Based on AHP -Grey Comprehensive Evaluation of Social Benefits of Eco-Tourism Scenic Areas

Yueqing Ding[1, a], Wei Hong[2, b] Jianhua Yang[1, c, *]

[1]School of Automation, Northwestern Polytechnical University, Xi 'an, shaanxi, China

[2]College of Urban and Environmental Sciences, Northwestern University, Xi 'an, shaanxi, China

[a]342129843@qq.com, [b]2764565953@qq.com, [c]yangjianhua@nwpu.edu.cn

*Corresponding author

Keywords: Eco-tourism zone;Social benefits;Grey statistics;Fuzzy evaluation;Analytic hierarchy

Abstract: According to the social benefit system structure and constituent elements of geological relic ecological scenic spot. This paper chooses the important core index from the three levels of value, benefit and performance, and constructs the social benefit evaluation index system of tiankeng group in hanzhong, shaanxi. Analytic hierarchy process (*AHP*) combined with particle swarm optimization (*PSO*) method to modify the expert scoring matrix, to put forward the use of AHP and gray fuzzy theory model for ecological scenic spot of social benefit evaluation methods of geological remains, in shaanxi province - hanzhong tiankeng ecological tourism scenic spot of social benefit evaluation, and to quantify the evaluation results, determine the grey class for A class of grade. The scientific exploration and leisure function value of shaanxi hanzhong tiankeng group of tourism, for the development of economy and culture, ecological construction, sustainable development has a positive practical significance.

1. Introduction

Since the mid-1980s, as a new form of tourism, ecological tourism of geological relics has been playing an increasingly prominent role in economic and social development.

According to the geological heritage resources development and protection of the dual nature [1], from ecological scenic area of geological remains the social benefits of system structure and components, the comprehensive analysis on shaanxi hanzhong tiankeng group of protection by using the actual benefit influence factors, constructing shaanxi hanzhong tiankeng group of social evaluation index system of geological relics scenic spot [2], based on the multilevel grey fuzzy evaluation method, comprehensive evaluation of ecological tourism scenic spot of shaanxi hanzhong tiankeng group for the geological relic resources comprehensive value upgrade to provide reliable decision basis.

2. Social evaluation system of ecological scenic spots of geological relics

The evaluation of the value of ecological scenic spots of geological relics emphasizes the idea of comprehensive, coordinated and sustainable development throughout the whole process of the protection, development and utilization of geological relics. Its fundamental benefits are reflected in the protection of geological relics, local economic development, spiritual civilization education, scientific research and teaching, and ecological environment construction. The contribution of social sustainable development is taken as the highest measurement index. The system has three layers: value layer, benefit layer and performance layer.

2.1 Social evaluation index system of tiankeng group ecological tourism scenic spot in hanzhong, shaanxi

2.1.1 Comprehensive *evaluation index system*

Drawing on public infrastructure, social benefit evaluation of characteristic towns and government-invested projects is constructed [3], and social evaluation index system of geological relics ecological landscape of tiankeng group in shaanxi is constructed, as shown in table 1.

Table 1. Summary table of evaluation index weight.

The target layer	Rule layer	The weight (w)	Index layer	The weight (w_i)
Social benefits	Social X_1	0.2249	Improving infrastructure and service facilities are X_{11}	0.1093
			Improving population literacy and happiness effect X_{12}	0.1373
			Improving equity and participation X_{13}	0.1378
			Scenic area product culture and other sustainable innovation X_{14}	0.0692
			Labor transfer effect and labor absorption capacity X_{15}	0.0886
			Improving the quality of life X_{16}	0.162
			Local visibility, cultural brand value X_{17}	0.1148
			Community transportation X_{18}	0.0855
			Research learning and eco-tourism experience X_{19}	0.0955
	Economy X_2	0.3232	Experiential consumption brings added value X_{21}	0.1043
			Scenic spot direct tourism operation income X_{22}	0.1345
			The scenic spot indirect tourism management income X_{23}	0.1057
			Tourism development and management income X_{24}	0.1535
			Industrial pull and structured income X_{25}	0.1319
			Government revenue X_{26}	0.0761
			Regional traffic revenue X_{27}	0.0711
			Residents benefit from getting rid of poverty X_{28}	0.1037
			Contribution to regional economic development X_{29}	0.1192
	Ecological X_3	0.4524	Regional ecological and environmental protection X_{31}	0.3326
			Biodiversity conservation X_{32}	0.2689
			Residents' awareness of environmental protection X_{33}	0.1545
			The spatial layout and landscape optimization of the scenic area X_{34}	0.0413
			Scenic area revenue X_{35}	0.1004
			Optimizing the industrial structure for green and circular development X_{36}	0.1022

2.1.2 Weight *calculation*

The analytic hierarchy process is adopted to divide all the factors in the complex problem into relevant sequential hierarchical structure [4], and particle swarm optimization (PSO) is used to modify the expert scoring matrix [5].The formula is as follows:

$$V_i = V_i + c_1 \times rand(0 \sim 1) \times (pbest_i - x_i) + c_2 \times rand(0 \sim 1) \times (pbest_i - x_i) \quad (1)$$

$$x_i = x_i + V_i \quad (2)$$

I = 1, 2..., M and M are the total number of particles, V_i is the particle velocity, p_{best} is the individual optimal value, g_{best} is the global optimal value, and $Rand(0 \sim 1)$ is the random number between (0, 1). X_i is the current position of the particle. c_1 and c_2 are learning factors, usually $c_1 = c_2$ = 2. The maximum limiting velocity of a particle in each dimension is V_{max}.

2.2 Weighting results

According to the construction of judgment matrix, calculation of importance order, consistency test steps and particle swarm optimization algorithm correction, the weight of the social evaluation index system of tiankeng group eco-tourism scenic spot in hanzhong, shaanxi was calculated, as shown in table 1.

3. Grey fuzzy comprehensive evaluation

The development and protection of tiankeng group geological relics in hanzhong, shaanxi province is a complicated systematic project. Due to the grey degree and fuzziness of the evaluation information, the comprehensive benefits of the four distribution areas of tiankeng groups in Chenjiayan, Nanzheng district, Xiaonanhai, Xixiang county, Lujiaba and Zhenba county were evaluated by combining the grey theory with the fuzzy evaluation method [6].

3.1 Grey fuzzy comprehensive evaluation model

According to the national standard of geological relic resources, the grade of each evaluation factor is determined, and the evaluation index set D = {excellent, good, medium, bad and worse} of benefit evaluation is established. At the same time, the threshold of each gray level is set, and the standard grading set $H = (h_1, h_2..., H_d)$ = (9, 7, 5, 3, 1).

3.1.1 Determine the evaluation sample matrix

The study was conducted by 4 geological experts and 2 tourism experts (T1, T2...T6 represents) a total of 6 people form an evaluation team. According to on-site investigation, consultation and interview, the indicators are scored on a 10-point scale, as shown in table 1. U1t (t=1, 2...9) establish the evaluation matrix as

$$D_i = \begin{pmatrix} d_{i11} & d_{i12} & \cdots & d_{i1n} \\ d_{i21} & d_{i22} & \cdots & d_{i2n} \\ \vdots & \vdots & \cdots & \vdots \\ d_{ip1} & d_{ip2} & \cdots & d_{ipn} \end{pmatrix} \quad (3)$$

$$D_1 = \begin{pmatrix} 7 & 8 & 8 & 8 & 7 & 8 \\ 7 & 8 & 8 & 7 & 8 & 7 \\ 8 & 9 & 7 & 8 & 9 & 8 \\ 7 & 6 & 7 & 7 & 8 & 7 \\ 9 & 8 & 9 & 8 & 8 & 8 \\ 8 & 9 & 8 & 7 & 9 & 8 \\ 9 & 8 & 7 & 9 & 8 & 9 \\ 7 & 7 & 6 & 7 & 6 & 7 \\ 8 & 9 & 8 & 8 & 7 & 8 \end{pmatrix} \quad (4)$$

Similarly, the evaluation sample matrix of other secondary evaluation factors is constructed.

3.1.2 Determine the grey class of evaluation

According to "excellent", "good", "medium", "bad", "worse" five grades, namely g=5, e=1, 2,..., 5. Determine the gray scale number, gray scale number and evaluation gray scale of whitening weight function, and establish the threshold of the corresponding whitening weight function as follows:

$$f_{e=1}=\begin{cases}1 & d_{itq}\geq 9\\ \dfrac{d_{itq}}{9} & d_{itq}<9\end{cases} \tag{5}$$

$$f_{e=2}=\begin{cases}2-\dfrac{d_{itq}}{7} & d_{itq}\geq 7\\ \dfrac{d_{itq}}{7} & d_{itq}<7\end{cases} \tag{6}$$

$$f_{e=3}=\begin{cases}2-\dfrac{d_{itq}}{5} & d_{itq}\geq 5\\ \dfrac{d_{itq}}{5} & d_{itq}<5\end{cases} \tag{7}$$

$$f_{e=4}=\begin{cases}0 & d_{itq}\geq 6\\ 2-\dfrac{d_{itq}}{3} & 6>d_{itq}\geq 3\\ \dfrac{d_{itq}}{3} & d_{itq}<3\end{cases} \tag{8}$$

$$f_{e=1}=\begin{cases}0 & d_{itq}\geq 1\\ 1 & d_{itq}<1\end{cases} \tag{9}$$

3.1.3 Calculate grey evaluation coefficient.

According to the evaluation factor U_i, which belongs to the $f_{e(diq)}$ of the e evaluation grey category, the grey statistical coefficient is determined, namely $b_{ie}=\sum_{q=1}^{q=n} f_e(d_{iq})$ and the total grey statistical number is $B_i=\sum_{e=1}^{e=g} b_{ie}$.

For the evaluation index U_{11}, the grey evaluation coefficient of the *e* evaluation grey class for the evaluated object is calculated as follows:

$$\text{e=1,}\ b_{111}=\sum_{q=1}^{q=6} f_{e=1}(d_{11q})=f_{e=1}(d_{111})+f_{e=1}(d_{112})+f_{e=1}(d_{113})+f_{e=1}(d_{114})+f_{e=1}(d_{115})+f_{e=1}(d_{116}) \tag{10}$$

$$=f_{e=1}(7)+f_{e=1}(8)+f_{e=1}(8)+f_{e=1}(8)+f_{e=1}(7)+f_{e=1}(8) \tag{11}$$

$$=5.111$$

Similarly, when e=2, b_{112}=5.429; When e=3, b_{113}=2.8; When e=4, b_{114}=0; When e is 5, b_{115}=0. Therefore, for the evaluation index U_{11}, the total gray evaluation coefficient of the evaluated object belonging to each evaluation grey category is:

$$B_{11}=\sum_{e=1}^{5} b_{11e}=b_{111}+b_{112}+b_{113}+b_{114}+b_{115}=5.111+5.429+2.8+0+0=13.34 \tag{12}$$

Similarly, it can be calculated B_{12}, B_{13} and B_{it}(i=2,3)(t=1,2,$\cdots p$).

3.1.4 Calculate grey evaluation weight and fuzzy weight matrix

The normalized evaluation coefficient is denoted as grey weight coefficient rie, and the grey evaluation weight coefficient matrix ri is obtained by synthesizing each evaluation weight coefficient.

$$r_{ie} = \frac{b_{ie}}{B_i} \tag{13}$$

$$r_{\mathrm{i}} = \begin{bmatrix} r_{i1} \\ r_{i2} \\ \vdots \\ r_{ip} \end{bmatrix}_{p\times g} = \begin{bmatrix} r_{i11} & r_{i12} & \dots & r_{i1g} \\ r_{i21} & r_{i22} & \cdots & r_{i2g} \\ \vdots & \vdots & \vdots & \vdots \\ r_{ip1} & r_{ip2} & \cdots & r_{ipg} \end{bmatrix}_{t\times g} \tag{14}$$

According to the above, the grey weight vector composed of the evaluation weight coefficients of each grey class of the evaluated object U_1 can be obtained, $r_{11} = (r_{111}, r_{112}, r_{113}, r_{114}, r_{115}) = (0.3831, 0.4010, 0.2099, 0, 0)$.

Similarly, the evaluation weight vector of other evaluation factors U_{1t} of each gray grade can be calculated, ramely r_{1t} (t=1, 2, 3, 4, 5, 6, 7, 8, 9) and the gray evaluation weight coefficient matrix can be established. Similarly, the grey evaluation weight matrix of r_2 and r_3 can be obtained.

$$r_1 = \begin{bmatrix} r_{11} \\ r_{12} \\ r_{13} \\ r_{14} \\ r_{15} \\ r_{16} \\ r_{17} \\ r_{18} \\ r_{19} \end{bmatrix} = \begin{bmatrix} 0.3831 & 0.4140 & 0.2099 & 0 & 0 \\ 0.3684 & 0.4105 & 0.2211 & 0 & 0 \\ 0.4305 & 0.3954 & 0.1740 & 0 & 0 \\ 0.3337 & 0.4087 & 0.2575 & 0 & 0 \\ 0.4845 & 0.3652 & 0.1506 & 0 & 0 \\ 0.4652 & 0.3870 & 0.1478 & 0 & 0 \\ 0.5003 & 0.3958 & 0.1039 & 0 & 0 \\ 0.3017 & 0.4267 & 0.2716 & 0 & 0 \\ 0.4845 & 0.3652 & 0.1506 & 0 & 0 \end{bmatrix} \tag{15}$$

$$r_2 = \begin{bmatrix} r_{21} \\ r_{22} \\ r_{23} \\ r_{24} \\ r_{25} \\ r_{26} \\ r_{27} \\ r_{28} \\ r_{29} \end{bmatrix} = \begin{bmatrix} 0.3751 & 0.4193 & 0.2055 & 0 & 0 \\ 0.4835 & 0.3825 & 0.1339 & 0 & 0 \\ 0.3542 & 0.4140 & 0.2318 & 0 & 0 \\ 0.4142 & 0.3994 & 0.1864 & 0 & 0 \\ 0.4305 & 0.3954 & 0.1740 & 0 & 0 \\ 0.4652 & 0.3870 & 0.1478 & 0 & 0 \\ 0.3542 & 0.4140 & 0.2318 & 0 & 0 \\ 0.4305 & 0.3954 & 0.1740 & 0 & 0 \\ 0.5003 & 0.3958 & 0.1039 & 0 & 0 \end{bmatrix} \tag{16}$$

$$r_3 = \begin{bmatrix} r_{31} \\ r_{32} \\ r_{33} \\ r_{34} \\ r_{35} \\ r_{36} \end{bmatrix} = \begin{bmatrix} 0.4835 & 0.3826 & 0.1339 & 0 & 0 \\ 0.4652 & 0.3870 & 0.1478 & 0 & 0 \\ 0.3831 & 0.4070 & 0.2099 & 0 & 0 \\ 0.3894 & 0.4032 & 0.1984 & 0 & 0 \\ 0.4305 & 0.3954 & 0.1741 & 0 & 0 \\ 0.4142 & 0.3994 & 0.1864 & 0 & 0 \end{bmatrix} \tag{17}$$

3.2 The results of grey fuzzy comprehensive evaluation are calculated

According to the maximum membership method, the grade of the evaluation object is determined [7], and the value of the grey class is assigned, and the evaluation object is evaluated and scored by $A=R\cdot C^T$, where $R_i=Q_i\cdot R_i$ (Q_i is the weight of each evaluation index).

$R_1=Q_1\cdot r_1$=(0.42265845, 0.42265773, 0.18191436, 0, 0)

R_2=Q_2·r_2=(0.42586792, 0.39946864, 0.17366473, 0, 0)

R_3=Q_3·r_3=(0.44672899, 0.39136756, 0.16143175, 0, 0)

Thus, the total gray evaluation value matrix $r=(R_1, R_2, R_3)^T$ is obtained, and the comprehensive evaluation result is $R=Q·r$=(0.439263781, 0.405132348, 0.171686931, 0, 0). Evaluation results in the vector A maximum of 0.439263781. According to the results of comprehensive evaluation and quantitative and qualitative evaluation, C=(100, 85, 70, 55, 40), the value of tiankeng ecotourism scenic area in hanzhong, shaanxi province is $A=R·C^T$=90.3807.

4. Conclution

In this paper, based on local world-class resources endowment advantage, the value of resources and the environmental conditions of development, and by the ecological scenic area of the geological relics social benefit structure and people - society - economy - environment - management on the basis of the five elements of shaanxi hanzhong tiankeng group of geological vestiges resources scenic spot has carried on the comprehensive evaluation, evaluation for A class of grey class level.

Active exploration of green development, sustainable and high-grade direction of development path not only reflects "green mountains and clear water", "golden mountains and silver mountains" win-win goals, but also to adapt to the national and provincial economic development strategic pillar industry needs. Fully exploring the functional value of tourism, scientific exploration and leisure vacation, the social benefits, environmental benefits and human benefits are of positive practical significance to the development of economy and culture, ecological construction and sustainable development.

Acknowledgments

This work was financially supported by Project of Finacial Department of Shaanxi Province (211827180068) and Project of *CIGEM* (*WT*2018055B) fund.

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