with temporary congestion often occurring during public events. Because comprehensive parks are managed by established administrative departments and receive substantial government funding, they maintain relatively strong infrastructure and management systems.

However, several potential issues and conflicts persist. First, user–management conflicts may arise when park visitors perceive management rules as overly restrictive or find the design and landscape aesthetics unsatisfactory. Second, infrastructure-related problems emerge due to heavy daily use and the variety of user groups, which accelerate wear and tear on fitness equipment, playgrounds, and activity areas. Even with adequate maintenance funding, repairs take time and temporarily reduce usability. Third, environmental concerns—such as large green and water areas becoming mosquito breeding grounds—also negatively affect visitor comfort.

These observations are largely consistent with the survey results. The most severe negative impacts identified for comprehensive parks were infrastructure damage and potential environmental harm, followed by unsatisfactory landscape quality, insufficient facilities, and mosquito bites. The high incidence of facility damage is primarily attributable to the large user base; despite prompt maintenance, some downtime is unavoidable, and damaged surfaces can pose safety risks. Additionally, given the diversity of park users, it is difficult to satisfy everyone's aesthetic preferences. Expansive lawns and water features, while visually pleasing, tend to create conditions conducive to mosquito proliferation. Since comprehensive parks serve as major recreational venues where relaxation is the main objective, their landscape design should align as closely as possible with prevailing aesthetic standards. Given their systematic management structure and sufficient financial support, excessive emphasis on maintenance speed is unnecessary. Instead, parks should implement timely safety warnings and temporary closures around damaged areas to prevent injury.

Therefore, all comprehensive parks and similar large-scale urban green spaces should prioritize safety and service functions, promptly address potential hazards, repair damaged facilities, and simultaneously cultivate visually appealing landscapes to enhance user satisfaction and well-being.

4.2.2. Analysis and Improvement Measures for Community Parks

Community parks generally refer to small- or medium-sized urban green spaces that provide residents with daily leisure and fitness opportunities. They are typically embedded within residential neighborhoods, with spatial boundaries that align closely with those of surrounding communities. The primary users are nearby residents, particularly the elderly and children, while a smaller number of young people visit to engage in recreational sports such as badminton or basketball. Peak visitation occurs in the evening, when older adults exercise after dinner and children play after school, followed by morning hours when residents perform early exercises. During most of the day, these parks remain relatively uncrowded. Their main funding sources include modest allocations from the community or the municipal landscaping bureau, supplemented by voluntary maintenance efforts from local residents.

Potential issues and conflicts within community parks primarily include the following. First, interpersonal conflicts among residents are common. For instance, early morning exercise routines may generate noise that disturbs nearby households, and behavioral differences—such as children running or individuals smoking—can create friction between

user groups. Second, infrastructure deficiencies often arise from limited financial resources and insufficient management personnel. Damaged facilities cannot be repaired promptly, and spontaneous maintenance by residents can only address surface-level concerns such as cleanliness or minor gardening, without effectively resolving issues involving fitness equipment or structural repairs. These conditions align closely with the negative impact scores identified in the survey.

According to the results, the most serious negative impacts in community parks are lack of infrastructure, facility damage, mosquito bites, and noise disturbances. The high incidence of mosquito bites is associated with prolonged stationary activities such as chatting, chess playing, or walking. To address these problems, the responsible community or municipal departments should prioritize funding for infrastructure improvement, ensuring timely maintenance and repair of facilities. Additional measures—such as installing mosquito-repellent devices, providing guidance signage, and managing early-morning noise—can mitigate the impact of insects and human activity on other visitors.

Because community parks generally allow pets and carts, and users are mostly nearby residents, the negative impacts of behavioral restrictions and crowding are minimal. Furthermore, due to financial limitations, most parks lack water features, eliminating concerns regarding water pollution. Community parks are primarily valued for daily fitness, social interaction, and relaxation, rather than for landscape aesthetics or cultural experiences. Nonetheless, odor-related issues from littering or pet waste are occasionally reported; these should be mitigated through public signage, resident education, and surveillance mechanisms.

Community parks and similar facilities should allocate limited resources strategically, focusing on upgrading infrastructure, installing complete sets of recreational equipment and clear guidance signage, maintaining cleanliness, and cultivating a pleasant yet simple landscape environment to enhance residents' comfort and satisfaction.

4.2.3. Analysis and Improvement Measures for Historic Parks

Historic parks are typically located away from residential land and high-rise buildings, with surrounding transition zones that gradually shift from modern to classical settings. They primarily serve as venues for sightseeing and cultural appreciation rather than daily recreational activities. Visitors include individuals of all ages, with peak attendance during weekends and holidays. These parks often experience crowding throughout the year. Their main sources of funding are special appropriations from the municipal landscaping bureau and government, supplemented by internal commercial operations.

The primary issues and contradictions in historic parks are relatively concentrated. The most prominent problem is severe overcrowding, resulting from their high reputation, cultural value, and well-developed facilities. Popular historical sites attract large numbers of visitors, leading to congestion during most periods and substantial declines in user experience—consistent with the survey findings. Moreover, because of the long-standing vegetation, plant physiological emissions, such as pollen release, have become significant sources of discomfort, especially in spring.

Survey results indicate that the most serious negative impacts in historic parks are crowding and plant physiological emissions, both of which directly affect residents' experience. Crowding is a persistent issue, while pollen emissions are seasonal. Heavy visitor flow increases infrastructure demand, contributing to facility wear and damage, and raising concerns over potential environmental degradation. Although repairs are generally prompt, temporary service interruptions affect many visitors. Additionally, to manage large crowds, strict internal regulations are often implemented, which some visitors perceive as restrictive, resulting in moderate dissatisfaction with behavioral limitations. Since most

visitors come to appreciate historical and cultural elements, landscape dissatisfaction is relatively low. However, a subset of visitors may feel disconnected from the traditional ambiance, leading to moderate levels of cultural conflict.

In summary, historic parks and similar cultural sites should strengthen visitor flow management to prevent overcrowding and improve the overall experience. Measures should include crowd control systems, reservation mechanisms, and improved visitor guidance. In addition, efforts should be made to manage pollen emissions from aging vegetation through controlled pruning or species replacement, ensuring visitor comfort while preserving historical authenticity.

4.2.4. Analysis and Improvement Measures for Specialized Parks (Humanities)

In China, specialized parks refer to urban parks designed around a specific thematic concept or function. This section focuses on those with humanistic or cultural themes. These parks are typically located closer to the city center, surrounded by diverse land uses, and serve both everyday recreational needs and themed holiday events. The number and type of users vary depending on the park's thematic focus. Generally, these parks attract large visitor volumes and benefit from well-established management departments and substantial government funding for construction and maintenance.

Potential issues and contradictions in cultural-themed specialized parks primarily include the following.

First, cultural conflicts tend to be pronounced. Because such parks are developed around distinct themes, their design often caters to specific groups, which can limit inclusivity. For example, children's theme parks may discourage young adults or the elderly from frequent use.

Second, service capacity limitations emerge due to the heavy daily visitor load and constrained physical space. Even with adequate funding, high crowd density and pressure on infrastructure result in maintenance challenges and decreased user satisfaction—consistent with the negative impact scores identified earlier.

According to the survey results, the most serious negative effects in specialized (humanities) parks were mosquito bites, cultural conflict, crowding, and infrastructure damage, with potential environmental harm also rated highly. The causes of mosquito bites are similar to those observed in community parks, stemming from prolonged outdoor activities and stagnant vegetation areas. High visitor density further contributes to congestion, though to a lesser extent than in historic parks. A particularly notable issue in cultural-themed parks is the presence of multiple subthemes—such as children's, sports, or heritage-oriented designs—that may exclude broader audiences. For example, children's parks offer limited appeal to young adults, who may struggle to find suitable activity areas, leading to both inconvenience and potential safety concerns. To address this, park managers should introduce small-scale, inclusive facilities—such as multiuse courts or rest areas at the park periphery—to enhance accessibility and inclusiveness without compromising thematic integrity.

Specialized parks with cultural themes and those of similar nature should strive to enrich the overall cultural atmosphere while avoiding the alienation of specific user groups caused by overly singular themes. In addition, park authorities should strengthen crowd management, infrastructure maintenance, and mosquito control to enhance visitor satisfaction and park usability.

4.2.5. Analysis and Improvement Measures for Specialized Parks (Natural)

This section examines specialized parks with natural themes, which differ markedly from their cultural counterparts. These parks are typically situated in suburban areas sur-

rounded by extensive natural green spaces, with minimal nearby residential or commercial development. Due to their distance from city centers and associated travel costs, visitor numbers are highest on weekends and holidays, though still lower than those of historic parks. Visitors mainly come to experience natural scenery, relax mentally, and escape urban pressures. These parks also operate under formal management systems with government financial support.

Potential problems and contradictions in natural-themed specialized parks include the following.

First, mismatched user expectations and reality. Because of longer travel distances and higher access costs, visitors tend to have elevated expectations regarding scenic quality and water environments. When the park's natural aesthetic fails to meet these expectations, dissatisfaction arises.

Second, issues inherent to natural environments. The large scale and low population density of these parks can create a sense of isolation or anxiety among visitors. Infrastructure coverage is often sparse, and extensive vegetation may harbor sharp plants or attract mosquitoes—consistent with the survey findings.

According to the results, the most severe negative impacts in natural parks were unsatisfactory landscape quality, water pollution, and mosquito bites. Other notable issues included infrastructure damage, visual obstruction, psychological pressure, and potential environmental harm. The relative lack of aesthetic satisfaction may stem from the dominance of natural rather than ornamental landscapes, leading visitors to perceive them as less visually appealing. Water pollution is often caused by the accumulation of leaves and branches rather than chemical contamination. Similarly, excessive vegetation height can obstruct sightlines, reducing scenic visibility. These problems can be mitigated through routine pruning and cleaning. To alleviate visitors' psychological discomfort, additional lighting, directional signage, and emergency assistance facilities should be installed in less-frequented areas. Potential environmental hazards such as sharp plants or wildlife (e.g., bees and snakes) should be clearly marked, isolated, or fenced, while adequate resting areas should be provided.

Specialized parks with natural themes should first enhance the quality of internal natural and aquatic spaces, creating landscapes that maintain ecological authenticity while aligning better with public aesthetic preferences. Second, infrastructure development should be strengthened, ensuring sufficient coverage and accessibility throughout the park to improve both safety and visitor experience.

4.3. Suggestions for Expanding Funding Sources

While the previous sections identify the major ecosystem disservices affecting different park types and propose corresponding improvement measures, the implementation of these strategies often requires stable financial support. Therefore, addressing the issue of sustainable funding becomes essential for the long-term mitigation of ecosystem disservices in urban parks.

While most internal park management issues can be technically resolved through adequate financial investment, securing sufficient funding remains a persistent challenge for municipal governments. To address this constraint, we propose an innovative governance model emphasizing low investment with high returns, currently being implemented by the Beijing Municipal Bureau of Landscape and Greening in collaboration with other relevant departments [49]. This approach advocates for the strategic integration of business operations within parks to establish sustainable revenue streams while maintaining free public accessibility.

The core idea of this model is to introduce commercial activities that complement each park's unique ecological or cultural characteristics. These businesses stimulate moderate and reasonable consumption among residents, creating a self-sustaining financial cycle that supports infrastructure maintenance, enhances visitor experience, and alleviates fiscal pressure on local governments. A successful example of this approach can be found in Beijing's Yuyuantan Park, which has implemented a range of diversified revenue-generating strategies [49]. The park hosts traditional cultural and festival events [50,51] that combine free public programs with optional premium experiences; develops signature cherry blossom–themed products, including distinctive ice creams that reinforce its cultural identity; and offers specialized bird-watching activities [52] that capitalize on its rich avian diversity. Together, these initiatives create an integrated cultural–commercial system that generates stable income for park operations while enriching recreational opportunities for visitors.

For parks possessing distinctive ecological or cultural assets—such as historical relics, ancient trees, rare botanical collections, or unique wildlife—we recommend targeted preinvestment to establish optional paid experiential projects. These initiatives preserve free general access while offering enhanced experiences for paying participants. Within China's park classification framework, specialized parks (with unique thematic concepts) and historic parks (containing heritage features) are particularly suitable for this model. Internationally, similar strategies can be adapted by identifying and developing local ecological or cultural advantages.

Comprehensive parks, though generally lacking distinctive heritage resources, benefit from their large spatial capacity, comprehensive facilities, and proximity to residential, educational, and commercial areas. For such parks, managers can organize publicly accessible events—such as cultural festivals, science fairs, or community sports competitions—while integrating sponsored components or premium segments. For example, Haidian Park hosts an annual Science and Technology Festival [53], which effectively combines public engagement with corporate sponsorship. Partnerships with local enterprises can provide mutual benefits: businesses gain promotional opportunities, while parks receive vital financial support.

In contrast, community parks and neighborhood green spaces typically lack the size and visitor volume needed for major business ventures. In these cases, limited resources should focus on basic infrastructure improvements addressing residents' primary concerns, including mosquito control, shading facilities, sanitation, and noise mitigation.

Overall, this business-integrated operational model requires moderate initial investment but ensures long-term financial sustainability. Stable funding enables timely equipment repair, enhanced accessibility, and consistent maintenance, thereby reducing dependence on government subsidies. Moreover, this approach promotes social equity by maintaining park quality and accessibility for all residents, ensuring that urban green spaces continue to serve as inclusive, well-managed environments that support both ecological and social well-being.

4.4. Future Research Directions

While this study provides a comprehensive assessment of perceived ecosystem disservices in Beijing's urban parks, several avenues for future research could enhance its replicability and generalizability. First, future studies could expand the sample to include a larger number of parks across different urban districts or in other cities, capturing greater spatial and functional variability. Second, combining multiple data collection methods—such as online questionnaires, on-site interviews, and observational surveys—would improve the robustness of perception data and allow cross-validation of responses. Third, future research may apply advanced statistical analyses, to examine rela-

tionships among ecosystem disservices and park characteristics more rigorously. Fourth, the validity of the selected indicators could be further verified through expert evaluation or longitudinal studies to ensure they consistently reflect residents' perceptions. These measures would enhance methodological transparency and enable other researchers to replicate and extend the findings in different urban contexts.

5. Conclusions

This study investigates 68 parks of various types located in the central urban area of Beijing, analyzing their negative impacts EDS based on extensive resident feedback. The present study identifies both common patterns within similar park types and distinct differences across park categories in terms of negative impacts, their underlying causes, and appropriate mitigation strategies. It also explores funding and operational solutions to support park maintenance and renovation under financial constraints.

The proposed recommendations consider multiple dimensions—surrounding land use, target user demographics, functional orientation, internal resources, and financial allocation—ensuring practical applicability. These insights are not only relevant to large Chinese cities but can also serve as reference models for government-managed urban parks globally, provided that adaptations are made to reflect local conditions. Implementing these targeted improvement strategies can effectively enhance resident satisfaction, increase the frequency of park use, and ultimately improve urban well-being.

Well-maintained parks with comprehensive facilities foster greater inclusivity, offering safer and more accessible environments for the elderly and people with disabilities, thereby promoting social equity, which aligns with the United Nations Habitat's Sustainable Development Goals [9]. Furthermore, the development of park-based industries leveraging unique local resources—such as cultural events, ecological experiences, and creative commercial initiatives—can stimulate urban consumption, strengthen the cultural atmosphere, and support sustainable community engagement.

It is important to note that the degree of each negative impact presented in this study represents a relative assessment. Given the current limitations in quantitative research on EDS, this work primarily synthesizes subjective resident feedback to reconstruct an objective overview of the existing issues. Because EDS exhibit strong regional characteristics, their manifestation may vary under different socio-environmental conditions. For example, variations in public safety levels across regions may exacerbate residents' perceptions of psychological stress [54]. Nevertheless, the transformation and improvement strategies proposed here remain broadly applicable across diverse urban contexts.

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Abbreviations

EDS Ecosystem disservices
GIS Graphic information system

Appendix A

Questionnaire on the Negative Impact of Parks in Downtown Beijing

Dear citizens,

We are students from Beijing Forestry University conducting a research project. We kindly request your valuable time to support this study. All of the collected information will be used exclusively for data analysis purposes. Your participation will remain anonymous, and no personal details will be disclosed. Please complete this questionnaire by selecting appropriate options based on your daily park experience. Thank you for your cooperation.

Part 1. Basic information
1. Gender:
☐ Male
☐ Female
2. Your age:
☐ Under 18
☐ 18–28 years
☐ 29–45 years
☐ 46–60 years
☐ Over 60
3. Your education
☐ Primary school or below
☐ Middle school
☐ Academic
☐ Undergraduate
☐ Master's or doctoral degree
4. Your occupation
☐ Student
☐ Business employee
☐ Government employee
☐ Self-employed
☐ Other
5. Choose a park you know best from the administrative district you live in
Part 2. Park–negative impact survey
1. How is the noise pollution in the park you use?
☐ Troubling
☐ Tolerable
☐ Average
☐ Occasionally heard
☐ No feeling

2. Do you feel afraid or uneasy in the parks you use?
☐ Scared
☐ Sometimes scared
☐ Average
☐ A little bit claustrophobic
☐ No feeling
3. Do you feel vulnerable to accidents in parks you use?
☐ Frequent injuries
☐ Easy to get hurt,
☐ Stay alert
☐ Only one or two places,
☐ No danger
4. Do you smell a pungent odor in the park you use?
☐ Nauseous
☐ Always smell
☐ Smell in certain areas
☐ Sometimes
☐ No feeling
5. How is the water pollution in the park you use?
☐ Turbid and foul-smelling
☐ Some trash
☐ Slightly turbid
☐ Occasionally has fallen leaves
☐ Very clean or no water bodies
6. How often do you get bitten by mosquitoes in the park you use?
☐ Can't escape the mosquitoes
☐ Stop and get bitten
☐ Sometimes gets slapped
☐ Occasionally
☐ No feeling
7. How is pollen pollution in the parks you use?
☐ Serious pathogenic
☐ Protection must be complete
☐ Sometimes the pollen makes me choke
☐ Isolated plants have pollen
☐ There is no pollen.
8. Are there any visual disturbances in the park you frequently visit?
☐ None visible
☐ Obvious obstruction
☐ Slightly dirty
☐ Requires angle adjustment,
☐ Not applicable.
9. Are you restricted from moving around in your favorite parks?
☐ Very restricted
☐ Many restrictions
☐ Acceptable
☐ Few restrictions
☐ Very free

10. Do you think the scenery in the park you often use is beautiful?
☐ Unattractive
☐ Monotonous and old-fashioned
☐ Acceptable
☐ Somewhat attractive
☐ Attractive
11. Are there service facilities in the park you often use?
☐ Barely
☐ Few
☐ Single-type facilities
☐ Sufficient
☐ Full facilities
12. How is the condition of the facilities in the park you use?
☐ Dented
☐ Substantially damaged
☐ Partially damaged
☐ Old in appearance
☐ Well maintained
13. Are there cultural conflicts in the parks you use?
☐ Severe conflicts
☐ Uncomfortable
☐ Neutral
☐ Occasionally uncomfortable
☐ No feeling
14. How crowded is the park you use?
☐ Very crowded
☐ Crowded
☐ More crowded on weekends
☐ Crowded in some areas
☐ Spacious

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