THE LANDSCAPE EVALUATION SYSTEM OF ECOTOURISM VILLAGES IN QINLING MOUNTAINS

YU, X. H.1,2* – WANG, X.1 – REN, Y. G.1 – LIU, J. C.3

1School of Architecture, Chang’an University, Xi’an 710061, China
2School of Architecture, Xi’an University of Architectural Science and Technology, Xi’an 710055, China
3Agile Property Holdings Limited, Xi’an Branch, Xi’an 710061, China

*Corresponding author
e-mail: yuxiaohui@chd.edu.cn; phone: +86-029-8233-7365; fax: +86-029-8233-7365

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Abstract. Despite the importance of landscape resources in ecotourism villages, there is no scientific and complete index system for the evaluation of rural ecotourism landscape. This paper attempts to construct an evaluation index system for the ecotourism villages in the Xi’an section of the northern piedmont of Qinling Mountain. Firstly, the preliminary indices and relevant data were collected through field surveys and expert consultation. Next, the weight of each index was determined using the AHP. The conclusion is that: in the criteria layer, the weights of the elements can be ranked as natural elements (A1) > humanistic material elements (A2) > non-material elements (A3); in the factor layer, the weights of the factors under the natural elements can be ranked as ecological environment (B1) > hydro-geomorphic features (B2) > landscape quality (B3), the factors under the humanistic material elements as settlement landscape (B4) > farmland landscape (B6) > road landscape (B5) > facility construction (B7), and the factors under the non-material elements as folk culture (B8) > community participation (B9). Among the 37 indices, the natural disaster frequency (C3), folk culture diversity (C33) and Preservation of traditional residence (C15) were more important than the remaining 34 indices.

Keywords: ecotourism villages, rural landscape; landscape resources, landscape character assessment, index system, analytical hierarchy process (AHP)

Introduction

Ecotourism is an important strategy for Chinese villages, as the country has entered a new phase of high-quality development. The quality and sustainability of ecotourism villages are essential to China’s pursuit of ecological civilization and rural development. To achieve sustainable development of ecotourism villages, it is a must to evaluate rural landscape resources in a scientific manner.

Among foreign scholars, Ianas (2013) evaluated the landscape in Almăj rural land system between 1990 and 2010. Hogan et al. (2012) estimated the cumulative ecological effect of local landscape changes in south Florida. Gottero and Cassatella (2017) explained the relationship between rural policymakers, agricultural policies and rural landscape through developing and testing key landscape indices. Steinhardt evaluated and planned small and medium rural landscapes on different levels, and applied the fuzzy evaluation theory into the research (Steinhardt, 1998). Gulinck et al. (2001) carried out rural landscape evaluation with three factors (i.e. completeness, diversity, and visual quality) and six indices (i.e. land use suitability, fragmentation degree, species richness, natural restoration potential, and tourism potential).
About the rural landscape evaluation, the Chinese scholars have mainly tackled three issues: ecological evaluation (Xu, 2007; Meng et al., 2011), aesthetic evaluation (Xie, 2004; Petrova et al., 2015) and the evaluation system. There are two widely accepted rural landscape evaluation systems in China. One of them was a human settlement-oriented one proposed by Liu and Wang (2002). This system consists of such three layers as the goal layer, the criteria layer (5 criteria) and the index layer (21 indices). The five factors are habitability, accessibility, compatibility, sensitivity and beauty. The other evaluation system was designed in light of the features of rural landscapes (Xie et al., 2003). Focusing on the social effect, ecological quality and aesthetic effect of rural landscape, this evaluation system has four layers, including a goal layer, a criteria layer (3 criteria), a factor layer (11 factors) and an index layer (31 indices).

To sum up, the foreign studies on rural landscape evaluation mainly concentrate on the ecological effect and aesthetics of a landscape, while also exploring landscape evaluation systems. The domestic studies have designed comprehensive evaluation indices, yet the evaluation systems are still incomplete due to the lack of weight analysis. Considering the previous studies, this paper attempts to construct an evaluation index system for the ecotourism villages in the Xi’an section of the northern piedmont of the Qinling Mountain (hereinafter referred to as the study area). The remainder of this paper mainly deals with data acquisition, index system construction, index weighting, the possible shortcomings and conclusions.

**Materials and methods**

Rural ecotourism requires a delicate balance between ecotourism and rural life (Yu, 2015). The ecotourism villages should provide services in line with the functions of rural landscape. These services need to cover natural elements (e.g. topography, hydrological conditions, and animal and plant resources), human elements (e.g. settlement environment, service facilities and farmland landscape), as well as non-material cultural elements (e.g. folk culture). For the sustainable development of rural landscape, the following goals should be fulfilled through rural ecotourism: a memorable travel experience of the original life, customs, humane care and unique agricultural landscape in the villages; the development of the villages and the local economy; full demonstration of the functional, aesthetic and ecological values of rural landscape; the coordination between rural development and eco-environmental protection.

Considering the definition of ecotourism villages and the existing index systems for landscape evaluation, this paper sets up an evaluation index system for ecotourism villages in the study area through qualitative and quantitative methods. A total of 75 indices were obtained for rural landscape elements by the investigation. On this basis, each index was rated by experts, and its weight was determined by the analytic hierarchy process (AHP), using data processing software like the SPSS and Matlab.

**Data sources**

The author investigated 33 towns across the 6 districts/counties (Fig. 1) in the study area. A total of 53 villages were identified as ecotourism villages in this region, according to the definitions and functional classifications on the term by various scholars (Dong, 2013; Wu, 2011). Then, the natural, human, social and ecological resources were sorted out in these villages, revealing that the local landscape of
ecotourism villages mainly covers the natural element, the humanistic material element and the non-material element (Fig. 2). Among them, the natural element contains ecological environment, hydro-geomorphic features and landscape quality; the humanistic material element includes settlement landscape, road landscape, farmland landscape and facility construction; the non-material element encompasses the folk culture and community participation.

**Figure 1. Towns in the study area**

**Figure 2. Elements of rural tourism landscape in the study area**

**Structure of the index system**

Referring to the relevant studies (Liu and Wang, 2002; Liu and Wu, 2014; Xie et al., 2003), this paper divides the landscape evaluation index system of the ecotourism villages in the study area into four layers according to the landscape features of such villages and the structural features of the research system. From abstract to concrete and from macro to micro, the four layers are respectively the goal layer (G), the criteria layer (C), the factor layer (F) and the index layer (I). As shown in Figure 3, the
The proposed index system adopts a $1 + 3 + 9 + N$ (i.e. 1 goal, 3 criteria, 9 factors and N indices) structure, and evaluates the landscape of ecotourism villages from the perspectives of natural, humanistic material and non-material elements.

**Figure 3. Structure of landscape evaluation index system of the ecotourism villages**

The first layer is the goal layer (G). This layer specifies the ultimate goal of the index system and reflects the comprehensive level of rural ecotourism landscape in the study area. The second layer is the criteria layer (C). This layer mirrors the status of rural ecotourism landscape in the aspects of natural, humanistic material and non-material elements. The third layer is the factor layer (F). This layer contains 9 factors on the details of the three criteria. The fourth layer is the index layer (I). This layer gives the 37 indices under the 9 factors.

**Selection of evaluation indices**

The evaluation indices were selected through preliminary selection, screening and correction:

1. Preliminary selection: A total of 75 indices, more than twice the number of final indices, were selected preliminarily according to the features of rural ecotourism landscape in the study area, the expert opinions and the survey data on local residents. A large number of preliminary indices was designed to ensure the reasonability of the final indices.

2. Screening: The set of preliminary indices were made into a questionnaire, and rated by experts and scholars in relevant fields. The valid questionnaires were analyzed on the SPSS statistical software. The significance of each index was evaluated by the mean value, and the concentration of expert opinions was determined by the mode percentage and the coefficient of variation. The results are presented in Appendix 2. After two rounds of expert consultation, the 35 indices with a coefficient of variation in $[0-0.37]$ were all retained.

3. Correction: The index “diversity of riverside greening plants” had large mean value and mode percentage. It was retained after professional discussion. The two indices “perfection of service reception facilities” and “perfection of tourism facilities” were combined into “perfection of tourism service facilities”. Finally, a total of 37 indices were included in the index system (Table 1).
| Goal layer G | Criteria layer C | Factor layer F | Index layer I |
|-------------|-----------------|----------------|--------------|
| Landscape evaluation index system for ecotourism villages P | Natural element A1 | Ecological environment B1 | Forest coverage C1 |
| | | | Landscape diversity C2 |
| | | | Natural disaster frequency C3 |
| | | | Natural landscape beauty C4 |
| | Hydro-geomorphic features B2 | Waterbody cleanliness C5 | |
| | | | The diversity of riverside greening plants C6 |
| | | | Coordination between waterbody and surrounding environment C7 |
| | Landscape quality B3 | The diversity of topographical landscapes C8 | |
| | | | Human disturbance in topographical landscape C9 |
| | | | Accessibility of rural landscape C10 |
| | Humanistic material element A2 | Uniqueness of rural landscape C11 | |
| | Settlement landscape B4 | The authenticity of rural landscape C12 | |
| | | | Scale and richness of rural tourism resources C13 |
| | | | Coordination between construction project and surrounding landscape C14 |
| | Road landscape B5 | Preservation of traditional residence C15 | |
| | | | The uniqueness of residential building C16 |
| | | | The overall beauty of settlement space C17 |
| | | | Coordination between building and landscape C18 |
| | Facility construction B7 | Accessibility of road landscape C19 | |
| | | | Effect of street trees on rural ecological landscape C20 |
| | | | Effect of new roads on rural landscape C21 |
| | Farmland landscape B6 | Area ratio of a landscape to farmland C22 | |
| | | | Commercial rate of agricultural products C23 |
| | | | Continuity of agricultural landscape C24 |
| | | | Regional features of rural agricultural landscape C25 |
| | Non-material element A3 | Waste treatment rate C26 | |
| | Community participation B9 | The perfection of tourist transport facilities C27 | |
| | | | The perfection of infrastructure C28 |
| | | | The perfection of tourism service facilities C29 |
| | | | The perfection of tourism safety facilities C30 |
| | Folk culture B8 | Building materials C31 | |
| | | | Cultural inheritance and retention C32 |
| | | | Folk culture diversity C33 |
| | | Resident satisfaction C34 | |
| | | | The proportion of community residents in employees C35 |
| | | | Resident hospitality C36 |
| | | | A diversity of participated projects C37 |
Determination of index weights

According to the steps of the AHP, the index weights were determined in a comprehensive manner through questionnaire survey and expert scoring. In total, 13 judgement matrices were set up, 20 questionnaires were sent out, and 10 experts were invited to rate the indices. All returned questionnaires were valid. The elements on each layer were evaluated systematically through pairwise comparison, with respect to their impact on an element above them in the hierarchy. The results of this single hierarchal arrangement include the weights of A relative to P $W_A (i = 1, 2, 3)$, the weights of B relative to A $W_B (i = 1, 2, \ldots, 9)$, the weights of C relative to B $W_C (i = 1, 2, \ldots, 37)$. Finally, the weights of A to P $W_A (i = 1, 2, 3)$ were adopted to check the consistency between the single hierarchal arrangement results on each layer, yielding the final results of index weights.

Evaluation results

Results of single hierarchal arrangement

The single hierarchal arrangement results of the 13 judgement matrices are recorded in Tables 2–14.

Table 2. List of eigenvectors of matrix B1 \([C1\sim C4]\)

| Matrix B1               | Forest coverage C1 | Landscape diversity C2 | Natural disaster frequency C3 | Natural landscape beauty C4 | Weight |
|-------------------------|-------------------|------------------------|-------------------------------|-----------------------------|--------|
| Forest coverage C1      | 1                 | 2                      | 1/2                           | 3                           | 0.272  |
| Landscape diversity C2 | 1/2               | 1                      | 1/3                           | 2                           | 0.157  |
| Natural disaster frequency C3 | 2              | 3                      | 1                             | 5                           | 0.483  |
| Natural landscape beauty C4 | 1/3            | 1/2                    | 1/5                           | 1                           | 0.088  |

Table 3. List of eigenvectors of matrix B2 \([C6\sim C9]\)

| Matrix B2               | Waterbody cleanliness C5 | Diversity of riverside greening plants C6 | Coordination between waterbody and surrounding environment C7 | The diversity of topographical landscapes C8 | Human disturbance in the topographical landscape C9 | Weight |
|-------------------------|--------------------------|------------------------------------------|---------------------------------------------------------------|---------------------------------------------|---------------------------------------------------|--------|
| Waterbody cleanliness C5 | 1                        | 2                                       | 1/2                                                          | 6                                           | 4                                                 | 0.285  |
| Diversity of riverside greening plants C6 | 1/2                  | 1                                       | 1/3                                                          | 3                                           | 2                                                 | 0.150  |
| Coordination between waterbody and surrounding environment C7 | 2                    | 3                                       | 1                                                            | 6                                           | 5                                                 | 0.430  |
The diversity of topographical landscapes C8

|     | 1/6 | 1/3 | 1/6 | 1  | 1/2 | 0.052 |
|-----|-----|-----|-----|----|-----|-------|

Human disturbance in topographical landscape C9

|     | 1/4 | 1/2 | 1/5 | 2  | 1   | 0.083 |
|-----|-----|-----|-----|----|-----|-------|

**Table 4. List of eigenvectors of matrix B3 [C10–C14]**

| Matrix B3 | Accessibility of rural landscape C10 | Uniqueness of rural landscape C11 | Authenticity of rural landscape C12 | Scale and richness of rural tourism resources C13 | Coordination between construction project and surrounding landscape C14 | Weight |
|-----------|------------------------------------|----------------------------------|-----------------------------------|-----------------------------------------------|-------------------------------------------------|--------|
| Accessibility of rural landscape C10 | 1 | 2 | 1/4 | 1/6 | 1/2 | 0.076 |
| Uniqueness of rural landscape C11 | 1/2 | 1 | 1/4 | 1/7 | 1/3 | 0.051 |
| Authenticity of rural landscape C12 | 4 | 4 | 1 | 1/2 | 2 | 0.263 |
| Scale and richness of rural tourism resources C13 | 6 | 7 | 2 | 1 | 1/4 | 0.288 |
| Coordination between construction project and surrounding landscape C14 | 2 | 3 | 1/2 | 4 | 1 | 0.322 |

**Table 5. List of eigenvectors of matrix B4 [C15–C18]**

| Matrix B4 | Preservation of traditional residence C15 | Uniqueness of residential building C16 | Overall beauty of settlement space C17 | Coordination between building and landscape C18 | Weight |
|-----------|-----------------------------------------|--------------------------------------|---------------------------------------|-----------------------------------------------|--------|
| Preservation of traditional residence C15 | 1 | 6 | 4 | 2 | 0.520 |
| Uniqueness of residential building C16 | 1/6 | 1 | 1/2 | 1/3 | 0.081 |
| Overall beauty of settlement space C17 | 1/4 | 2 | 1 | 1/2 | 0.140 |
| Coordination between building and landscape C18 | 1/2 | 3 | 2 | 1 | 0.260 |
Table 6. List of eigenvectors of matrix B5 [C19–C21]

| Matrix B5                  | Accessibility of road landscape C19 | Effect of street trees on rural ecological landscape C20 | Effect of new roads on rural landscape C21 | Weight |
|----------------------------|-------------------------------------|--------------------------------------------------------|--------------------------------------------|--------|
| Accessibility of road      | 1                                   | 3                                                      | 5                                          | 0.648  |
| landscape C19              |                                     |                                                        |                                            |        |
| Effect of street trees     | 1/3                                 | 1                                                      | 2                                          | 0.230  |
| on rural ecological        |                                     |                                                        |                                            |        |
| landscape C20              |                                     |                                                        |                                            |        |
| Effect of new roads on     | 1/5                                 | 1/2                                                    | 1                                          | 0.122  |
| rural landscape C21        |                                     |                                                        |                                            |        |

Table 7. List of eigenvectors of matrix B6 [C22–C25]

| Matrix B6                  | Area ratio of a landscape to farmland C22 | Commercial rate of agricultural products C23 | Continuity of agricultural landscape C24 | Regional features of rural agricultural landscape C25 | Weight |
|----------------------------|--------------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------------------------|--------|
| Area ratio of a landscape  | 1                                          | ½                                           | 1/4                                      | 1/6                                                   | 0.072  |
| to farmland C22            |                                            |                                             |                                          |                                                       |        |
| Commercial rate of         | 2                                          | 1                                           | 1/3                                      | 1/5                                                   | 0.114  |
| agricultural products C23  |                                            |                                             |                                          |                                                       |        |
| Continuity of agricultural | 4                                          | 3                                           | 1                                        | 1/2                                                   | 0.293  |
| landscape C24              |                                            |                                             |                                          |                                                       |        |
| Regional features of rural | 6                                          | 5                                           | 2                                        | 1                                                     | 0.522  |
| agricultural landscape     |                                            |                                             |                                          |                                                       |        |
| C25                        |                                            |                                             |                                          |                                                       |        |

Table 8. List of eigenvectors of matrix B7 [C26–C30]

| Matrix B7                  | Waste treatment rate C26 | Perfection of tourist transport facilities C27 | Perfection of infrastructure C28 | Perfection of tourism service facilities C29 | Perfection of tourism safety facilities C30 | Weight |
|----------------------------|--------------------------|-----------------------------------------------|--------------------------------|-------------------------------------------|---------------------------------------------|--------|
| Waste treatment rate C26  | 1                        | 1/7                                           | 1/5                           | ½                                         | 1/3                                         | 0.052  |
| Perfection of tourist     | 7                        | 1                                             | 2                             | 5                                         | 3                                           | 0.440  |
| transport facilities C27  |                          |                                               |                               |                                           |                                             |        |
| Perfection of infrastructure C28 | 5                      | 1/2                                           | 1                             | 4                                         | 2                                           | 0.275  |
| Perfection of tourism     | 2                        | 1/5                                           | 1/4                           | 1                                         | 1/2                                         | 0.083  |
| service facilities C29    |                          |                                               |                               |                                           |                                             |        |
| Perfection of tourism     | 3                        | 1/3                                           | 1/2                           | 2                                         | 1                                           | 0.150  |
| safety facilities C30     |                          |                                               |                               |                                           |                                             |        |
### Table 9. List of eigenvectors of matrix B8 [C31–C33]

| Matrix B8          | Building materials C31 | Cultural inheritance and retention C32 | Folk culture diversity C33 | Weight |
|--------------------|------------------------|----------------------------------------|----------------------------|--------|
| Building materials C31 | 1                      | 1/3                                    | 1/4                        | 0.117  |
| Cultural inheritance and retention C32 | 3                      | 1                                      | 1/3                        | 0.268  |
| Folk culture diversity C33 | 4                      | 3                                      | 1                          | 0.614  |

### Table 10. List of eigenvectors of matrix B9 [C34–C37]

| Matrix B9            | Resident satisfaction C34 | Proportion of community residents in employees C35 | Resident hospitality C36 | Diversity of participated projects C37 | Weight |
|----------------------|---------------------------|----------------------------------------------------|--------------------------|----------------------------------------|--------|
| Resident satisfaction C34 | 1                        | 4                                                  | 2                        | 1/2                                   | 0.275  |
| Proportion of community residents in employees C35 | 1/4                      | 1                                                  | 1/2                      | 1/6                                   | 0.074  |
| Resident hospitality C36 | 1/2                      | 2                                                  | 1                        | 1/4                                   | 0.138  |
| Diversity of participated projects C37 | 2                        | 6                                                  | 4                        | 1                                     | 0.513  |

### Table 11. List of eigenvectors of matrix A1 [B1–B4]

| Matrix A1            | Ecological environment B1 | Hydro-geomorphic features B2 | Landscape quality B3 | Weight |
|----------------------|----------------------------|-------------------------------|----------------------|--------|
| Ecological environment B1 | 1                        | 2                              | 4                    | 0.571  |
| Hydro-geomorphic features B2 | 1/2                      | 1                              | 2                    | 0.286  |
| Landscape quality B3    | 1/4                        | 1/2                           | 1                    | 0.143  |

### Table 12. List of eigenvectors of matrix A2 [B4–B7]

| Matrix A2               | Settlement landscape B4 | Road landscape B5 | Farmland landscape B6 | Facility construction B7 | Weight |
|-------------------------|-------------------------|-------------------|-----------------------|--------------------------|--------|
| Settlement landscape B4 | 1                       | 3                  | 2                     | 5                        | 0.483  |
| Road landscape B5       | 1/3                     | 1                  | 1/2                   | 2                        | 0.157  |
| Farmland landscape B6   | 1/2                     | 2                  | 1                     | 3                        | 0.272  |
| Facility construction B7 | 1/5                     | 1/2                | 1/3                   | 1                        | 0.088  |
Table 13. List of eigenvectors of matrix A3 [B8–B9]

| Matrix A3                  | Folk culture B8 | Community participation B9 | Weight |
|----------------------------|-----------------|----------------------------|--------|
| Folk culture B8            | 1               | 2                          | 0.667  |
| Community participation B9 | 1/2             | 1                          | 0.333  |

Table 14. List of eigenvectors of matrix P [A1–A3]

| Matrix P                  | Natural element A1 | Humanistic material element A2 | Non-material element A3 | Weight |
|---------------------------|--------------------|-------------------------------|--------------------------|--------|
| Natural element A1        | 1                  | 2                             | 2                        | 0.493  |
| Humanistic material element A2 | 1/2                | 1                             | 2                        | 0.311  |
| Non-material element A3   | 1/2                | 1/2                           | 1                        | 0.196  |

Weights of evaluation indices

The 37 indices were subjected to weight analysis by the AHP. The final results are shown in Table 15.

Table 15. List of index weights

| Goal layer                  | Criteria layer                  | Factor layer                  | Single hierarchical arrangement weights | Total hierarchical arrangement weights | Index layer                                                                 | Single hierarchical arrangement weights | Total hierarchical arrangement weights | Single hierarchical arrangement weights |
|-----------------------------|---------------------------------|-------------------------------|-----------------------------------------|---------------------------------------|----------------------------------------------------------------------------|-----------------------------------------|----------------------------------------|-----------------------------------------|
| Landscape evaluation index system for ecotourism villages in the study area | Ecological environment B1 | 0.571 | 0.282 | Forest coverage C1 | 0.27197 | 0.076679 | 0.2720 |
|                             | Landscape diversity C2 | 0.15699 | 0.044261 | 0.1570 |
|                             | Natural disaster frequency C3 | 0.48289 | 0.136145 | 0.4829 |
|                             | Natural landscape beauty C4 | 0.08815 | 0.024853 | 0.0882 |
|                             | Waterbody cleanliness C5 | 0.28529 | 0.040216 | 0.2853 |
|                             | Diversity of riverside greening plants C6 | 0.14973 | 0.021107 | 0.1497 |
|                             | Coordination between waterbody and surrounding environment C7 | 0.43023 | 0.060648 | 0.4302 |
|                             | Diversity of topographical landscapes C8 | 0.05191 | 0.007317 | 0.0519 |
|                             | Human disturbance in topographical landscape C9 | 0.08284 | 0.011677 | 0.0828 |
| Component | Weight | Standard Deviation | Value |
|-----------|--------|--------------------|-------|
| Landscape quality B3 | 0.143 | 0.070 | 0.07632 0.00538 0.0763 |
| Accessibility of rural landscape C10 | | | |
| Uniqueness of rural landscape C11 | | | 0.0511 0.003602 0.0511 |
| Authenticity of rural landscape C12 | | | 0.26278 0.018522 0.2628 |
| Scale and richness of rural tourism resources C13 | | | 0.28794 0.020296 0.2879 |
| Coordination between construction project and surrounding landscape C14 | | | 0.32186 0.022687 0.3219 |
| Settlement landscape B4 | 0.483 | 0.1500 | 0.51952 0.077973 0.5195 |
| Preservation of traditional residence C15 | | | |
| Uniqueness of residential building C16 | | | 0.08077 0.012123 0.0808 |
| Overall beauty of settlement space C17 | | | 0.13995 0.021005 0.1400 |
| Coordination between building and landscape C18 | | | 0.25976 0.038987 0.2598 |
| Humanistic material element A2 | 0.31081 | | |
| Road landscape B5 | 0.157 | 0.049 | 0.64833 0.031635 0.6483 |
| Accessibility of road landscape C19 | | | |
| Effect of street trees on rural ecological landscape C20 | | | 0.22965 0.011206 0.2297 |
| Effect of new roads on rural landscape C21 | | | 0.12202 0.005954 0.1220 |
| Farmland landscape B6 | 0.272 | 0.085 | 0.07154 0.006047 0.0715 |
| Area ratio of landscape to farmland C22 | | | |
| Commercial rate of agricultural products C23 | | | 0.11373 0.009614 0.1137 |
| Continuity of agricultural landscape C24 | | | 0.2928 0.024751 0.2928 |
As shown in the table above, in the criteria layer, the weights of the elements can be ranked as natural elements (A1) > humanistic material elements (A2) > non-material elements (A3); in the factor layer, the weights of the factors under the natural elements can be ranked as an ecological environment (B1) > hydro-geomorphic features (B2) > landscape quality (B3), the factors under the humanistic material elements as settlement landscape (B4) > farmland landscape (B6) > road landscape (B5) > facility construction (B7), and the factors under the non-material element as folk culture (B8) > community participation (B9). Among the 37 indices, the natural disaster frequency C3, folk culture diversity C33 and Preservation of traditional residence C15 were more important than the rest 34 indices.
Discussion

In this research, the indices are selected through field survey and expert consultation, in reference to the previous studies on landscape index system. Besides, the weight of each index was quantified accurately and scientifically using the AHP. Nevertheless, some problems and possible deviations were discovered during the theoretical construction.

First, the AHP is a subjective method that may be biased in the weighting of some qualitative indices.

Second, rural landscape evaluation involves many fields. The selection of indices may not be comprehensive enough due to the limitations of professional knowledge.

Third, the experts involved in this research are all engaged in landscape-related fields; the author did not carry out effective consultations with experts in the fields of ecology, economics, tourism or sociology.

Conclusions

Ecotourism is an important strategy for Chinese villages, as the country has entered a new phase of high-quality development. This paper attempts to design a scientific and effective index system for landscape evaluation of ecotourism villages in the study area. Based on the existing theories on rural landscape evaluation system at home and aboard, the author carried out a field survey and expert consultation to comb the elements of rural ecotourism landscape and determined the weight of each index by the AHP. The following conclusions were drawn from the results and discussion.

This paper sets up a 4-layer index system that evaluates the rural ecotourism landscape from three aspects (i.e. the natural element, the humanistic material element and the non-material element). On this basis, it is necessary to consider the biological impacts of the humanistic material environment, such as the negative effects of settlement landscape, road landscape and facility construction on the biological environment and their indirect impacts on the rational layout of land use in rural planning. Consideration should also be given to the economic impacts of the non-material element, and the effects of landscape index system on agricultural policies and rural housing policies, aiming to create a multi-directional interaction mechanism between ecological, economic, and cultural elements in rural areas.

According to the AHP analysis, in the criteria layer, the weights of the elements can be ranked as natural elements (A1) > humanistic material elements (A2) > non-material elements (A3); in the factor layer, the weights of the factors under the natural elements can be ranked as ecological environment (B1) > hydro-geomorphic features (B2) > landscape quality (B3), the factors under the humanistic material elements as settlement landscape (B4) > farmland landscape (B6) > road landscape (B5) > facility construction (B7), and the factors under the non-material element as folk culture (B8) > community participation (B9). Among the 37 indices, the natural disaster frequency C3, folk culture diversity C33 and Preservation of traditional residence C15 were more important than the rest 34 indices. The natural environment provides the material basis for human survival. There is no time to delay for the protection of the natural environment, facing the severe environmental impacts of human activities. For the study area, the ecotourism villages should rationalize the rural planning, construction and management according to their unique landscape resources and the weights of the proposed indices.
The rural macro-system is involved in the landscape evaluation of ecotourism villages. The future research will improve the rural ecotourism evaluation index system in terms of objective and comprehensive quantification, aiming to provide desirable solutions to rural problems like sustained economic growth, eco-environmental protection and human settlement.

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