

The Impact of Greenway Environment on Residents' Use Intensity from the Perspective of Health

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ABSTRACT: The conversion of the health benefits of the greenway space needs to be completed by residents' use, and different environmental composition characteristics will directly affect the user's use intensity. Based on the perspective of health needs, taking the greenway area of Jiulongpo District, Chongqing City as the research object, based on existing research and field investigation, quantitative analysis and evaluation of the environmental characteristics of the greenway and the intensity of residents' use are carried out. The research results show that: 1) The environmental characteristic factors that affect the attractiveness of the greenway mainly include environmental coordination, suitable sites, recreational facilities, and unobstructed walking; 2) There are significant differences in the frequency and duration of use of different environmental elements in the greenway for the interviewees. There is a positive correlation between the frequency of use of greenways by unobstructed walking, landscape art, safety protection, suitable venues, and recreational facilities, and there is a positive correlation between landscape art, environmental coordination, suitable venues, and recreational facilities and the length of single use. In order to build a greenway environment that promotes healthy behavior activities, space optimization suggestions are put forward from four aspects: accessibility, landscape features, activity venues and recreational facilities, and safety protection.

KEY WORDS: urban greenways; environmental characteristics; health needs; intensity of use

1 Introduction

The incidence of chronic diseases, mental illnesses and other health problems is gradually increasing in our country, which has seriously threatened the health of Chinese residents and affected the country's economic and social development [1-3]. The "China Medium- and Long-Term Plan for the Prevention and Treatment of Chronic Diseases (2017-2025)" proposed that creating a healthy and supportive environment and building a healthy production and living environment are important ways to control the occurrence of chronic diseases. The 2019 "O-

pinions of the State Council on Implementing the Healthy China Action" further pointed out that building a healthy environment and advocating a healthy and civilized lifestyle are conducive to the prevention and control of major diseases. In the face of the current reality of increasing work and life pressure, creating modern living spaces and places that relieve mental stress and encourage walking is an important way to help overcome the occurrence of health diseases. Urban green space is a significant environmental factor for a healthy lifestyle [4]. By providing

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outdoor recreational and leisure venues, the urban green space allows urban residents to relieve stress in the process of getting close to nature, and promotes physical health by stimulating residents' fitness behaviors [5]. A green and low-carbon lifestyle can also better meet travel needs. As a key part in our country's urban ecological construction, greenways have the characteristics of small footprint, wide coverage and strong connectivity, which can make up for the lack of green space in developed urban areas. The unique linear characteristics of greenways can connect existing green spaces in cities to maximize the function of natural landscapes, create open space corridors, and increase the use opportunities by combining with the construction of urban transportation systems. A large number of studies have confirmed that the conversion of health benefits of green spaces depends on the use of residents [6-9]. Residents who use green spaces for a long time are much less likely to feel stress. The higher the frequency of using public green spaces, the lower the probability of suffering from diseases related to mental stress [10-11]. Comparing frequent exposure to natural environments with frequent contact with urban environments, the former can promote people's physiological conditions (lower blood pressure), improve cognitive ability, enhance happiness, and reduce excitement [12]. Therefore, exploring the greenway environment that affects residents' use has a strong research significance for creating a healthy lifestyle.

At present, the relationship between greenways and residents' use focuses more on accessibility analysis and landscape environment quality. The former studies highlight the inspiration for greenway route selection and design. For example, Zhu Zhanqiang et al. used a multivariate linear regression model to explore the relationship between the built environment around the greenway and the use of the greenway from the perspective of "greenway-neighborhood," and the results showed that the built environment around the greenway affects its use effect, as the surrounding land use mix and residential population density can affect the intensity of greenway use [13]. Zhu Jiang et al. conducted an empirical study on the slow-moving system in the Pearl River Delta region through

correlation analysis and structural equation modeling. The study found that accessibility is an important factor affecting residents' use, which should be used to guide residents' travel preferences in traffic design [14]. The research on landscape environment focuses more on exploring environmental attractiveness. For example, Fan Rong et al. used drone aerial photography tools and eCognition intelligent image analysis methods to construct a model of the visual attraction characteristics of greenway landscape space and found four characteristics of greenway landscape space visual attraction: significance, selectivity, positivity and repetitiveness [15]. Gao Yushi et al. took the 198 LOHAS Greenway in Jinjiang, Chengdu as an example, applied the POE method and conducted a coupling analysis of its conclusions and the spatial participation and landscape preference of users at each node of the greenway. They found that the organic combination of ecology and recreation can enhance the attractiveness of open space [16]. The research on the relationship between greenways and residents' use characteristics has made considerable progress, but the impact of internal environmental factors on the use frequency of users in the built greenways is still lacking. At present, the construction of greenways in our country is in full swing, but there are still problems such as environmental homogeneity leading to low overall use efficiency or even abandonment [17-18]. How to further deepen the existing research and explore the influence mechanism between the two can improve residents' recreational experience, increase use intensity, and accelerate the delivery of health benefits. In view of this, this paper takes the Jiulongpo Greenway as the research object, conducts a quantitative analysis and evaluation of the attributes and use characteristics of greenway users through a questionnaire survey, and puts forward specific suggestions for the optimization of greenway space in a targeted manner. The research results can provide an important basis and reference for the optimization and improvement of greenways.

2 Research Methods

2.1 Selection of influencing factors

The health benefits of greenways are to provide residents with a space for healthy behaviors, ensure that they

can relieve negative emotions, increase physical activity and social interaction in the greenway, and ultimately promote positive adjustments and recovery in psychological state, physiological level, behavior and cognitive function. Therefore, the effect of greenway environment on residents' health benefits is affected by the following factors:

(1) Greenway environmental characteristics

From the perspective of the health benefits that greenways can provide to residents, their environmental characteristics (such as landscape perception, facility services, and maintenance) can be divided into three categories: landscape elements, facility elements, and service elements. Landscape elements (such as beautiful scenery, naturalness, vegetation and water features) can affect the use of greenways [19], and the quality of the environment can directly affect the subjective well-being of users [20]; facility elements (such as road paving, benches, landscape pavilions, activity spaces, etc.) can increase the attractiveness of green spaces [21] and increase the length of time users spend there [22]; maintenance of greenways (such

as safety protection, public security management, etc.) can affect users' subjective perception and is also an important factor in measuring a healthy outdoor environment [23]. Green spaces with low maintenance levels will affect the frequency of use by residents [24].

(2) User behavior patterns

The acquisition of health benefits is closely related to the user's behavioral activities. Studies have shown that participating in physical activities (such as walking and jogging) can improve mental health and physical health more than participating in other activities (such as reading and going to clubs) [25]. In addition, walking in green spaces has higher benefits than walking indoors [26]. Combining relevant research and actual survey results, the user behavior patterns in the greenway are finally divided into sports and fitness (running, walking, equipment exercise), leisure and relax (seeing the scenery, learning history and culture, relieving stress), and social entertainment (staying with friends or family, dancing, chess and cards).

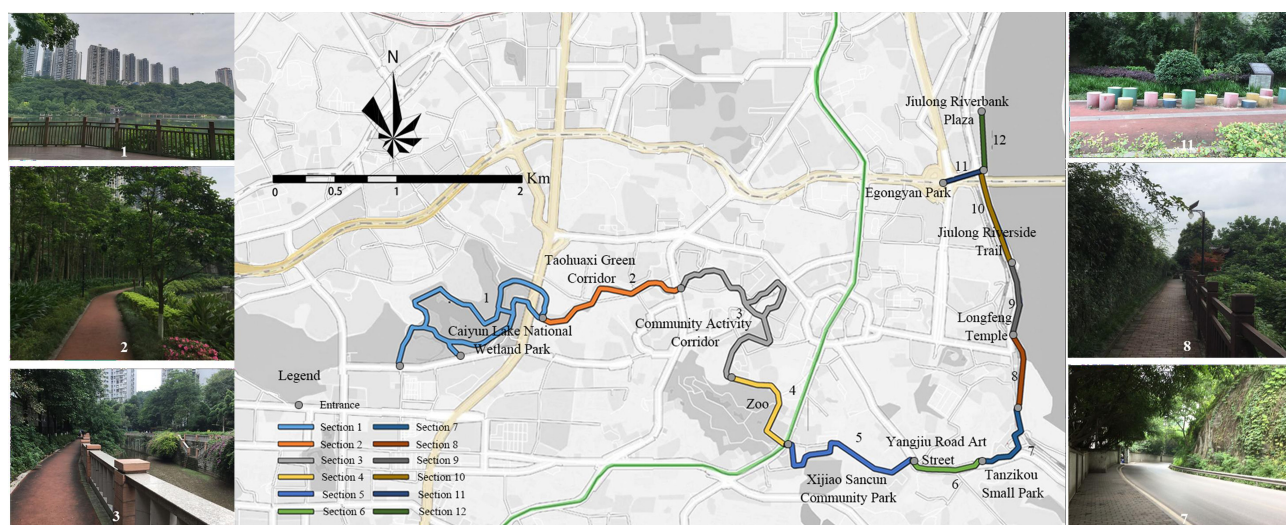


Figure 1 Plan of Jiulongpo Greenway

2.2 Questionnaire and scale design

A questionnaire survey method was used to collect data and record the age, gender, activity type, duration and weekly frequency of users along the greenway during the peak period of greenway use (17:30-21:30 on weekdays and 09:00-21:30 on weekends). Through face-to-face interviews, data from three aspects were collected: 1) the socio-economic attributes of the respondents (age, gender, edu-

cation level, income level); 2) the environmental characteristics of the greenway (landscape elements, facility elements, service elements). The selected indicators (Table 1) were explained to the respondents before the evaluation; 3) residents' usage preferences (the degree of attraction of environmental characteristics to residents) and usage characteristics (duration of use, frequency of use). The questionnaire mainly adopted the chance sampling method. The

survey time was from October 6, 2019 to October 13, 2019, and 273 valid questionnaires were obtained.

Table 1 Indicators in the questionnaire

	Measurement indicator	Definition
Landscape elements	Adequate lighting	Whether the venue is equipped with enough street lights and landscape lighting facilities
	Clear signs	Are the indicator devices around the venue (the start of the greenway, important node signs, entrance and exit signs) clear
	Ease of walking	Is there any traffic interference in the venue, and is the accessibility smooth
	Comfortable paving	Is the paving material suitable for walking
	Landscape art	Is the cultural landscape in the greenway unique (whether the landscape nodes have the regional characteristics of Chongqing)
	Environmental coordination	Is the landscape in the greenway ornamental (vegetation richness, color diversity, seasonal variability, etc.)
Facility elements	Suitable venues	Is the sufficient activity space in the greenway
	Recreation facilities	Is the venue equipped with ordinary seats, pavilions, corridors, flower stands and other rest facilities
	Sanitation facilities	Whether the venue is equipped with sufficient trash cans
Service elements	Safety protection	Whether the venue has safety protection facilities (such as safety guardrails near the car lane, safety guardrails on the overhead walkway, complete lighting equipment, etc.)
	Public security management	Can you call for help in time if there is danger in the venue

2.3 Research Methods

This paper measures the intensity of greenway use through two aspects: first, the degree of attraction of the current environmental characteristics of the greenway to users, that is, whether users are willing to carry out activities in the greenway; second, the frequency of respondents' weekly use of the greenway and the duration of each use of the greenway, and finally the time users are willing to spend in the greenway each week.

2.3.1 The attractiveness of environmental characteristics to residents' use behavior

The 11 environmental characteristics are measured and evaluated using the Likert 5-point scale. The survey content includes "Based on the current environmental composition of the greenway, will these environmental factors attract you to enter the greenway to carry out activities? (1 = very bad, 5 = very good)," and descriptive statistics (mean size) are used as the performance of the environment. The study used KMO and Bartlett's sphericity test to obtain a KMO value of 0.727 and a sig. value of 0.00, indicating that the data sample is sufficient, there is a correlation between the variables, and it is suitable for factor analysis. In order to eliminate the impact of the average value, the coefficient of variation is used to test the consistency of user cognition (Table 2), and the first three fac-

tors with a cumulative variance contribution rate greater than 72.61% are selected, and the weighted summation and normalization processing are used to obtain the weight value of each factor (Table 3). Finally, the weighted summation of the factor weight value is used to obtain a comprehensive evaluation of the impact of environmental factors on users.

2.3.2 Greenway usage level

The time users are willing to spend on the greenway each week is taken as their greenway usage level, and finally the usage level of 12 sections of greenways is obtained (Figure 4).

$$p = \frac{\sum_{i=0}^n t_i * f_i}{n} \quad (\text{Formula 1})$$

Note: t_i is the weekly usage time of the i -th person, f_i is the weekly usage frequency of the i -th person, and n is the total number of people

3 Results Analysis

3.1 Analysis of User Attributes and Purposes

As can be seen from Figure 2, the proportion of females is 52.75%, slightly higher than that of males at 47.25%; in terms of age structure, the largest number of people aged 45-60, accounting for 24.18%, while those under 18 (9.16%) and over 60 (9.89%) accounted for smaller proportions; in terms of education level, the proportion of

people with vocational education or above was the highest (58.24%), and the overall education level was relatively high; in terms of income level, the low-income group (monthly income $\leq 3,000$ yuan) accounted for 20.51%, the middle- and high-income groups ($3000 \leq$ monthly income ≤ 7000 yuan) accounted for the highest proportion of 63.74%, and the high-income group (monthly income ≥ 7000 yuan) accounted for 15.75%; in terms of the pur-

pose of use, the proportions of people using the greenway for leisure and relax (33.97%) and sports and fitness (33.67%) were relatively high, and there were also some using it for commuting and shopping (19.05); the proportion of people using the greenway more than twice a week was 79.49%, and the proportion of people staying in the greenway for 15-60 minutes was 79.49%.

Table 2 Total variance explained

Total variance explained									
Component	Initial eigenvalue			Extracted sum of squares of loadings			Rotated sum of squares of loadings		
	Total	Variance percentage	Cumulative/%	Total	Variance percentage	Cumulative/%	Total	Variance percentage	Cumulative/%
1	5.630	51.184	51.184	5.630	51.184	51.184	4.366	39.692	39.692
2	1.353	12.299	63.483	1.353	12.299	63.483	2.536	23.058	62.750
3	1.004	9.124	72.606	1.004	9.124	72.606	1.084	9.856	72.606
4	.831	7.556	80.163						
5	.546	4.963	85.126						
6	.493	4.482	89.607						
7	.425	3.865	93.472						
8	.322	2.927	96.399						
9	.193	1.752	98.151						
10	.145	1.317	99.469						
11	.058	.531	100.000						

Table 3 Weightranking of each factor

Dimension	Factor	Mean	Coefficient of variation	Common factor variance extraction	Weight	Order
Environmental quality and safety	Adequate lighting	3.36	26.85%	.810	0.0942	5
	Clear signs	2.48	36.61%	.700	0.0852	6
	Ease of walking	3.91	16.01%	.640	0.1044	4
	Comfortable paving	3.73	23.89%	.557	0.0803	9
	Landscape art	3.85	20.34%	.631	0.0807	8
	Environmental coordination	3.66	23.50%	.947	0.1185	1
Facilities	Suitable venues	4.1	22.00%	.684	0.1178	2
	Recreation facilities	3.9	23.13%	.683	0.1146	3
	Sanitation facilities	3.85	17.56%	.563	0.0812	7
Maintenance and management	Safety protection	2.95	36.44%	.839	0.0759	10
	Public security management	2.22	34.41%	.931	0.0472	11
	Overall attractiveness	3.42	11.44%			

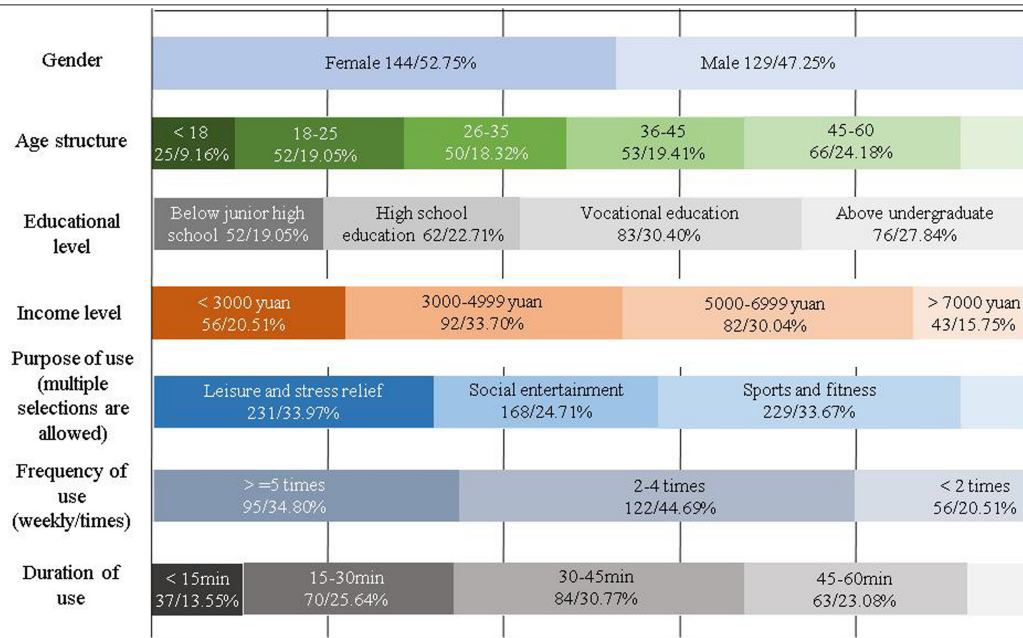


Figure 2 Social demographic characteristics of the respondents

3.2 Evaluation of the attractiveness of the environmental factors of Jiulongpo Greenway

3.2.1 Evaluation of the attractiveness of individual environmental factors

From the perspective of the performance of individual factors of the environment, the high average values of suitable venues, recreational facilities, comfortable pavement, ease of walking, and landscape art can better serve users, while the low average values of sign system, public security management, and safety protection indicate that the current status is poor. In addition, the coefficients of variation for ease of walking (16.01%) and sanitation facilities (17.56%) were relatively small, indicating that users had a high degree of consistency in their performance evaluation of these two items; while the coefficients of variation for clear signs (36.61%), safety protection (36.44%), and public security management (34.41%) were relatively large, indicating that the respondents had large differences in their opinions about these three factors. Combining the sample description (Figure 3) with the field interviews, it can be inferred that there are two reasons: 1) There are differences in individual subjective cognition. Taking the clear sign factor as an example, in the current Jiulongpo Greenway sign system, only the greenway starting and ending points (Caiyun Lake Wetland Park and

Egongyan Park points), are map marks combined with written introductions. The rest of the sign points are simple names and direction markings, especially for special mountainous terrains, which cannot provide effective guidance. From the perspective of public security management, the overall score of the greenway is currently low (2.22), and the average of different sections is also low. There are significant differences in public security management between individuals. Female groups, especially those with children, have more urgent safety needs, which also reflects that the Jiulongpo Greenway urgently needs to be optimized and improved in terms of public security management; 2) The performance of the two factors of safety protection varies significantly between different greenway sections (the highest is 3.87, the lowest is 1.57). From the distribution of greenways, the 7th section (1.57) and the 8th section (2.01) perform poorly in safety protection. In the on-site survey, it was found that the current pedestrian path of the 7th section of the greenway is narrow and there is no safety isolation due to the large slope and the difficulty of optimization, which leads to safety hazards. The 8th section of the greenway is adjacent to the railway track, and there are some greenway walking widths less than 1m and the guardrails on one side are short, which are dangerous for children, so it needs to be paid attention to.

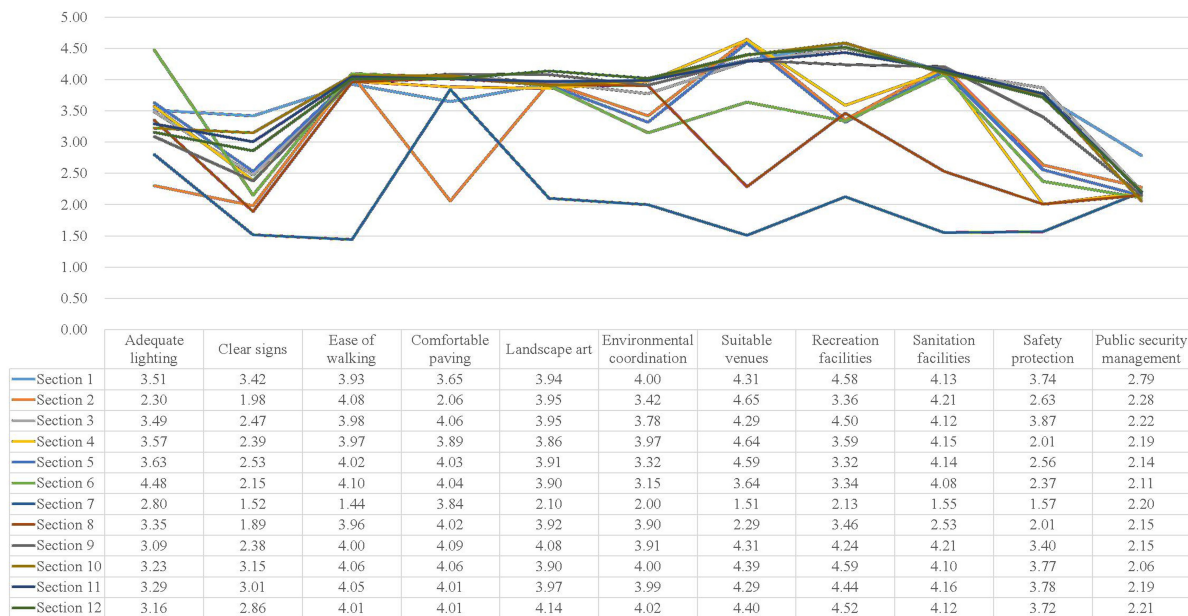


Figure 3 Performance of attractiveness of each factor in greenway segment

3.2.2 Overall attractiveness evaluation of the greenway

As shown in Table 2, the average value of the overall attractiveness of greenway to the respondents is 3.42, and the coefficient of variation is 11.44%, indicating that the overall attractiveness of greenway to users is relatively large, and the level of cognitive consistency is high, which also shows that the planning and construction of Jiulongpo Greenway is relatively successful. The weight of an environmental characteristic evaluation factor can characterize the influence of this factor on the overall attractiveness of greenway. As shown in Table 2, the four factors with the largest contribution rate to the evaluation of the current attractiveness of greenway are environmental coordination (11.85%), suitable venue (11.78%), rest facilities (11.46%), and ease of walking (10.44%), which shows that the factors affecting the level of attractiveness of greenway to users are mainly concentrated in the service function of greenway, whether there are sufficient activity venues and rest facilities (pavilions, seats, etc.), environmental quality and walking accessibility.

3.3 Analysis of usage level of Jiulongpo Greenway

3.3.1 Comparison of usage duration and usage frequency between the sections

At present, there are significant differences in the usage levels between the sections Jiulongpo Greenway, and the overall spatial pattern is “more in the west and less in the east” (Figure

4). Among them, there are 5 greenway sections with high usage levels calculated through Formula 1: section 1 has the highest usage level (10.46), followed by section 3 (7.94), section 11 (7.53), section 12 (7.38), and section 4 (7.20). The reason is that the western sections of the greenway have the highest level of use. Among them, Caiyun Lake Park (section 1) has good current landscape conditions and is highly attractive to users. The Taohuaxi Community Activity Corridor Section (section 3) currently has many residences and public services, with complete supporting facilities and sufficient fitness facilities; there is a height difference between the eastern part of the greenway near the Yangtze River and the surrounding roadways (Zhigang Avenue, Jiubin Road), and the entrances to the greenway were few, resulting in limited accessibility. It can be seen that the level of greenway usage is closely related to the environmental characteristics of the greenway itself.

In terms of frequency of use, users of section 1 mostly use it more than 5 times a week, users of section 3 mostly use it 2-4 times a week, and users of section 12 and section 4 use it more than 2 times a week. There are large individual differences among users of section 11, which indicates that users may have different purposes of using section 11. In terms of usage time, users of sections 1 and 3 all spend more than 30 minutes, and some users spend more than 1 hour. The usage time of sections 12 greenways is mostly concentrated between 30-60 minutes, and the length of

time users spend on section 11 of the greenway varies significantly among individuals. In addition, the usage frequency of 6 sections is higher than 5 times but the dura-

tion is low, suggesting that there may be behaviors such as commuting and shopping, which has nothing to do with the environmental characteristics of the greenway itself.

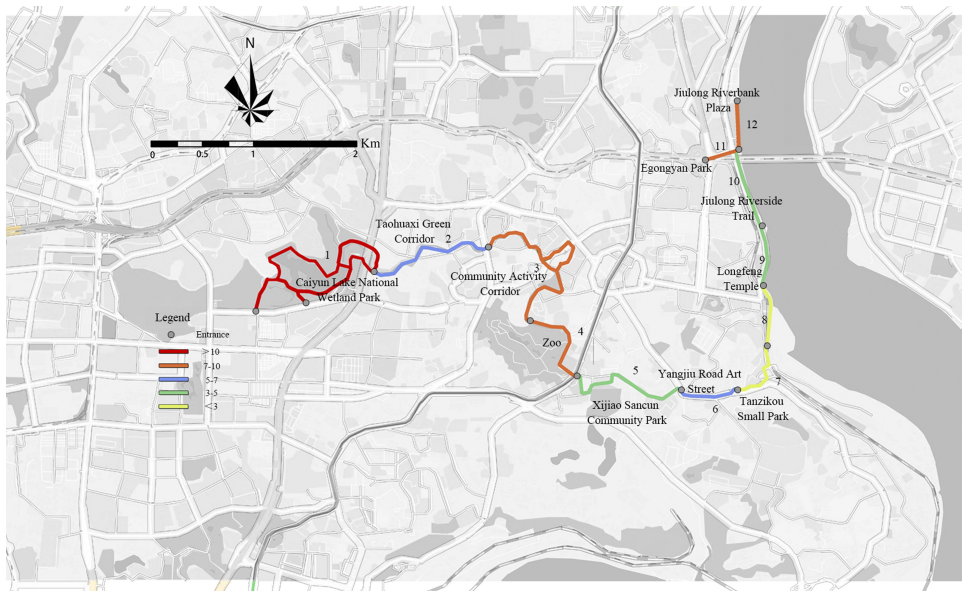


Figure 4 Jiulongpo Greenway usage time analysis chart

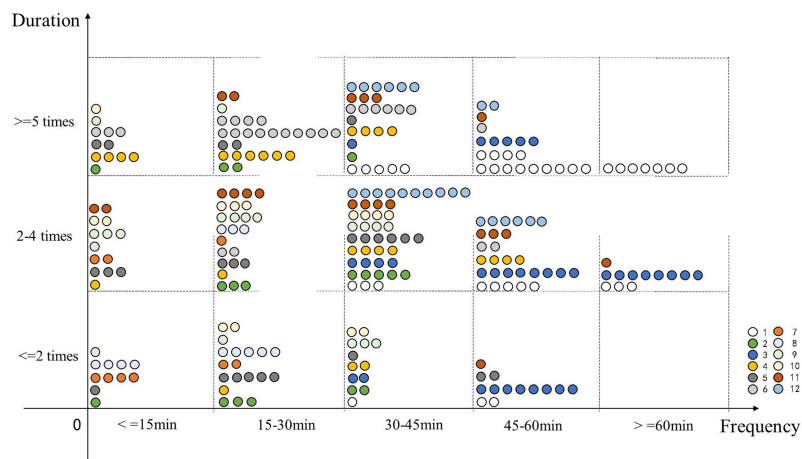


Figure 5 Sample distribution performance chart

3.3.2 Correlation analysis between environmental characteristics, usage duration and usage frequency

As can be seen from Table 4, there are significant differences in the attractiveness of different environmental elements in greenways to respondents in terms of frequency of use and duration of use. There is a positive correlation between the overall environmental quality and supporting facilities of the greenway and the frequency of use of the greenway (0.201^{**} , 0.181^{**}) and the duration of single use (0.326^{**} , 0.243^{**}) of the respondents. Among them, ease of walking (0.220^{**}), landscape art (0.261^{**})

and frequency of use are positively correlated at the confidence zone of 0.01, that is, the stronger the accessibility of the greenway and the more distinctive the landscape, the greater the frequency of use; secondly, landscape art (0.261^{**}), environmental coordination (0.184^{**}) and single use duration are positively correlated at the confidence zone of 0.01, that is, the higher the uniqueness and richer types of the landscape, the longer the respondent's single use duration; suitable venues (0.199^{**} , 0.203^{**}) and recreational facilities (0.304^{**} , 0.15^{**}) in supporting facilities and frequency of use are positively correlated at the confidence

zone of 0.01, that is, the more complete the greenway is with sufficient activity space and recreational facilities, the larger the respondent's frequency of use and the duration of single use; the overall maintenance facilities of the greenway are positively correlated with the respondent's frequency of use (0.380^{**}),

among which safety protection (0.423^{**}) and frequency of use show a positive correlation in the confidence area of 0.01, that is, the more complete the adequate safety guardrails and safety prompt facilities in the greenway site, the higher the frequency of use by the respondents.

Table 4 Correlation analysis between individual factors and usage duration and frequency

Environmentalelements		Usage frequency	Sig.(two-tailed)	Singleuse time	Sig.(two-tailed)
Environmental quality		.201 ^{**}	0.001	.181 ^{**}	0.003
	Adequate lighting	—	—	—	—
	Clear signs	—	—	—	—
	Ease of walking	.220 ^{**}	0.000	—	—
	Comfortable paving	—	—	—	—
	Landscape art	.261 ^{**}	0.000	.213 ^{**}	0.000
	Environmental coordination	—	—	.184 ^{**}	0.002
Facilities		.326 ^{**}	0.000	.243 ^{**}	0.000
	Suitable venues	.199 ^{**}	0.001	.203 ^{**}	0.001
	Recreation facilities	.304 ^{**}	0.000	.159 ^{**}	0.005
	Sanitation facilities	—	—	—	—
Maintenance and service		.380 ^{**}	0.000	—	—
	Safety protection	.423 ^{**}	0.000	—	—
	Public security management	—	—	—	—

Note: ^{**} means at the 0.01 level (two-tailed), the correlation is significant; ^{*} means at the 0.05 level (two-tailed), the correlation is significant.

3.3.3 The impact of Jiulongpo Greenway environmental characteristics on residents' use level

Taking Jiulongpo Greenway as an example, the study took the attractiveness of the current environmental characteristics of the greenway and the time respondents were willing to spend as the research objects. The study found that: improving environmental beauty and pedestrian accessibility will increase the attractiveness of the greenway and increase the frequency of use of respondents; suitable activity venues and sufficient recreational facilities will help psychologically encourage users to actively participate in green space activities and extend their single use time.

In terms of landscape art, the current performance of section 1 (Caiyun Lake Park), section 4 (around Chongqing Zoo), and sections 9-10 (Riverside Landscape) is better when comparing the ornamental value of the greenway environment. This shows that the urban trails that connect the existing landscape nodes of the city can rely on the existing high-quality landscape resources to

conveniently create an environment that meets the viewing needs of residents. In terms of ease of walking, the network analysis module of ArcGIS was used to buffer the entrance of each section of the greenway along the road, and the walking range of 500m and 1000m was obtained respectively. By comparing the accessibility of each section, it was found that the 500m walking accessibility of sections 3-6 was the highest, and those of sections 9-14 were the worst. The heterogeneity was highlighted and each had its own advantages and disadvantages. First of all, the wide traffic radiation around the greenway sections 3-6 brought convenient accessibility, but on the other hand, the convenience of traffic also caused a certain degree of interference to the sightseeing walking behavior, resulting in a high frequency of use but a short use time for users of this section of the greenway (Figure 6). Due to the influence of the terrain height difference, sections 9-14 have poor connection with the surrounding traffic, but their relatively closed environment also creates a quiet and comfortable walking space. Therefore, the overall use frequency of this section is relatively low, but the single use

time is longer, which shows that the accessibility and walking accessibility of the greenway are equally important in route selection and design. In terms of suitable venues and recreational facilities, by comparing the current activity venues and rest facilities of each section of the greenway (Table 5), it was found that some sections of sections 6-8 lacked fitness facilities and entertainment facilities, while other sections had them arranged, but there were differences in the evaluation scores. It is speculated

that the quality of venue and facility arrangement will directly affect the attractiveness of the greenway. By comparing the high-scoring greenways of sections 1, 3, 10, and 12, there common features were found. Concentrated activity venues of sections 1, 3, and 12 were surrounded by appropriate rest seats, and the rest seats of sections 1, 3, and 10 were often set up in combination with small nodes (small landscapes, cultural corridors, historical corridors, etc.).

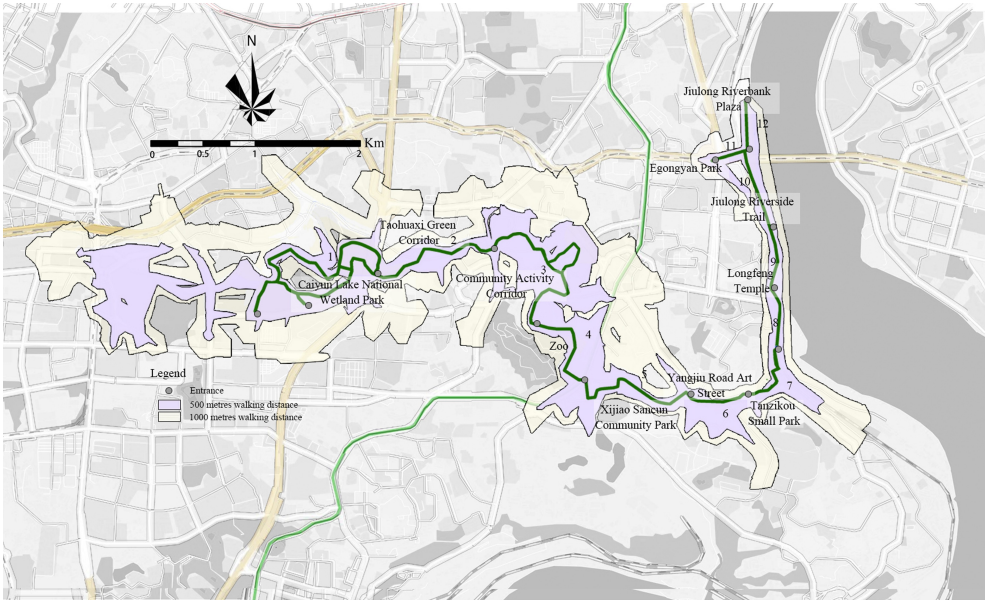


Figure 6 Greenway accessibility analysis diagram

Table 5 Distribution of activity venues and recreational facilities along the greenway

Greenway section	Activityvenues				Recreational facilities		
	Fitness facilities	Entertainment facilities	Activity squares	Plastic fitness tracks	Seats (open-air)	Landscape pavilions (rain shelter)	Landscape bridges
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
6			<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
7			<input type="checkbox"/>		<input type="checkbox"/>		
8	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		
9		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
10		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
11		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		
12	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		
13		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Note: ☐ indicates that there are sites or facilities of this type within the greenway.

4 Conclusions and suggestions

The intensity of residents' use of greenways reflects their physical activity level and healthy life quality to a certain extent, and it is closely related to the level of environmental characteristics within the greenway. In the planning and design of greenways, emphasis should be put on the environmental factors of greenways that affect the use intensity, because the use intensity of urban greenways is not only affected by one or two factors, but by multiple factors and their interaction. Starting from users' frequency and duration of use of greenways, the study explored the statistical correlation between environmental characteristics and usage intensity. The research results show that there are significant differences in the attractiveness of different environmental elements to respondents in terms of frequency of use and duration of use. In terms of environmental quality, landscape art will affect the frequency and duration of use by residents. The more prominent the landscape features are, the higher the intensity of use of greenways. Ease of walking will affect the frequency of use by residents. The more accessible the path, the higher the frequency of use by residents. Environmental coordination affects residents' usage time. The more ornamental the landscape, the longer a single usage time. Among the supporting facilities, suitable venues and recreational facilities have an impact on the duration and frequency of residents' use. Sufficient activity space and complete recreational facilities will increase the intensity of residents' use. In maintenance and management, greenways with good safety protection are used more frequently by residents. In view of this, in order to build a greenway environment that promotes healthy behavioral activities, this article puts forward space optimization suggestions from four aspects: path accessibility, landscape features, activity venues and recreational facilities, and safety protection.

(1) Enhance path accessibility and reduce walking interference. From the perspective of ease of walking, urban greenways mainly serve surrounding residents, so their lo-

cation selection should give priority to the accessibility of their paths. Studies have shown that 79.8% of greenway users live within a radius of 1 kilometer from the greenway. Within the greenway, the closer it is to residences, the higher its utilization rate [27]. Since urban greenways have a wider radiation range, the setting up of convenient public transportation is more conducive to serving urban residents. In addition, the setting of greenways should reduce external interference. For example, Partially closed facilities can reduce the motorized traffic load and the impact of road intersections on the greenway, providing users with a better walking space environment.

(2) Optimize environmental quality and enhance landscape features. Trails with high naturalness can help maximize the health benefits of urban greenways and increase the frequency of users' activities. Creating an environment with regional characteristics can help enhance users' satisfaction and improve their health recovery functions. Therefore, when selecting greenway routes, priority should be given to areas with good green landscape background in the city, connecting existing urban resources and maintaining existing natural landscapes during planning and construction, and on this basis, integrating regional culture and landscapes and pursuing maximized utilization of landscape features. Secondly, in addition to combining the existing cultural characteristic elements of the city, the creation of regional characteristic landscapes also helps to create a cultural sense of the place by exploring the city's characteristic elements.

(3) Create suitable activity venues and equip them with sufficient recreational facilities. Through questionnaire surveys, it was found that the availability of facilities (sports equipment, trails) in greenways directly affects their frequency of use, and the comfort of rest seats directly affects the use of greenways. Therefore, in the design of activity venues, attention should be paid to the different recreational motivations of users, and the diversified needs of users should be met. According to different usage purposes and their strengths, different numbers of venues

should be set up to optimize and reasonably divert various types of users to the greatest extent. In the setting of recreational facilities, the seats should be comfortable and safe, a balance between privacy and publicity should be achieved, and the fun of rest should be improved by combining landscape items.

(4) Add protective facilities to improve walking safety. Users are more likely to avoid greenways that are crowded, unsafe, or poorly maintained [28]. From the perspective of the width of the trail, isolation facilities should be installed near the surrounding roadways. For areas with large traffic flow, green isolation can be added to reduce some exhaust gas and noise pollution; from the perspective of the signage system, for special areas (such as greenway sections with steep slopes) clear warning signs and protective facilities should be installed to ensure walking safety; from the perspective of the lighting system, lighting facilities in the greenway should be regularly maintained to ensure safe use at night.

As a key project of urban ecological construction in our country, greenways have become an important recreational resource in cities due to their small footprint, wide coverage and strong connectivity. The conversion of greenway spaces to health benefits depends on residents' use. Increasing the intensity of greenway use can help create a healthy lifestyle. However, the impact of greenway environmental characteristics on usage intensity is diverse, and the social attributes of different groups and individual usage purposes will have an impact on the research results. This study only investigated how physical and environmental attributes affect the intensity of greenway use, and there is insufficient research on social factors and individual attributes. Therefore, the next step of research should highlight the complex interactions between environmental factors and other factors (such as individuals and society), and explore the cumulative impact and related constraints of urban greenway use, so as to have a more comprehensive understanding of the impact of comprehensive factors on the intensity of urban greenway use.

Figure and table sources

All figures and tables in the paper are created by the authors.

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