

# Establishment of Plant Landscape Evaluation System for Mausoleum Park

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**Abstract--In this paper, the plant landscape evaluation system for Mausoleum Park has been established with 23 evaluation indicators which were categorized by questionnaire investigation. Analytic hierarchy process (AHP) was used to figure out the significance ranking. For norm hierarchy, ecological value is prior to landscape value and culture value is prior to recreation value. The entire above offered theoretical basement for construction of Mausoleum Park.**

**Keywords--landscape comprehensive evaluation; AHP; Mausoleum Park**

## I. INTRODUCTION

Park green land is not only an important part in city greenly, but also a centralized reflection of overall style and features and historic culture of the city [1]. Ecological service function, landscape recreation function, cultural propaganda and economic production function make it a major support for public activities and recreations [2]. Requirement of greenly is enhanced in term of ecological benefit besides the visual effect as the basic demand. Meanwhile, it is a significant symbol of modern urban culture as well as a vital important component of realization of great 'China Dream', which was construction of beautiful China suggested in 18th CPC National Congress [3]. Plant communities are basic factors both of greenly component and balance of the effect of ecology and landscape in various types. To a extent, plant communities spread culture. As for plant communities structure, a certain progress has been gained in the realm of species diversity and referring research [4-5]. Mausoleum Park has to show its ecological service function and play an irreplaceable role in culture heritage. However, fewer researches, especially on plant landscape evaluation in Mausoleum Park, have been found. It's meaningful for Mausoleum Park construction to establish a complete and scientific plant landscape evaluation system in Mausoleum Park.

## II. MATERIAL AND METHOD

### A. Brief Introduction of The Research Area

Beiling Park is located in the North Shenyang. To be precisely, it is in the north of Taishan Road, south of Baishan East Road, east of Huanghe North Road and west of Ling East Road. It is 4km far from the city center. Its altitude is 65m and square area is 327.4ha. It is national AAAA Scenery Park, including Qing Zhao Ling (world cultural heritage), Friendship Park, Fangxiu Park, Rhododendron Park and some

other scenery. Among them, the area of water is 30ha and green space is near 260ha. Beiling Park is one of the urban parks with the most diverse plant species, the best growing situation and the perfectest management in Shenyang. There are 98 kinds of trees and shrubs, 408 kinds of groundcover plants, but less original species. There are You Yi Garden, Fangxiu Garden and Rhododendron Garden and several other sceneries, including Zhaoling Mausoleum of the Qing Dynasty which is world cultural heritage. As one of places of historic interest and scenic beauty in Shenyang, Zhaoling stands for the essence of China ancient architecture and the representative of culture exchange between Manchu and Han nationalities.

### B. Method

#### 1) Questionnaire investigation

People who evaluate are required referring professional knowledge when they process plant landscape evaluation, especially when the greenly is like Mausoleum Park with special application. Therefore, the questionnaires were designed for experts. There were 50 questionnaires in all and 43 of them were collected back (86%). The relative evaluation indicators were confirmed by objective quantitative results gained from the collection of the data of the questionnaires.

#### 2) Analytic hierarchy process

Analytic Hierarchy Process (AHP) was founded by American operational research expert T. L. Saaty in early 70s in 20th century. It is a system analysis methodology conducted by combination of quantitative and qualitative [6-7]. The theory is to decompose a complicated question into several factors. The next is to confirm the progressive relation among the factors. Then to get the numerical value of importance by comparing two factors. Finally, the consistency check had to be done to the results. When  $C_R < 0.1$ , an agreeable satisfaction was got; when  $C_R \geq 0.1$ , an unagreeable satisfaction was got, which means the numerical values had to be adjusted and estimated in the matrix.

#### (1) Confirmation of the Weight Value

According to the scale of AHP (Table 1), the judgment matrix was established by comparing every two factors to calculate the weight value of every factor relative to the previous one. Then the consistency check was conducted [8-9].

TABLE I. SCALE AND DESCRIPTION.

Importance Scale	Description of the definition
1	Compare two factors, 1 <sup>st</sup> is as important as 2 <sup>nd</sup> .
3	Compare two factors, 1 <sup>st</sup> is a bit more important than 2 <sup>nd</sup> .
5	Compare two factors, 1 <sup>st</sup> is obviously more important than 2 <sup>nd</sup> .
7	Compare two factors, 1 <sup>st</sup> is strongly more important than 2 <sup>nd</sup> .
9	Compare two factors, 1 <sup>st</sup> is extremely more important than 2 <sup>nd</sup> .
2,4,6,8	Median value of the two factors.
Reciprocal of the above	In term of the corresponding significance, the degree of less importance of 1 <sup>st</sup> compared to the 2 <sup>nd</sup> .

Calculation of the importance value of the corresponding factor in named hierarchy relative to the one in the precious hierarchy. The formulation is (1)

$$T_i = \sqrt[n]{\prod_{k=1}^n X_{ik}} \quad (i, k=1,2,\dots,n) \quad (1)$$

In the equation,  $T_i$  is the importance value of the corresponding factor in named hierarchy relative to the one in the precious hierarchy;  $X_{ik}$  ( $i, k=1,2,\dots,n$ ) is the scale value of comparative importance between factor  $i$  and  $k$ ;  $n$  is the number of estimation factors.

$W_i$ , which is the weigh value of the corresponding factor in named hierarchy relative to the one in the precious hierarchy, was got by the normalized treatment to  $T_i$ . The formulation is(2)

$$W_i = \frac{T_i}{\sum_{i=1}^n T_i} \quad (i=1,2,\dots,n) \quad (2)$$

(2) Consistency check. The formulation is (3),(4) and (5).

$$\lambda_{\max} = \sum_{i=1}^n \frac{1}{nW_i} \sum_{k=1}^n X_{ik} W_k \quad (3)$$

$$C_1 = \frac{\lambda_{\max} - n}{n-1} \quad (4)$$

$$C_R = \frac{C_1}{R_1} \quad (5)$$

TABLE II. VALUE OF  $R_1$ .

	1	2	3	4	5	6	7	8	9	10
$R_1$	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49

### III. RESULT AND ANALYSIS

#### A. Analyzation of The Elected Indicators

In order to gain the relative evaluation indicators for Mausoleum Park, the questionnaires were designed specially to the experts. As a result, 43 questionnaires, which were 86% of all, were collected back in all the 50 ones. Based on the data analyze, the plant landscape evaluation system of Mausoleum Park was founded. Shown in table3.

Known from table3, the evaluation system could be divided into four hierarchies which are ecology value, recreation value, landscape value and culture value. There are 20 evaluation indicators all together.

TABLE III. PLANT COMMUNITY LANDSCAPE EVALUATION INDICATOR SYSTEM OF MAUSOLEUM PARK.

Target Hierarchy	Standard Hierarchy	Indicator Hierarchy	Target Hierarchy	Standard Hierarchy	Indicator Hierarchy
Plant Landscape Evaluation in Mausoleum Park(G)	Ecological Value	Biology Diversity(I <sub>1</sub> )	Plant Landscape Evaluation in Mausoleum Park(G)	Landscape Value	Diversity of Flowering Plants(I <sub>11</sub> )
	(C <sub>1</sub> )	Plant Life-form(I <sub>2</sub> )		(C <sub>3</sub> )	Diversity of Coloured Plants(I <sub>12</sub> )
		Harmony Condition Between Plants and Habitats(I <sub>3</sub> )			Seasonal Change(I <sub>13</sub> )
		Carbon Sink Function(I <sub>4</sub> )			Sufficiency of Botanical Morphology(I <sub>14</sub> )
		Dust-Retention Function(I <sub>5</sub> )			Sufficiency of Spacial Layers(I <sub>15</sub> )
		Reducing Temperature and Increasing Humidity Function(I <sub>6</sub> )			Coordination with Overall Environment(I <sub>16</sub> )
		Ratio among Arbor and Shrub and Grass(I <sub>7</sub> )			Agreeableness of Landscape Scale(I <sub>17</sub> )
	Recreation Value	Landscape Accessibility(I <sub>8</sub> )		Cultural Value	Plant Culture(I <sub>18</sub> )
	(C <sub>2</sub> )	Stopover(I <sub>9</sub> )		(C <sub>4</sub> )	Place Culture(I <sub>19</sub> )
		Anti-Interference(I <sub>10</sub> )			Artistic Conception of Plant Landscape(I <sub>20</sub> )

#### B. Confirmation of Weigh Value and Consistency Check

Combined the method of establishing matrix and the way how to calculate importance degree, the judgment matrix of every two factors were set up for Mausoleum Park evaluation. Normalized treatment was applied to the importance degree value which had been got from the judgment matrix. After the normalized treatment, the weigh value of the corresponding indicator relative to the one in the previous hierarchy. Shown in talbe4-8.

TABLE IV. JUDGMENT MATRIX OF G-C.

G	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	W
C <sub>1</sub>	1	5	3	3	0.5318
C <sub>2</sub>	1/5	1	1/2	1/2	0.0971
C <sub>3</sub>	1/3	2	1	1	0.1855
C <sub>4</sub>	1/3	2	1	1	0.1855

TABLE V. JUDGMENT MATRIX OF C1-I.

C <sub>1</sub>	I <sub>1</sub>	I <sub>2</sub>	I <sub>3</sub>	I <sub>4</sub>	I <sub>5</sub>	I <sub>6</sub>	I <sub>7</sub>	W
I <sub>1</sub>	1	4	2	2	3	4	5	0.311
I <sub>2</sub>	1/4	1	1/3	1/3	1/2	1	2	0.0699
I <sub>3</sub>	1/2	3	1	1	2	3	4	0.1946
I <sub>4</sub>	1/2	3	1	1	2	3	4	0.1946
I <sub>5</sub>	1/3	2	1/2	1/2	1	2	3	0.1166
I <sub>6</sub>	1/4	1	1/3	1/3	1/2	1	2	0.0699
I <sub>7</sub>	1/5	1/2	1/4	1/4	1/3	1/2	1	0.0435

TABLE VI. Judgment Matrix of C<sub>3</sub>-I

C <sub>3</sub>	I <sub>11</sub>	I <sub>12</sub>	I <sub>3</sub>	I <sub>4</sub>	I <sub>5</sub>	I <sub>6</sub>	I <sub>7</sub>	W
I <sub>1</sub>	1/2	1/2	1/3	1/4	1/6	1/7	1/8	0.0264
I <sub>12</sub>	1	2	1/2	1/3	1/5	1/6	1/7	0.0392
I <sub>13</sub>	2	3	1	1/2	1/4	1/5	1/6	0.0581
I <sub>14</sub>	3	4	2	1	1/3	1/4	1/5	0.0863
I <sub>15</sub>	5	6	4	3	1	1/2	1/3	0.1766
I <sub>16</sub>	6	7	5	4	2	1	1/2	0.2575
I <sub>7</sub>	1/5	1/2	1/4	1/4	1/3	1/2	1	0.3558

TABLE VII. JUDGMENT MATRIX OF C<sub>2</sub>-I, C<sub>4</sub>-I

C <sub>2</sub>	I <sub>8</sub>	I <sub>9</sub>	I <sub>10</sub>	W	C <sub>4</sub>	I <sub>18</sub>	I <sub>19</sub>	I <sub>20</sub>	W
I <sub>8</sub>	1	3	4	0.6250	I <sub>18</sub>	1	3	2	0.0264
I <sub>9</sub>	1/3	1	2	0.2385	I <sub>19</sub>	1/3	1	1/2	0.0392
I <sub>10</sub>	1/4	1/2	1	0.1365	I <sub>20</sub>	1/2	2	1	0.0581

According to the equation of consistency check, the satisfaction consistency among the weigh values of indicators. Table9 tells that all the consistency check results meet  $C_R < 0.1$ . That is to say, the consistency of weigh values' calculation of every indicator assured the weigh value.

TABLE VIII. CONSISTENCY CHECK.

	C <sub>1</sub> -I	C <sub>2</sub> -I	C <sub>3</sub> -I	C <sub>4</sub> -I
	7.0792	3.0367	7.2159	3.0092
CI	0.0132	0.0183	0.036	0.0046
CR	0.0097	0.0316	0.0265	0.0079

Based on the weigh value, the synthetical weigh values were calculated to determine the weigh value of every indicator in the system. Shown in talbe10.

TABLE IX. PLANT LANDSCAPE EVALUATION SYSTEM IN MAUSOLEUM PARK.

Target Hierarchy	Standard Hierarchy	Indicator Hierarchy	Target Hierarchy	Standard Hierarchy	Indicator Hierarchy
(G)	(C <sub>1</sub> )	(I <sub>1</sub> ) 0.1654	(G)	(C <sub>3</sub> )	(I <sub>11</sub> ) 0.0049
	0.5318	(I <sub>2</sub> ) 0.0372		0.1855	(I <sub>12</sub> ) 0.0073
		(I <sub>3</sub> ) 0.1035			(I <sub>13</sub> ) 0.0108
		(I <sub>4</sub> ) 0.1035			(I <sub>14</sub> ) 0.0160
		(I <sub>5</sub> ) 0.0620			(I <sub>15</sub> ) 0.0328
		(I <sub>6</sub> ) 0.0372			(I <sub>16</sub> ) 0.0478
		(I <sub>7</sub> ) 0.0231			(I <sub>17</sub> ) 0.0660
	(C <sub>2</sub> )	(I <sub>8</sub> ) 0.0607		(C <sub>4</sub> )	(I <sub>18</sub> ) 0.1001
	0.0971	(I <sub>9</sub> ) 0.0232		0.1855	(I <sub>19</sub> ) 0.0303
		(I <sub>10</sub> ) 0.0133			(I <sub>20</sub> ) 0.0551

In talbe10, the highest weigh value of ecological value in standard hierarchy is 0.5318, which states that the establishment of plant landscape gives ecological value the highest priority in the three principles in this hierarchy, which is also a highlight in plant landscape. Both the landscape value and cultural value are 0.1855. That is to say, they are equally significant in the process of plant distribution. In the target hierarchy, biological diversity has the highest weigh, which is 0.1654, proving the dominated position of plant landscape consisting of multi-species in Mausoleum Park construction. The flowering plant diversity tends to be weak which was indicated by its lowest weigh value which is 0.0049.

#### IV. CONCLUSION AND SUGGESTION

In ecology, aesthetics and culture perspectives, the combination of quantitative indicators and qualitative indicators has set up plant landscape evaluation model for Mausoleum Park and confirmed 23 evaluation factors and their weigh values. It also provides reference to design and construct a Mausoleum Park. The conclusion of this research has profound meaning to upgrade the overall level of his kind of landscape and coordinate the landscape, ecology, recreation and some other functions harmoniously. The researching approach was provided too. In order to make the evaluation system more scientific and reasonable, greater samples ought to be surveyed in the future study.

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