

## THREE ELEMENTS STRUCTURE AND SOUND EXPECTATION CONCEPT IN SOUNDSCAPE -- A CASE STUDY OF THE NEW LAKESIDE PARK, HANG ZHOU

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**ABSTRACT:** The three elements structure "sound, environment and human" is the core of soundscape. These three elements are closely related, influenced by each other. The specific meanings of the three elements, and how they interact, should be noted in soundscape studies. Only the three elements are considered together, can the findings obtained be convincing. In this paper, the three elements structure is made as a basis and the concept of sound expectation is put forward, which means: people will have a unique expectation on soundscape when they face a particular landscape. A set of research context is designed for sound expectation in order to apply this concept to actual projects. A Case Study of soundscape research in "New Lakeside Park" demonstrates the authenticity and feasibility of sound expectation concept.

**Keywords:** Soundscape, three elements structure, landscape, west lake

### BACKGROUND

#### The Concept and History of Soundscape

The concept of soundscape was first raised on the 1970s, by Canadian composer R. Murray Schafer. Be composed of "sound" and etyma "-scape", it means the scenery of hearing, relative to traditional word "landscape" which means the scenery of sight. That is, the sound worth to be enjoyed and remembered, in natural or artificial environment, through Cultural perspective and aesthetic appreciation(Ge Jian, Kazunori Hokao, 2005).

Against to the traditional way of design in architecture and landscape, soundscape take "sound" as another important object of design. The plan and design of sound environment can lead to more comprehensive and coordinative scenery.

On 1975, the concept of soundscape was drawn into Europe by Schafer's touring report. On 1993, World Forum for Acoustic Ecology was established which indicated the concept of soundscape became globally accepted. Nowadays, many countries and regions like Australia, Canada, Switzerland, Germany, Austria, Italy, Finland, England, Japan, have their own soundscape

research association. The study of global soundscape has begun.

#### Soundscape in Landscape

Human aware the environment through the five senses. Landscape design has always been "visual supremacy", with little consideration of other sensory elements. However, from the view of environmental acoustics, hearing is not only an access to information, but also an important means of experiencing landscape.

Currently in China, environmental acoustics research mainly concentrated in two areas: auditorium acoustics design and noise problems in the urban and building environments. The former is under room acoustics category, while the latter is the passive solutions of the noise problems already existing in environment.

How to form a new comprehensive landscape design mode is a new subject: soundscape. Through conscious planning and design, Soundscape creates sound environment consistent with the users' aesthetic value. This is a conceptual leap both for landscape design and environmental acoustics.

#### Soundscape Research

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*Note:* Discussion on this paper is open until December 2012

The first research direction is the relationship between residential soundscape and human health. The program "Soundscape Support to Health" investigated the impact of residential soundscape on human health, and the difference between with and without access to a quiet side of the dwelling (A. Skånberg, E. Öhrström, 2002). An exposure indicator NALden was derived and the generic spatial procedures were developed and implemented (R. Klæboe, E. Engelen, et al., 2006). The assumption was confirmed by subjective evaluation survey (E. Öhrström, A. Skånberg, et al., 2006). The affection of nearby green areas on human well-being in noise-condition groups was examined (Anita Gidlöf-Gunnarsson, E. Öhrström, 2007). The different affections of noisy and quiet neighborhoods on residential noise annoyance were studied (R. Klæboe, 2007).

The second research direction is soundscape evaluation. Through the questionnaires survey of two French cities, the main elements to influence soundscape evaluation was known as sound level, time and space (Manon Raimbault, Catherine Lavandier, et al., 2003). The integrity analysis and subjective evaluation were carried out in the case spot as Saga Park (Ge Jian, 2004). The urban street areas were studied by image evaluation and spatial analysis in Saga City (Ge Jian, Kazunori Hokao, 2005). By questionnaire survey and laboratory study in Europe and China, factors influencing the sound preference were found (Lei Yu, Jian Kang, 2010). Semantic analysis factors that characterize soundscape were identified through survey in Sheffield (Jian Kang, M. Zhang, 2010).

The third research direction is the relationship between hearing and other senses. The matching experiments of pictures and sounds, demonstrated that the consistence of auditory and visual information can lead to high sound evaluation (José Luis Carles, Isabel López Barrio, José Vicente de Lucio, 1999). The degree of matching between visual and sound information and the degree of implication of the perceiver with sound environments were further studied (Stéphanie Viollon, Catherine Lavandier, Carolyn Drake, 2002). The relationship between sound and time system was also proposed (D. Botteldooren, B. De Coensel, T. De Muer, 2006). The research result that people's perceptions in train station based on soundscape, demonstrated the connection between soundscape and perceptions of space (Julien Tardieu, Patrick Susini, Franck Poisson, Pauline Lazareff, Stephen McAdams, 2008). Audio-visual interaction was a necessary condition to obtain tranquil environment (Robert J. Pheasant, Mark N. Fisher, Greg R. Watts, David J. Whitaker, Kirill V. Horoshenkov,

2010). Sound and color have been combined in exhibitions to enhance the overall artistic experience (Marianne Greated, 2011).

The fourth research direction is soundscape practice. Spatial sound authoring and applications were used to create virtual reality environments (Jens Herder, 1998). The experiences of urban soundscape were summarized and conceived (Manon Raimbault, Danièle Dubois, 2005). The review of soundscape management in US National Park led to preliminary design criteria of soundscape design (Nicholas P. Miller, 2008). Using soundscape concept, an auditory way-found system was designed and evaluated in train stations (Julien Tardieu, Patrick Susini, Franck Poisson, Hiroshi Kawakami, Stephen McAdams, 2009).

### Three Elements Structure

The three basic elements of soundscape studies have been defined as sound, environment and human (Qin Youguo, 2005). By study one or two elements, the traditional subjects are formed as: landscape, physiological, psychological acoustics and environmental acoustics. While soundscape begins to comprehensively study the relationship between the three elements (Figure 1).

The traditional landscape has always been only concerned about the visual element, so that to create a "silent" visual landscape; the physiological and psychological acoustics study the physical stimulations of sound and the acoustical principles, independently of the environment and human elements; the environmental acoustics focuses on the physical properties of sound transmissions, without the visual and human elements. The meaning of soundscape is just to concern about the relationship between three elements and so that to perfect the traditional subjects.

It is possible that some basic elements will still be

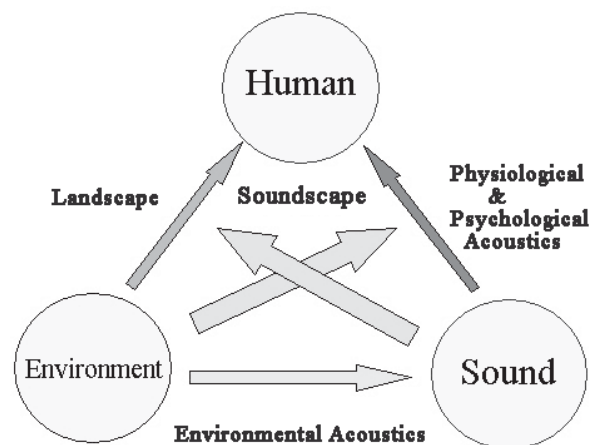


Fig. 1 Three elements structure (Qin Youguo, 2005)

ignored in soundscape studies and leads to unconvincing results. To avoid this, two points should be noted: (1) take full account of the three basic elements in order to do an objective assessment and rational design; (2) full use of the existing research results of the three traditional subjects so that to improve and deepen the soundscape studies.

## NEW CONCEPT

### Innovation Points

Soundscape is influenced by many factors: not only the regional characteristics but also the historical and cultural background. For each landscape design project, these factors are unique. It reveals the truth that each soundscape design is unique and diversity. Based on this, sound Expectation Concept is proposed.

Although the concept of soundscape has been extensively studied, how to use it in practice, that is to introduce soundscape design into the landscape design, still need further study. The plans and designs of soundscape already existing in practice are either common means empirically chosen, or a series of experimental devices. Sometimes, it even tends to behavioral Art. However, this study proposes a rigorous system of planning and design steps.

By this the concept as "Sound expectation" is newly brought out in this paper. It contains a set of research methods, which can be used for soundscape design and evaluation. By this, soundscape is possible to be used in actual projects.

Some late steps of the context, such as the induction of soundscape design techniques and credible soundscape simulation by software, still need further study.

### Farther Explanation of Three Elements

The three elements of soundscape are deeply connected. Following will describe their definitions and reciprocity.

Environment, especially visual environment, is the primary impact of the soundscape evaluation. Environment creates sound and receives effect from sound either. Environment coordinates with sound to produce a combined effect on people. So the concert of sound and environment is the basic requirement of good sceneries. Farther more, this coordination may inspire people's feeling, in order to make advantages in both vision and hearing.

Human has double meanings. In general terms, it means humanities contained in scenery, mainly history or culture. For example: poems, legends and traditions. It makes people an inherent impression on which sound should appear in particular scenery. Humanities can enlighten people how to appreciate and affects evaluation. In a narrow sense, it refers to personal factors, especially sound in memory. That is: individual acoustic experience in the past can cause familiarity in similar sound environment and then mobilize people's emotions. Like the natural sound of birds and insects, streams and rivers, the cultural sound of temple bell, traditional ceremonies and living sound of children playing, these sounds in childhood memory are disappearing in the process of urban construction, making people nostalgic (Ge Jian, Bu Jinghua, 2003). Besides, differences in education and characteristic may also affect individual's sound evaluation.

The object of soundscape design and evaluation is Sound. In design, the information from environment and human background should be analyzed first, thus the basic orientation can be determined. In evaluation, all the elements should also be fit.

### The Concept of Sound Expectation

Through "sound expectation" in subjective evaluation, the environment and human elements play roles on soundscape (Figure 2). The concept of sound expectation is: people will have a unique expectation on soundscape when they face a particular landscape. Sound expectation is in harmony with the landscape condition. For example, the forests cause expectation of natural sound, while the highways cause expectation of traffic noise. The name as "sound of wave pavilion" will lead to the expectations of

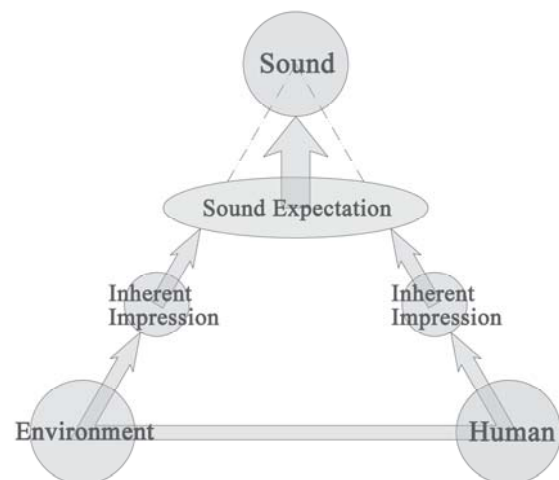


Fig. 2 The schematic representation of sound expectation

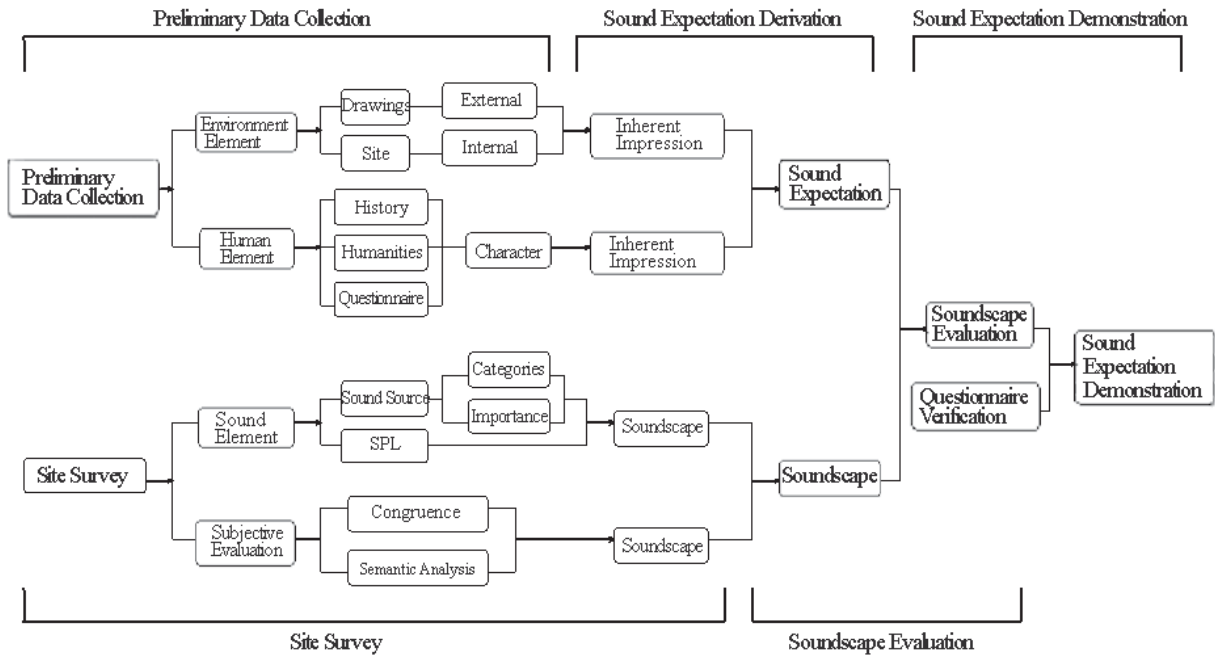


Fig. 3 Methodological framework

tidal sound. Studies have shown that the more similar soundscape with sound expectation, the higher the value of subjective evaluation. It shows that a reasonable soundscape shall meet the requirements of sound expectation. Sound expectation, from the environmental element, is inspired by the special conditions of visual environment. While from the human element, sound expectation is caused by the inherent impression of humanity and personal factors.

The concept of sound expectation is a good theoretical explanation of the three elements' relationship. That is: by studying the known environment and human elements, the sound expectation of the location is derived. Also, it is a way for soundscape design and evaluation in practical project. Sound expectation can be used as a reference and guidance to soundscape design. By compared with the existing soundscape, it can be used for soundscape evaluation.

Research Methods

By further clarifying the research thread, the research methods are formed. Methodological framework for this study is shown below (Figure 3).

Soundscape design can be divided to three steps (Figure 4). Then the concept of sound expectation can be finally introduced into practical projects. This paper has demonstrated the concept of sound expectation and done case study of soundscape evaluation. Some later steps, such as: summarizing soundscape design methods, accurate soundscape software simulation, still need further research.

CASE STUDY

Materials

West Lake

Hang Zhou is a famous tourist city. Often people will call it "paradise in the world" as it has a unique West Lake Scenic. This is one of the most famous national scenic areas in China, containing not only the beautiful lakes and mountains but also splendid heritages of culture and arts.

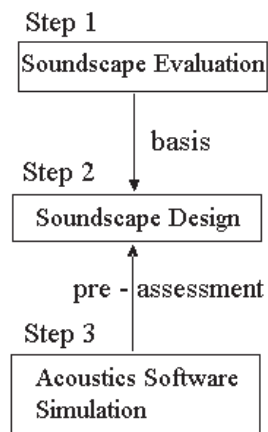


Fig. 4 Soundscape design steps



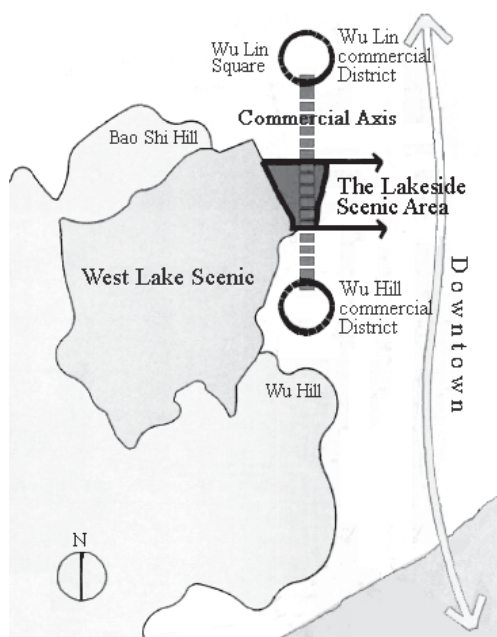


Fig. 5 The location of the Lakeside Scenic area (Zhang Haiyan, Wang Zhu, 2004)

The West Lake Scenic is a 60 square kilometers area with 5.68 square kilometers' lake area in the center, surrounded by mountains on three sides. It has ninety distinctive parks and scenic spots, while the most notably thirty ones are the "Ten Views of the West Lake" selected in Southern Song Dynasty, the "Ten New Views of the West Lake" selected in 1984, and the "Third Ten Views of the West Lake" selected in 2007. Here, every seasons have their own views, and different weathers are always fantastic (Figure 5).

West Lake Scenic is full of monuments, including 5 national key cultural relic protection units, 35 provincial cultural relic protection units, 25 municipal cultural relics protection units, as well as 39 heritage sites and museums with various topics.

Far from the ancient times, West Lake attracts tourists from the whole world. Just as the great ancient poet wrote in <The West Lake's Spring Scenes> "I hate leaving Hang Zhou, Half for the lake's thrill." (Bai Juyi, Tang dynasty).

#### New Lakeside Park

The New Lakeside Park is one of the "top thirty attractions" in West Lake Scenic. In 2007, the third time of the "top ten attractions Selection in West Lake Scenic" was held in China's famous tourist city Hang Zhou. After an eight-months vote, the New Lakeside Park was elected by people finally. And it got a more poetic name as "sunny and rainy Lakeside".

This paper studies the soundscape in New Lakeside Park, indicating that "sound, environment and human" three elements are closely related, influenced by each

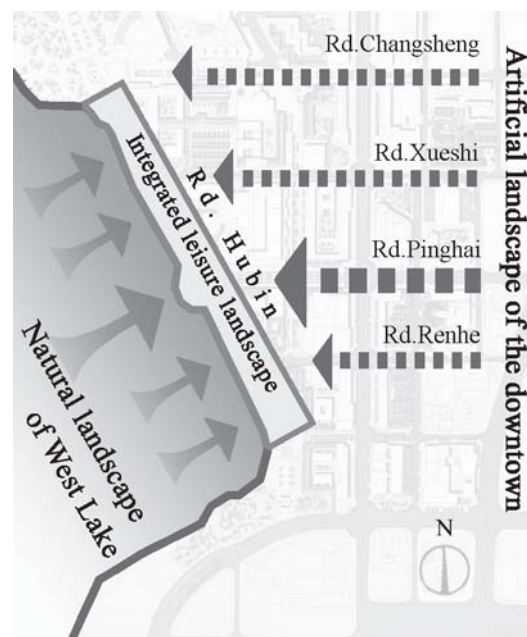


Fig. 6 The landscape of New Lakeside Park

other, so that the authenticity and feasibility of sound expectation concept are verified.

#### Preliminary Data Collection and Sound Expectation Derivation

##### Data Collection of Environment Element

The Lakeside scenic area is located in the border of West Lake and the downtown, which is critical in Hang Zhou (Figure 5). The New Lakeside Park refers to the linear landscape unrolled along the Rd. Hubin. As a door from downtown to West Lake, natural landscape and cultural landscape coexist here, which form the characteristics as tranquility, liveliness and rich functions (Figure 6).

The New Lakeside Park consists of clear divided zones. Transversely, the strip zones from West Lake to downtown are: Landscape Waterfront, Parterre Belt, Rd. Hubin, Walking and Shopping Street (Figure 7). Vertically, it is crossed by six roads. From north to south there are: Rd. Qingchun, Rd. Changsheng, Rd. Xueshi, Rd. Pinghai, Rd. Renhe, Rd. Jiefang. Roads introduce urban landscape and human flow into the park, forming six node- plazas with different themes. From north to south as follows: No.6 Park Plaza (the English corner); Sculpture plaza (Memorial of Songhu Battle); Pier Plaza (hand-boat parking); Musical Spring Plaza; Boats Plaza (Floating restaurant boarding); No.1 Park Plaza (Activities for the elderly) . In addition, there are open-air tea houses, kiosks, Piers, sculptures, water platforms, wood flower shelves. The park be more varied by these opusculum buildings (Figure 8).

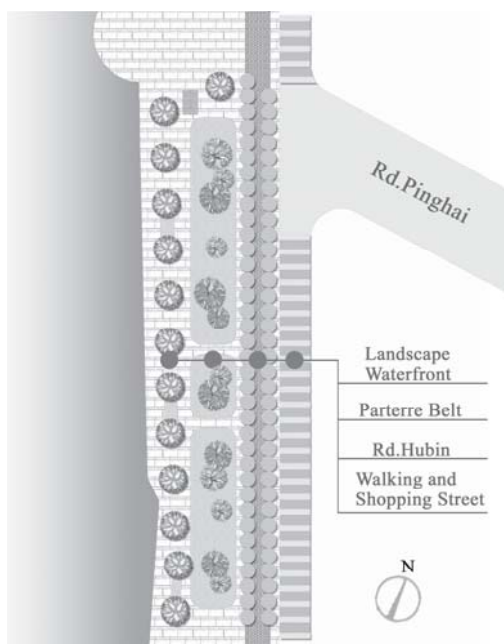


Fig. 7 The landscape transverse zoning

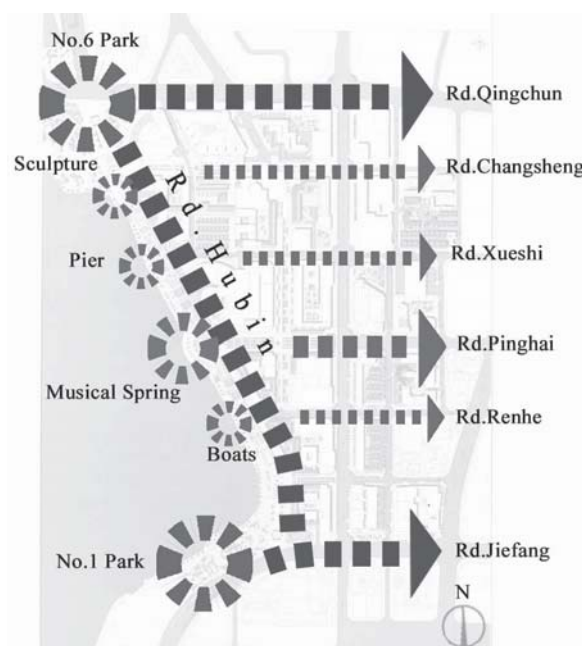


Fig. 8 Six node-plazas with different themes

#### Data Collection of Human Element

The poetic name "sunny and rainy Lakeside" comes from the ancient poetry <drinking in West Lake from sunny to rainy>". The brimming waves delight the eyes on sunny days, the dimming hills present rare view in rainy haze" (Su shi, Song dynasty ). There is old saying in Hang Zhou: West Lake is more dazzling in rainy haze than on sunny days. However, from the "top ten attractions" coming out in Song dynasty to " new top ten attractions" in 1985, none is related to rainy lake. "Sunny

and rainy Lakeside" is just the complement of West Lake's beauty.

Many famous Literatures in the history described the rainy haze of West Lake's lakeside. Su shi in Song dynasty wrote "drinking in West Lake from sunny to rainy" and "Pentasyllabic quatrain written drunk in Wanghu Pavilion on June 27". Fan Jingwen in Song dynasty wrote "many travelers along the lakeside, half in the misty rain of the Broken Bridge". Huang Zhongze in Qing dynasty wrote "a new lake after the rain, plenty of trees in the mist. Drizzly rain is misty while the lake seems to melt into the sky". This is the impression of lakeside these verses created.

The modern writer Zong Pu described the sounds of paddling and singing in "West Lake essay" "the lake smooth as a mirror, boats are gliding on water; the only whisperings from paddle bring more quietness to the lake". The local female poet Lu Wenli wrote a poem named "sunny and rainy lakeside": "drizzly rain like soft whispering... breezy wind like implicit singing... paddling sound like dream flowers". The sounds of rain, wind and paddle are components of the sound memory of lakeside.

However, the rain of lakeside is not lonely. As a point of connection for the landscape culture and downtown culture, it is also lively. Yu Guobao in Song dynasty wrote "In the warm air, miles of path full of beauty, fragrant hair full of flowers". In Qing dynasty, this site was called "Qi Xia camp", which means it is the place for nobilities and officers living. This is the ancient scene to show how prosperous the lakeside was.

In modern times, "West Lake essay" wrote "the West Lake becomes lively even on disposition; in weekends, people boating on water, the Lake is filled with smile and songs; it's an original place to contain vivacity and jollification, no matter a few people's visit or a crowd trip". So the lakeside is an interesting attraction for modern weekends. Today, with the new plan of the Lakeside scenic area, the Walking and Shopping Street in New Lakeside Park becomes the most expensive international blocks in Hang Zhou. This is a recreational park for travel and shopping.

Rain hazy and vitality interweave the impression of New Lakeside Park.

#### Sound Expectation Derivation of New Lakeside Park

According to the analysis of environmental element and human element, the soundscape characteristics of New Lakeside Park can be deduced.

From environmental element: firstly, as the New Lakeside Park located in the intersection of natural environment and artificial environment, the soundscape here should consist of natural and artificial sounds;

secondly, as the New Lakeside Park is divided to zones internally and full of opusculum buildings, so the soundscape here should also be clearly divided and various.

From human element: firstly, by the poetic name "sunny and rainy Lakeside" and the literatures describing the rainy haze in the lakeside, the soundscape in New Lakeside Park should show obvious differences between sunny and rainy days; Secondly, as parts of literatures also reflect other aspect of the park's inherent impression, that is rain hazy and vitality, the soundscape here shall be both lively and tranquil.

### Site Survey and Soundscape Evaluation

#### Site Survey of New Lakeside Park

The site survey of New Lakeside Park consists of two parts: soundscape investigation and subjective evaluation, while the soundscape investigation still can be divided to three steps, that is: site inspection, SPL measurement and sound recording ( Ge Jian, Lu Jiang, et al, 2009).

##### (1)Site Inspection

From November to December, 2009, we do site inspection to collect soundscape information of New Lakeside Park in autumn and winter in order to find out geographical position, general plan, sound sources constitution and spatial distribution of the park.

##### (2)SPL Measurement

The SPL measurement was done on November 26, 2009. It is foggy and cloudy, with temperature 9°C- 20°C, with level 2-3 east wind. The method of measurement is dividing the whole park into 10 \*10 grids. The sound pressure level of the center of each grid is measured by 1 minute calculus (leq 1'). The measurement was done three times in the same day (13:00, 15:00, 17:00) in order to get average values. The measuring instrument is Sound Level Meter AWA6270+.

##### (3)Sound Recording

The sound recording of the six node- plazas was

Table 1 Statistics of subjects' age

Age	10-20	20-30	30-40	40-50	50-60	>60
Number	10	36	10	2	1	1
Ratio	16.67%	60%	16.67%	3.33%	1.67%	1.67%

carried out on November 26, 2009, PM. It is foggy and cloudy, with temperature 9°C- 20°C, with level 2-3 east wind. The accurate recording points are in the center of each plaza, where the sound was recorded for 5 minute. The recording instruments are Sound Card BSWA TECH- - MC 3022 and Sound Probe BSWA TECH- - MA 201 connected with PC.

##### (4)Subjective Evaluation

The questionnaire was done on November 17, November 26 and December 5, 2009, in New Lakeside Park. Its content includes soundscape congruence and semantic analysis. 73 questionnaires were sent out and 60 available questionnaires were retrieved including 31 males (51.67%) and 29 females (48.33%) aged 10-65 years old. The ratio of callback of valid questionnaire is 82.19%. Statistics of subjects' age is shown (Table 1). Statistics of subjects' educational level is shown (Table 2). Statistics of subjects' proficiency of the park is shown (Table 3).

#### Results of Soundscape Investigation

##### (1) Analysis of Sound Sources Constitution

According to soundscape investigation, the soundscape of New Lakeside Park consists of three types of sound sources, that is natural sound, activity sound and artificial sound (Ge Jian, Kazunori Hokao, 2004). The 18 sound sources possible to exist in the park are classified (Table 4).

Table 2 Statistics of subjects' educational level

Educational level	Elementary school	Junior middle school	Senior high school	Junior college	Bachelor	Master and above
Number	2	7	12	17	12	10
Ratio	3.33%	11.67%	20%	28.33%	20%	16.66%

Table 3 Statistics of subjects' proficiency of the park

Proficiency	First visit	Once visited	Visit by half a year	Visit by month	Visit by week
Number	7	4	21	15	11
Ratio	11.67%	11.67%	35%	25%	18.33%

Table 4 Sound sources constitution of the park

Natural sound	Activity sound	Artificial sound
Bird chirps, Sound of water, Sound of leaves, Sound of wind, Sound of rain, Worm chirps	Speaking voices, Walking sound, Children shouts, Singing voices, Buddhist chanting, Sound of sweeping floor	Music, Sound of transportation, Sound of music spring, Broadcasting, Sound of oars, Bell ringing

The importance of the 18 different sound sources was studied through questionnaire. The research was done by ranking method: the 7 most important sound sources were selected by subjects first and then scored from 7 to 1 in accordance with the importance from main to minor (Table 5).

The sums of the scores for each sound are obtained and the statistical result is as follows (Figure 9).

Figure 9 shows that the three types of sound sources both occupy a certain proportion in New Lakeside Park soundscape. The ranking by score is: activity sound (38.36%) > artificial sound (36.6%) > natural sound (25.04%).

The seven sound sources with highest scores are: speaking voices > music> sound of transportation > walking sound> bird chirps > sound of music spring > sound of water. That is: artificial sound (No. 2 music, No. 3 sound of transportation, No. 6 sound of music spring)> Activity sound (No. 1 speaking voices, No. 4 walking sound)> natural sound (No. 5 birds chirps, No. 7 sound of water) (Figure 10).

The analysis of sound sources constitution shows that the soundscape of New Lakeside Park do consist of three parts as natural sound, activity sound and artificial sound, while the activity sound and artificial sound are a little

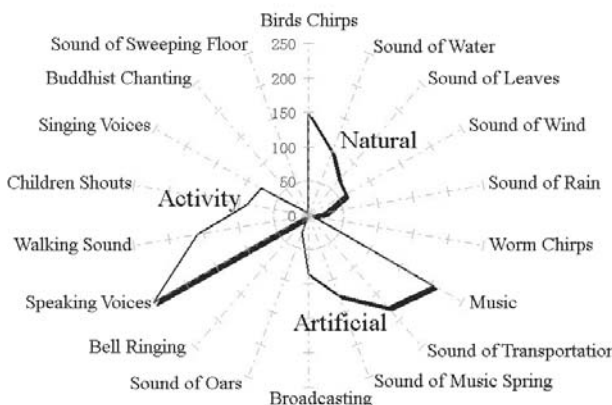


Fig. 9 The statistical result of soundscape importance of each sound source

Table 5 Sound sources ranking method

	main -----> minor						
Score	7	6	5	4	3	2	1
Sound sources	S1	S2	S3	S4	S5	S6	S7

higher than the natural sound . As the three kinds of sounds all play important roles in soundscape, it is confirmed that the soundscape in New Lakeside park consist of natural and artificial sounds. It meets the sound expectation.

(2) Analysis of Soundscape Zoning

1).SPL Map

SPL map shows that the SPL in New Lakeside Park is regularly distributed. It is different transversely and vertically. Transversely, SPL significantly changes by zones. Vertically, SPL is almost evenly distributed while mutations in the six node plazas (Figure 11).

2).Vertical Zoning

By averaging SPL measurements in every vertical row, the SPL vertical change map was get (Figure 12). The figure shows that SPL in New Lake Park is almost evenly distributed while becomes higher in the six node plazas, as the main function of the plazas is to accommodate visitors.

It is worthy to mention that the sound sources of the six plazas vary as their different functions, which leads to different soundscape (Table 6). No.6 Park Plaza is vigorous; Sculpture Plaza is solemn; Pier Plaza is comfortable; Musical Spring plaza is majestic; Boats Plaza is interesting; No.1 Park Plaza is leisurely. Thus, although New Lakeside Park is shaped like a long strip, it is not boring walking along here.

3).Transverse Zoning

By averaging SPL measurements in every transverse row, the SPL transverse change map was get (Figure 13). The figure 13 shows that SPL in New Lake Park gradually decreases in the direction from Walking and Shopping Street to Landscape Waterfront.

The SPL transverse change is relevant to the

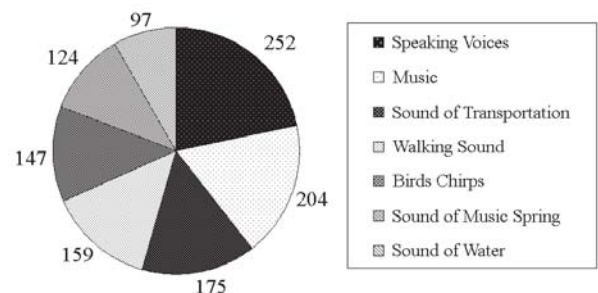


Fig. 10 The seven sound sources with highest total scores of soundscape importance



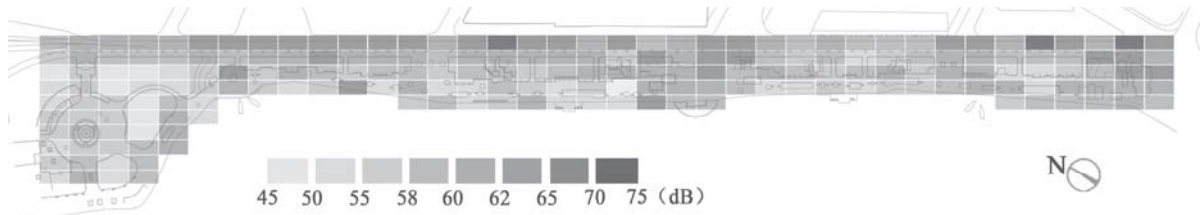


Fig. 11 The SPL map of New Lakeside Park

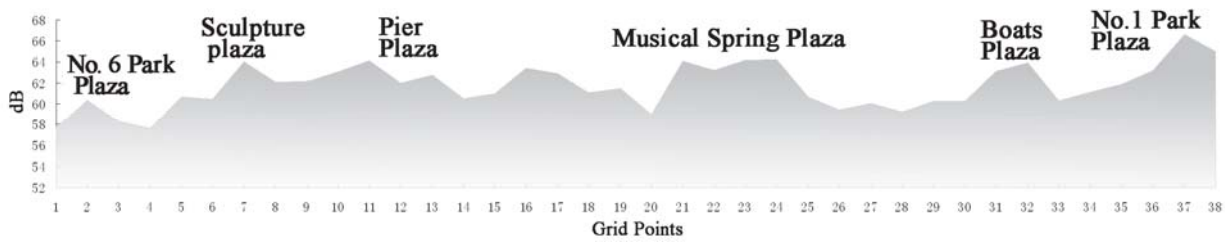


Fig. 12 Average SPL in vertical zoning

Table 6 Soundscape analysis of plazas

Plaza	Function	Landscape	Users	Sound Sources
No.6 Park Plaza	English Corner	Regular	Youth	Speaking voices, Sound of children
Sculpture Plaza	In memory of Songhu Battle	Small, Center for the statue	All visitors	Speaking voices, Walking sound
Pier Plaza	Row Boat Pier	Open space strip along the lake, close to the pier	Non-local visitors	Speaking voices, Sound of oars
Musical Spring Plaza	Musical Spring & Halfway Break	Large open space with seats, shops, toilets	All visitors	①Daily : activity sound ②Music spring start : music and sound of water
Boats Plaza	Boats Mooring & Information	Boats moorings, with various pieces	All visitors	Speaking voices, Walking sound Music of the multimedia billboard(in night)
No.1 Park Plaza	Elderly Activities	Natural, with multi-platforms, pavilions	Elderly	Singing voices, Speaking voices

characteristic of sound sources and landscape in transverse Zoning.

The landscape is clearly divided to four parts transversely, as: Landscape Waterfront, Parterre Belt, Rd. Hubin, Walking and Shopping Street. Every part has its own function and unique sound sources. By investigation the list is shown (Table 7).

Rd. Hubin is one of the main roads in West Lake Scenic, with frequent motor vehicle through and high traffic noise. The design of transverse zoning is just for handling this. The transverse vegetation design of the

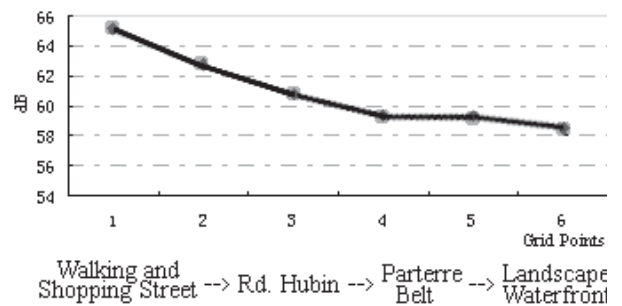


Fig. 13 Average SPL in transverse zoning

Table 7 Sound sources in transverse zones

Transverse Zones Sound Sources	Landscape Waterfront	Parterre Belt	Rd. Hubin	Walking and Shopping Street
Natural sound	Sound of plants	Sound of plants	No	No
Activity sound	Tourist activities	No	No	Tourist activities
Artificial sound	Music spring	Sound of broadcasting	Sound of transportation	No
Characteristics	Positive	Positive	Negative	Neutral

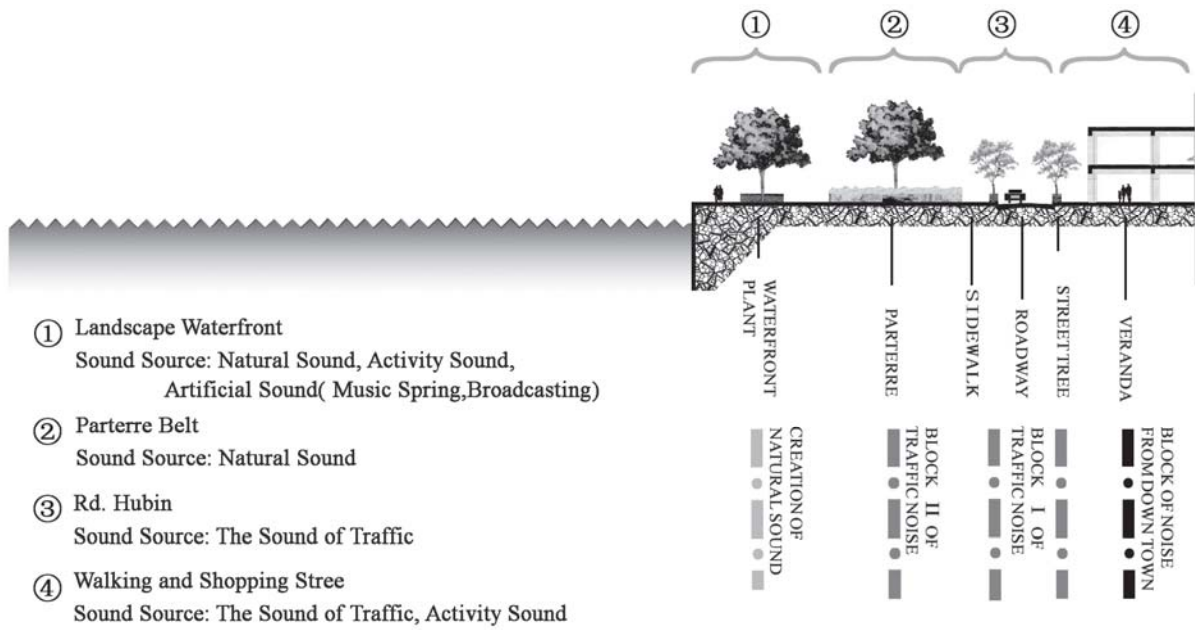


Fig. 14 The soundscape transverse zoning

park is three superimposed to avoid noise. The first layer is street trees of Rd. Hubin, which can block traffic noise from spreading to Landscape Waterfront and Walking and Shopping Street. The second layer is Parterre Belt planted with trees and shrubs, which isolated traffic noise completely. The third layer is waterfront plants which create positive and natural sound environment (Figure 14).

(3) Analysis of Soundscape Diversity

1).Change with Time

It is found by observation that the soundscape in New Lakeside Park change regularly with time as the sound sources change with time.

The first time rank to be considered is year, which shows variation by four seasons change.

The natural sound is greatly influenced by the four seasons change, because of the environment and the biological activity changes along with the temperature change. The birds chirps louder in spring, summer and autumn; the worm chirps louder in spring and autumn; the sound of leaves is louder in summer and lower in

winter; the sound of wind is louder in winter and summer typhoon days; the sound of rain is even in one year except the plum rains in June and typhoon in summer, in addition the thunder showers in summer can create more noise.

The activity sound changes with the variety of human activities in four seasons. As a well-known attraction, New Lakeside Park is used mainly by tourists and nearby residents. Because of the nice climate, spring and autumn become peak tourist seasons in Hang Zhou. More people create more activity sound. In addition, people prefer to enjoy nighttime cool in summer and midday sun in winter here. So there is still some activity sound existing in the two slack seasons.

The artificial sound is little affected by the seasons. Only the sound of boats, especially the sound of oars, is louder in spring and autumn. Because of the windy weather in scorching summer and frosty winter, boating is banned frequently.

The second time rank to be considered is month, which shows variation between working days and weekend.

The natural sound has slightly changes within a week.

The activity sound changes a lot within a week. There are far more residents nearby in the weekend than in the working days, which is related to people's working schedule. This trend is more apparent for young people, while the elderly residents and long-distance tourists change slightly. As a result, the activity sound like speaking voices, walking sound and children shouts grow in weekend, while singing voice of the elderly in No.1 Park slightly change.

Some artificial sound, such as music, sound of music spring, broadcasting, bell ringing, which are control by electronic equipment, change slightly in a week. Sounds of transportation and oars are related with population flow. There are far more boats on the lake in the weekend than working days, as long queue before the ticket office. That's why the sound of oars is significantly higher in weekend. The increased population in weekend also leads to heavy traffic in Rd. Hubin and eventually creates higher traffic noise.

The third time rank to be considered is day, which shows variation during a day.

The natural sound has slightly changes within a day.

The change of activity sound in a day is related to human daily schedule. People active more in daytime than in the night, especially from 9 a.m. to 4 p.m. which is the best time for tourists visiting West Lake.

Some artificial sounds, such as music, sound of music spring, broadcasting, play on the accurate setting time and change obvious in a day. The bell rings regularly on each time bit whole. In the time from 9 a.m. to 4 p.m., the sound of oars is greater than in the morning and evening, while none in the night. The traffic noise is related to Rd. Hubin. During the rush hours in working days, heavy traffic cause higher noise.

### 2). Various Opusculum Buildings

Numerous opusculum buildings are designed in the park to avoid monotony. The arrangement of soundscape opusculum buildings follows the guideline as "one main center, multiple focal points, grid distribution".

The main center is music spring. There are several focal points. The first one refers to multimedia billboard which introduces scenic spots, indicates directions and plays Chinese folk music at the same time. The second one is archaizing opusculum waterscape with sound of water. The electroacoustic broadcasting system is in grid distribution pervasively in the park. The audio players are made as small green mushrooms, unaffectedly placed in the parterres, transferring homogeneously.

These opusculum buildings are essential part of soundscape diversity in New Lakeside Park.

### 3). Change with Weather

Human elements of New lakeside Park are shown by the "rain" in "Sunny and Rainy Lakeside". In this investigation, soundscape in rainy days was explored and compared with in sunny days.

In rainy days the soundscape changes on two points. The first point is decrease on animal activity. The sounds of cicadas in daytime and insects in the night disappear. The bird chirps are also weakened. However, the sound of rainy days appears, such as: sound the rain knocking at trees, lotus leaves, umbrella, surface of the lake, surface of floor etc. The second point is the masking effect of sound of rain and wind. By this effect, the traffic noise from Rd. Hubin is greatly reduced and no longer apparent. Meanwhile, other environmental sounds are correspondingly weakened, even the signal sound of music spring.

By investigation it is found that there are significant differences existing between sunny and rainy soundscape in New Lakeside Park, which create the changeable characteristics of soundscape in New Lakeside Park.

### Results of Subjective Evaluation

#### (1) Analysis of Soundscape Congruence

The data of soundscape congruence for analysis obtain through the questionnaire to visitors.

The subjects of soundscape congruence analysis are the seven most important sound sources selected in the importance study of sound sources. The research was still done by ranking method: the seven most important sound sources were scored from 7 to 1 in accordance with the congruence from high to low by subjects.

The sums of the scores for each sound are obtained and the statistical result is as follows (Figure 15).

Figure 15 shows that the congruence scores of the three types of sound sources are similar in New Lakeside

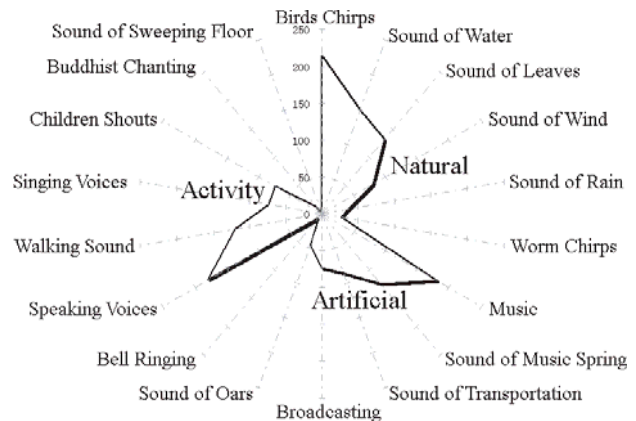


Fig. 15 The statistical result of soundscape congruence of each sound source

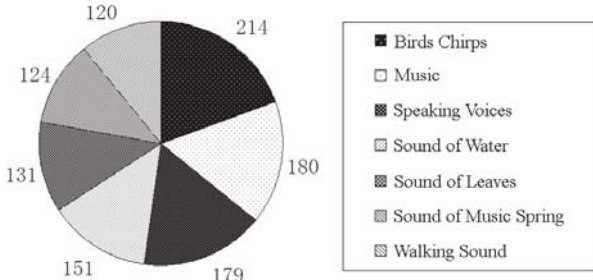


Fig. 16 The seven sound sources with highest total scores of soundscape congruence

Park. The ranking by score is: natural sound(638)>artificial sound(516)>activity sound(460).

The seven sound sources with highest total scores are: birds chirps > music > speaking voices > sound of water > sound of leaves > sound of music spring > walking sound. That is: natural sound (No. 1 birds chirps, No. 4 sound of water, No. 5 sound of leaves) >artificial sound (No. 2 music, No. 6 sound of music spring) > Activity sound (No. 3 speaking voices, No. 7 walking sound). Compared with the statistical result of importance study, the sound of the leaves is added and traffic noise is deleted (Figure 16).

The analysis of soundscape congruence shows the similar congruence of three types of sound sources in New Lakeside Park, while the natural sound is a little higher than the activity sound and artificial sound. The analysis result reflects the tourists' acceptance to different kinds of sound sources in New Lakeside Park. It meets the sound expectation.

(2) Soundscape Semantic Analysis

The research of subjective impression also includes semantic analysis. Subjects were asked to score on 8 pairs of anti-adjectives from four aspects. The adjectives on the left reflect tranquil impression while the adjectives on the right reflect lively impression (Table.8). Seven grades evaluation index was adopted in the

Table 8 Evaluation items as anti-adjectives

	Tranquil	Lively
Comfort	quiet	noisy
	natural	artificial
Social	significant	insignificant
	peaceful	demagogical
Space	simple	complex
	distant	close
Time	slow	fast
	gentle	intense

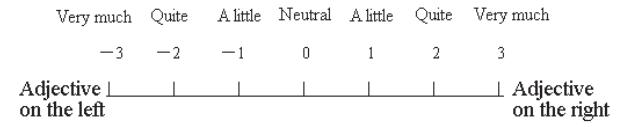


Fig. 17 Seven grades evaluation

questionnaire (Figure 17).

The statistical average scores of each pair of anti-adjectives were figured out and shown (Figure 18). It is seen from the figure that all the scores are closely around the neutral value "0". The farthest score is 1.17 and the nearest score is 0.52. The absolute value of the total scores on the left side is 3.46 while the absolute value of the total scores on the right side is 3.15, quite close.

Tourists' subjective impressions on soundscape in New Lakeside Park are both tranquil and lively as their scores show considerable. It meets the sound expectation.

Soundscape Evaluation of New Lakeside Park

The result of site survey was compared with sound expectation derivation and meets.

Analysis result of sound sources constitution conforms to the derivation that the soundscape here should consist of natural and artificial sounds; analysis results of soundscape zoning and soundscape diversity conform to the derivation that the soundscape should be clearly divided and various; analysis of soundscape diversity conforms to the derivation that the soundscape should show obvious differences between sunny and rainy days; analysis results of soundscape congruence and soundscape semantics conform to the derivation that the soundscape should be both lively and tranquil.

So the soundscape in New Lakeside Park is proper and should gain high satisfaction.

Then the tourists' satisfaction evaluation on soundscape was done by questionnaire. The average score is 7.37/10. It is found by this score that satisfaction of soundscape in New Lakeside Park is high. It fits the

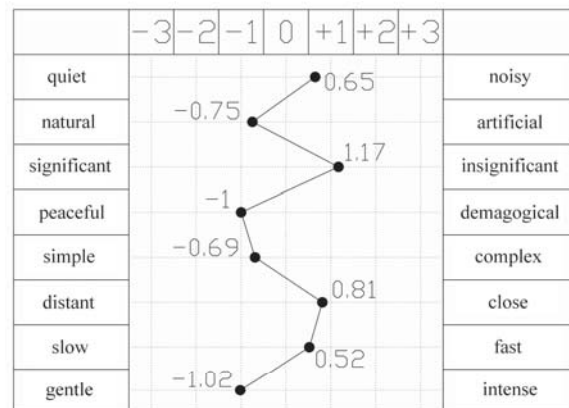


Fig. 18 The result of soundscape semantic analysis



result of sound expectation analysis.

This research on New Lakeside Park is in strict accordance with sound expectation theoretical approaches. It confirmed the authenticity and feasibility of sound expectation theory.

Meanwhile, the research of adequate and inadequate points of soundscape design in this case can promote the next step of sound landscape design.

The adequate points from the environment element: firstly, the reasonable zoning can create orderly and various soundscape, such as the transverse and vertical zonings in New Lakeside Park; secondly, different types of vegetation combined together organically can create positive sound and block negative sound.

The adequate points from the human element: firstly, the humanities can be introduced into soundscape design like the name of scenery and inscriptions to create suggestive soundscape, such as "Sunny and Rainy Lakeside" with the ancient poetry of Su Shi; secondly, promote some specific humanity soundscape to gain lingering charm, such as the Chinese aesthetical sound created by rain knocking at lotus leaves.

In addition to coordination within the three elements structure, exquisite design of artificially sound is an important high point of soundscape design in New Lakeside Park. The music spring, multimedia billboard and electroacoustic broadcasting system which create an impressive and unique soundscape are all successful examples.

The inadequate points in New Lakeside Park are: firstly, traffic noise in the park and from Rd. Hubin; secondly, too frequent activity sound, such as too many hawkers; thirdly, abused artificial sound, such as the music sound from battery cars and video toys. All these need to be considered and resolved.

The study also do survey of the problem whether soundscape and landscape interact with each other. Within 60 objects, about 2/3 consider that there are links existing, which shows the necessity of soundscape studies.

## CONCLUSION

Though soundscape study is global, the Practical application remains limited. The proper design and evaluation methods are needed.

Based on the existing research result of soundscape, especially the deeply analysis of the three elements structure, the concept of "sound expectation" and its research methods are put forward. By the case study of the new lakeside park, the authenticity and feasibility of sound expectation theory is proved. This case study is strictly in accordance with soundscape evaluation

methods in theory. There are four steps as: Preliminary Data Collection, Soundscape Expectation Derivation, Site Survey and Soundscape Evaluation. And the result shows that soundscape in the new lakeside park is consistent with sound expectation. Then, through an integrated soundscape satisfaction survey, the average points obtained are 7.37/10. The thesis that the soundscape meets sound expectation will gain a high degree of subjective evaluation is proved.

Some later steps, such as: summarizing soundscape design methods, accurate soundscape software simulation, still need further research.

## ACKNOWLEDGEMENTS

This paper is one of the achievements of the research project supported by Foundation for Open Projects of Semitropical Archi-Science National Key Laboratory; and National Natural Science Foundation of China (51078325).

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