RATIONAL PLANNING OF PUBLIC OPEN SPACE BY EXPLORING THE EFFECTS OF ENVIRONMENTAL FACTORS ON HUMAN RECREATION – A CASE STUDY IN SHANGHAI, CHINA

LI, Z.¹ – XIE, C.¹ – LU, H.² – CHE, S.^{1*}

¹*Eco-Planning and Design Lab, School of Agriculture and Biology, Shanghai Jiao Tong University, Shanghai 200240, China*

²*International Education College, Zhengzhou University of Light Industry Zhengzhou 450002, China*

**Corresponding author
e-mail: chsq@sjtu.edu.cn*

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Abstract. Along with the urbanization, the rapid increase in urban population has become one of the most important global environmental issues. The natural spaces were continually replaced by built-up areas. There is a growing recognition that public open space (POS) in urban areas could offer many desirable human well-being possibilities by interactions with nature. In the current study, we conducted a survey in POS to investigate residents' recreation features and environmental factors affecting their recreation perceptions. The results show that diversified activity types including both active enjoyment and passive activity were required in urban POS by people in Shanghai, which was different for people from some other countries and cultures. Furthermore, the results have revealed how landscape and environmental factors of POS affect residents' recreation perceptions. Crime situation, quiet atmosphere, and environmental sanitation have been the three most critical variables of POS concerned by people. For the natural environment in POS, even the diversified species of plants were concerned by most residents, the vegetation density received the relatively lowest preference rating. Overall, planning of a large open grassland with tree patches on the edges is desirable in POS, where visitors could not only get close to nature but also some recreational activities could be carried out. All the findings in this study could give insights into the design and management of urban POS that are favorable for natural places and the health of people in urban areas.

Keywords: *architecture & greenery, outdoor spaces, landscape elements, landscape preference, questionnaire, Shanghai*

Introduction

As reported by many previous studies, rapid urbanization caused high concentrations of population and built-up areas in urban areas. The loss of natural spaces in urban areas leads to deterioration of urban residents' health (Peen et al. 2010; Lederbogen et al. 2011). All these resulted in a great need to plan open space for outdoor recreation and connection with nature (Lin et al. 2014; Zhu et al. 2017). A public open space (POS) means one open-access public space, which should be facilely accessed by all people regardless of age, ethnicity, physical limitations or other characteristics (Carmona et al., 2003; Judd, 2010; Hecke et al., 2016). The appearance of POS may be varied, such as urban parks, playgrounds, squares, streets, and vacant lots etc. The functions of POS may also be varied, such as providing the opportunities for leisure, socializing, sports or just simple relaxation (Chiesura, 2004; Laforteza et al., 2009). As essential elements in modern urban design, many studies have confirmed that POS was a cost-effective

contributor for improving public health, relieving urban life stress and creating democratic space (Wang, 2011; Henderson, 2013). The benefits of POS would continue to increase as more people would be concentrated in urban areas (Madanipour et al., 2013).

Considering these benefits, POS were greatly welcomed and required by urban residents (Matsuoka and Kaplan, 2008). It became increasingly important in urban design, especially in some highly urbanized regions where more people concentrated and natural lands were quite poor (Lafortezza et al., 2013; Lin et al., 2014). Thus, it puts forward higher requests to both the quantity and quality of POS. There were close relations and intense interactions between people and POS. The activity pattern of residents could be affected by the environmental factors of urban POS (Rishbeth, 2004). Furthermore, the application of POS would also be determined by residents per their characteristics (Pescharadt et al., 2012). The attitudes of residents towards POS would be influenced by both the physical conditions of spaces and demographic features of involved people. Thus, both the objective attributes and subjective psychology should be taken into account in POS design (Berg and Koole, 2006; Acar and Sakıcı, 2008; Berg and Winsum-Westra, 2010; Zheng et al., 2011).

Over the past decade, many studies have found that people with different cultural and ethnic backgrounds may use POS in different ways. Urban POS are generally used for active activities including walking, dog walking, sports activities and exercise in some western countries (Agency, 1994; Dunnett et al., 2002). While Gobster found that minority groups in Lincoln Park (Chicago) were more likely to engage in passive social park activities such as picnicking, talking and socialising than were the white people (Gobster, 2002). It was a challenge for urban or landscape professionals to provide an all-purpose POS for people with diverse socio-economic and cultural characteristics. On the other hands, the environmental factors of POS would also affect human perception. People generally tend to prefer the POS with more natural elements such as water, vegetation, etc. (Kaplan, 2001; Chou et al., 2016). It means that the larger proportion of natural patch area may promote urban residents' environmental preference in urban POS (Van den Berg, 2010). However, some studies held the opposing opinions referring to the relationship between landscape environment and human preference. Parsons suggested that ecologically natural landscapes are perceived to be less attractive (Parsons, 1995). Thus, more effort should be made for broadening our knowledge through examining the relationship between environmental factors of POS and human's preferences. It is essential to investigate the perspectives of people on the recreational functions of POS, as well as critical influence variables of POS.

With accelerated urbanization, making humans and natural systems in urban area develop toward the mutually beneficial direction has become one of the most important environmental topics. Considering the fact that Shanghai in China has experienced the largest and rapidest flux of urbanization and many people have moved from rural regions to urban regions (Peng, 2011; Zhang et al., 2013) the population of this city is quite diverse, including immigrants, new and native Shanghai residents. These people are distributed across classes with different demographic and socio-economic characteristics. It is necessary and significant for us to explore the recreation features and landscape perceptions of people on POS at the beginning of 'the Overall Planning of Shanghai (2020-2040)'. It aimed to ensure that as many residents as possible could benefit from POS in Shanghai where natural resources were quite limited and partially taken up by building areas. In this study, the main focuses were the followings: (1)

exploring the interactions between residents and urban POS, understanding how the residents utilized and perceived POS in their daily life; (2) examining the relationship between environmental factors of POS and residents' recreation, which were conducive to explore the most attractive features of POS. The findings in this study may be significant for the planning, design and management of POS. It also provides a methodology for linking environmental design and human preferences, which can be applied not only in Shanghai but also in some other cities with similar situations.

Materials and methods

Ethical approval

This study was approved by the Shanghai Jiao Tong University and Shanghai Urban Planning and Land Resources Bureau. All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Description of the study area

This selected study area was Shanghai, China, 30°82'30"–31°82'70"N and 120°85'20"–121°84'50"E. It was one of the largest cities and most important global economic centres. The total area of Shanghai is 6340.5 km² with a population of 24.2 million (Bureau, 2017). The built-up area is 2408 km², which accounts for 43.6% of the city area. Approximately 50% of the population are distributed in the city centre. Based on the data of sixth national census, most Shanghai residents are aged between 45-60 years old.

Since the large area and population diversity of Shanghai, sample plots were performed. The selected sample plots were distributed across different districts. From the geographic location, the built-up area of Shanghai could be divided into central city, suburban area, and satellite town. According to the development history of the districts in Shanghai, the built-up area could be categorized into five stages: before the founding of the People's Republic of China (before 1949), before the reform and opening-up policy (1949 to 1978), the 1980s, the 1990s, and the early 21st century. In this study, eight representative sample plots with varying socio-economic and environmental characteristics were selected for the investigation, including plots from the central city, suburban area, and satellite town (*Fig. 1, Table 1*).

Table 1. Sample plots in Shanghai

Sample plot	Area (km ²)	Location	Development history	Main function
People's square (PSS)	1.41	Central city	Early 1950s	Traditional center
Ruijin (RJ)	1.72	Central city	Mid-19th century	Historical concession
Xujiahui (XJH)	1.42	Central city	1980s	Commercial sub-center
Caojiadu (CJD)	1.53	Central city	Late 1980s	Residential area
Xinzhuang (XZ)	1.75	Suburb area	Late 1990s	Residential area
Fangsong (FS)	2.36	Satellite town	Early 21st century	Residential area
Laochengxiang (LCX)	1.66	Central city	Before the founding of the People's Republic of China	Special neighborhood
Weifang (WF)	2.09	Central city	1960s	Workers' village

Figure 1. Locations of eight sample plots in Shanghai. (The black circles mean the sample plots)

In each sample plot, all the available POS were pre-investigated and marked on a map. During the pre-investigation towards these POS, all the recreational activity types were identified and recorded. Especially, in each sample plot, the POS that greatly contributed to the recreation of residents were identified as investigation sites, where questionnaire survey could be easily conducted for gathering more residents (*Fig. 2*). A total of 18 urban parks, 18 playgrounds and squares, and 20 casual streets were selected from the sample plots for further questionnaire survey.

Figure 2. Examples of POS selected in this study. A, B, urban parks; C, squares; D, casual streets

Questionnaire design

The questionnaire was designed, including the following sections: (1) profile of the respondents, including their demographic and socio-economic characteristics (*Table 2*); (2) activity types, providing with multiple choices; (3) degree of recreational demands (single choice; quantifying the demand level on visiting POS for recreation). The quantification was evaluated with a five-point Likert-type scale ranging from 1 (very low demand) to 5 (very high demand); and (4) preferences for characteristics of POS, including the landscape features and attributes. There was a total of 33 variables for describing general features of POS and evaluating the attractiveness to nearby residents (Asa et al., 2009; Tveit, 2009; Sevenant and Antrop, 2010; Zhao, 2012). These variables were designed and characterized based on previous studies (Tveit et al., 2006; Ode et al., 2008; Fry et al., 2009). The attractiveness of each variable to respondents was also scored from 1 (with very weak attraction) to 5 (with very strong attraction). Generally, the questionnaire was designed to collect the information and answer following questions: What were the general characteristics of the POS visitors in Shanghai? What were the recreation features of POS visitors, including recreational activity types and recreational demand level? How the environmental factors of POS would affect residents' behaviour?

Table 2. Demographic and socio-economic characteristics of the respondents

Characteristics	No.	Ratio (%)	Characteristics	No.	Ratio (%)
Gender			Monthly income per capita (RMB)		
Male	572	57.3	<2000	108	10.8
Female	427	42.7	2000–5000	380	38.0
Age			5000–8000	286	28.6
<18 years	94	9.4	>8000	226	22.6
18 years to 44 years	611	61.2	Dwelling location		
45 years to 60 years	117	11.7	Central city	480	48.0
>60 years	177	17.7	Suburb area	342	34.3
Education level			Satellite town	177	17.7
Primary and junior middle school	158	15.8	Household size		
High school and technical school	276	27.6	1	89	8.9
Junior college and bachelor's degree	468	46.8	2	164	16.4
Graduate degree and above	98	9.8	3	406	40.6
			4	197	19.7
			≥5	144	14.4

Questionnaire survey

The questionnaire survey was performed in the selected POS during July 10th to August 16th in 2015 (excluding rainy days). The survey was conducted on a face-to-face basis, which has been considered as the most sociable way to recruit interviewers and collect data (Sheskin, 1985). The questionnaires were randomly distributed to the

residents who visited the selected POS for recreation. During the survey, each POS was visited twice every week (once in weekdays and once in weekend) mainly at two periods (7:00-11:00 and 16:00-19:00). Since it was hot in summer, POS would be visited by relatively more residents for recreation in this period.

Before the survey, the respondents would be informed on the purpose of this investigation, ensuring the confidentiality of their answers. When the participants agreed to fill in questionnaires and checked the box stating their agreement, the interview began. Some respondents were minors, thus their agreement form would be checked by guardians. For minors without stating agreement form guardians could refuse the participation of children by sending us an email after investigation. It was assumed that they agreed to participate without receiving refusal. A total of 1150 questionnaires were delivered and collected on site, with 999 containing complete and valid responses. Only the questionnaires with complete and valid results were included in the following analysis. The field survey was conducted with the assistance of undergraduate and graduate students from the Department of Landscape Architecture of the Shanghai Jiao Tong University.

Data analysis

The relationships between recreation features (including recreation activities and recreational demand degrees) and characteristics of respondents were analysed with a one-way analysis of variance (ANOVA). In addition, the environmental variables of POS affecting residents' recreation perceptions were identified with factor and principal component analyses. All statistical analyses were conducted with SPSS v.18.0 software package (SPSS Inc., USA).

Results

Characteristics of respondents

The demographic and socio-economic characteristics of respondents in this study were analysed and presented (*Table 2*). Respondents between the ages of 18-44 were the most representative group and those less than 18 years were the least representative group. For the gender, the number of male respondents was slightly higher (57.3%) than that of female (42.7%). Following characteristics were also most frequently and typically observed in POS visitors: the educational level was junior college and bachelor' degree (46. 8%); the monthly income per capita was 2000-5000 RMB (38.0%) and the household size was 3 persons (40.6%).

Recreation features in relation to characteristics of respondents

Degree of recreational demands

The degree of recreational demands was collected from respondents, which was significantly related to the age, gender, educational level and monthly income of the respondents ($p < 0.01$). For the age, the degree of recreational demands was generally increased with age (*Fig. 3*). The degree of recreational demands was the highest for people above 60 years (4.956). For the gender, the degree of recreational demands reported by female respondents (4.858) was higher than that of by male respondents (4.211). For the educational level, the degree was also increased with higher educational

level. Specifically, the degree of recreational demands was the highest (4.723) for those respondents with a graduate degree and above. Finally, the degree of recreational demands was negatively associated with the monthly income of the respondents. The degree was the highest in respondents with monthly income per capita under 2000 RMB (4.923), while it was the lowest for those with monthly income per capita above 8000 RMB (4.128).

Figure 3. Degree of recreational demands in relation to the characteristics of respondents

Choice of recreational activity types

The preferred recreational activity types in POS were revealed by the questionnaire data (Fig. 4). And respondents' choices of recreational activity types were significantly related to their gender, age, and educational level ($p < 0.01$).

Figure 4. Respondents' preferences to activity types based on the questionnaire

For the gender, sports activities were preferred by male respondents, such as ball games, chess and card, while more quiet and low-intensity activities were preferred by female respondents, such as dancing and sightseeing. The preference of recreational activity types was also varied among respondents with different age. The respondents less than 18 years old preferred to walk, sightsee, read or jog; those aged between 18-44 years old preferred to walk, sightsee, and play ball games; those aged between 45-59 years old preferred to walk, play exercising facilities, rest and sightsee; walk and rest were preferred by those aged above 60 years old. Varied activity types were also observed among respondents with different educational levels. Specifically, the respondents graduated from primary and junior middle school preferred to rest or walk; those who graduated from high school and technical school preferred to walk, sightsee; the respondents with higher education levels preferred to walk, sightsee, rest or jog in POS, including those graduated from junior college and with the degree of bachelor, graduate and above.

Preferences for landscape elements and environmental factors of POS

The six factors were extracted via varimax rotation based on the results of eigenvalue-one criterion. Then the six factors were named per their features (*Table 3*): resources and maintenance, landscape cognitive attributes, facilities, natural environment, safety, and municipal services. Totally 22 variables were included with factor loadings greater than 0.5, while some variables were excluded, including buffets, toilets, signage systems, form and activity duration etc.

From the results in *Table 3*, it showed that crime situation (4.67) was considered as the most essential variable by most respondents, which was followed by quiet atmosphere (4.42) and environmental sanitation (4.41). The attractiveness of urban POS would also be influenced by some other variables, such as accessibility (4.07), diversified species of plants (4.09), air environment (4.30) and microclimate (4.06) etc. The recreational facility (4.01) was ranked as the most critical variable in facilities by respondents and it was followed by the resting facility (3.96).

Discussion

Recreation features of residents in POS

In this study, it was found that recreation features in POS would be varied for residents with different demographic and socio-economic characteristics, which was consistent with some previous studies (Maas et al., 2009). Meanwhile, both the active (walking and exercising) and passive activities (resting and sightseeing) in POS were preferred by the residents of Shanghai, China. Socializing with each other was specially preferred by these residents and they would like the activities such as dancing and singing, chess and card, and Chinese Taiji. While people in some western countries mainly used urban POS for active activities (Agency, 1994; Dunnett et al., 2002), minority groups in Lincoln Park (Chicago) preferred passive social park activities (Gobster, 2002). Compared to that in these countries and cultures, residents' selection of recreation activities in POS of Shanghai was quite different (Dunnett et al., 2002; Gobster, 2002; Özgüner, 2011). This finding may be resulted from the special lifestyles and habits of residents in Shanghai, China.

Table 3. Principal component analysis of the preferences for the landscape elements and attributes in POS

	Average value	Standard deviation	Factor load	Variance (%)	Cronbach's α
Factor 1: Resources and maintenance				10.759	0.825
Diversified species of plants	4.09	0.835	0.686		
Maintenance of infrastructure	3.90	0.940	0.655		
Environmental sanitation	4.41	0.714	0.573		
Unique sites for special needs	3.80	0.935	0.532		
Diversified sites for recreation	3.60	0.907	0.638		
Factor 2: Landscape cognitive attributes				9.244	0.748
Accessibility	4.07	0.995	0.699		
Cultural features	3.55	0.942	0.735		
Coherence	3.67	0.952	0.546		
Diversity	3.50	0.886	0.572		
Factor 3: Facilities				9.101	0.759
Recreational facilities	4.01	0.881	0.792		
Resting facilities	3.96	0.891	0.698		
Landscape structures	3.33	0.927	0.652		
Exercising facilities	3.92	0.885	0.648		
Factor 4: Natural environment				8.722	0.711
Air environment	4.30	0.912	0.805		
Vegetation density	3.90	0.918	0.666		
Microclimate	4.06	0.873	0.766		
Quiet atmosphere	4.42	0.741	0.546		
Factor 5: Safety				6.623	0.651
Patrol	4.35	0.827	0.836		
Crime situation	4.67	0.619	0.621		
Limited open time	3.71	1.009	0.513		
Factor 6: Municipal services				6.343	0.676
Illumination	4.03	0.856	0.735		
Groundwater treatment	4.00	1.140	0.527		

Environmental factors affecting residents' perceptions of POS

According to some previous studies, the feeling of personal safety was one of the main reasons for preventing people from visiting POS for recreation, especially for the women and children (He, 2002; Jorgensen et al., 2002). Consistent with the results of these studies, our study also revealed that crime situation was one of the most critical factors concerned by the residents (4.67). It meant that the feeling of personal safety in POS has still been worried by most people in Shanghai. During our investigation, groups of people complained that tramps and scavengers were frequently observed in the POS which may be scary for women and children. It may also help explain the fewer female respondents in our questionnaire survey, although their degree of

recreational demands was higher than that of male respondents. Meanwhile, both the quiet atmosphere (4.42) and environmental sanitation (4.41) ranked high in preference ratings of POS, which was similar to some previous studies. Gobster found that the cleanliness and maintenance were critical preferences for POS (Gobster, 2002). During our questionnaire survey in these POS, the littering of garbage could be observed which partially indicate the lack of management and maintenance of POS in Shanghai. Furthermore, it is further noted in this study that diversified species of plants (4.09), air environment (4.30) and microclimate (4.06) were also one of the most appealing environmental factors of POS. However, the vegetation density received the lowest preference rating (3.90) in the factor of natural environment (*Table 3*), which suggested that respondents preferred a moderately open vegetation. While plant communities with densely spaced plants are perceived as less attractive and unsafe. This finding confirmed the conclusions of some studies that found a correlation between vegetation density and security considerations in POS (Bjerke et al., 2006; Laing et al., 2009). Gobster observed that humans have strong preferences for landscapes correlated to the vegetation configuration with cleared or grassy understory (Gobster, 1994). While POS with highly dense vegetation are usually perceived as messy, unkempt and unattractive (Hands, 2002).

Good accessibility to POS (4.07) was another preference of respondents. The visiting of residents to POS would be increased after improving the accessibility of POS. Since the POS should be easily accessed by all the people including the elderly and disabled residents, barrier-free access should be provided (Adinolfi et al., 2014). Regarding the facilities, recreational (4.01) and resting facilities (3.96) were intensely preferred by the respondents. This result was also consistent with several previous studies by Dunnett et al. (2002), Woolley (2006) and Jim and Chen (2006). In all these studies, it was observed that the diversity of recreational facilities and the number of available seats would be closely related to the visiting frequency of people to POS. Kemperman and Timmermans even found that diverse visitors would be attracted by facilities applicable for group activities in POS (Kemperman and Timmermans, 2006).

Some practical implications for POS design

The results have indicated that recreation features in POS were quite different for residents with various characteristics. And considering that the aging population has been greatly increased in Shanghai in China (Institute of finance and trade economics 2010/2011), the recreation features of the elderly should be primarily considered in POS planning and design. For example, the walkways around and across the POS meeting the requirements of walking may be welcomed by elderly residents. In addition, the specific composition of target residents should be analysed and considered. As above mentioned, for residents with different characteristics, the recreation features would be varied, as well as the types of recreational activity. On this basis, the preferences for the POS should be found and the POS must be designed and developed to satisfy these preferences, including recreational facilities, multifunctional space divisions, and special sites etc.

On the other hand, landscape and environment preferences of people would be determined by many specific aspects. The environmental factors of POS could affect residents' perceptions. Even the diversified species of plants were concerned by most residents, the vegetation density received relatively the lowest preference rating. This finding demonstrated that an open space with large continuous grassland and scattered

trees can promote the residents' perceptions of POS when considering the feeling of personal safety. Planning of a large open grassland with tree patches on the edges is desirable in POS, where visitors could not only get close to the nature but also some recreational activities could be carried out. Meanwhile, regular patterns, diverse colors, and cultural elements, such as direction signs, or street furniture, may help diminish the negative effects of dense vegetation on residents' feeling of security. Furthermore, increasing surveillance and patrol could also improve the feeling of personal safety in POS. The quiet atmosphere could be achieved by optimizing the site selection while the sanitation could be maintained by improving management. Finally, the sufficient resting facilities should be provided, such as seats and resting areas. Some good measures enabling improved POS were shown in *Figure 5*.

Figure 5. *Optimal measures for improving and modifying POS*

Conclusion

Previous studies have stated that urbanization is associated with people's depression, chronic diseases and mental disorders (Peen et al., 2010; Lederbogen et al., 2011). POS in urban area has the potential to significantly contribute to public health, relieving urban life stress and creating democratic space (Henderson, 2013; Tyrväinen et al., 2014). Both the environmental conditions of POS and demographic features of people would influence the recreation attitudes towards POS. The study attempted to bridge the gap between people's recreation features and natural environmental factors in POS. We investigated how the residents utilized and perceived POS in their daily life. The results further reveal how landscape and environmental factors of POS affect residents' recreation perceptions. Even the diversified species of plants were preferred by residents, the vegetation density would influence their perceptions on POS. All the findings we observed in this study could contribute to urban and landscape professionals in POS designing and improvement that focus on a healthy and sustainable urban environment. And the methodology in this study can be applied not only in Shanghai but also in some other cities, which link environmental design and human preferences together.

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