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Research on the Influence of Saihanba on the Ability of Resisting Wind and Sand in Beijing based on the Entropy Weight-TOPSIS Evaluation Model

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Abstract

Based on the entropy weight-TOPSIS comprehensive evaluation model, a model was established for the ability of Saihanba to resist wind and sand after the environmental restoration of Saihanba. Sandstorms affect Beijing's air quality. This question was mainly based on the study of Beijing's air quality. Impact. The six indicators of SO2, CO2, PM2.5, PM10, NO2, and AQI were selected to establish a comprehensive evaluation model, and the weight of the six indicators was calculated by the entropy weight method, and then the air quality of Beijing in the past 20 years was scored by TOPSIS. According to calculations, the overall trend of Beijing's air quality scores was showing an upward trend, indicating that as the environmental conditions in the Saihanba area gradually recover, Beijing's ability to resist sand and dust storms was gradually improving.

Keywords

Entropy Method, TOPSIS Method, Environmental Governance Effect.

1. Introduction

With the help of the government, China's Saihanba Forest Farm has changed from a desert to an environmentally friendly and green farm with sand prevention functions. [1]The forest coverage rate in Saihanba area has reached 80%. Each year, it provides 137 million cubic meters of clean water to Beijing and Tianjin, absorbs 747,000 tons of carbon, and releases 545,000 tons of oxygen. After more than half a century of hard work, the world's largest artificial forest was built on the land of Saihanba. A green ocean is created on the plateau wasteland 400 kilometers north of Beijing. The restoration of Saihanba Forest Farm played an important role in Beijing's resistance to sandstorms.

2. Model Establishment

2.1 Factors Affecting Air Quality

Table 1. Factors affecting air quality

(SO_2)1	(CO)1	(NO_2)1	(O_3)1	(O_3)8	(PM2.5)24	(PM10)24

Indicator: For example (O3) 8, which represents the average concentration of O3 in eight hours.

Index unit:µg/m3.

2.2 The Impact of Sandstorms on Air Pollutants in Beijing [2] and the Selection of Indicators

Sandstorms usually cause a serious decline in air quality in a certain area, but the changes in air quality indicators vary in different regions.

SO2: Compared with southern cities, northern cities have built many heavy industrial enterprises, and the concentration of SO2 in the air is generally higher. When sandstorms come, they are often accompanied by strong winds, which play a role in purifying and spreading.

CO,NO2,O3: These gases are mainly produced by automobile exhaust, fuel combustion, ultraviolet radiation and so on. Therefore, regardless of the north and south cities, when the sandstorm hits, the accompanying high wind will purify and spread it, and the concentration in the air will be reduced accordingly.

PM2.5,PM10: When a sandstorm passes through the border, the rolled up dust, windy sand, etc. will cause the concentration of the two to increase rapidly and continue for a certain period of time, causing the air quality to drop rapidly.

In summary, Beijing is a northern city and is close to Saihanba. The impact of sandstorms on the air is mainly the increase of PM2.5 and PM10 and the decrease of SO2, CO, NO2, and O3.

2.3 Data Preprocessing

Collect the original json-type data of Beijing's daily air quality from 2013/12/2 to 2018/8/24, through data preprocessing, convert multiple json files into csv data files, and merge them. By analyzing the data characteristics and adopting the built-in datetime method, the date in the data is split according to year, month, and day. Finally, the data is compressed, and the daily data is averaged and combined into monthly data to obtain the monthly air quality historical data of Beijing from 2013 to 2018, which will help establish the effect of Saihanba on Beijing's sand resistance. The evaluation model provides data to provide data support.

2.4 TOPSIS Method Model Establishment and Solution

This question requires evaluation of the impact of Saihanba on Beijing's ability to resist sand and dust storms. Sand and dust storms mainly affect Beijing's air quality. In the selection of indicators, in addition to the above six indicators, the AQI (Air Quality Index) should also be added to this question. Evaluate the impact of Saihanba on the ability of Beijing to resist sandstorms.

In order to better use the original data and ensure the rationality of the weight distribution of the selected indicators, construct a more scientific and objective data model. In this article, in addition to the entropy weight method to obtain the weight of the data, the TOPSIS evaluation method is also used. Selecting 56 months of data, a comprehensive evaluation method of entropy weight TOPSIS is established. The specific process is as follows:

Use the entropy method to calculate the weight of the selected seven indicators:

$$\omega_1=[0.0756\ 0.1157\ 0.1447\ 0.2609\ 0.1776\ 0.0854\ 0.1401]$$

The TOPSIS method is also called the ideal solution method. It constructs the ideal solution and the negative ideal solution of the multi-attribute problem, and uses the two benchmarks of close to the ideal solution and the principle negative ideal solution as a sentence for evaluating each feasible solution. [3-6], The method steps are as follows:

(1) Positive indicator attributes, the so-called positive, is to agree to transform all indicator types into extremely large indicators. Among the indicators selected for this question, the impact of sandstorms will increase PM2.5 and PM10, and the smaller the two indicators in air quality, the better, so these two indicators are extremely small indicators. Sand and dust storms will reduce the content of SO2, CO, and NO2 in the air, so the larger the content, the smaller the impact of the dust storm, so these three indicators are extremely large indicators. AQI is an air quality index. According to national

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regulations, an AQI index between 0-50 is good, so AQI is an interval index. The formula for converting into a very large index is as follows:

Extremely small→Extremely large:

$$x = max - x \tag{1}$$

Interval type→Extremely large:

Suppose x_i is an interval index, and its optimal interval is [a,b], then the normalization formula is:

$$M = max\{a - min\{x_i\}, max\{x_i\} - b\}, \widetilde{x_\iota} = \begin{cases} 1 - \frac{a - x}{M}, x < a \\ 1 \quad , a \le x \le b \\ 1 - \frac{x - b}{M}, x > b \end{cases} \tag{2}$$

(2) Construct a weighted normalization matrix, and normalize the attributes (that is, each column element is divided by the norm of the current column vector):

$$Q = (q_{ij})_{m\times n} = ({x'}_{Iij} \times \omega_j)_{m\times n} \tag{3}$$

Get the normalized matrix after normalization:

$$Q = (q_{ij})_{m\times n} = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1m} \\ z_{21} & z_{22} & & z_{2m} \\ \vdots & & \ddots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nm} \end{bmatrix}_{m\times n} \tag{4}$$

(3) Determine the best plan and the worst plan:

$$q_j^+ = max\left(q_{1j}, q_{2j}, \cdots, q_{mj}\right)$$

$$q_j^- = max\left(q_{1j}, q_{2j}, \cdots, q_{mj}\right) \tag{5}$$

(4) Calculate each evaluation object and the best plan and the worst plan:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (q_{ij} - q_j^+)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (q_{ij} - q_j^+)^2} \tag{6}$$

(5) Calculate the closeness C of each evaluation object to the optimal solution: C:

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$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \tag{7}$$

Among them, $C_i \in [0,1]$, the larger the C_i, the better the solution.

(6) Sort according to the size of C and give the evaluation result. (See Appendix 2 for details).

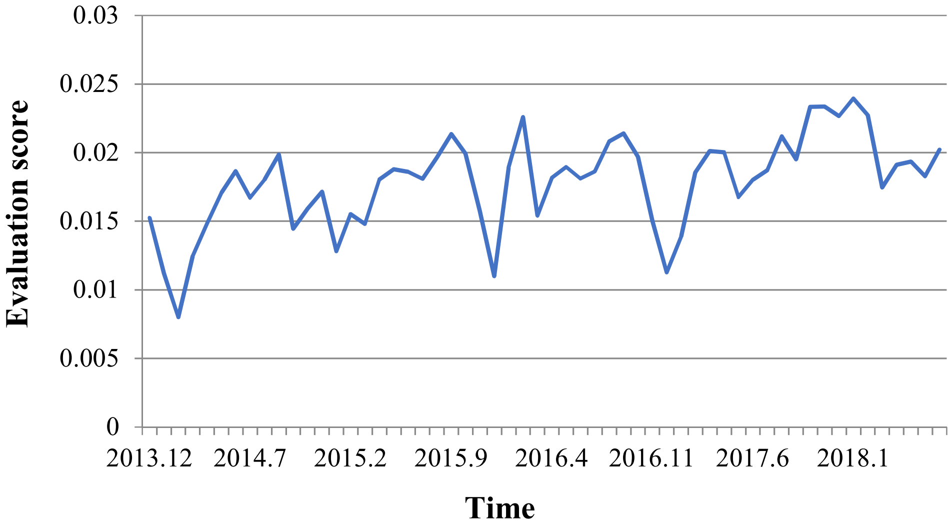

Figure 1. Comprehensive evaluation score

3. Conclusion

It can be concluded from the data that the score results are fluctuating, but the overall trend is increasing, indicating that with the gradual recovery of Saihanba's environmental conditions, Beijing's ability to resist sand and dust storms is gradually improving.

References

[1] Liu Yi. Carry forward the spirit of Saihanba and promote the construction of ecological civilization[N]. People's Daily,2021-11-16(006).

[2] Wang Jianjun, Chen Liqi, Zhang Yuanhui, Yang Xulin, Sun Xia, Li Wei, Zhan Jianqiong, Xu Guojie. The impact of a sandstorm event in 2008 on the content of SO_2 and other pollutants in the atmosphere of Xiamen Island[J]. Taiwan Strait, 2010, 29(03):297-303.

[3] Zeng Yangyan, Deng Jilin, Zhang Qihui. Regional road safety evaluation method based on entropy weight TOPSIS[J]. Computer Knowledge and Technology, 2021, 17(20): 5-8. DOI: 10.14004/j. cnki.ckt . 2021.1950.

[4] Yang Jin,Wang Zhongwei,Pang Yan.Evaluation of Camellia Industry Development Performance Based on Entropy TOPSIS Method[J/OL].Journal of Central South University of Forestry and Technology, 2021(12):168-177[2021-12-04].

[5] Yu Yunlong,Zhang Yong,Zhang Xiaoming,Huang Dongdong.Priority decision analysis of automobile APEAL factors based on TOPSIS method[J].Automotive Practical Technology, 2021,46(22): 193-195+ 199.

[6] Cao Xianzhong, Zeng Gang. Research on the Selection of Industrial Transformation and Upgrading Models in Economic and Technological Development Zones Based on Entropy TOPSIS Method--Taking Wuhu City as an Example[J].Economic Geography,2014,34(04):13-18.