Research on Ecological Environment Evaluation System of Saihanba

Lining Yang*, Jinbo Yang, Haoming Li

Leicester International Institute, Dalian University of Technology, Panjin, Liaoning, 124000, China

*Corresponding author: yanglining0329@163.com

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Abstract: This paper uses a multi-level fuzzy comprehensive evaluation model to establish the Saihanba ecological environment (wind-defense and sand-fixing) evaluation scoring system based on a fuzzy comprehensive evaluation model. In terms of determining the weight, the weights given in the authoritative national standard documents are tapped to ensure the objectivity of the results. In terms of data comparison results, 24 items are selected, which deepens the vertical dimension of the data to ensure the accuracy of the results. Combining the above two key factors, establish a corresponding multi-level fuzzy comprehensive evaluation scoring system. The evaluation is concluded that during the 30 years before and after the restoration of Saihanba, the ecological quality has improved. The environmental quality has increased by 37% year-on-year.

1. Introduction

The prosperity of ecology leads to the prosperity of civilization, and the decline of ecology can lead to the decline of civilization. China adheres to the concept that green waters and green mountains are golden mountains and silver mountains. Since the beginning of the farm, generations of people from Saihanba Mechanical Forest Farm have listened to the Communist Party of China's call and responded to China's call to work hard and dedicate themselves to the sandy desert land, turning the wasteland into a sea of forests. With the help of the Chinese government, China's Saihanba Forest Farm has recovered from the desert and has become an eco-friendly green farm with stable sand prevention functions. It interprets the concept that green waters and green mountains are golden mountains and silver mountains and casts the Saihanba spirit of keeping the mission, hard work, and green development in mind.

In this paper, it is selected appropriate indicators, collected relevant data, established an evaluation model of Saihanba's impact on the ecological environment, and quantitatively evaluated the impact of Saihanba on the environment after the restoration, that is, to compare and analyze the environmental conditions before and after the Saihanba restoration.

2. Problem Analysis

Quantitative evaluation of the environmental impact of Saihanba restoration is a fuzzy concept, and fuzzy comprehensive evaluation method is a comprehensive bid evaluation method based on fuzzy mathematics. The comprehensive evaluation method transforms qualitative evaluation into quantitative evaluation according to the membership degree theory of mathematics. Namely, the comprehensive evaluation method of fuzzy mathematics, namely, fuzzy mathematics, makes an overall evaluation of things or objects restricted by various factors. It has the characteristics of clear results and strong systematicness. It can solve fuzzy and difficult to quantify problems well and is suitable for solving uncertain problems. Therefore, a two-level fuzzy comprehensive evaluation model was selected to evaluate the impact on the ecological environment from the ecological status index and the environmental status index, and the model determined the evaluation score. Secondly, the evaluation results of the years before and after saihanba restoration (1987 and 2017) were compared, and the final conclusion was drawn.

3. Foundation of Model

1)The evaluation index system of ecological environment in Saihanba area was established by using a multi-level fuzzy comprehensive evaluation model, and the evaluation set of factor set was established based on the following influencing conditions:

Table1. Correlation Analysis Table

First-level indicator	The weight	Second-level indicator	The separation of weight
Ecological status index	0.6	Vegetation cover index	0.24
		Forest and grassland coverage	0.22
		Ambient temperature index	0. 10
		Water wetland area ratio	0.20
		Biological diversity	0. 14
		Desertification land area ratio	0. 10
Environmental status indicators	0.4	Discharge degree of main pollutants	0.45
		Emission compliance rate of pollution sources	0. 10
		Surface water quality	0. 10
		Water quality compliance rate	0. 15
		Air quality compliance rate	0. 15
		Water conservation index	0.05

2) The first level factor set of ecological environment status was established with the first level index as elements, and the second level factor set was established with 12 main environmental influence factors as elements. At the same time, the comment set first takes 0, 1, 2, 3 and finally assigns the comment set according to the average value of the interval 0-25, 25-50, 50-75, 75- 100. Moreover, the weights of the first and second-factor sets were determined through the ecological environment status evaluation criteria in the national environmental protection standards of the People's Republic of China, and finally established single factor evaluation matrix, the second level evaluation matrix is processed first. Then, the first level evaluation matrix is processed, and n elements are evaluated by a single factor, respectively.

3) Empowerment and comprehensive evaluation

After determining the weight, the single-factor comprehensive evaluation formula can be obtained by combining the above conditions with the formula:

$$Bi = Ai \cdot Ri(i = 1, 2, ..., k) \tag{1}$$

After normalization, according to the first-level factor set U and the first-level weight A, we can get the overall comprehensive evaluation:

$$B = A \cdot R \tag{2}$$

After normalization, the corresponding comprehensive membership degree vector is obtained according to the maximum membership degree.

4) Set the assignment score set and compare the results with weighted assignment scores.Set the corresponding assignment score set F = (f1, f2, ..., fn)to obtain the final score set of the evaluation object:

$$T = B \cdot F \tag{3}$$

4. Solution And Result

1) Determine the factor set and corresponding weight vector

• the first order factor set: U ={ U1 ,U2 } U1 = "Ecological status index"
U2 = "Environmental status indicators"
the first order weight set:A = [0.6, 0.4]
• the second order factor set: U1 ={ u1 ,u2 ,u3 ,u4 ,u5 ,u6 } u1 = "Vegetation cover index"
u2 = "Forest and grassland coverage"
u3 = "Ambient temperature index"
u4 = "Water wetland area ratio"
u5 = "Biological diversity"
u6 = "Desertification land area ratio"
the first order weight set:A1 = [0.24,0. 10,0.22,0.20,0. 14,0. 10]
• the second order factor set: U2 ={ u7 ,u8 ,u9 ,u10 ,u11 ,u12 } u7 = "Discharge degree of main pollutants"
u8 = "Emission compliance rate of pollution sources"
u9 = "Surface water quality"
u10 = "Water quality compliance rate"
u1 1 = "Air quality compliance rate"
u12 = "Water conservation index"
the first order weight set:A2 = [0.45,0. 10,0. 10,0. 15,0. 15,0.05]
2)Determine the comment set
• the first order comment set: V = [0, 1,2,3]
The ith comment set of the second order: Vi = [0, 1,2,3](i= 1,2)
3) Determine the membership function of each factor to the comment set. The membership function of "vegetation coverage rate" to each comment. Since sections represent vegetation coverage, it is suitable to use the trapezoidal membership function. We define "0", "1", "2" and "3" as satisfaction within the comment set interval, which can be obtained:
Membership function of "vegetation coverage rate" to "0" :

$$C_0(u_1) = \begin{cases} 1 & 0 \le u_1 < 25 \\ \frac{50-u_1}{50-25} & 25 \le u_1 < 50 \\ 0 & 50 \le u_1 < 100 \end{cases} \tag{4}$$

Membership function of "vegetation coverage rate" to "1" :

$$C_1(u_1) = \begin{cases} \frac{u_1-0}{25} & 0 \le u_1 < 25 \\ 1 & 25 \le u_1 < 50 \\ \frac{75-u_1}{75-50} & 50 \le u_1 < 75 \\ 0 & 75 \le u_1 < 100 \end{cases} \tag{5}$$

Membership function of "vegetation coverage rate" to "2" :

$$C_2(u_1) = \begin{cases} 0 & 0 \le u_1 < 25 \\ \frac{u_1-25}{50-25} & 25 \le u_1 < 50 \\ 1 & 50 \le u_1 < 75 \\ \frac{100-u_1}{100-75} & 75 \le u_1 < 100 \end{cases} \tag{6}$$

Membership function of "vegetation coverage rate" to "3" :

$$C_3(u_1) = \begin{cases} 0 & 0 \le u_1 \le 50 \\ \frac{u_1 - 50}{25 - 50} & 50 \le u_1 < 75 \\ 1 & 75 \le u_1 < 100 \end{cases} \tag{7}$$

The membership function of each UI for each comment is similar to solving the process of ui, which is omitted in this study.

4) Set the fuzzy evaluation matrix

Four evaluation matrices were calculated by substituting the ecological and environmental status indices in 1987 and 2017 into the corresponding membership functions.

Take the 1987 ecological status indicator U1 as an example:

- u1 = 0.571,it belongs to comment set "0","1","2","3" and its membership degree is:

r1=[C0(u1),C1(u1),C2(u1),C3(u1)] = [0,0.716,0.284, 1]

- u2 = 0.5504,it belongs to comment set "0","1","2","3" and its membership degree is:

r2=[C0(u2),C1(u2),C2(u2),C3(u2)] = [0,0.798, 1,0.202]

In the same way,ui(i=3,4,5,6),it belongs to comment set "0","1","2","3" and its membership degree is:

- ri =[C0(ui),C1(ui),C2(ui),C3(u2)] (i=3,4,5,6)
- r3 =[0.371, 1,0.629,0],r4 =[0.791, 1,0.209,0], r5 =[0.314, 1,0.686,0],r6 =[0,0.274, 1,0.726]

Thus, the fuzzy judgment matrix of the ecological status index in 1987 is obtained:

$$\bullet\ R_1 = \begin{bmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \\ r_6 \end{bmatrix} = \begin{bmatrix} 0 & 0.289 & 0.716 & 1 \\ 0 & 0.798 & 1 & 0.202 \\ 0.371 & 1 & 0.629 & 0 \\ 0.791 & 1 & 0.209 & 0 \\ 0.314 & 1 & 0.686 & 0 \\ 0 & 0.274 & 1 & 0.726 \end{bmatrix} \tag{8}$$

Similarly, three fuzzy judgment matrices R2, R3, and R4 of the environmental status index in 1987 and ecological status index and environmental status index in 2017 can be obtained, respectively.

$$\bullet\ R_2 = \begin{bmatrix} 0.08 & 1 & 0.92 & 0 \\ 1 & 0.997 & 0 & 0 \\ 0.737 & 0.263 & 0 & 0 \\ 1 & 0.993 & 0.027 & 0 \\ 0.027 & 0.993 & 0 & 0 \\ 0.738 & 0.262 & 0 & 0 \end{bmatrix}$$

$$\bullet\ R_3 = \begin{bmatrix} 0 & 0.136 & 1 & 0.864 \\ 0 & 0 & 0.89371 & \\ 0 & 0.892 & 1 & 0.108 \\ 0 & 0.789 & 1 & 0.211 \\ 0 & 0.525 & 1 & 0.475 \\ 0.625 & 1 & 0.375 & 0 \end{bmatrix} \mathrm{R}_4 = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 0.811 & 1 \\ 0 & 1 & 0.121 & 0.829 \\ 0.868 & 1 & 0.132 & 0 \\ 0.985 & 0.015 & 0 & 0 \\ 0 & 0 & 0.879 & 0.121 \end{bmatrix} \tag{9}$$

5) Fuzzy comprehensive evaluation

In order to take into account all factors, we use M(., +)operator (weighted average type) to calculate the total evaluation Bi = AiRi, and normalize B.

we can get the fuzzy comprehensive evaluation in 1987:

$$\begin{aligned} B_1 &= \mathrm{A}_1 \cdot R_1 = \begin{bmatrix} 0.14 & 0.37 & 0.32 & 0.17 \end{bmatrix} \\ \mathrm{B}_2 &= \mathrm{A}_2 \cdot R_2 = \begin{bmatrix} 0.24 & 0.52 & 0.24 & 0 \end{bmatrix} \end{aligned} \tag{10}$$

After normalization B1, B2, get B:

$$B = A \cdot R = \begin{bmatrix} 0.6 \\ 0.4 \end{bmatrix} \cdot \begin{bmatrix} 0.14 & 0.37 & 0.32 & 0.17 \\ 0.24 & 0.52 & 0.24 & 0 \end{bmatrix} = \begin{bmatrix} 0.18 & 0.43 & 0.288 & 0.102 \end{bmatrix} \quad (11)$$

Finally, the score K of Saihanba environmental quality assessment in 1987wascalculated by weighted average: K1=57.8

In the same way, based on determining R3 and R4 wecangetthescoreKof Saihanba environmental quality assessment in 1987 was calculated by weighted average: K2=79.7 By comparing K1 and K2, it is calculated by k-value that the ecological environment level of Saihanba before and after restoration increases by 37% year-on-year, showing significant changes.

5. Conclusion

Aiming at the fuzzy comprehensive evaluation model in Topic One, in terms of determining the weight, this article excavated the weights given in the authoritative national standard documents to ensure the objectivity of the results. In terms of data comparison, 24 items were selected Data comparison deepens the vertical dimension of the data and guarantees the accuracy of the results.

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