Landscape Evaluation of Color-leaf forest from the Perspective of Different Scales: A Case of Jinyang Village in China

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Abstract. With the development of forest tourism, Color-leaf forest has gradually become one of the most popular tourism destination. Based on related researches about forest landscape evaluation, this paper takes Jinyang village as the research object, which is known as the “Western Ginkgo No. 1 Village”, to conduct scenic beauty evaluation (SBE) on different scales of the same landscape. The result shows that the landscape outside the forest is affected by terrain changes, overall landscape combination, landscape contrast, human landscape, and human activities; the landscape inside the forest is affected by diameter, color of the leaves, composition and density of the forest, and leaf coverage. The results will provide some references for the practice of forest landscape planning in China.

1. Introduction
In recent years, Sichuan forest ecotourism has developed rapidly and has become an important type of tourism products. The direct income of forestry ecotourism in Sichuan Province in the first half of 2018 was 54.582 billion yuan, an increase of 19.84% over the same period of last year. The number of tourists received was 170 million, and the social income was 169 billion Chinese Yuan, accounting for 38.89% of the total tourist reception in the province [1].

Ginkgo, as the "national tree of China", has a very high value of edible, medicinal, ornamental and scientific research. In the late autumn, the yellow leaves are flying everywhere, which draws a fascinating painting. In recent years, the ginkgo tree forest tourism, which mainly includes the ginkgo landscape, the ginkgo culture and the consumption of ginkgo products, has gradually become a new highlight of China's forest tourism, eco-tourism and rural tourism. Many tourists choose to visit the Color-leaf forests in the suburbs on weekends to relax.

In the process of color forest landscape evaluation, the significant differences in tree species composition, community horizontal structure and vertical structure of different color forest types will affect the beauty of the color forest landscape; but even the same color forest type, forest trunks, shape of trees will also be different between the view inside the forest and outside the forest, which will affect the beauty of the forest [2]. If the landscape evaluation is carried out on a single scale, the results cannot truly and objectively describe the beauty of the forest landscape in the study area [3]. Therefore, this study selects Jinyang Village, Shiyang Town, Dujiangyan City, Sichuan Province, which has the reputation of “Western Ginkgo No. 1 Village” as the research object, and evaluate the
beauty of different scales of the same landscape, to determine a relatively objective forest landscape and lead to more objective evaluation results.

2. Literature review

2.1. Color-leaf forest landscape

The Color-leaf forest, called “cai lin” in China, is the customary name of the people. The concept of the Color-leaf forest landscape is derived from the forest landscape [5]. Zhong believes that the main body of the forest landscape is a collection of various types of forest vegetation [6]. The Color-leaf forest landscape is a forest landscape composed of colorful plant communities. Color-leaved plants are those that exist in nature or are cultivated by artificial cultivation, and whose leaves show colors that are significantly different from natural green at certain stages of the growing season or growing season, and plants with higher ornamental value [7]. As color is the most influential information element of the senses, these leaves have significantly higher color and natural green color, which has higher ornamental value. In the forest landscape, the maximum experience and perception of the forest landscape by tourists is mainly from the tourist attraction of the Color-leaf forest landscape.

2.2. Scenic beauty evaluation

“Scenic beauty evaluation” is an important indicator used to quantify the aesthetic quality of the landscape in landscape evaluation. Zhang believes that the beauty evaluation of the landscape mainly refers to the individual or group's evaluation of the visual quality of the landscape by some standard, which depends on the visual perception [8]. This evaluation method was first proposed by Daniel, which is a very dynamic and effective means. He believed that the evaluation results mainly had two factors, one was the viewer's perception of the landscape; the other was the aesthetic scale of the public participation in the evaluation [9]. The standard beauty study needs to process the data and convert the scores of each landscape into values, which can eliminate the influence of the evaluation criteria and the score system, and truly reflect the beauty of the forest landscape.

2.3. Landscape Evaluation from the Perspective of Different Scales

In the research on the color evaluation of forest landscape, the scale of the object is scarcely explained. Forest landscapes are divided into two categories at the spatial level-inside the forest and outside the forest. Because of different scales of forest landscapes, the beauty presented are different. At the same time, the landscape inside the forest differs from that of outside the forest. Color evaluation without scales cannot be truly described. Previous studies show that landscape inside the forest landscape is mainly for unilateral, such as a season or a scale, which lacks of a comprehensive overall evaluation [10].

3. Examination

3.1. Research site

The Jinyang Village, Shiyang Town, Dujiangyan City, Sichuan Province, which held the “Dujiangyan-Qingcheng Color-leaf forest Festival” for three consecutive years, was chosen as the research object of this project. Due to the characteristics of Ginkgo, the photos were collected in November under the same conditions, the same person, the same time period, and the same camera were used for shooting. Finally, 30 photos inside and 30 outside the forest were selected as the samples.

3.2. Data collection

According to the plant landscape integrity, plant species diversity and actual environmental requirements, the tree species, height, diameter, crown diameter, branch height and genetic data are selected for the beauty evaluation method [11]. Collecting photos by scene and evaluating the slide
show is the most important evaluation method for the color forest landscape. The scores of the lectures are converted into numerical values. Finally, the model is established to make the beauty of the color forest landscape more precise.

Many experts at home and abroad have studied the differences in the aesthetic attitudes of the evaluation subjects. The aesthetic judgments of different levels of evaluation groups are obviously consistent, and some scholars believe that the professional students' perception ability will be better than the general public[12]. In this study, 60 students of Sichuan Agricultural University were selected as the judges to score the photos. Students are asked to judge each photo independently based only on feelings. And reaction was given on a scale of one to ten (not very beautiful - very beautiful).

After conducting field investigation, photographing, recording, we used the SBE method to evaluate the beauty of the selected representative pictures, the values of the remaining score tables are standardized and processed according to the following formula:

$$Z_{ij} = (R_{ij} - \bar{R}_j)/S_j$$

$Z_{ij}$—standardized value, $i$—number of photo, $j$—number of student,

$R$—students’ evaluation value, $\bar{R}_j$—average score, $S_j$—standard deviation

### 3.3. Measures

Based on the existing literature, this study considered with the characteristics of the forest landscape, and selected six landscape elements outside the forest according to the scale of Liu and Pan [11], and six landscape elements inside the forest were selected according to the scale of Zhang and Wei [13]. The specific landscape structure to be decomposed is shown in Table 1 and Table 2.

| Category                | 1     | 2           | 3           |
|-------------------------|-------|-------------|-------------|
| $X_1$ Tree diameter     | ≤15cm | 15cm-25cm   | ≥25cm       |
| $X_2$ Leaf color        | tan   | yellow-green| Golden      |
| $X_3$ Trunk form        | bending| ordinary    | straight    |
| $X_4$ Tree species(Ginkgo) | <30% | 30%-80%     | >80%        |
| $X_5$ Canopy closure    | ≤0.5  | 0.5-0.8     | ≥0.8        |
| $X_6$ Deciduous coverage| ≤30%  | 30%-80%     | ≥80%        |

| Category                | 1     | 2           | 3           |
|-------------------------|-------|-------------|-------------|
| $X_1$ Terrain change    | slight| ordinary    | obvious     |
| $X_2$ Forest cover      | low   | ordinary    | high        |
| $X_3$ General combination | bad  | ordinary    | good        |
| $X_4$ Contrast          | low   | ordinary    | high        |
| $X_5$ Cultural attractions | bad  | ordinary    | good        |
| $X_6$ Human activity impact | bad  | ordinary    | good        |

Multiple comparisons are made among each factor and beauty score, and the model is established by multiple regression equations to explore the relationship between the content of the element and the degree under different scales of the landscape. In the preliminary modeling process, some less important factors are gradually eliminated, and finally the factors that contribute more to the dependent variables are retained, and the mathematical model is established as the independent variable of each type of landscape model. By normalizing the standardized scores of all landscape pictures in the forest/outside forest, the standardized score values of the scale are obtained. The table below shows the normalized values for the forest/outside landscape (30 locations):
The color forest with less canopy landscape with a large degree of canopy has a higher beauty value than the landscape with a small color in the forest will be similar, and the visual advantage will be more attractive to tourists. (5) the beauty of the landscape within the forest. When the ginkgo tree species is more than 80%, the dominant elements of the landscape in the studied shape of the trunk is less in aesthetic and visual influence, so the trunk shape does not affect the beauty of the forest, the following relationship is obtained. (1) The landscape inside the Color-leaf forest with large breast diameter is more visually appealing than the landscape inside the Color-leaf forest with small breast diameter, which will be more natural. (2) There are thousands of trees in the world of green leaves, but there are few trees with golden leaves. Compared to the tan and yellow-green, the golden leaves are more unique and beautiful, and the colors are dazzling. (3) The shape of the trunk is less in aesthetic and visual influence, so the trunk shape does not affect the dominant elements of the landscape in the studied forest. (4) Different levels of tree species will affect the beauty of the landscape within the forest. When the ginkgo tree species is more than 80%, the color in the forest will be similar, and the visual advantage will be more attractive to tourists. (5) The landscape with a large degree of canopy has a higher beauty value than the landscape with a small degree of canopy, and the overall will give a feeling of tranquility. The color forest with less canopy

4. Results
Based on the scores and partial correlation coefficients of each category, after multiple linear regression calculations, the weakly influential factors (trunk morphology) were removed and the landscape models in and outside the forest were established as follows:

4.1. Relationship between landscape elements and beauty inside the forest
One-way ANOVA analysis of each factor and beauty value inside the forest showed: There is a significant relationship between the five elements (tree diameter (p=0.000), leaf color (P=0.000), tree species composition (P=0.001), canopy density (p=0.000), deciduous coverage (p=0.000)) and the beauty. The beauty value was not significantly effected by trunk shape (P=0.0983) so only the species composition (P=0.001), canopy density (p=0.000)) and the significant relationship between the five elements (tree diameter (p=0.000), leaf color (P=0.000))

| No. | Score | No. | Score | No. | Score | No. | Score |
|-----|-------|-----|-------|-----|-------|-----|-------|
| P1  | -0.27 | P16 | -0.33 | P1  | -0.20 | P16 | -0.21 |
| P2  | -0.22 | P17 | 0.23  | P2  | -0.13 | P17 | -0.22 |
| P3  | -0.28 | P18 | 0.77  | P3  | 0.21  | P18 | 0.02  |
| P4  | -0.18 | P19 | 0.13  | P4  | -0.36 | P19 | -0.11 |
| P5  | -0.23 | P20 | 0.23  | P5  | -0.07 | P20 | 0.21  |
| P6  | -0.06 | P21 | 0.09  | P6  | -0.13 | P21 | -0.05 |
| P7  | -0.35 | P22 | -0.19 | P7  | 0.39  | P22 | -0.05 |
| P8  | 0.08  | P23 | -0.01 | P8  | 0.29  | P23 | 0.09  |
| P9  | -0.14 | P24 | -0.43 | P9  | -0.23 | P24 | -0.02 |
| P10 | -0.48 | P25 | 0.55  | P10 | -0.35 | P25 | 0.34  |
| P11 | 0.35  | P26 | 0.28  | P11 | 0.39  | P26 | 0.07  |
| P12 | 0.00  | P27 | -0.14 | P12 | -0.07 | P27 | 0.25  |
| P13 | 0.41  | P28 | 0.01  | P13 | -0.32 | P28 | 0.01  |
| P14 | 0.22  | P29 | 0.57  | P14 | 0.04  | P29 | 0.35  |
| P15 | -0.49 | P30 | -0.15 | P15 | -0.43 | P30 | 0.28  |

| Model equation | R2  | F    | P    |
|-----------------|-----|------|------|
| Inside the forest | SBE$_1$ = $-0.944 + 0.550x_1 - 0.163x_2 + 0.349x_4 + 0.053x_5$ + $0.272x_6$ | 0.862 | 30.020 | 0.000 |
| Outside the forest | SBE$_2$ = $-0.594 - 0.09x_1 + 0.244x_2 + 0.314x_4 + 0.144x_5$ + $0.303x_6$ | 0.703 | 11.364 | 0.000 |
will give a dull, monotonous feeling. (6) When the leaf coverage area is greater than or equal to 80%, the beauty value is the largest, and the coverage effect is excellent, which improves the landscape quality to a certain extent.

4.2. Relationship between landscape elements outside the forest and beauty
The results of one-way analysis of variance for each factor and beauty value outside the forest indicate: There is a significant relationship between the six elements (topographic change (P=0.000), forest cover (P=0.002), overall landscape combination (P=0.001), contrast (P=0.001), Human landscape (P=0.008), human activities (P=0.000)) with the beauty. However, the overall combination of landscapes has a very small impact coefficient on the beauty of the landscape, which is not the main influencing factor, so this element is removed in subsequent studies. The remaining five projects can be used directly in subsequent studies.

(1) The beauty score of the flat-colored forests is higher than that of the landscape whose terrain change is obvious. (2) In terms of forest coverage, the higher the coverage, the higher the landscape beauty, but the higher the forest coverage rate has no significant difference with the highest. (3) The difference in the degree of beauty caused by different levels of landscape combination is not much obvious (β=0.074), so the overall landscape combination is not the dominant factor affecting the landscape outside the forest. Subsequent research can remove this element. (4) The contrast has a great influence on the beauty value. The contrast of the forest landscape includes not only the type of the framing elements, but also the contrast of the colors and shapes between the framing elements. (5) The state of human landscape has a significant impact on the landscape outside the forest. (6) Poor human landscapes will destroy the overall visual aesthetic quality and reduce the beauty of this landscape.

5. Discussion and Regulation
In this study, the SBE beauty analysis method was used to evaluate the landscape beauty of the forest inside the 30 main scenic spots of Jinyan Forest in Jinyang Village, Shiyang Town, Dujiangyan City, and to establish a quantitative regression between the beauty and the landscape elements. model. The modeling results show that the color forest landscapes of different scales are affected by different landscape factors. The key framing elements affecting the landscape outside the Jinyang Village of Shiyang Town, Dujiangyan City are the overall combination of topographical changes, contrast, human landscape and human activities. The key framing elements affecting the landscape of the Jinyang Village in Shiyang Town, Dujiangyan City are the diameter of the breast, the color of the leaves, the composition of the trees, the density of the forest, and the coverage of the leaves.

The landscapes presented by forest landscapes of different scales are different. The evaluation of the beauty from the two scales is not only the evaluation of the landscape aesthetics and the local level, but also the research on the spatial aesthetics and the best aesthetic combination of the landscape. This study combines the comprehensive theories of Botany, Ecology and Aesthetics, and studies the color forest evaluation system based on different scales. It can understand the landscape features and differences of the same landscape at different scales. Landscape research has made certain theoretical expansions and provided some practical data to provide reference for color planning of Color-leaf forest landscape.

Therefore, this paper puts forward the following suggestions for the Color-leaf forest landscape planning: (1) Carry out landscape planning in a flat terrain, and rectify the undulating zone; (2) Reasonably weigh the density of forest planting, increase the coverage of colored forests, and rectify large exposed bare grounds for forest growth; (3) Optimize the overall landscape combination, rationally configure the human landscape and water body, and maintain the overall cleanliness of the landscape; (4) The species of the trees in the forest should not be too complicated, and there may be some improvements in the quality of the landscape.
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