THE LANDSCAPE EVALUATION SYSTEM OF ECOTOURISM VILLAGES IN QINLING MOUNTAINS

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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).

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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

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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.

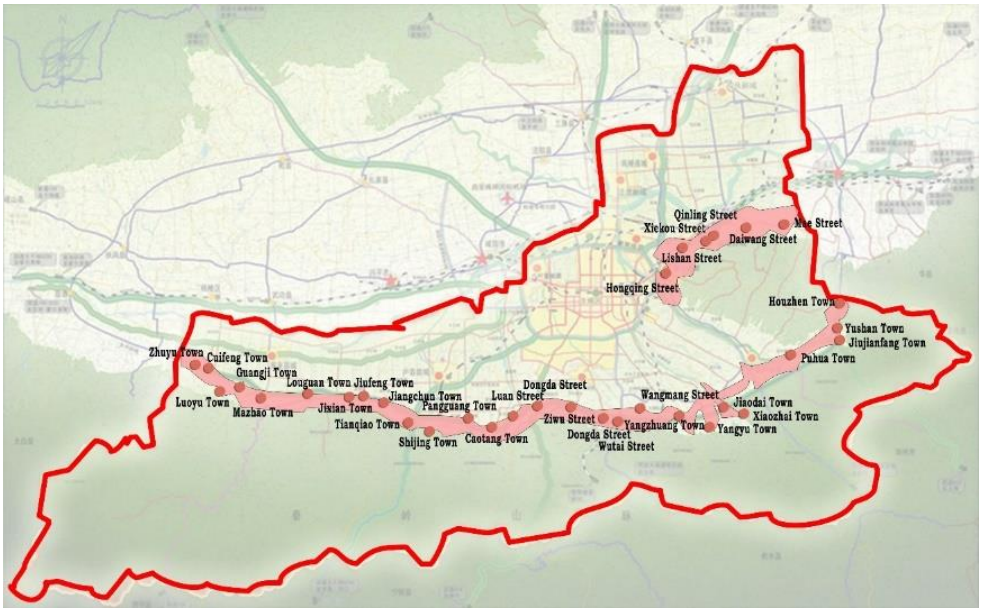

Figure 1. *Towns in the study area*

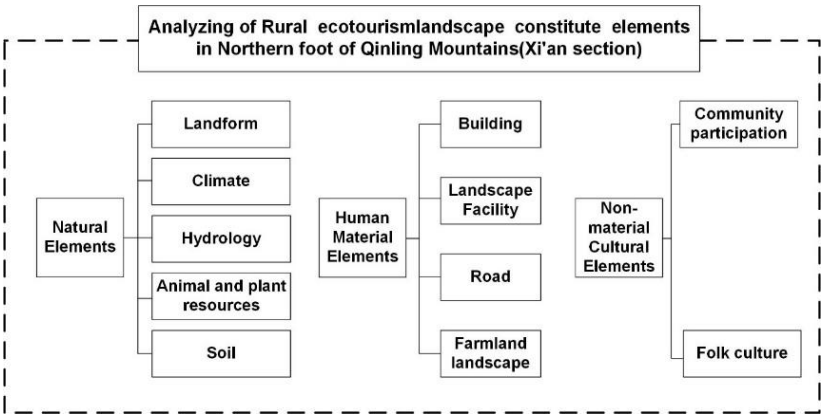

Figure 2. *Elements of rural tourism landscape in the study area*

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

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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.

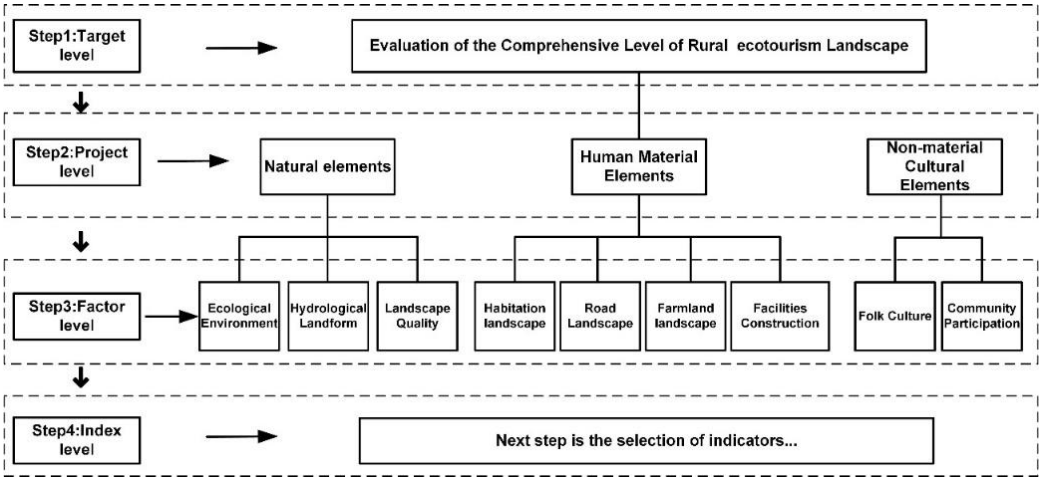

Figure 3. *Structure of landscape evaluation index system of the ecotourism villages*

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*).

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Table 1. *List of landscape evaluation indices for ecotourism villages in the study area*

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
			The diversity of topographical landscapes C8
			Human disturbance in topographical landscape C9
			Accessibility of rural landscape C10
		Landscape quality B3	Uniqueness of rural landscape C11
			The authenticity of rural landscape C12
			Scale and richness of rural tourism resources C13
			Coordination between construction project and surrounding landscape C14
	Humanistic material element A2	Settlement landscape B4	Preservation of traditional residence C15
			The uniqueness of residential building C16
			The overall beauty of settlement space C17
			Coordination between building and landscape C18
		Road landscape B5	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
		Facility construction B7	Waste treatment rate C26
			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
	Non-material element A3	Folk culture B8	Building materials C31
			Cultural inheritance and retention C32
			Folk culture diversity C33
		Community participation B9	Resident satisfaction C34
			The proportion of community residents in employees C35
			Resident hospitality C36
			A diversity of participated projects C37

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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 WAi (i = 1, 2, 3), the weights of B relative to A WBi (i = 1, 2, …, 9), the weights of C relative to B WCi (i = 1, 2, …, 37). Finally, the weights of A to P WAi (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~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~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

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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

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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 landscape C19	1	3	5	0.648
Effect of street trees on rural ecological landscape C20	1/3	1	2	0.230
Effect of new roads on rural landscape C21	1/5	1/2	1	0.122

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 to farmland C22	1	½	1/4	1/6	0.072
Commercial rate of agricultural products C23	2	1	1/3	1/5	0.114
Continuity of agricultural landscape C24	4	3	1	1/2	0.293
Regional features of rural agricultural landscape C25	6	5	2	1	0.522

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 transport facilities C27	7	1	2	5	3	0.440
Perfection of infrastructure C28	5	1/2	1	4	2	0.275
Perfection of tourism service facilities C29	2	1/5	1/4	1	1/2	0.083
Perfection of tourism safety facilities C30	3	1/3	1/2	2	1	0.150

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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

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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 hierarchal arrangement weights	Total hierarchal arrangement weights	Index layer	Single hierarchal arrangement weights	Total hierarchal arrangement weights	Single hierarchal arrangement weights
Landscape evaluation index system for ecotourism villages in the study area	Natural element A1 0.49339	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
		Hydro-geomorphic features B2	0.286	0.141	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

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		Landscape quality B3	0.143	0.070	Accessibility of rural landscape C10	0.07632	0.00538	0.0763
					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
	Humanistic material element A2 0.31081	Settlement landscape B4	0.483	0.1500	Preservation of traditional residence C15	0.51952	0.077973	0.5195
					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
		Road landscape B5	0.157	0.049	Accessibility of road landscape C19	0.64833	0.031635	0.6483
					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	Area ratio of landscape to farmland C22	0.07154	0.006047	0.0715
					Commercial rate of agricultural products C23	0.11373	0.009614	0.1137
					Continuity of agricultural landscape C24	0.2928	0.024751	0.2928

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					Regional features of rural agricultural landscape C25	0.52193	0.044119	0.5219
		Facility construction B7	0.088	0.027	Waste treatment rate C26	0.05183	0.00142	0.0518
					Perfection of tourist transport facilities C27	0.44011	0.012058	0.4401
					Perfection of infrastructure C28	0.27507	0.007536	0.2751
					Perfection of tourism service facilities C29	0.08303	0.002275	0.083
					Perfection of tourism safety facilities C30	0.14996	0.004109	0.1500
	Non-material element A3 0.1958	Folk culture B8	0.667	0.131	Building materials C31	0.11722	0.015301	0.1172
					Cultural inheritance and retention C32	0.26837	0.035031	0.2684
					Folk culture diversity C33	0.61441	0.080201	0.6144
		Community participation B9	0.333	0.065	Resident satisfaction C34	0.2751	0.017955	0.2751
					Proportion of community residents in employees C35	0.07411	0.004837	0.0741
					Resident hospitality C36	0.13755	0.008977	0.1376
					Diversity of participated projects C37	0.51324	0.033497	0.5132

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.

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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.

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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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