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Study on Index System of Saihanba Forest Farm Based on TOPSIS

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Abstract: *China has always adhered to the development concept that green water and green mountains are golden mountains and silver mountains. This paper focuses on the analysis and research of Saihanba Experimental Forest Farm. Using topsis approximate ideal solution evaluation model, the indexes such as altitude, air temperature, precipitation, total value of assets and water conservation are screened, and the following indicators are obtained: coverage area/10,000 mu, forest accumulation, water conservation, CO2 absorption, Q2 release. In recent years, through the continuous introduction of new policies to protect nature and control Saihan Dam, Saihan Dam has a greater and greater positive impact on the natural environment. Make a contribution to the natural ecological environment of the world.*

Keywords: *Saihanba Experimental Forest Farm; Index System; TOPSIS Model*

1. Introduction

When General Secretary Xi Jinping was the Zhejiang Provincial CPC Committee, when he inspected Anji in Huzhou, Zhejiang Province, he put forward that "We want not only green waters and green mountains, but also Jinshan and Yinshan." I would rather have green water and green mountains than Jinshan and Silver Mountains [1], and green waters and green mountains are Jinshan and Silver Mountains. " The scientific conclusion. Saihanba Mechanical Forest Farm in Hebei Province was established in 1962 with the approval of the former Ministry of Forestry. It is a large state-owned forest farm, national nature reserve and national forest park directly under the Forestry and grassland Bureau of Hebei Province. Saihanba was once a famous natural garden with rich water and plants and dense forests. In this paper, the temperature and precipitation data of 21 meteorological stations in Hebei Province are collected, and the variation characteristics of precipitation and temperature in Hebei Province in recent 56 years are analyzed by using KMel S and MF-DFA.

2. Data Preprocessing

Data preprocessing refers to the necessary processing such as review, screening and sorting before classifying or grouping the collected data. On the one hand, it is to improve the quality of data [2]. On the other hand, it is also a software or method to adapt to the data analysis.

2.1. Data Cleaning

For missing values, the identification and processing of missing values are considered; for outliers, including the identification of outliers and the processing of outliers. When dealing with outliers, we should first identify the possible causes of outliers, and then judge whether outliers should be chosen or not [3].

2.2. Data Integration

Data integration is to merge multiple data sources into one data store. If the analyzed data is original in one data store, data integration is no longer required.

2.3. Data Transformation

Data transformation is to transform it into an appropriate form to meet the needs of analysis theory.

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2.4. Data Reduction

Data reduction refers to finding the useful features of the data that depend on the discovery target on the basis of understanding the mining task and the content of the data itself, so as to reduce the data scale [4], so as to minimize the amount of data on the premise of maintaining the original appearance of the data as much as possible.

3. TOPSIS Model

(1) Firstly, the original data matrix is classified into indicator types (very large indicator, very small indicator, intermediate indicator and interval indicator).

(2) Carry out the index forward processing to obtain the forward matrix.

There are m objects to be evaluated in the first screening, and the matrix composed of N evaluation indexes (normalized) is represented by X.

$$X=\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & & x_{2m} \\ \vdots & & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \quad (1)$$

(3) Standardize the forward normalized matrix.

Note that the standardized matrix is Z, and each element in Z: $z_{ij}=x_{ij}\Big/\sqrt{\sum_{i=1}^{n}x_{ij}^2}$, the square of each element divided by the square sum of the elements in its column.

(4) Calculate score.

$$Z=\begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1m} \\ z_{21} & z_{22} & & z_{2m} \\ \vdots & & \ddots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nm} \end{bmatrix} \quad (2)$$

Define maximum: $Z^+=(Z_1^+,Z_2^+,\cdots,Z_m^+)$

$$=(\max\{z_{11},z_{21},\cdots,z_{n1}\},\max\{z_{12},z_{22},\cdots,z_{n2}\},\cdots,\max\{z_{1m},z_{2m},\cdots,z_{nm}\})$$

Define minimum: $Z^-=(Z_1^-,Z_2^-,\cdots,Z_m^-)$

$$=(\min\{z_{11},z_{21},\cdots,z_{n1}\},\min\{z_{12},z_{22},\cdots,z_{n2}\},\cdots,\min\{z_{1m},z_{2m},\cdots,z_{nm}\})$$

Define the distance between the first evaluation object and the maximum value:

$$D_i^+=\sqrt{\sum_{j=1}^{m}\left(z_j^+-z_{ij}\right)^2} \quad (3)$$

Define the distance between the first evaluation object and the minimum value:

$$D_i^-=\sqrt{\sum_{j=1}^{m}\left(z_j^--z_{ij}\right)^2} \quad (4)$$

Then, we can calculate the non normalized score of the evaluation object i(i= 1,2,…,n): $s_i=\frac{D_i^-}{D_i^++D_i^-}$

It is obvious that $0\le S_i\le 1$, and the bigger s_i is, the smaller D_i^+ is. That is, the closer it is to the maximum value.

(5) Normalized score: Divide each score by the sum of all scores.

(6) After scoring, the screening results are obtained: Forest coverage area and forest volume are the most influential indicators in.

(7) Positive transformation of other indicators:

a) Intermediate indicators ---- very large indicators.

$\{x_i\}$ is a group of intermediate index series, and the best value is x_{best}, then the forward formula is as

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follows:

$$M = \max\{|x_i - x_{best}|\} \quad (5)$$

$$\tilde{x_i} = 1 - \frac{|x_i - x_{best}|}{M} \quad (6)$$

b) Interval index ---- very large index.

$\{x_i\}$ is a group of intermediate index series, and the best interval is a and B, then the forward formula is as follows:

$$M = \max\{a - min\{x_i\}, max\{x_i\} - b\} \quad (7)$$

$$\tilde{x_i} = \begin{cases} 1 - \frac{a-x}{M} & x < a \\ 1 & a \le x \le b \\ 1 - \frac{x-b}{M} & x > b \end{cases} \quad (8)$$

After the establishment of three models, the forest coverage area, forest volume, average annual temperature, average annual precipitation, CO2 release and O2 absorption are selected as the final indicators for the next model establishment.

4. Fuzzy Comprehensive Evaluation

Fuzzy comprehensive evaluation model is a method to comprehensively evaluate the level of things from multiple factors by using the principle of fuzzy relationship.

4.1. Establish Comprehensive Evaluation Factors

Forest cover φ, Forest stock μ, Water conservation ω, CO2 absorption α And O2 release β The five indicators are determined as evaluation factors, and the component factor set u is recorded every ten years from 1962 to 2021.

4.2. Deterministic Factor Weight Vector

Determine the secondary index wind prevention and sand fixation capacity τ The weight vector of forest coverage area and forest volume of middle and third level indicators is:

$$t_1 = \{0.5, 0.5\} \quad (9)$$

Determine the natural contribution of secondary indicators γ The weight vector of CO2 absorption and O2 release is:

$$t_2 = \{0.5, 0.5\} \quad (10)$$

The weight vector of wind prevention and sand fixation capacity, water conservation and natural contribution in the primary index is determined as:

$$t_3 = \{0.3, 0.3, 0.4\} \quad (11)$$

4.3. Establish the Evaluation Set of Comprehensive Evaluation

The index data of each decade are used as the evaluation set of comprehensive evaluation:

$$V = \{v_1, v_2, \mathrm{L}, v_7\} \quad (12)$$

Table 1: List of comprehensive evaluation indicators

Year	Covered area/ 10000 mu	Forest volume/ 10000 m3	Water conservation volume/ 100 million m3	Carbon dioxide absorption/ 10000 tons	Oxygen release/ 10000 tons
1962	19.00	33.00	0.09	2.74	1.90
1972	48.43	54.57	0.15	4.53	3.15
1982	69.80	115.06	0.26	9.55	6.64
1992	84.62	297.08	0.40	24.65	17.15
2002	99.00	683.60	0.64	56.72	39.45
2012	103.30	935.40	1.07	77.62	53.99
2021	115.10	1036.80	2.84	86.03	59.84

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4.4. The Single Factor Fuzzy Evaluation Is Carried out to Obtain the Evaluation Matrix

Using the queried data, each factor is evaluated and expressed by membership function [5]:

1) The membership function of forest coverage area is:

$$D_1\ (x_1)=\begin{cases}0 & x_1\le 19\\ \dfrac{x_1-19}{115.1-19} & 19\le x_1\le 115.1\\ 1 & x_1\ge 115.1\end{cases} \quad (13)$$

2) The membership function of forest volume is:

$$D_2\ (x_2)=\begin{cases}0 & x_2\le 33\\ \dfrac{x_2-33}{1036.8-33} & 33\le x_2\le 1036.8\\ 1 & x_2\ge 1036.8\end{cases} \quad (14)$$

3) The membership function of water conservation is:

$$D_3\ (x_3)=\begin{cases}0 & x_3\le 0.09\\ \dfrac{x_3-0.09}{2.84-0.09} & 0.09\le x_3\le 2.84\\ 1 & x_3\ge 2.84\end{cases} \quad (15)$$

4) The membership function of carbon dioxide absorption is:

$$D_4\ (x_4)=\begin{cases}0 & x_4\le 2.74\\ \dfrac{x_4-2.74}{86.03-2.74} & 2.74\le x_4\le 86.03\\ 1 & x_4\ge 86.03\end{cases} \quad (16)$$

5) The membership function of oxygen release is:

$$D_5\ (x_5)=\begin{cases}0 & x_5\le 1.9\\ \dfrac{x_5-1.9}{59.84-1.9} & 1.9\le x_5\le 59.84\\ 1 & x_5\ge 59.84\end{cases} \quad (17)$$

According to the membership function, the evaluation matrix of the three-level indicators can be obtained: the evaluation matrix of the three-level indicators in the wind prevention and sand fixation capacity of the second-level indicator is determined as:

$$R_1=\begin{bmatrix}0 & 0.3062 & 0.5286 & 0.6828 & 0.8324 & 0.8772 & 1\\ 0 & 0.0214 & 0.0817 & 0.2631 & 0.6481 & 0.8990 & 1\end{bmatrix} \quad (18)$$

The evaluation matrix of CO2 absorption and O2 release of the third level index in the natural contribution of the second level index is determined as:

$$R_2=\begin{bmatrix}0.0005 & 0.0220 & 0.0822 & 0.2635 & 0.6486 & 0.8994 & 1\\ 0 & 0.0215 & 0.0818 & 0.2631 & 0.6481 & 0.8989 & 1\end{bmatrix} \quad (19)$$

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4.5. Establish a Comprehensive Evaluation Model

After determining the weight and evaluation matrix: B=toR

B is normalized to obtain the corresponding evaluation index:

$$B_1 = [0 \quad 0.3062 \quad 0.5000 \quad 0.5000 \quad 0.5000 \quad 0.5000 \quad 0.5000] \quad (20)$$

$$B_2 = [0.0004 \quad 0.0219 \quad 0.0822 \quad 0.2635 \quad 0.5000 \quad 0.5000 \quad 0.5000] \quad (21)$$

4.6. Determine Total Index

Through the single factor fuzzy evaluation, and then repeat the above steps, the total average index of the primary index is:

$$B = [0.0004 \quad 0.3012 \quad 0.3500 \quad 0.3940 \quad 0.4153 \quad 0.4400 \quad 0.4860] \quad (22)$$

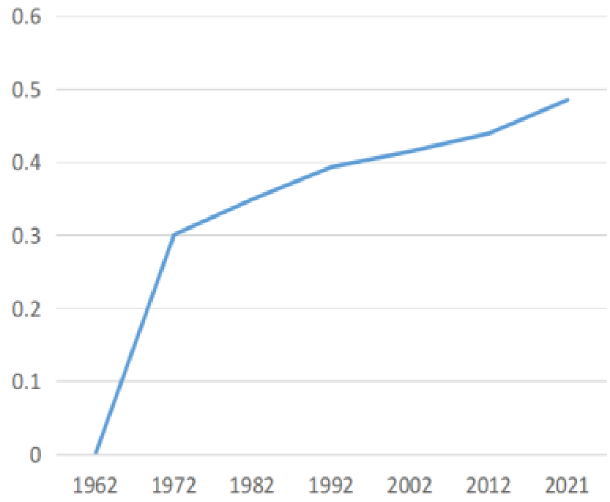

Figure 1: Evaluation index result

According to the total evaluation index, the line chart is drawn with the year as the Abscissa and the total evaluation index as the ordinate. As a result, it can be seen that with the passage of time, the impact of Saihanba on the ecological environment is increasing, and the positive impact on the ecological environment is increasing.

5. Conclusion

In this paper, around the Saihanba Experimental Forest Farm, we first use the TOPSIS evaluation model to build the relevant index system, and then use the fuzzy analysis model to calculate the total evaluation index from 1962 to 2021 shows an upward trend.

References

[1] Guo Zhiqi, Wang Xiuru. Analysis on the variation characteristics of precipitation in Hebei Province in the past 50 years [J]. South-to-North Water transfer and Water Conservancy Science and Technology, 2012 focus v. 10 position No. 60 (03): 67-72.

[2] Ma Fenglian, Wang Hong, Song Xijun. Influence of urbanization on air temperature and air humidity in Chengde City [J]. Journal of Hebei normal University (Natural Science Edition), No. 125 (03): 393-399.

[3] Ma Fenglian, Sun Qingchuan, Cai Lina, Shi Xianyue, Liu Zhifang. Analysis of the possible influence of urbanization on precipitation change in Chengde City [J]. Journal of Sichuan normal University (Natural Science Edition), 2010 Ji 33 (02): 251-256.

[4] Acquisition and compilation Department, Liu Yuan.2016 National grassland Monitoring report [J]. China Animal Husbandry, 2017 No. 479 (08): 18-35.

ISSN 2616-5767 Vol.5, Issue 2: 24-29, DOI: 10.25236/AJETS.2022.050205

[5] Liu Jiyuan, Shao Quanqin, Fan Jiangwen, Deng Xiangzheng. Discussion on the path of ecological protection construction in western China [J]. Population, Resources and Environment of China, 2013, No. 158 (10): 38-43.