Evaluation of Forest Landscape Resources of National Forest Park in Typical Area of China

Ziru Chen¹,a, Zhipeng Zhu¹,b, Zhenzhen Guo¹,c, Jingru Chen¹,d, Weicong Fu¹,e
Jianwen Dong¹,2,*, Guochang Ding¹,2,f

¹College of Arts & Landscape Architecture, Fujian Agriculture and Forestry University, Fuzhou, China
²State Forestry Administration National Forest Park Engineering Research Center, Fuzhou, China

*Corresponding author e-mail: fjdjw@fafu.edu.cn

Abstract. The Scenic Beauty Evaluation (SBE) method is used to access multidimensionally landscape beyond forests multi-dimensionally in different seasons and classify different kinds of forestry landscape. 14 landscape elements including plants color, landscape uniformity and so on to build the landscape model: Y=0.17+0.039X1-1+0.249X1-2+0.487X1-3-0.322X3-1+0.027X3-3+0.165X4-1-0.228X4-2-0.237X6-1+0.129X6-3+0.066X10-1-0.214X10-2-0.35X11-2+0.615X11-3+0.09X11-4+0.543X12-1+0.229X12-2-0.151X13-1-0.562X13-2-0.01X13-3-0.08X14-2 As we can know from the model, the state of the water has the greatest influence on the value of landscape, and the smallest influence is the skyline of the landscape; the richness of plant color has positive influence on it, while the slope of the mountain and the whole vegetation are negatively affected. In the end, analysis are conducted based with different people grouped by age, education background, living area tourism aims.

1. Introduction
With the rapid growth of urban population, the lack of urban leisure space is becoming increasingly prominent. Exploiting a new recreational space has become an urgent need. With the increase of income and leisure time of the urban population, coupled with the smooth urban and rural transport and the beautiful landscape view, forest in the suburban has become a tourist destination for more and more urban population [1]. Previous studies have made some exploration in the forest parks like forest ecology [2], landscape security pattern [3], forest landscape pattern evolution law [4], forest park spatial heterogeneity [5] and so on, which greatly enriched the research system of forest landscape. But the use of Scenic Beauty Assessment (SBE) to distinguish between different groups of forest landscape differences, and quantitative research, rarely reported.

The psycho-physical method is considered to be the most objective evaluation method. The SBE is one of the most maturity methods to evaluate the landscape [6-8]. The study shows that the response
of the different viewers to the same landscape is different. Results of the evaluation according to different classes of people can make the evaluation results more scientific.

2. Materials and methods

2.1. Research methods

Days with typical weather were selected to monitored the data in spring, summer, autumn and winter, during the study period. Observation time are 7:00, 9:00, 11:00, 13:00, 15:00, 17:00, 19:00. The monitors were set with the height of 1.2 ~ 1.5 m, and 3 times were repeated at each observation point.

2.1.1. Landscape sample acquisition. In order to be more truly reflect the aesthetic characteristics of forest landscape, we took the photo abide by: ① high visibility conditions; ② front lighting conditions; ③ showing the main vision. About 31 photographs were selected which can reflect typical regional forest landscape resources in China.

2.1.2. Landscape evaluation. We used on-line questionnaire to evaluate and used 7 points system to score the photos by 3, 2, 1, 0, -1, -2, -3 (3 means very good, -3 means very bad, 0 means neither good nor bad) [9-10].

2.1.3. Landscape factor decomposition. In order to determine the relationship between the landscape evaluation score and the landscape elements reflected in the evaluation photographs, the elements were extracted, and these landscape elements were decomposed into different categories according to the same standard (see Table 1).

| No. | Landscape Elements                  | Category       | 1    | 2    | 3    | 4    | Category Number |
|-----|------------------------------------|----------------|------|------|------|------|-----------------|
| X1  | Number of plant color              | 1 kind         | 2 kinds | 3 kinds | >3 kinds | 4               |
| X2  | Number of colors                   | 3 kinds         | 4 kinds | 5 kinds | >5 kinds | 4               |
| X3  | Scene Cleanliness                  | Mess            | General | Tidy   |        | 3               |
| X4  | Crop Uniformity                    | Mess            | General | Tidy   |        | 3               |
| X5  | Haruhana or Autumn Leaves          | No              | Yes    |        |        | 2               |
| X6  | Landscape texture                  | Steel           | Soft   | Mixed  |        | 3               |
| X7  | Water surface                      | Yes             | No     |        |        | 2               |
| X8  | Building style                     | New style       | Ancient | No     |        | 3               |
| X9  | Building color                     | White           | Red    | Brownish yellow | No | 4               |
| X10 | Water dynamic                      | Dynamic         | Static state | No     |        | 3               |
| X11 | Water surface occupy               | <5%             | 5%~15% | 15%~30% | >30%   | 4               |
| X12 | Skyline                            | Gentle          | General | Steep  |        | 3               |
| X13 | Gradient of the mountain           | 0~30°           | 30°~45° | 45°~60° | >60°   | 4               |
| X14 | Plaque definition                  | Clear           | No Clear |        |        | 2               |
2.1.4. Data analysis. We use standardized calculation to reduce error, the calculation formula is as follows:

\[ Z_{ij} = \frac{(R_{ij} - R_j)}{S_j} \quad [11-12] \]

\( Z_{ij} \) is the normalized value for the i-th photograph of the j-th responder; \( R_{ij} \) is the SBE score of the j-th judge for the i-th photograph; \( R_j \) is the average of the j-j judge for all photographic values; For the j-j judge on the standard deviation of all photo beauty values.

3. Result and analysis

3.1. Overview
A total of 303 responders were issued to meet the sample requirements of the Factor Analysis Experiment Questionnaire [13-14] by statistics, the proportion of men and women in the overall sample was balanced (134 males, 49.1% and 139 females, accounting for 50.9%); The majority of the population under the age of 40, 20 to 30 years old; occupation composition, the company staff or self-employed groups are more than the student group. In the questionnaire collection, the number of respondents reached 30 or more, in line with statistical requirements [15], indicating that the survey data is representative, can reflect the public and most of the population of aesthetic and psychological reactions. In the data analysis, it was found that almost all respondents (95.5%) thought that the beauty of the forest landscape was of great significance to the construction of the forest park, which could enhance the construction level of the forest park. Most of the respondents (73.2%) yearn for the forest park has a high view of the forest landscape, and is willing to visit it. It is worth mentioning that 91.9% of the respondents believe that the enjoyment and relaxation of the forest landscape for the important social function.

3.2. Model establishment and analysis
According to the results of the calculation, the partial correlation coefficient was tested by T test, and the items with different coefficients were not significant and the partial correlation coefficient was smaller. Then, the results were compared with those of the selected ones. The remaining items continue to operate, and so on, a total of 6 operations. Get the forest park forest landscape resource model:

\[ Y = 0.17 + 0.039X_{1,1} + 0.249X_{1,2} + 0.487X_{1,3} - 0.322X_{3,1} + 0.027X_{3,3} + 0.165X_{4,1} - 0.228X_{4,2} - 0.237X_{5,1} + 0.129X_{6,3} + 0.066X_{10,1} - 0.214X_{10,2} - 0.35X_{11,2} + 0.615X_{11,3} - 0.09X_{11,4} + 0.543X_{12,1} + 0.229X_{12,2} - 0.151X_{13,1} - 0.562X_{13,2} - 0.01X_{13,3} - 0.08X_{14,2} \]

Forest Landscape Evaluation Model Overview It can be seen from Table 2 that the linear relationship between the landscape factor and the predicted value of the preference is strong, and the regression model is better and has high prediction accuracy.
Table 2. Evaluation modeling results of forest landscape

| Item Number | 1th | 2th | 3th | 4th | 5th | 6th |
|-------------|-----|-----|-----|-----|-----|-----|
|             | P-value | t-value | P-value | t-value | P-value | t-value | P-value | t-value | P-value | t-value | P-value | t-value |
| X1          | 0.43 | 1.90 | 0.47 | 2.20 | 0.46 | 2.26 | 0.54 | 2.80 | 0.53 | 2.80 | 0.57 | 3.18 |
| X2          | 0.07 | 0.30 | 0.07 | 0.32 | 0.09 | 0.42 |       |      |      |      |      |      |
| X3          | 0.18 | -0.74 | 0.18 | -0.79 | 0.19 | -0.85 | 0.21 | -0.96 | 0.23 | -1.07 | 0.24 | -1.16 |
| X4          | 0.23 | 0.97 | 0.23 | 0.98 | 0.22 | 1.00 | 0.21 | 0.98 | 0.22 | 1.05 | 0.19 | 0.90 |
| X5          | 0.11 | -0.47 | -0.13 | -0.55 | 0.13 | -0.59 | 0.13 | -0.58 |       |      |      |
| X6          | 0.61 | 3.09 | 0.61 | 3.18 | 0.61 | 3.27 | 0.60 | 3.33 | 0.59 | 3.34 | 0.62 | 3.66 |
| X7          | 0.19 | 0.79 | 0.19 | 0.81 | 0.18 | 0.82 | 0.20 | 0.91 | 0.15 | 0.72 |       |      |
| X8          | 0.05 | 0.22 |       |      |      |      |      |      |      |      |      |      |
| X9          | 0.06 | -0.27 | 0.03 | 0.16 |       |      |      |      |      |      |      |      |
| X10         | -0.36 | -1.54 | 0.56 | 1.58 | 0.35 | 1.63 | 0.38 | 1.80 | 0.36 | 1.75 | 0.58 | 3.29 |
| X11         | 0.55 | 2.68 | 0.35 | 2.80 | 0.56 | 2.89 | 0.59 | 3.20 | 0.68 | 4.23 | 0.69 | 4.38 |
| X12         | 0.56 | 2.76 | 0.56 | 2.83 | 0.56 | 2.93 | 0.57 | 3.07 | 0.58 | 3.23 | 0.57 | 3.12 |
| X13         | 0.4 | 1.74 | 0.39 | 1.78 | 0.40 | 1.88 | 0.41 | 1.96 | 0.47 | 2.42 | 0.47 | 2.46 |
| X14         | 0.28 | 1.18 | 0.28 | 1.20 | 0.27 | 1.23 | 0.26 | 1.21 | 0.24 | 1.12 | 0.19 | 0.93 |
| R           | 0.881 | 0.881 | 0.881 | 0.879 | 0.877 | 0.877 |      |      |      |      |      |      |
| R²          | 0.581 | 0.605 | 0.626 | 0.642 | 0.654 | 0.662 |      |      |      |      |      |      |

From the comparison of the size of each factor class regression coefficient, we can see the following rules: ① In the forest landscape, the more colorful the plant color, the higher the degree of its landscaping; ② the higher the scene cleanliness, the higher the landscape evaluation value, In order to create a forest park forest landscape should try to enhance the forest environment cleanliness, such as: reasonable planning telecommunications tower, high-voltage cable, high-altitude cable car, etc.; ③ plant uniformity, in the forest to view the forest from the perspective of the landscape, more neat The effect of different landscape texture on the evaluation of forest landscape also has a certain impact,
the overall view of the steel landscape in terms of the contribution rate of the landscape to show a negative value, while the soft landscape has a certain extra points, indicating that the soft forest landscape is more attractive to the visitors; ⑤ whether the forest landscape contains the surface, is the impact of its beauty assessment of the key factors, and static water features tend to have a strong role in the forest landscape, and the size of the water area on the judge the scale also has a certain impact; ⑥ the size of the mountain slope so that visitors have a certain impact on the observation of the skyline The higher the slope of the skyline showed a rolling state, the mountain slope is small when the mountain showed a gentle change also affect the landscape beauty value, generally about the gentle landscape is the higher the value; ⑦ plaque clarity on The overall landscape has a certain impact, the more clear the patch is the higher the landscape beauty value, see Table 3.

Table 3. Score of the forest landscape evaluation items

| Item                        | Category | Parameter | Score | Rate of contribution% |
|-----------------------------|----------|-----------|-------|------------------------|
| Number of plant color       | 1        | 0.039     |       | 10.47                  |
|                             | 2        | 0.249     | 0.448 |                        |
|                             | 3        | 0.487     |       |                        |
|                             | 1        | -0.322    |       |                        |
| Scene Cleanliness           | 2        | 0         | 0.349 | 8.15                   |
|                             | 3        | 0.027     |       |                        |
|                             | 1        | -0.165    |       |                        |
| Uniformity of plant         | 2        | -0.228    | 0.393 | 9.18                   |
|                             | 3        | 0         |       |                        |
|                             | 1        | -0.237    |       |                        |
| Landscape texture           | 2        | 0         | 0.366 | 8.55                   |
|                             | 3        | 0.129     |       |                        |
|                             | 1        | 0.66      |       |                        |
| Water                       | 2        | -0.214    | 0.874 | 20.42                  |
|                             | 3        | 0         |       |                        |
|                             | 1        | 0         |       |                        |
|                             | 2        | -0.35     | 0.965 | 22.55                  |
|                             | 3        | 0.615     |       |                        |
|                             | 4        | 0.09      |       |                        |
|                             | 1        | 0.543     |       |                        |
| Water surface occupy        | 2        | 0.229     | 0.314 | 7.34                   |
|                             | 3        | 0         |       |                        |
| Skyline                     | 1        | 0         |       |                        |
| Gradient of the mountain    | 2        | -0.151    | 0.563 | 33.15                  |
|                             | 3        | -0.01     |       |                        |
|                             | 4        | 0         |       |                        |
| Plaque definition           | 1        | 0         | 0.008 | 0.19                   |

3.3. Analysis of Landscape Preference of Different Forest Landscape by Different Groups

The results showed that different people exhibited difference in the aesthetic preferences. From the data point of view, different groups of different types of forest landscape response has a certain difference, and to age, education, permanent residence, the purpose of different groups of people on the forest landscape evaluation value difference is more obvious.

As shown in Figure 1-a, gender differences in forest landscape evaluation of the difference is less obvious; age group is reflected in: in addition to the age of 18 people over the age of the remaining segments of the population is more similar to the aesthetic, and 18 years of age, The landscape shows
great appetite and the relative lack of interest in the familiar environment may be related to its growing
environment and life experience.

There are significant differences between the scoring system of junior middle school group and
doctor group and the other groups, which also shows that the two groups have great differences in
aesthetic attitude and aesthetic orientation. In high school, undergraduate and master group, There was
no significant difference between the two groups, indicating that the aesthetic differences of these
three groups were small.

The sub-grouping to the Forest Park once a quarter to show the aesthetic trend of the seasonal
change of the forest park landscape is not obvious, and the quarterly go to the Forest Park more than 2
times the group, the spring flowers, autumn leaves and winter scenery preferences Level higher than
the other two groups. The results show that the number of forest parks is more sensitive to the seasonal
changes in forest landscape, and the number of forest parks per season is higher, indicating that people
who are more interested in forest landscape are more willing to visit Forest Park.

From the resident to the city, suburban, county, township, rural and life attitude for the positive,
general, not actively different groups of people to analyze. The results showed that there was no
significant difference in the preference of the forest population.
Fig. 1 Preference analysis of different groups for different forest landscapes

- a: Gender; b: Age; c: Education Background; d: Number of visits per season; e: Place of residence; f: Tour purpose; g: Attitude towards life

4. Conclusion
The visual landscape of the selected national forest parks was evaluated and compared with each other. The results show that there is a great preference for the different landscapes of the same place of
residence, and the relative lack of interest in the familiar environment may be related to its growth environment and life experience.

Forest Park in the construction of the forest landscape should be considered: 1) the appropriate construction of the forest landscape seasonal changes, so rich colors, the scene clean and tidy, to enhance the overall landscape of the forest; 2) transformation process, more gentle or too steep mountain should be based on the needs of the field, increase or decrease the height of the tree planting, so that the slope of the mountain contours in the 45 ° and 60 ° between, to enhance the comprehensive landscape quality; 3) appropriate planting spring flowers, autumn leaves plants to enhance the seasonal changes in the mountain: the construction process Should be peach, pear, lime and other fresh and have some economic functions of plants as a spring plant selection, and autumn leaves plants should be selected in the subtropical common fruit chestnut, persimmon, etc., both to enhance the aesthetic quality of the mountain can increase the villagers income.

Compared with the previous studies [16-18], SBE data analysis and different groups of people to compare the data, enrich the evaluation results, make the data more objective and more practical. Evaluation method has a strong operability, with the promotion of significance.

References
[1] Lan,S.R.,You,Y.F.,Fu, Y.H., Present State and Development Countermeasure of Forest Parks and Forestry Tourism Industry in Fujian Province[J]. Problems of Forestry Economics, 2000, 20(05):277-279+298.
[2] Deng,X.J.,Yue, S.Z., Research on Structure Optimization of Forest Resources in Hainan[J]. Ecological Economy, 2017, 33 (01):88-91.
[3] Wang, Y.F.,Liu,Z.F.,Zhang,L., et al. The evaluation and analysis of the quality grade of landscape resources in longdong national forest park [J].Tourism Overview,2015,(09):93-94.
[4] GB/T 18005—1999,China Forest Park Landscape Resources Grade Evaluation[S].
[5] Lan,S. R. Forest landscape measurement and evaluation and development and application of forest landscape in Fujian [J]. EastChinaForestManagement, 2001, 19 (04):53-57+42.
[6] Wang,N.,Zhong,Y.D.,Li,S., SBE Based Evaluation of In-forest Landscape Aesthetic Quality of Forest Park in Suburb[J]. Journal of Northwest Forestry University, 2017, 32 (01):308-314.
[7] Dong,J.W.,Zhai,M.P.,Zhang ,Z. D., et al. Single-factor analysis on scenic beauty of scenic-recreational forest in mountainous region of Fujian Province, eastern China[J]. Journal ofBeijing Forestry University, 2009, 31 (06):154-158.
[8] Chen, Z. R.,Fu,W.C.,Zhu,Z.P., et al. Farmland Landscape Aesthetic Quality Evaluation in Moutainous and Hilly District of Fujian Province[J]. Journal of Anhui Agricultural University.
[9] Daniel,T.C., Buster, R.S. Measuring landscape esthetics: the scenic beauty estimation method[J]. USDA For. Rocky Mtn Forest and RangeExpStn, 1976.102 ~ 167.
[10] Dong,J.W.,Zhang,Z.D.,Xu,X.S., et al. Estimationon Scenic Beauty of Scenic-recreational Forests in Mountainous Region Fujian and Its Construction Technique[J].Journal of Northeast Forestry University, 2010,38(04):45-48.
[11] Daniel.TC, Vining J. Methodological issues in the assessment of landscape quality[M]//ALTMANL,WOHHWL J F, eds. Behaviour and Natural Environment. New York: Plenum Press, 1983.
[12] Zhang, Z.D., XU,C.Y., Gong,L. et al. Assessment on structural quality of landscapes in green space of Beijing suburban parks by SBE method[J]. Scientia Silvae Sinicae, 2011, 47 (8):53-60.(in Chinese)
[13] Feng,X.T.,Non-response and Sample Substitution in Social Survey[J].Journal of Nanjing University(Philosophy Humanities and Social Sciences),2010,47(5): 102-111.
[14] Wang,C.,Zhai,M.P.,Jin,Y.S.,Ma,R.G.Current Research and Prospects on Forest Landscape Quality Evaluation[J].World Forestry Research, 2006, (06):18-22.
[15] Guo,K.J.,Xiong,J.W.,Wu,J.Z.Scenery Resources Survey and Feature Analysis of Forest in
Sanya City [J]. Central South Forest Inventory And Planning, 2013, 32 (03):46-50+54.

[16] Eeva Karjalainern, Liisa Tyrvainen. Visualization in forest land-scape preference research: a Finnish perspective [J]. Landscape and Urban Planning, 2002, (59):13～58

[17] Approaching an Integrated Qualification and Evaluation System for Geological Heritage [J]. Reis P. R, Henriques M. H. Geoheritage. 2009

[18] Fu, W.C., Qin, J.D., Chen, Z.R., Zhu, Z.P., Dong, J.W., Ding, G.C. Analysis on choosing touring route in Baili Rhododendron National Forest Park at blooming period [J]. Journal of Forest and Environment, 2016, 36 (01):117-123.