The Urban Park Soundscape in Mountainous Cities：A case study in Chongqing

Heng Li[1,2]; Hui Xie[1,2]; Jian Kang[2,3]

[1] Faculty of Architecture and Urban Planning, Chongqing University, Chongqing, 400045, China

[2] Key Laboratory of New Technology for Construction of Cities in Mountain Area, Ministry of Education, Chongqing University, Chongqing, 400045, China

[3] School of Architecture, Sheffield University, Sheffield, S10 2TN, UK

ABSTRACT

As a typical mountainous city, undulating terrain in Chongqing creates a unique urban structure, and the richness of urban park soundscapes is enhanced as well. In this paper, one urban park, named 'ShaPing Park', was selected for the field measurement and questionnaire survey. Approximately 10 receiver points were arranged, with the consideration of both elevations and functional zones. The recreation zone and quiet zone were generally dominated by low frequency sounds, whereas the middle frequency sounds were more significant at the activity zone. Some special sounds, such as whipping tops, were observed in the park. People singing (65.1%) was the most annoying sound due to its unpleasantness. 57.2% of the respondents considered the acoustic environment as severely or relatively noisy, but only 44.5% of the interviewees regarded it comfortable or relatively comfortable. 'Sound level' (57.1%) and 'personal interests' (49.2%) were recognized as the major factors influencing personal sound preference, and the appropriate improvements of acoustical environment were identified as the priority in the studied urban park.

Keywords: Soundscape, Mountainous city, Urban park I-INCE Classification of Subjects Number(s): 56.3

1. INTRODUCTION

Chongqing is a typical mountainous city in Southwestern China. Undulating terrains bring diversified uncertainty to the urban open spaces. The increased density of buildings makes urban noise complicated [1]. However, the richness of urban park soundscape in Chongqing is enhanced as well.

Generally, the urban parks are multifunctional, including tours, entertainment, sports, recreation, catering, accommodation and other functions [2]. The various open spaces in the parks would be required to fulfill the needs of activities from different age groups [3]. For the study on the soundscape adaptability of the open spaces in urban parks, the focus should be the activities involved by visitors, and the subjective sound preference and sound comfort [4-6]. However, most of previous studies in mountainous cities were only simple noise level surveys with limited acoustic indices considered. The effects of subjective reactions have largely been ignored. Soundscape approach has never been applied to guide the environmental design and planning in urban parks of mountainous cities. Therefore, in this paper, one urban park, named 'ShaPing Park', with typical mountainous features was selected for urban soundscape survey, through a series of field measurements and questionnaire survey.

[1] liheng0621@gmail.com
[2] yanshencun@hotmail.com
[3] j.kang@sheffield.ac.uk

2. METHODS

2.1 Case Study Site

Shapingba District is one of the most densely populated regions in Chongqing. The central park in Shapingba District, namely 'ShaPing Park' was chosen as the case study site, from November to December 2013. This park is very close to the city center, and occupies an area of 18 hectares. It attracts large numbers of tourists and local residents every day. In accordance with the original planning, this park could be divided into three functional zones, including activity zone, recreation zone and quiet zone, as shown in Figure 1 [7].The uneven feature of terrain could be observed in this park, and different zones are connected with stairs or ramps. The locations of receiver points were also presented in Figure 1.

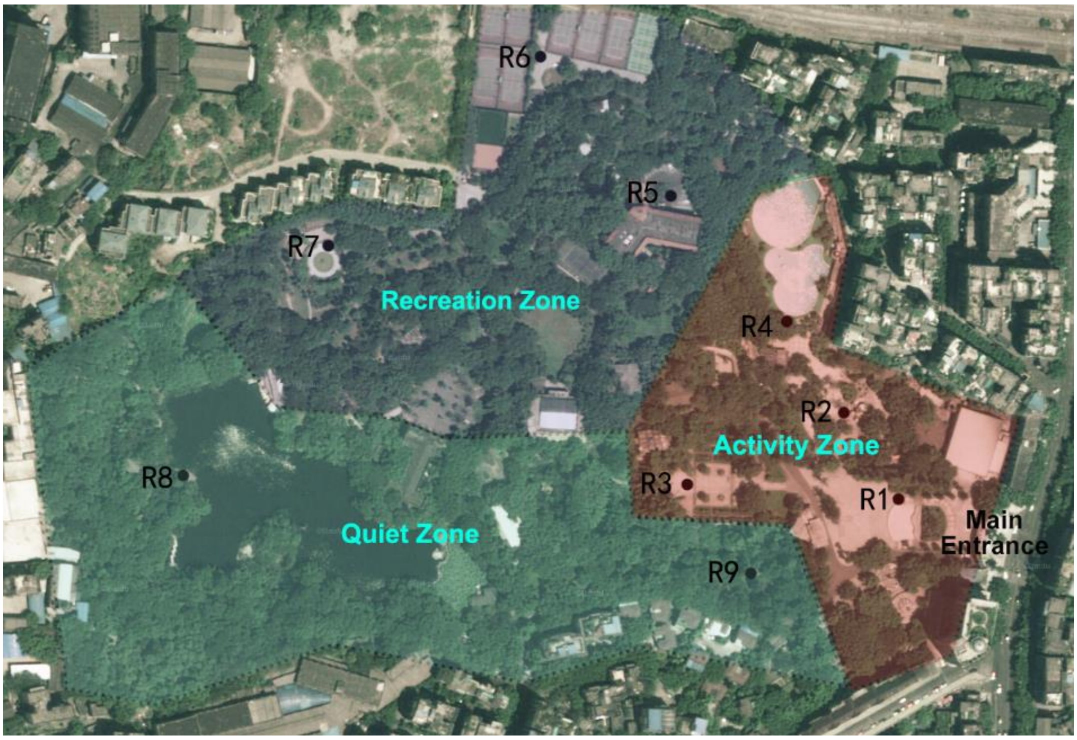

Figure 1 – Receiver points and functional zones of ShaPing Park, Chongqing

2.2 Field Measurements

In the study area, 9 receiver points were arranged, with the consideration of different elevations and functional zones (on the weekends, from 3 p.m. to 5 p.m.). Six main noise indicators were analysed, namely L_{Aeq} (dBA), maximum L_{max} (dBA), minimum L_{min} (dBA), background noise L_{90} (dBA), intrusive noise L_{10} (dBA) and 1/3 octave frequency, respectively. Meanwhile, terrain characteristics and people activities of each measured location were recorded in the forms of photographs and videos. The section plan of this park with all the receivers was illustrated in Figure 2.

2.3 Questionnaire Survey

A total of 126 valid questionnaires were collected from the randomly approached visitors in this park. Firstly, interviewees were asked to provide information about their gender, age, occupation, and local residency. In the questionnaire, there were three open questions (Q1-Q3) and four 5-point scale questions (Q4-Q7) as follows, 'Q1: Please list the soundmarks you hear in the surrounding environment.' 'Q2: Please list the sounds you favour.' 'Q3: Please list the sounds you dislike.' 'Q4: How noisy is the sound environment?' 'Q5: How comfort is the sound environment?' 'Q6: How much do the favorite sounds positively affect you?' 'Q7: 'How much do the sounds you dislike negatively affect you?' Similar answers were provided as 'not at all, slight, moderate, relatively severe, severe' for Q4-Q7. Moreover, two multi-choice questions were added in the end, 'Q8: Which factors (the occurrence time and location of sound event, sound level, surrounding environment, weather, personal interests, physiological or psychological status and others) would affect your sound preference?' 'Q9: Among the five environmental factors (acoustics, air quality, humidity and thermal, lighting, waste pollution), which one should be improved as the priority?'

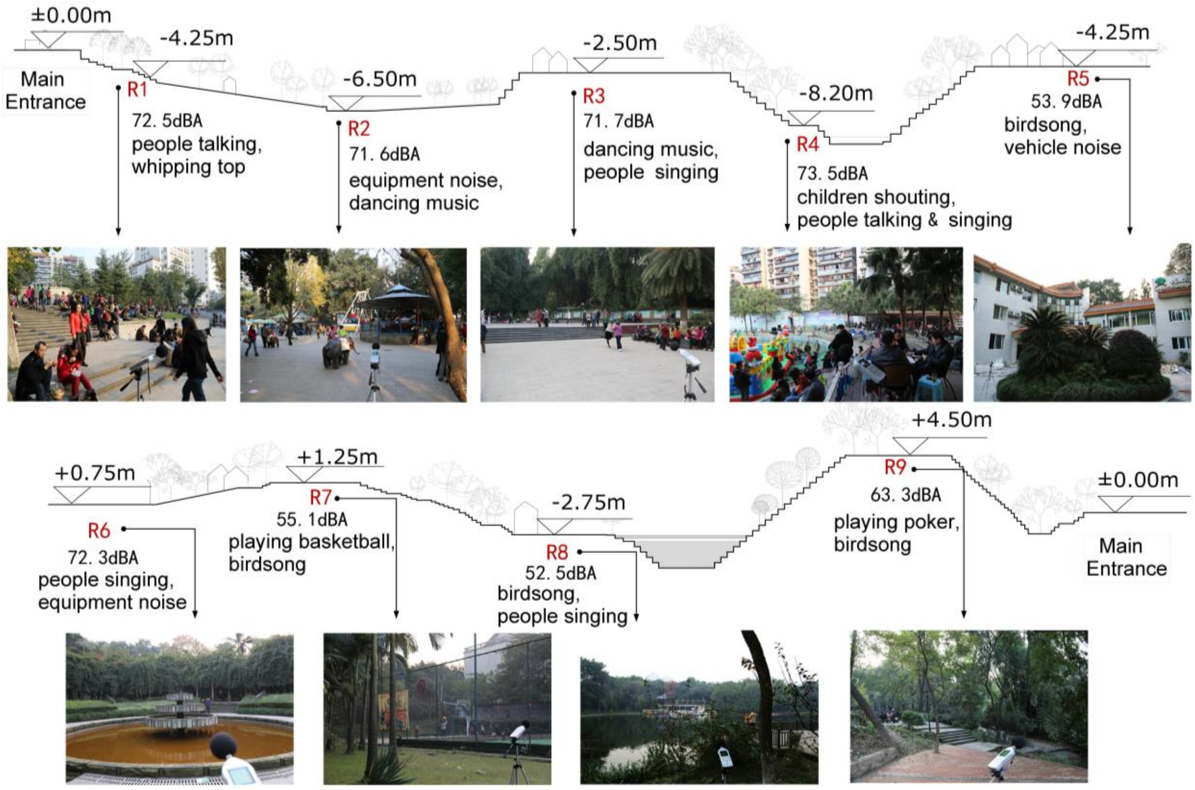

Figure 2 – Section plan of 'ShaPing Park' along with receiver points, relative elevations, $L_{Aeq\text{-}5mins}$, and the corresponding soundmarks

3. RESULTS AND DISCUSSIONS

3.1 Environmental Sound Levels

Table 1 demonstrates the comparisons of three noise indicators, namely the equivalent, maximum, minimum noise levels of all the receivers in the functional zones. It can be seen that, L_{Aeq} of R1-R4 exceeded 70.0dBA in the 'Activity zone' close to the external highway areas, and even L_{min} were at least 63dBA. L_{min} of three receivers (R5-R7) in the 'Recreation zone' was measured as 50.0dBA approximately. In the 'Quiet zone', R8, near the lakeside, its L_{Aeq} (52.5dBA) was the lowest among all the nine receivers. The differences between maximum and minimum levels at R6 were as high as 34.4dBA, due to the influences of nearby mini Karaoke bar.

Table 1 – Logarithmic averages and standard deviations of sound level L_{Aeq}, maximum level L_{max}, minimum level L_{min}, statistical sound levels (L_{90}, L_{10}), in terms of $L_{Aeq\text{-}5mins}$ (dBA)

	Activity zone				Recreation zone			Quiet zone	
Receivers (location)	R1 (entrance stairs)	R2 (play-ground)	R3 (dancing square)	R4 (swimming pool)	R5 (hotel)	R6 (fountain)	R7 (basketball court)	R8 (lakeside)	R9 (bamboo grove)
L_{Aeq}(dBA)	72.5 (±3.64)	71.6 (±2.43)	71.7 (±2.77)	73.5 (±1.62)	53.9 (±2.22)	72.3 (±6.38)	55.1 (±2.17)	52.5 (±2.23)	63.3 (±2.16)
L_{max}(dBA)	84.3	84.4	83.5	80.8	70.6	85.1	70.5	59.6	74.4
L_{min}(dBA)	63.7	64.3	62.8	64.7	48.9	50.7	50.3	43.3	58.0
L_{90}(dBA)	66.8	68.1	67.0	71.3	50.6	60.1	52.2	49.5	60.2
L_{10}(dBA)	76.0	74.0	74.1	75.1	54.5	76.6	56.7	55.2	65.7

Moreover, Figure 3 shows detailed one-third octave band sound levels of all the receivers with the relative elevations and distances to the main entrance of this park. The recreation zone and quiet zone (R5, R7, R8 and R9) were generally dominated by low frequency sounds, whereas the middle frequency sounds were more significant at the activity zone (R1-R4).

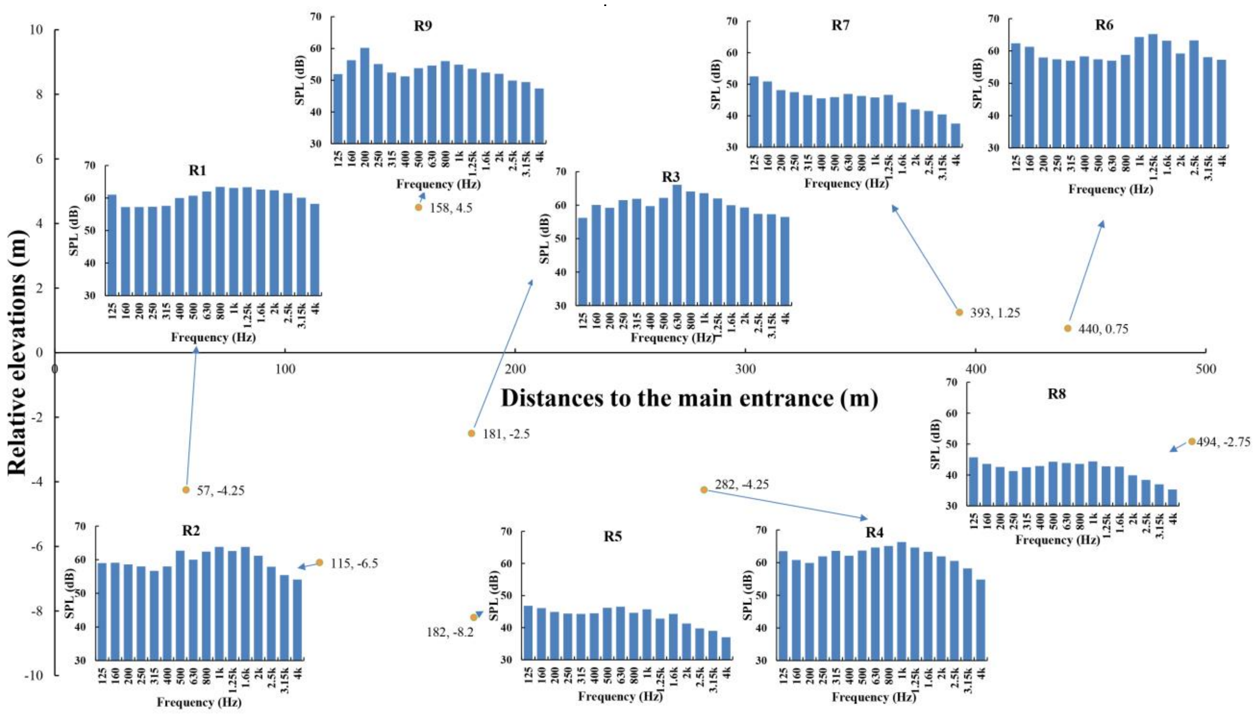

Figure 3 – One-third octave band sound levels of all the receivers with the relative elevations and distances to the main entrance

Based on the on-site measurements and observations, the features of the urban park soundscape in the study area were summarised below,

Dancing music, people singing or other noisy activities at the 'Recreation zone' and the 'Quiet zone' caused considerable dissatisfactions and complaints from the visitors. In particular, the intrusive sounds of mini Karaoke televisions spread over the lakeside and bamboo areas, given 74.4dBA in the bamboo area (R9), and 85.1dBA near the fountain (R6) in terms of maximum sound levels. Obviously this do not harmonise with its peaceful natural surroundings. Not only the mood of people doing morning exercises were notably affected by the excessive noise levels, but also the majority of visitors found very difficult to stay for a rest at those areas.

Apart from music and singing, sound from whipping tops was another special but annoying source close to the main entrance (R1). Its peak noise level could reach 85dBA within a constant time period. The highest flow of visitor traffic in this park was observed at this area. Surprisingly, as interviewed, 71.4% of visitors helplessly sat there and simply waited for their friends, rather than enjoyed the special sounds or comfortable sound environment, indicating the great importance of appropriate improvements upon the urban park soundscape.

As shown in Figure 4, obvious time variations were also featured in the soundscape of studied urban park, taking its swimming pool (R4) as an example. On weekends it was crowded with a large number of exciting kids and accompanied parents, while on weekdays only few tea drinkers stayed there. As the comparison, L_{Aeq} measured on Sunday was 17dBA higher than the level on Monday at the same time.

3.2 Questionnaire survey

According to the questionnaire results, people singing (65.1%) and dancing music (54.0%) were identified as the most annoying sounds by the local residents or visitors. The main reasons were 'too noisy' (84.5%) and 'too unpleasant' (62.4%). As expected, birdsong (71.4%) and water sound (50.8%) were mostly favoured. Figure 5 provides that 57.2% of the respondents considered the acoustic environment as severely or relatively severely noisy, whereas only 44.5% of the interviewees regarded it comfortable or relatively comfortable. More than half of the respondents (66.7%) believed that annoying sounds could make severe or relatively severe negative effects on their daily life or work, while only 30.2% of the respondents stated that favorite sounds could make considerable positive impacts on them.

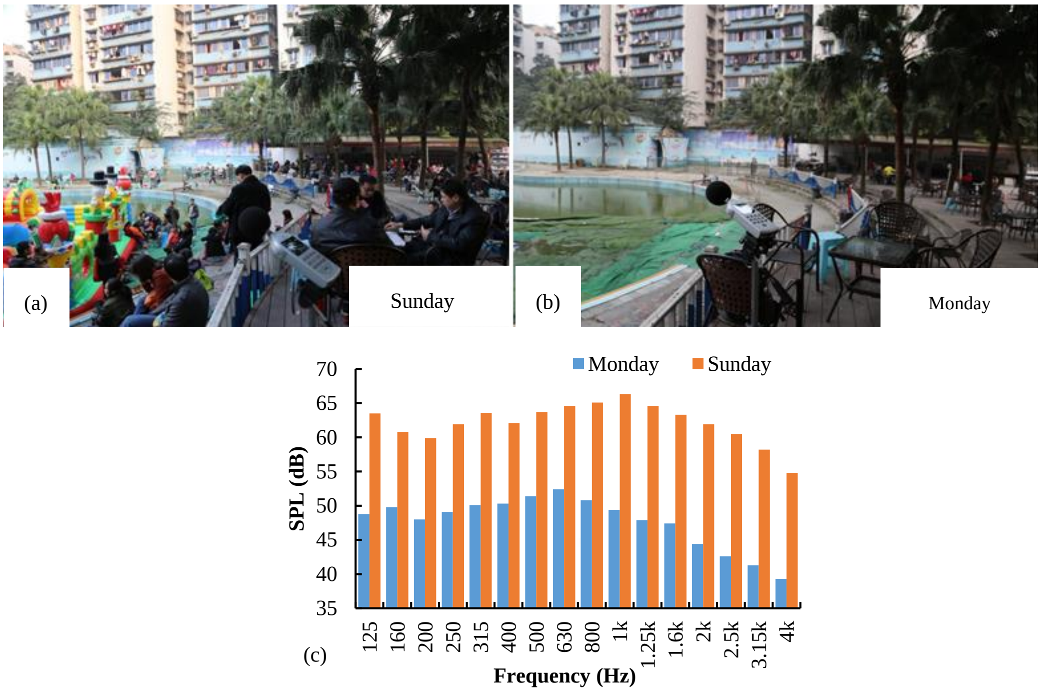

Figure 4 – Comparison of swimming pool (R4) on weekday and weekend afternoon; (a) the scene on Sunday, (b) the scene on Monday, (c) 1/3 octave band

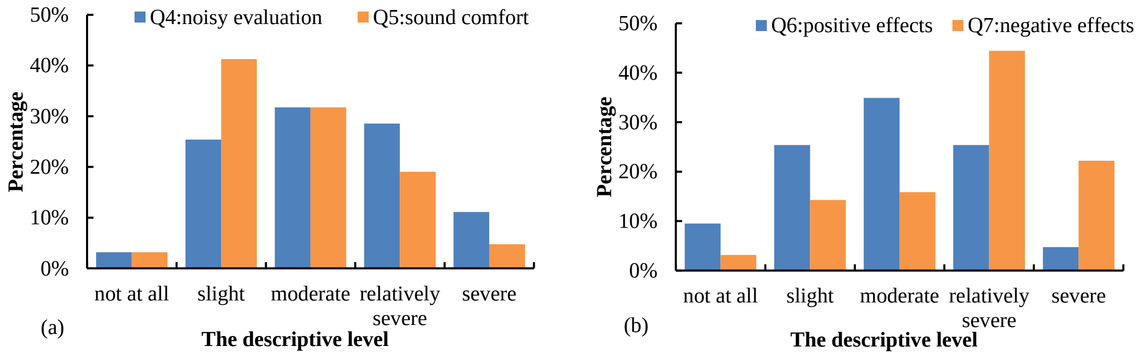

Figure 5 – The result of Q4- Q7; (a) noisy evaluation (Q4), acoustic comfort evaluation (Q5), (b) the sound positive effects (Q7) , the negative effects (Q7)

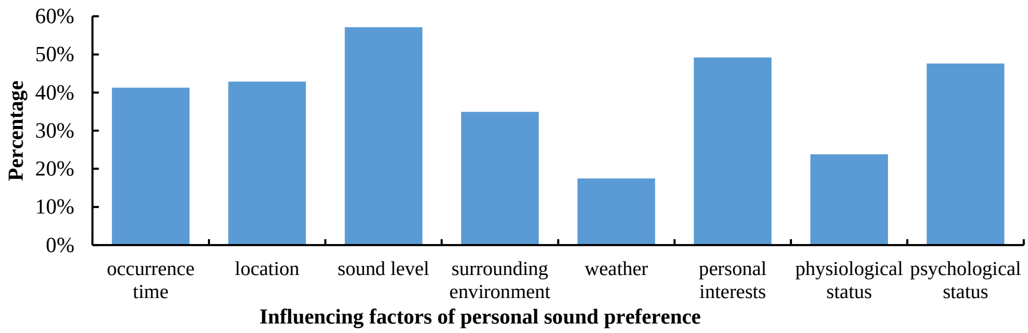

Figure 6 – The result of Q8: which factor can affect your sound preference?

Figure 6 presents that 'sound level' (57.1%) and 'personal interests' (49.2%) were regarded as the top factors influencing personal sound preference, within the context of urban park soundscape. Among the five main physical environmental factors displayed in Figure 7, 38.1% of subjects regarded the acoustic environment as the crucial priority to be improved appropriately, followed by waste pollution (28.6%), such as the dirty water in the fountain (R5).

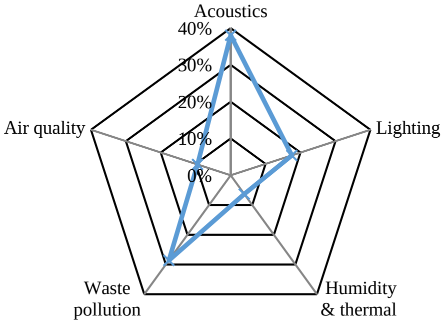

Figure 7 – The result of Q9: the importance to improve physical environmental factors in the park

4. CONCLUSIONS

This paper investigated the urban park soundscape in a mountainous city, through a series of field measurements and questionnaire survey. The recreation zone and quiet zone were generally dominated by low frequency sounds, whereas the middle frequency sounds were more significant at the activity zone. Some special sounds, such as whipping tops, were observed in the park. People singing (65.1%) was the most annoying sound due to its unpleasantness. 57.2% of the respondents considered the acoustic environment as severely or relatively noisy, but only 44.5% of the interviewees regarded it comfortable or relatively comfortable. 'Sound level' (57.1%) and 'personal interests' (49.2%) were recognized as the major factors influencing personal sound preference, and the appropriate improvements of acoustical environment were identified as the priority in the studied urban park.

ACKNOWLEDGEMENTS

The authors are indebted to the Chinese Postdoctoral Science Foundation for the support.

REFERENCES

1. Xie H, Kang J. Relationships between environmental noise and social–economic factors: Case studies based on NHS hospitals in Greater London[J]. Renewable energy. 2009;34(9): 2044-2053.
2. Low S, Taplin D, Scheld S. Rethinking urban parks: Public space and cultural diversity. University of Texas Press. 2009.
3. Kang J, Zhang M. Semantic differential analysis of the soundscape in urban open public spaces. Building and environment. 2010;45(1): 150-157.
4. Yang W, Kang J. Acoustic comfort evaluation in urban open public spaces. Applied Acoustics. 2005;66(2): 211-229.
5. Axelsson, Ö. Introducing soundscape. In Proceeding of AESOP 2012. Ankara, Turkey: Association of European Schools of Planning. 2012
6. Kang J. Urban sound environment. Taylor & Francis. 2006
7. Qian X. Reconstruction of City Parks in Mountainous areas with 'the organic Renewal' Theory: Taking the reconstruction of ShaPing Park in Chongqing city for example. Southwest University. 2010. (in Chinese)